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Dynamics of participation in utilization of local value chain services: assessing barriers and enablers in Uganda

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ABSTRACT

Integrating smallholders into agri-food value chains has become a widely endorsed strategy for transforming food systems and reducing poverty in agrarian communities. However, value chain development initiatives are increasingly criticized for their lack of inclusiveness—benefits tend to accrue to resource-rich households, while marginalized communities are often left behind, exacerbating social inequality. There is no clear consensus on the factors driving disparities in participation and utilization of value chain services. Using panel data from soybean smallholders in Uganda, we trace the evolution of participation in value chain service use. We employ a multinomial logit model to (a) identify the drivers and barriers to participation in value chain (VC) service utilization and (b) examine the determinants of variation in service uptake—specifically, the types and number of services used. While the Multinomial Logit Model is also used to analyse variation in service types, a Two-Part Model is applied to assess participation intensity. Our findings show that barriers such as insecure land tenure, limited education, poor access to credit, and distance from service points hinder inclusive participation. Value chain service delivery appears to operate as a mechanism for selecting more viable participants, suggesting that value chain service providers might be adopting risk-averse strategies that (whether intentionally or unintentionally) can exclude resource-poor households from accessing services. Moreover, exclusion tends to persist even after initial participation in farm-level training, limiting subsequent engagement with input and output market services. We discuss the implications of these findings for fostering more inclusive and resilient food systems.

PUBLIC INTEREST STATEMENT

Smallholder farmers in Uganda are essential to food security and rural livelihoods, yet many struggle to access services that could increase their productivity and income. This study investigates why some farmers succeed in participating in farm-level training, input markets, and output markets offered by small and medium agribusiness enterprises, while others are excluded. We identify key barriers–such as limited education, insecure land rights, restricted credit access, and distance from service points–as well as enabling factors like mobile phone access. The findings offer practical insights for policymakers, development organizations, and businesses aiming to make agriculture more inclusive and resilient. By understanding what helps or hinders farmers, we can design better support systems that reach those most in need, promoting fairer and more sustainable food systems in Uganda and beyond.

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1. Introduction

Agri-food value chains (AVCs) have emerged as critical frameworks for transforming agricultural systems and linking smallholder farmers to input and output markets (Barrett et al., 2022; Reardon et al., 2021).

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In these AVCs, actors are coordinated to enhance efficiency, productivity, and market access (De Janvry et al., 2019; Devaux et al., 2018). These integration mechanisms can facilitate access to value chain services including financial products, business training, and improved agricultural inputs, ultimately aiming to improve food system's productivity, household incomes, and resilience to climate change (Devaux et al., 2018).

Indeed, AVCs have become a cornerstone of development strategies across sub-Saharan Africa, including Uganda, where the integration of farmers into value chains is promoted as a pathway to alleviate poverty and improve food security (Allen & Heinrigs, 2016). Particular emphasis has been placed on inclusive and climate-smart value chain services to drive agricultural innovation and sustainability (Tadesse et al., 2021).

However, the impacts of AVC integration are far from uniform. Empirical findings report mixed outcomes, especially for export-oriented global value chains (GVCs), which have been criticized for their limited inclusivity (German et al., 2020; Martiniello & Azambuja, 2019; Van Dijk & Trienekens, 2012). These initiatives often disproportionately benefit relatively resource-rich farm households while excluding marginalized farmers, thereby exacerbating inequality and limiting the developmental reach of value chain programs (German et al., 2020; van Dijk & Trienekens, 2012). As a result, there has been a growing policy shift toward strengthening local and regional AVCs, where small- and medium-sized agribusiness enterprises (SMAEs) (often referred as SMEs) are positioned as key intermediaries for inclusive food system transformation (Amador & Cabral, 2016; Herrmann et al., 2018).

Despite this policy shift, concerns remain. Literature highlights that VC integration does not consistently lead to positive outcomes for the poorest and marginalized (Devaux et al., 2018; Francesconi & Wouterse, 2015; Orr et al., 2018; Ros-Tonen et al., 2019). For instance, partnerships between farmers and SMAEs have been critiqued for reinforcing structural inequalities by prioritizing better-off producers or excluding those with fewer assets and lower market orientation (Bassett et al., 2018; Crane et al., 2014), or they may voluntarily disengage due to perceived risks or limited benefits (Ros-Tonen et al., 2019). Women, in particular, face systemic constraints to participation due to gender inequalities inscribed in informal institutions and rooted in social norms and attitudes (Ruben et al., 2006).

Further complicating the picture, participation in VC service use varies over time and by farmer profile. Some farmers respond quickly to integration initiatives, while others delay participation or drop out and rejoin later, consistent with the technology adoption lifecycle (Rogers, 1983). These patterns are influenced by wealth, knowledge, risk attitudes, or even temporal changes in crop decisions due to factors like rotation or previous market disappointments (Chamberlain & Anseeuw, 2017; Dedehayir et al., 2017; Vicol et al., 2018).

In addition to demand-side factors, the design and supply of VC services play an important role in shaping uptake. Bundled services may exhibit variations in utilization that reflect underlying barriers or enabling factors influencing uptake. Alternatively, VC service providers could possibly prioritize 'loyal' farmers or locations with higher perceived returns (Vučković, 2014; Ward et al., 2018).

In addition, policy interventions aimed at improving access to value chain services and associated outcomes often target either supply-side or demand-side barriers, but rarely both. This narrow focus can lead to suboptimal outcomes if key constraints–such as affordability, contract uncertainty on the demand-side, and limited value chain service availability on the supply-side–are not addressed simultaneously. For example, farmers may hesitate to utilize value chain services if they perceive unfavourable contract terms, uncertain payments, or a loss of bargaining power in thin markets. In such cases, addressing only supply-side factors while overlooking behavioural factors such as trust, risk preferences, and time preferences may fail to generate the desired levels of participation and associated development outcomes (Adekunle et al., 2016; Chavas & Nauges, 2020; Takahashi et al., 2019).

While previous research has primarily focused on causal links between VC participation and performance outcomes, such as productivity and income, less attention has been paid to heterogeneity in service uptake. Understanding what drives variability in participation–both across farmers and services–can give deeper understanding into the effectiveness and inclusiveness of VC initiatives. In particular, there is limited empirical evidence explaining why some farmers participate fully or regularly in VC service utilization while others participate selectively, sporadically, or not at all (Orr et al., 2018; Vellema, 2015). Moreover, studies often treat VC participation as a binary variable–either farmers participate or they do not –without

delving into the gradations and dynamic nature of service use. This limits the ability to design interventions that are truly inclusive and responsive to the realities of smallholder farming systems.

This paper aims to examine the nature and extent of smallholder participation in VC service use and to identify the key drivers and barriers influencing that participation. What motivates or hinders the participation of farmers in value chain service use? Among participating households, what explains differences in the uptake of value chain services? To answer these questions, we analyze panel data from a survey of 2,533 smallholder farmers in Uganda conducted in 2020 and 2021.

The rest of the paper is organized as follows. Section two provides the background and context of this study. Section three outlines the analytical framework and testable hypotheses. Section four describes the methodology used in the study. Section five presents and discusses the empirical findings, while section six concludes with implications and recommendations.

2. Background and setting

This study took place within the SNV-led 'Climate Resilient Agribusiness for Tomorrow (CRAFT)' project in Uganda, Kenya and Tanzania within the context of inclusive food systems.[1] The project offered technical and financial support to SMAEs engaging organized smallholder farmers in the production of different crops such as soybean, sesame, sunflower and potatoes. Our study focuses on the soybean value chain that was supported and implemented through three Ugandan SMAEs: ACILA Enterprises, ALITO Joint, and OKEBA in eastern, northern, and central/western regions, respectively. Soybean is an important crop in Uganda as it is widely used in food and nutrition supplements to address nutrition deficiencies among children and adults, as well as in the formulation of animal feed. Soybean has also been identified as one of the key crops to be developed and supported by the government for export (The Government of Uganda, 2020). in response to the increasing demand for plant-based meat and dairy products (Geijer & Gammoudy, 2020; Mika, 2019; Tonheim et al., 2022). The objective of SNV's support to the SMAEs was to improve farmers' access to the SMAEs value chain and its benefits.[2]

To integrate smallholder farmers into the soybean value chain, the SMAEs relied on two types of services:

i. Farm-level training (FLT) was provided through two channels. First, training in climate-smart agricultural (CSA) practices and technologies was delivered by the SMAEs' extension officers through training workshops at centralized locations. Second, agricultural extension and advisory services were delivered by volunteer trainer of trainees (ToTs) through farmer field schools established within communities where farmers reside.[3]
ii. Verbal or written production and marketing contracts were offered to FLT participants to facilitate access to the SMAEs' input market services (IMS) and output market services (OMS). The IMS entails bio-fertilizer (rhizobia inoculants) and climate-resilient soybean seed; these inputs are collectively purchased by farmers and delivered by the SMAEs through village-agents. Similarly, OMS involves village agents aggregation and verification of quantities and quality of farmers' supplies before effecting payments.

To encourage participation, the SMAEs provided premium seeds, ensure timely input delivery, offered access to scarce biofertilizers, and guaranteed market access for farmers' produce. Due to capacity constraints, service delivery was phased over four cropping seasons, with volunteer trainers supporting outreach and promoting the adoption of climate-resilient practices.

3. Analytical framework

This study adopts an analytical framework grounded in three complementary theories–Resource Dependence Theory (Pfeffer & Salancik, 1979), Transaction Cost Economics (Williamson, 1979), and Agency Theory (Eisenhardt, 1989)–as synthesized by Chamberlain & Anseeuw (2017). This framework helps to conceptualize the complex interactions between smallholder farmers and the SMAEs that shape participation in VC service utilization. The three theories present a hierarchy of decisions, narrowing down from partnership formation to contractual details, and are linked by two cross-cutting themes: uncertainty and power imbalance.

Resource Dependency Theory focuses on how SMAEs and farmers manage mutual dependencies (Pfeffer & Salancik, 1979). SMAEs use relational contracts and services as instruments to secure a stable supply of soybean and accommodate these dependencies (Chamberlain & Anseeuw, 2017). However, to mitigate risk, the SMAEs often prioritize farmers with adequate land and capability, which can lead to the initial exclusion of resource-poor or geographically distant farmers (Chamberlain & Anseeuw, 2017). These excluded farmers may only be included later as SMAE operations expand or to replace those who opt out.

Transaction Cost Economics explains how SMAEs design governance structures to reduce the costs associated with transactions (Williamson, 1985). They employ intermediaries like village agents and volunteer trainers to streamline input delivery, collective bulking, and contract enforcement to minimize risks such as side-selling. However, selection criteria based on landholding, investment capacity, and ex-ante assessment of trustworthiness can exclude farmers deemed risky or unprofitable, limiting the inclusiveness of VC services.

Agency Theory frames the relationship as a principal (SMAE)-agent (farmer) problem, characterized by goal conflicts and information asymmetry (Eisenhardt, 1989). To overcome outcome uncertainty and risks like moral hazard or adverse selection (Chamberlain & Anseeuw, 2017), SMAEs impose specific contractual conditions. These safeguards, such as requiring participation in farm-level training, can act as a first form of exclusion for farmers only interested in inputs like seed (Chamberlain & Anseeuw, 2017). Conversely, farmers often lack safeguards against opportunistic behaviours from SMAEs, such as delayed payments or input deliveries, further discouraging participation (Ménard & Vellema, 2020).

Finally, contextual factors such as poor road infrastructure, distance to markets, and community characteristics further influence smallholders' access to VC services, often compounding the exclusionary effects of the theoretical mechanisms described above. By integrating these three theories, the framework provides a robust structure for analysing drivers and barriers to smallholder participation in the soybean value chain.

4. Methodology

4.1. Data

We use panel data that includes a baseline survey conducted between June and September 2020, and a follow-up survey for the same period one year later.[4] The surveys were canvassed in the eastern, northern, and central/western regions of Uganda, where the SMAEs are active. At baseline, a total of 2,533 households from 318 farmer groups were covered, and we were able to revisit 2,398 households one year later, resulting in an attrition rate of 5.3%. The sample involves both growers and non-growers of soybean, where non-growers comprised mostly farmers that waited to be enrolled into CRAFT in the second year.

For both surveys, the same household questionnaire was used, comprising multiple modules. Specifically, the questionnaire included a module on individual and household characteristics; a detailed section on farm households' participation in SMAE-organized training workshops and farmer field schools—collectively referred to as farm-level training (FLT) services; information on the gender of participants; and data on the distance to learning sites, travel time, and duration spent at those sites.

Additionally, the questionnaire included modules on access to inputs and technologies provided by SMAEs, such as climate-resilient seeds, rhizobia inoculants and related services—categorized as input market services (IMS). It also captured whether SMAEs purchased soybeans from farmers, either under a contract or through informal arrangements, referred to as output market services (OMS). The questionnaire also included multiple questions used to measure trust for the SMAEs.[5] Lastly, the questionnaire covered regional and community-level characteristics and measures.

At endline, we elicited farmers' risk and time preferences through incentivized games.[6] Risk games were implemented using Holt-Laury lottery-choice experiment as described in Ihli et al. (2016). In the time preference games, farmers were asked to choose between a lower amount that could be paid in

two days and a higher amount that could be paid after 14 days, mimicking early and late purchases/payment, respectively (Casaburi & Willis, 2018).

We have three dependent variables of interest: participation in VC service use, bundles of services utilized (FLT, IMS/OMS, and FLT+IMS/OMS), and the intensity of VC service use. We distinguish farm-households that used only FLT services, only IMS/OMS, and those that used both.[7] Figure 1 maps the use of VC services for our sample in both years, where we can classify the respondents into 4 groups: (i) *Non-participants*—farmers that never participated in use of any of the SMAEs services at baseline or follow up periods, (ii) *New participants*—households that didn't utilize any of the SMAEs services at baseline but did use at least one of these services one year later, (iii) *Regular participants*—farmers that utilized at least one of the SMAEs services at both the baseline and follow up periods, and (iv) *Irregular participants*—households that utilized at least one of the SMAEs services at only baseline.

The selection of the independent variables follows from the background and analytical framework described in sections 3. The variables are categorized into individual/household, behavioural, regional/community and value-chain characteristics. The definitions and measurement of these variables are presented in Appendix A3.

4.2. Empirical strategy

4.2.1. Participation in VC service use

We use a Multinomial Logit Model (MNLM), as specified in Eq. (1), to analyze the factors motivating or hindering smallholder participation in VC service utilization (our first research question). This MNLM is the most suitable empirical strategy given that the dependent variable—participation category–is a multi-categorical and unordered measure.

$$\Pr(y_i = j) = \frac{\exp(x_i'\beta_j)}{\sum_{m=0}^{M}\exp(x_i'\beta_m)} \quad \text{for } j = 0,1,\ldots,M \tag{1}$$

where y_i reflects the unordered categorical outcome variable (participation in VC service utilization), x_i' is a set of explanatory variables and β_j contains the parameters for participation regime j. In this case, $M = 4$ (regular, new, irregular or non-participants).

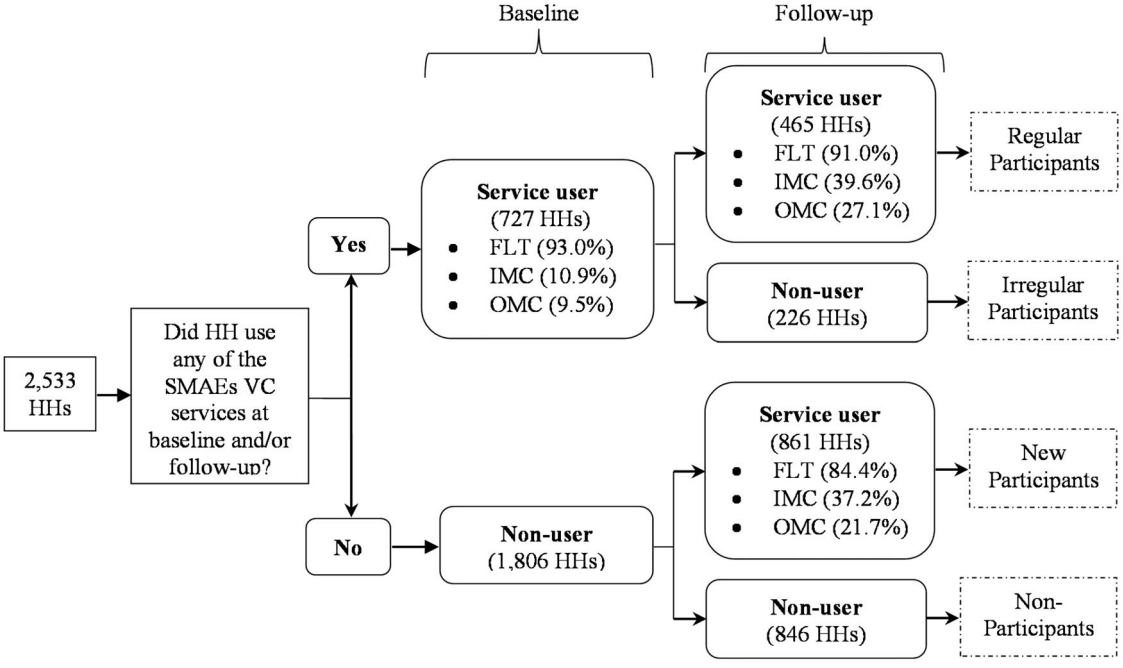


Figure 1. Categorization of participation in VC service use.

4.2.2. Determinants of differential uptake of value chain services

We employ two distinct methods—a MNLM and a Two-Part Model—to address the second research question: among participating households, what explains the differences in the uptake of value chain (VC) services? We use an MNLM, similar to that specified in Eq. (1), where the dependent variable—use of different VC services—comprises multiple discrete and unordered outcomes. Specifically, service use is categorized into three alternatives (M = 3): (i) FLT + IMS/OMS, (ii) only IMS/OMS, or (iii) only FLT.

To examine the determinants of participation intensity, we use a Two-Part Model. Participation intensity is defined as the number of VC services used by a household at either the baseline or follow-up survey, taking discrete values from 1 to 3, corresponding to the three available VC services (FLT, IMS, and OMS). In our sample, approximately one-third of households did not use any service, while 36.8, 10.2, and 8.3% used one, two, or all three services, respectively. The decision not to participate may be driven by different factors than those influencing the intensity of service use among participants. Therefore, imposing a linear specification could lead to biased estimates. The Two-Part Model allows us to disentangle these two processes by estimating them separately, thus accommodating potentially distinct sets of determinants (Farewell et al., 2017). A key advantage of this approach is that it does not require assumptions about the correlation between the error terms of the binary and continuous components, and treats zero values as true non-participation.

The two-part model defines a likelihood function that includes both the zero and non-zero decisions for each observation (Buntin & Zaslavsky, 2004; Leung & Yu, 1996; Liu et al., 2019). First, we define the binary decision by farm-households whether to use VC services as a logit:

$$\Pr\left(y_i > 0 \mid x_i\right) = F\left(x_i'\omega\right) \tag{2}$$

where x_i is again a vector of explanatory variables for farm-household i, ω is a vector of parameters, and F is the cumulative distribution function. Second, the non-zero decisions are defined as the expected number of VC services used conditional on using at least one service:

$$E\left(y_i \mid y_i \rangle 0, x_i\right) = g\left(x_i'\beta\right) \tag{3}$$

where g is a normal density function. Both decisions are then combined in the likelihood contribution for each observation:

$$L_i = \left[1 - F\left(x_i'\omega\right)\right]^{Z(y_i=0)} \times \left[F\left(x_i'\omega\right)g\left(x_i'\beta\right)\right]^{Z(y_i>0)} \tag{4}$$

where Z is an indicator function.

Because we pool all the baseline and follow-up data together, our estimation does not include utilization of FLT, IMS and OMS at baseline as covariates as well as other endogenous variables such as competition and expert visits (defined in Appendix A3). The methodology used in this study is summarized in Figure 2.

5. Results and discussion

This section presents and discusses the empirical findings, structured to align with the analytical framework and empirical strategy outlined in sections 3 and 4. We first present descriptive results on participation patterns, followed by the econometric results addressing our two main research questions.

5.1. Descriptive results

Table 1 shows use rates of only FLT services, only IMS/OMS and combined FLT + IMS/OMS across participants in the balanced panel. Of the 1,707 non-participators at baseline, we differentiate those that never participate (49.6%) from others that started participating at follow-up (50.4%, see row 1). New participation represents 36% of the entire sample, compared to 29% baseline participants. Participation in VC service use almost doubled at follow-up (55%), although participants utilized different services. About two thirds of

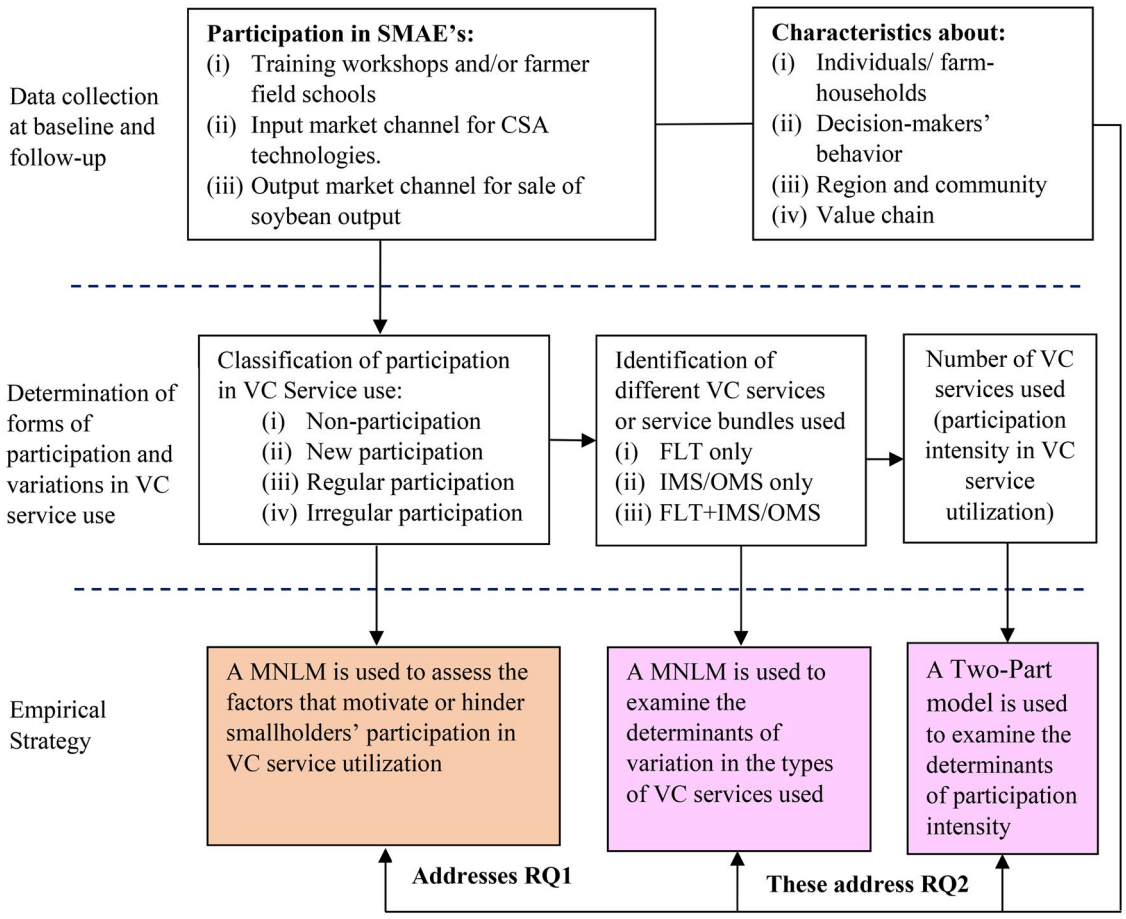


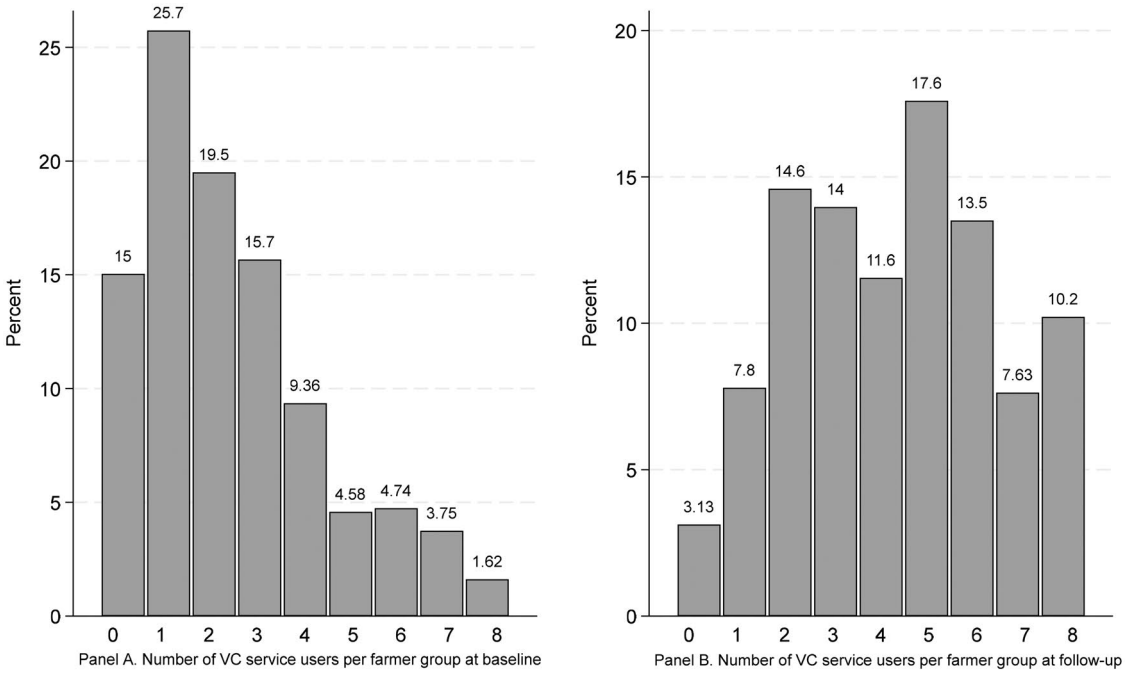
Figure 2. Schematic representation of empirical design.

Table 1. Participation in utilization of single or a combination of VC services (balanced panel).

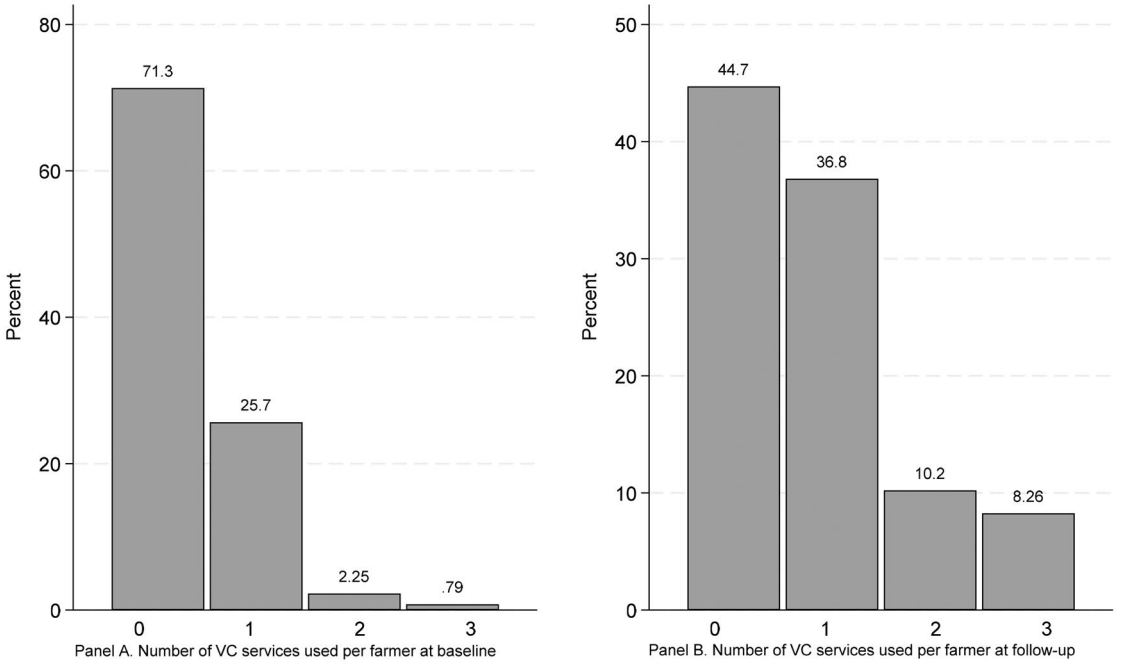
	Non-participant ($n=846$)	New participant ($n=861$)	Regular participant ($n=465$)	Irregular participants ($n=226$)	Total ($n=2,398$)
Panel I. *Baseline*					
Non-user	0.496	0.504	0.000	0.000	1,707
FLT	0.000	0.000	0.674	0.326	576
IMS/OMS	0.000	0.000	0.569	0.431	51
FLT + IMS/OMS	0.000	0.000	0.750	0.250	64
Panel II. *Follow-up*					
Non-user	0.789	0.000	0.000	0.211	1,072
FLT	0.000	0.656	0.345	0.000	749
IMS/OMS	0.000	0.761	0.239	0.000	176
FLT + IMS/OMS	0.000	0.589	0.412	0.000	401

baseline participants continued to utilize the SMAEs' services at follow-up. Finally, 35% did not use any VC services at either baseline or follow-up, and most of these waited for enrolment into the CRAFT project in the second year, during the final roll-out phase. Some 9.4% of the sample discontinued VC service use at follow-up, possibly signalling the presence of supply-side and/or demand-side constraints.

Figure 3a and b illustrate an increase in the number of value chain (VC) services utilized at both the farmer group level (Figure 3a) and the farm-household level (Figure 3b) from the baseline (Panel A) to the follow-up (Panel B). In Figure 3a, each bar represents the share of farmer groups with the specific number of VC services users. About 26% of all farmer groups had only one VC service user at baseline; this reduced to 7.8% at follow-up. At baseline, the share of farmer groups reduced sharply with the increasing number of VC service users within each group. We observe the opposite trend at follow-up, signifying increased intensity of participation, presumably due to the CRAFT program. We can see this trend also at the individual level. As shown in Figure 3b, at baseline 71% of households did not utilize any of the SMAEs



a. Number of VC services used per farmer group.



b. Number of VC services used per farmer.

Figure 3. a. Number of VC services used per farmer group. b. Number of VC services used per farmer.

services, which reduced to 45% at follow-up. The share of households using just one service increased from 26 to 37%, while using more than one service increased even stronger, from around 3 to 18%.

5.2. Estimation results

5.2.1. Participation in value chain service utilization

To address our first research question on the factors motivating or hindering participation, we present the marginal effects from the Multinomial Logit model in Table 2.[8] The marginal effects reported here

Table 2. Probability of participation in value chain service (MNL marginal effects).

	Non-participation		New participation		Regular participation		Irregular participation	
	ME (dy/dx)	SE	ME (dy/dx)	SE	ME (dy/dx)	SE	ME (dy/dx)	SE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. *Individual and farm-household characteristics*								
Female head	−0.007	0.026	−0.043*	0.025	0.053**	0.022	−0.004	0.017
Age	0.000	0.005	0.002	0.005	−0.002	0.004	−0.001	0.003
Age squared	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Education	−0.006*	0.003	0.000	0.003	0.005**	0.002	0.000	0.002
Household size	−0.006	0.004	−0.002	0.004	0.003	0.003	0.004*	0.003
Landholding	−0.014	0.010	0.001	0.010	0.023***	0.007	−0.010*	0.005
Landholding squared	0.001	0.000	0.000	0.000	−0.001***	0.000	0.000	0.000
Extra land	0.008	0.019	−0.023	0.019	0.022	0.014	−0.007	0.011
Insecure land user rights	0.009	0.037	−0.028	0.036	−0.061**	0.030	0.080***	0.028
Phone ownership	−0.047*	0.027	0.052**	0.026	0.019	0.023	−0.023	0.019
Agric. Wage labour—base	−0.043	0.029	0.044	0.031	0.001	0.025	−0.002	0.018
Off-farm employment—base	0.028	0.028	−0.028	0.027	−0.010	0.021	0.011	0.017
Enterprise ownership—base	−0.029	0.024	0.023	0.023	0.010	0.019	−0.004	0.015
Formal lender's credit—base	−0.039	0.043	−0.036	0.043	0.075**	0.038	−0.001	0.026
Panel B. *Behavioural characteristics*								
Risk lover	−0.024	0.033	0.048	0.035	−0.015	0.025	−0.010	0.019
Risk averse	−0.014	0.027	0.009	0.029	0.012	0.021	−0.007	0.017
Time preference	−0.043**	0.019	0.041**	0.019	−0.005	0.018	0.008	0.012
Distrust for the SMAEs	0.051**	0.024	−0.055**	0.022	−0.014	0.020	0.018	0.016
Risk–missing values	−0.100	0.093	0.058	0.110	−0.009	0.080	0.051	0.066
Distrust—missing	0.091	0.108	−0.052	0.099	−0.017	0.080	−0.022	0.040
Panel C. *Regional and community characteristics*								
Urban location	−0.030	0.031	0.035	0.030	0.029	0.027	−0.034**	0.016
Distance to all-weather road	0.005	0.005	0.002	0.006	−0.011*	0.006	0.003	0.003
Distance to input market	−0.003	0.003	0.000	0.003	−0.001	0.002	0.004***	0.001
Distance to output market	0.001	0.003	0.005*	0.003	−0.002	0.002	−0.004***	0.002
Distance to SC headquarters	0.002	0.003	−0.001	0.003	0.000	0.002	−0.002	0.002
Seasonal drought at baseline	−0.003	0.022	−0.036	0.023	0.047***	0.017	−0.008	0.014
Seasonal floods at baseline	−0.032	0.021	0.011	0.023	0.002	0.018	0.020	0.015
Panel D. *Value-chain characteristics*								
Soybean producer at baseline	−0.057**	0.028	−0.045	0.028	0.081***	0.023	0.021	0.016
Irregular soybean grower	−0.170***	0.022	0.151***	0.025	0.031	0.019	−0.013	0.012
Grew beans– baseline	0.015	0.026	0.013	0.024	−0.046**	0.020	0.018	0.015
Grew groundnuts– baseline	−0.055**	0.023	0.039*	0.022	−0.009	0.020	0.025*	0.013
Grew sesame– baseline	−0.002	0.029	−0.022	0.029	0.034	0.024	−0.009	0.014
Grew sunflower– baseline	−0.025	0.038	0.029	0.036	0.000	0.027	−0.004	0.021
Grew maize– baseline	0.017	0.022	−0.036	0.025	−0.005	0.022	0.024*	0.013
Grew millet– baseline	−0.007	0.028	0.027	0.028	−0.025	0.023	0.005	0.017
Grew sorghum– baseline	−0.015	0.026	−0.052*	0.027	0.036	0.027	0.031*	0.018
Grew sweet potatoes– baseline	0.010	0.023	−0.001	0.024	−0.003	0.019	−0.005	0.015
Distance to the SMAE office	0.003	0.003	0.002	0.002	−0.004	0.002	−0.002	0.001
Distance to office squared	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Expert visit at baseline	−0.194***	0.035	−0.173***	0.039	0.280***	0.044	0.087***	0.031
Enrolled in first season	−0.053**	0.027	0.050**	0.024	0.003	0.022	0.000	0.013
ALITO	−0.176***	0.036	0.181***	0.043	0.023	0.038	−0.029	0.021
OKEBA	−0.216***	0.036	0.187***	0.046	0.075*	0.042	−0.046**	0.020
Pr (Participation)	0.353		0.359		0.194		0.094	
No. of observations	846		861		465		226	

*, **, *** denote significance at the 1, 5 and 10% levels, respectively. In the parenthesis are robust standard errors. *dy / dx* for dummy variables is the discrete change against the base category (non-participation = 0).

indicate the percentage point change in the probability of falling into a specific participation category for a unit change in each explanatory variable. To facilitate interpretation, we categorize the determining factors into individual/farm-household, behavioural, regional/community and value-chain characteristics, presented in panels A, B, C, and D, respectively.

5.2.2. Determinants of non-participation in VC service utilization

We first examine individual and household-level factors. Non-participation in VC service utilization is significantly influenced by individual and household characteristics, particularly the education level of the decision-maker and mobile phone ownership. A one-year decrease in the decision-maker's education level is associated with a 0.6% increase in the probability of non-participation. This finding underscores the importance of education in enhancing farmers' capacity to process information and navigate the

institutional and technical requirements of VC engagement (Tadesse et al., 2021; Wossen et al., 2017). Similarly, reduced mobile phone ownership is linked to a 5-percentage point increase in the likelihood of non-participation. Given the growing role of mobile technology in facilitating access to agricultural information, market prices, and digital financial services, this result highlights the digital divide as a barrier to inclusive VC participation (Fabregas et al., 2019).

Behavioral attributes also play a notable role. Farmers who perceive a delay in expected gains from participation are 4 percentage points more likely to remain non-participants. Likewise, distrust in the service providers (SMAEs) increases the likelihood of non-participation by 5 percentage points. These findings align with existing evidence that behavioral constraints—such as intertemporal discounting and lack of trust in institutions—can discourage engagement in formalized market arrangements (Mausch et al., 2018).

Switching to value chain-specific characteristics, households with limited prior engagement in soybean production are also significantly less likely to participate in VC services. Specifically, households with no previous experience or irregular involvement in soybean production are 6 and 17 percentage points less likely to participate, respectively. This reflects the importance of crop-specific experience in reducing perceived risks and increasing confidence in VC participation (Liverpool-Tasie & Parkhi, 2021). The cropping pattern also influences participation. Farm-households that did not engage in groundnuts production in the previous season are 6 percentage points less likely to participate in VC service utilization. This may indicate limited enterprise diversification, which in turn restricts farmers' flexibility in engaging with VC services. Limited interaction with agricultural extension agents, particularly the absence of home or farm visits, significantly increases non-participation by approximately 19 percentage points. Personalized advisory services are critical for building trust and providing tailored guidance, especially in contexts where farmers are uncertain about the benefits of VC participation (Davis et al., 2022).

5.2.3. Determinants of new (late) participation in VC service utilization

Column 3 reports factors that influence new participation in VC service use. Among individual and farm-household characteristics (Panel A), female-headed households are 4 percentage points less likely than males to participate late, suggesting that women with greater decision-making authority make quicker beneficial decisions. Mobile phone ownership raises the likelihood of new participation by 5 percentage points implying that mobile phones play a critical role in information sharing about beneficial VC opportunities.

Turning to behavioural characteristics, we observe a positive relationship between intertemporal preference and new participation. A higher time preference coefficient suggests that late participants tend to be present-biased. Hence, farm-households would delay their participation if anticipated benefits are perceived to materialize over a longer period of time. Our results also show that trust for SMAEs is an important enabler of new participation. As more farmers loose trust in the service providers, their participation in VC service use reduces by about 6 percentage points.

For regional/community characteristics, the longer the distance from the farm-household to the nearest output markets, the higher the likelihood of late participation, which increases by 0.5%. This suggests that farm-households with limited access to output markets would be more likely to take advantage of VC services involving new market for soybean.

In relation to value chain characteristics (panel D), households with prior experience in soybean production are 4.5 percentage points less likely to participate late although the influence is not significant. However, irregular engagement in soybean production increases the likelihood of late participation by 15 percentage points. The positive association with groundnuts production suggests that these households may be better positioned to transition into soybean farming due to similarities in crop management, favourable agroecological conditions, and market access. These factors likely reduce entry barriers and may also reflect a strategic move toward more profitable or better-supported value chains.

In contrast, the lower likelihood of participation among sorghum producers may be attributed to the fact that sorghum is relatively less resource-intensive and can be cultivated for both income and food security, particularly in the northern and eastern regions (Andiku et al., 2021; Businge et al., 2020).

Soybean, on the other hand, is more resource-intensive and typically grown as a cash crop. These differences may discourage sorghum farmers from shifting to soybean production. Furthermore, key informant interviews revealed that many sorghum producers are under contract to supply specific varieties to brewing companies. These existing market arrangements likely offer stable returns and secure buyer relationships, further reducing the incentive to engage in a potentially riskier and unfamiliar value chain like soybeans. Farm households that received on-farm visits from agricultural extension experts in the previous year are 17 percentage points less likely to participate late. As we will see among early or regular participants, extension visits appear to encourage earlier engagement in the value chain, likely by enhancing farmers' awareness, knowledge, and confidence to participate.

5.2.4. Determinants of regular participation in VC service utilization

Regular (or early) participation in VC service use is significantly influenced by various individual and farm-household characteristics. Specifically, female headship of the household, the educational level of the decision-maker, total landholding size, and access to credit from formal financial institutions are all positively associated with regular participation. In contrast, insecure land user rights and very large landholdings exhibit a negative correlation with sustained participation (Column 5, Panel A).

Female-headed households are approximately 5 percentage points more likely to participate regularly in VC service utilization compared to male-headed households. This finding aligns with broader gender-and-development literature that underscores women's proactive engagement with institutional support mechanisms (Ekesa et al., 2020; Kishaija & Heil, 2025; Lawry et al., 2017; Rugema et al., 2018), especially when they are empowered with decision-making authority (Doss, 2025; Meinzen-Dick et al., 2019). Female household heads may be more attuned to the potential benefits of VC services—especially when they face constraints in accessing traditional market channels—and thus more inclined to adopt and maintain participation.

Education, often a proxy for human capital, is another significant enabler. Each additional year of schooling for the primary decision-maker increases the likelihood of regular VC service use by 0.5%. This finding reinforces the role of education in enhancing farmers' ability to understand service offerings, manage risk, and negotiate contracts (Manda et al., 2020).

Access to formal credit—whether through banking institutions or mobile financial services such as MTN Mobile Money or Airtel Money—is strongly associated with higher participation. Households with access to credit were approximately 8 percentage points more likely to regularly use VC services. This supports long-standing empirical findings that access to liquidity enables farmers to overcome short-term financial barriers and better manage input purchases and production cycles (Islam et al., 2018; Jack et al., 2019). In particular, mobile financial services are proving to be a transformative tool in bridging rural credit gaps, facilitating greater participation in institutional arrangements such as VC platforms (Aker & Fafchamps, 2015).

Greater landholding size is generally associated with an increase in participation, suggesting that land availability facilitates access and creates greater economic incentive to engage with VC actors or invest in inputs (Barrett et al., 2022). However, these effects diminish as landholdings increase, suggesting that very large landholders may rely on their own resources or existing networks, making them less dependent on or interested in early VC service engagement.

In contrast, insecure land tenure significantly reduces the likelihood of participation—by approximately 6 percentage points. Tenure insecurity has consistently been shown to discourage long-term investment in land and productivity-enhancing technologies (Holden & Ghebru, 2016; Lawry et al., 2017). Where land rights are perceived as uncertain or revocable, farmers may be reluctant to engage in contracts or invest in value chains that require upfront costs or introduce market dependency.

At the community level, distance to infrastructure plays a notable role. Each additional kilometre from a farm-household to an all-weather road is associated with a one percent decrease in regular participation, reflecting the importance of physical connectivity in facilitating access to markets, inputs, and extension services (Chamberlin & Jayne, 2020). Conversely, exposure to seasonal drought appears to increase the likelihood of regular participation by 4 percentage points. This somewhat counterintuitive finding may reflect farmers' strategic response to climatic shocks, whereby they are more likely to engage

with structured VC services (e.g. for seed or financial assistance) as a form of adaptation and risk mitigation (Ceballos-Sierra & Dall'Erba, 2021).

Finally, factors directly related to the value chain itself also show significant associations (Panel D). Prior experience with soybean production, as indicated by engagement at baseline, is positively correlated with continued participation, suggesting that familiarity with the crop and the associated VC processes encourages sustained engagement. In contrast, prior engagement in other crops, such as beans, is negatively associated with regular use of VC services. This highlights how resource constraints may compel farm households to prioritize or specialize in soybean production, thereby limiting diversification. Additionally, prior visits from agricultural extension agents are associated with a 28-percentage-point increase in the likelihood of regular participation, highlighting the importance of technical support and information dissemination in fostering sustained engagement in value chain initiatives.

5.2.5. Determinants of irregular participation in VC service utilization

Lastly, we examine the factors that influence non-participation at follow-up among farm-households that had previously participated in value chain (VC) service utilization (Column 7). Among individual and farm-household characteristics, household size, and insecure land tenure emerge as the primary determinants of irregular participation. Larger households are less likely to maintain consistent engagement with VC services, possibly due to competing demands such as food, healthcare, and education, which may limit their ability to invest in inputs provided by the SMAEs. Furthermore, insecure land tenure dampens farmers' incentives to make sustained investments or maintain regular participation in value chain-related support systems (Ekesa et al., 2020; Kishaija & Heil, 2025; Lawry et al., 2017; Rugema et al., 2018).

Turning to environmental and locational factors (Panel C), farm households in urban or peri-urban areas are less likely to participate inconsistently or sporadically in value chain (VC) service utilization. This likely reflects better infrastructure and fewer logistical constraints compared to rural areas. In contrast, households located closer to major output markets or farther from input markets are more likely to disengage. On the supply side, farmers may be unwilling to sell to SMAEs at lower, pre-agreed prices if alternative buyers offer better rates—posing a risk to SMAEs. On the demand side, SMAEs may be reluctant to purchase at higher prices outside the terms of existing contracts. Together, these dynamics suggest that SMAEs may avoid extending services to well-connected households near output markets or to remote rural households due to delivery challenges. As a result, the risk of SMAEs reneging on purchase agreements may further discourage continued participation among geographically marginalized producers.

With regard to value chain characteristics (Panel D), greater involvement in the production of alternative oilseeds (groundnuts) or cereals (maize and sorghum) is associated with a 2–3 percentage point increase in the likelihood of irregular participation in soybean-focused VC services. This suggests that crops like groundnuts, maize, and sorghum—serving both food and cash purposes—may offer more attractive or viable alternatives for some households, providing competitive or comparative advantages over soybean production.

Interestingly, prior access to agricultural extension services—particularly those delivered through home or farm visits—is associated with an 8.6 percentage point increase in the probability of non-sustained VC participation. This counterintuitive result could reflect a mismatch between the type or quality of extension support and farmers' evolving needs, or the possibility that better-informed farmers choose to disengage when the expected benefits of VC participation do not materialize (Davis et al., 2022).

5.2.5.1. Discussion of participation dynamics. The findings on participation dynamics reveal a complex interplay of resource endowments, institutional factors, and behavioural traits, consistent with studies from smallholder contexts in Africa (e.g. Manda et al., 2020; Wossen et al., 2022). Our results underscore that initial and sustained participation is not merely a function of service availability but is deeply shaped by pre-existing household capabilities. The positive association between education, landholding, credit access, and regular participation echoes findings from value chain studies in Kenya and Tanzania, where human and financial capital were critical for smallholder integration (Fischer & Qaim, 2012; Herrmann et al., 2018).

The role of insecure land tenure as a barrier to sustained engagement aligns with a growing body of evidence linking tenure insecurity to agricultural investment across sub-Saharan Africa (Holden & Ghebru, 2016; Lawry et al., 2017). This highlights a fundamental challenge for inclusive value chain development: without secure rights, farmers are less likely to make the long-term commitments required for VC participation, thereby perpetuating cycles of exclusion.

Behavioural factors, particularly trust and time preferences, emerged as significant drivers, supporting the relevance of agency theory in this context. The importance of trust in fostering new and sustained participation resonates with research on relational contracts in African agriculture (Macchiavello & Morjaria, 2021). The finding that present-biased preferences lead to delayed participation suggests that interventions requiring upfront costs without immediate returns may struggle to attract time-sensitive farmers, a consideration often overlooked in VC design.

From a gender perspective, the proactive role of female-headed households in regular participation challenges common narratives of female marginalization and points to their potential as change agents when empowered with decision-making authority. This finding is consistent with gender-focused value chain analyses in Uganda and Rwanda that have documented women's strategic engagement with market-oriented iniatiaves (Ekesa et al., 2020; Rugema et al., 2018).

These participation patterns suggest that VC services, while expanding access, may function as a selection mechanism that favours better-endowed households. This creates a paradox where programs aimed at inclusion may inadvertently reinforce existing inequalities unless complementary measures address structural barriers like land tenure, education, and credit access.

Overall, the rollout of CRAFT interventions among new and continuing participants in SMAEs' value chains offers an opportunity to examine the factors influencing participation in value chain (VC) service use. Findings indicate that new participation is largely driven by improved availability of, or access to, VC services—facilitated through strengthened linkages with the SMAEs. Mobile phones play a central role in enabling these linkages, reinforcing farmers' reliance on SMAEs for VC services, in line with resource dependency theory. Specifically, mobile phones facilitate communication and information exchange both among farmers and between farmers and service providers. Those with mobile phones are often the first to learn about the availability of services and can be easily contacted regarding training visits or the delivery of inputs from SMAEs (Fischer & Qaim, 2012).

VC services also appear to benefit farmers who are less connected to output markets. It is plausible that SMAEs target these farmers as a risk mitigation strategy, given their lower likelihood of side-selling. Such farmers may also self-select into SMAE value chains when market access is otherwise limited but guaranteed through VC participation. However, as access to output markets improves, participation in VC services tends to decline—indicating that these services are most relevant to underserved, remote farmers. Yet paradoxically, SMAEs seem reluctant to extend services to these hard-to-reach areas.

Behavioral factors also influence new participation. Consistent with agency theory, participation is driven by the expectation of long-term benefits and trust that SMAEs will fulfil their obligations. Effective relational contracting and client retention require mutual trust between service providers and users (Macchiavello & Morjaria, 2021; MacChiavello & Morjaria, 2015). To build and maintain this trust, SMAEs must avoid practices that may trigger distrust, and ensure timely purchases, payments, and delivery of services.

Sustained VC service utilization requires inclusive participation. SMAEs are more likely to target female-headed households with access to land, partly due to perceptions of greater trust and loyalty. Continued engagement also depends on the education level of decision-makers, as education enhances farmers' ability to negotiate favourable contract terms and resist opportunistic behaviour by SMAEs. Additionally, sustained participation is more feasible for farmers with secure land tenure, adequate landholdings, or access to credit, all of which enable investment in farm inputs. Insecure land rights can undermine these investments and contribute to inefficient resource allocation (Mwesigye & Barungi, 2021). To mitigate risks related to moral hazard and adverse selection, SMAEs might be tempted to offer input or in-kind credit only to farmers with known repayment capacities, sufficient land, and secure tenure.

The next section explores the specific factors influencing the type and extent of VC services utilized by participating farmers.

5.2.6. Determinants of differential uptake of value chain services

To address our second research question on the differences in service uptake among participants, we first use a Multinomial Logit Model to examine the types of services used.

5.2.6.1. Factors influencing utilization of different value chain services. Table 3 presents the marginal effects from a MNLM examining the determinants of differential VC service uptake, partially addressing our second research question. The model specification mirrors that of Equation (1), but the dependent variable is now the type of service bundle used, also a multi-categorical unordered variable with three outcomes: using only FLT, only IMS/OMS, or the full bundle (FLT+IMS/OMS), as detailed in section 4.2.2. The results show the change in probability of using a specific service bundle for a unit change in each

Table 3. Drivers of utilization of different value chain services (MNL marginal effects).

	FLT		IMS/OMS		FLT+IMS/OMS	
	ME dy/dx)	SE	ME(dy/dx)	SE	ME (dy/dx)	SE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. *Individual and farm-household characteristics*						
Female head	0.012	0.034	0.033	0.028	−0.045	0.032
Age	−0.003**	0.001	0.001	0.001	0.001	0.001
Education	−0.005	0.005	0.005	0.003	0.000	0.004
Household size	0.003	0.005	−0.005	0.004	0.002	0.005
Landholding	−0.009	0.014	−0.004	0.007	0.014	0.012
Landholding squared	0.000	0.001	0.000	0.000	−0.001	0.001
Extra land	−0.019	0.021	−0.008	0.017	0.027	0.021
Insecure land user rights	−0.032	0.052	−0.004	0.035	0.036	0.052
Phone ownership	0.041	0.042	0.026	0.025	−0.067*	0.038
Agric. wage labour—base	0.000	0.040	0.003	0.031	−0.003	0.041
Off-farm employment—base	−0.003	0.039	0.020	0.024	−0.017	0.036
Enterprise ownership—base	0.036	0.030	−0.029	0.020	−0.007	0.027
Credit from formal source—base	0.004	0.055	0.011	0.042	−0.016	0.054
Panel B. *Behavioral characteristics*						
Risk appetite	−0.010	0.045	0.020	0.035	−0.009	0.044
Risk averse	−0.025	0.038	0.001	0.029	0.024	0.035
Time preference	−0.013	0.026	−0.015	0.018	0.029	0.023
Distrust for the SMAEs	−0.055	0.037	0.016	0.026	0.038	0.034
Risk preference—missing	0.137	0.127	0.014	0.107	−0.151	0.094
Distrust—missing values	−0.117	0.144	−0.070	0.105	0.187	0.140
Panel C. *Regional and community characteristics*						
Urban location	0.003	0.048	0.023	0.032	−0.026	0.041
All-weather road	0.008	0.010	−0.002	0.008	−0.005	0.009
Input distance	−0.001	0.004	0.001	0.002	0.000	0.003
Output Market distance	−0.003	0.004	−0.001	0.002	0.004	0.003
Distance to subcounty	0.009	0.008	0.004	0.006	−0.013*	0.008
Distance to subcounty squared	0.000	0.000	0.000	0.000	0.000	0.000
Seasonal drought	0.040	0.031	0.002	0.020	−0.042	0.029
Seasonal floods	0.035	0.031	0.025	0.019	−0.060**	0.028
Panel D. *Value-chain characteristics*						
Grew soybean—baseline	−0.082**	0.038	0.041*	0.023	0.041	0.038
Grew beans—baseline	0.074**	0.036	−0.025	0.022	−0.049	0.032
Grew groundnuts—baseline	0.030	0.030	−0.011	0.020	−0.019	0.030
Grew Sesame—baseline	−0.058	0.038	0.001	0.021	0.057	0.037
Grew Sunflower—baseline	0.023	0.045	0.002	0.029	−0.025	0.041
Grew Maize—baseline	−0.013	0.033	0.019	0.021	−0.006	0.032
Grew Millet—baseline	0.005	0.043	−0.006	0.023	0.002	0.040
Grew Sorghum—baseline	0.021	0.041	0.019	0.024	−0.040	0.038
Grew Sweet Potatoes—baseline	−0.018	0.040	0.010	0.023	0.008	0.037
Distance to SMAEs office	−0.006	0.004	0.007***	0.002	−0.001	0.003
Distance to office squared	0.000**	0.000	−0.000***	0.000	0.000	0.000
FLT—baseline	−0.030	0.045	−0.029	0.026	0.059	0.040
IMS—baseline	−0.283***	0.082	−0.012	0.045	0.295***	0.086
OMS—baseline	−0.148*	0.085	0.003	0.041	0.145	0.089
Competitor-organized FLT—base	0.100**	0.049	−0.073***	0.027	−0.027	0.044
Intensity of participation—base	0.128	0.080	−0.049	0.042	−0.079	0.075
Expert visit—base	−0.072	0.064	−0.043	0.030	0.115*	0.060
Enrollment season	−0.043	0.040	0.007	0.020	0.036	0.035
ALITO Joint	−0.046	0.061	−0.038	0.033	0.084	0.054
OKEBA	0.036	0.077	−0.158***	0.031	0.122*	0.070
Pr (Participation)	0.583		0.149		0.268	
No. of observations	749		176		401	

*, **, ***denote significance at the 1%, 5% and 10% levels, respectively. SE stands for robust standard errors; while ME stands for marginal effects. *dy / dx* for dummy variables is the discrete change against the base category (FLT+IMS/OMS).

covariate.[9] Column 1 reports determinants for FLT-only users, columns 3 and 5 for IMS/OMS-only and full-bundle users, respectively. The explanatory variables are categorized into individual/farm-household (Panel A), behavioural (Panel B), and regional/community (Panel C), and value chain characteristics (Panel D).

5.2.6.1.1. *Factors influencing utilization of FLT.* Households that utilize only FLT services tend to be younger (column 1, panel A), suggesting that younger farmers may be more open to learning or experimenting with new practices. However, increased distrust toward the SMAEs is associated with a reduced likelihood of FLT uptake (column 1, panel B), indicating that perceptions of service providers' credibility play a crucial role in farmers' willingness to engage.

With respect to value chain (VC) characteristics (column 1, panel D), experienced soybean growers are 8 percentage points less likely to rely solely on FLT. This may be because seasoned farmers have already internalized the practices taught through training or prefer more advanced forms of engagement, such as output or input market services. Conversely, households previously engaged in bean production are 7 percentage points more likely to use only FLT, possibly because they perceive training as a lower-risk entry point before committing to deeper participation. Key informant interviews also revealed that, prior to the CRAFT program, OKEBA initially focused its VC services on bean producers. Therefore, it is likely that such households use FLT to gauge the feasibility of participating in the soybean value chain.

Prior engagement with IMS or OMS reduces the likelihood of using only FLT by 28 and 15 percentage points, respectively. This suggests that FLT may serve as a transitional service—initially useful but less relied upon once farmers access more market-facing interventions. Indeed, the SMAEs select contract recipients from among the broader pool of FLT participants.

Interestingly, the farther households are from the SMAE office, the more likely they are to rely solely on FLT. This may reflect the relative accessibility of FLT services, which are often delivered via community-based demonstrations. Additionally, prior participation in competitor-led FLT programs increases the likelihood of engaging in SMAE-led FLT by 10 percentage points, indicating a positive spillover or cross-learning effect.

5.2.6.1.2. *Factors influencing utilization of IMS/OMS.* Utilization of only IMS or OMS services is shaped predominantly by value chain dynamics (column 3, panel D). Experienced soybean producers are 4 percentage points more likely to use IMS/OMS, implying that familiarity with the crop builds confidence to engage in more market-oriented services.

While households located farther from SMAE offices initially show higher uptake of IMS/OMS, utilization drops significantly when the distance doubles. This non-linear relationship suggests diminishing accessibility, logistical burdens or difficulty associated with contract enforcements when distance increases. Households with past participation in competitor-organized FLT are 7.3 percentage points less likely to use SMAE-provided IMS/OMS. This could be due to loyalty to competing organizations, exclusion by the SMAEs from contract uptake or a strategic shift toward alternative crops if soybeans yield relatively lower benefits.

5.2.6.1.3. *Factors influencing utilization of full bundle (FLT + IMS/OMS).* Households using both FLT and IMS/OMS services (i.e. the full-service bundle) are less likely to own mobile phones—ownership reduces the likelihood of bundle utilization by 7 percentage points (column 3, panel A). This may indicate that information access via phones substitutes for formal FLT or contract-based services, or that bundle interventions target farmers with more limited connectivity to circumvent side-selling issues.

Greater distance to distance to subcounty headquarters negatively affects bundle uptake, likely because demonstration gardens and village agents (who facilitate service delivery) are typically located closer to these administrative centres. Exposure to weather shocks such as seasonal floods reduces the likelihood of utilizing FLT + IMS/OMS in the subsequent year by 6 percentage points. This suggests that climatic shocks constrain farm households' ability to invest in bundled inputs and services, or shift their priorities toward short-term survival.

Value chain experience is a strong predictor of bundle uptake. Households that previously used IMS are 31 percentage points more likely, to adopt the full bundle in the following year. Prior visits by extension agents further increase utilization of bundled services by 12 percentage points, indicating that information support complements bundled service delivery. Households linked to OKEBA are more 12 percentage points more likely than those affiliated with ACILA to use the full service bundle, suggesting notable differences in service delivery effectiveness or farmer demand across these institutions.

5.2.7. Discussion of service uptake variation. The differential uptake of VC services reveals a strategic alignment between supply-side targeting and demand-side capabilities. The use of FLT as a low-barrier entry point, particularly for younger, less experienced, and remotely located farmers, reflects a common approach in smallholder development projects where knowledge transfer serves as a first step toward deeper market integration (Davis et al., 2022). However, the transition from FLT to more intensive services like IMS/OMS appears constrained for many, creating a participation ceiling that limits the potential benefits of value chain integration. This "training trap" is a significant hurdle for inclusive development, as it provides knowledge without ensuring the means (inputs, credit, market access) to act on it, potentially leading to frustration and disengagement.

The finding that SMAEs potentially use FLT as a filtering mechanism for selecting clients to participate in their input and output market channels aligns with transaction cost economics, where firms seek to minimize risks by working with more reliable partners (Williamson, 1979). This practice, while economically rational for the SMAEs, raises important questions about the inclusiveness of such value chains, as it may systematically exclude those who are perceived as high risk—often the most vulnerable farmers. This creates a fundamental tension between the commercial viability of SMAEs and the development goal of broad-based inclusion. Resolving this tension may require de-risking mechanisms, such as partial credit guarantees or outcome-based subsidies, that incentivize SMAEs to engage with wider, less "safe" client base.

The negative association between mobile phone ownership and full bundle utilization presents an interesting paradox. While phones generally facilitate VC access, their substitution effect for bundled services suggest that digitally connected farmers may have alternative information sources or market options, reducing their dependence on SMAE-provided bundles. This finding contributes to the emerging literature on digital agriculture in Africa, which highlights both the empowering and disruptive effects of mobile technologies on traditional service delivery models (Fabregas et al., 2019). It suggests that as digital access expands, the value proposition of traditional service bundles may need to evolve to remain competitive, perhaps by offering more customized or higher-quality services that digital platforms cannot easily replicate.

The significant variation in service uptake across different SMAEs (OKEBA or ACILA vs. ALITO) underscores the importance of institutional characteristics in value chain performance. Differences in business models, implementation capacity, and local embeddedness can substantially influence how smallholders experience and benefit from VC participation, a factor often overlooked in value chain analyses that treat implementing organizations as homogeneous. This implies that "one-size-fits-all" value chain interventions are unlikely to be effective. Supporting diverse ecosystem of SMAEs with tailored capacity-building may be a more successful strategy for fostering inclusive food systems than backing a single model.

Considering the combined results, why did farmers use different types of services? The variation in service utilization among farm households appears to be driven by both supply- and demand-side factors, including client retention strategies by SMAEs, farmers' intrinsic motivations (such as willingness to learn or innovate), and structural barriers such as distance, resource constraints, and market access. These patterns are consistent with the broader literature on rural service delivery and agricultural market systems (Barrett et al., 2022; Ghani & Reed, 2022; Macchiavello & Morjaria, 2021).

From the supply-side perspective, SMAEs appear to use FLT as a filtering mechanism to identify promising clients for more resource-intensive services like IMS/OMS, favouring those with stronger histories of repayment, consistent demand for improved inputs, and prior engagement with their service offerings. In this context, regular buyers and reliable clients are more likely to receive access to the full-service bundle (FLT + IMS/OMS), reinforcing relationship-building strategies geared toward client retention.

Meanwhile, farmers who utilize only FLT services are more likely to be younger, less experienced in soybean production, and located farther from SMAE offices. These findings suggest that FLT serves as a relatively low-barrier entry point, especially for resource-constrained or geographically remote households. The reliance on community-based demonstrations may make FLT more accessible in areas where the logistical costs of delivering IMS/OMS services are prohibitively high. This also supports the interpretation that FLT functions as an exposure or learning phase for newer or more marginalized farmers.

Importantly, prior exposure to seasonal floods reduce uptake of the full bundle in subsequent years, perhaps because such events deplete household resources or shift priorities toward short-term survival strategies.

On the demand side, value chain characteristics and household capabilities play an important role. Experienced soybean growers and households with prior engagement in IMS/OMS are significantly more likely to access the full service bundle, pointing to a cumulative pathway of participation where past involvement builds trust and eligibility. The SMAEs also appear adept at segmenting their clientele. Farmers with a history of engagement in competitor-led FLT programs are more likely to use SMAE-run FLT, but significantly less likely to access IMS/OMS services offered under contract.

5.2.8. Intensity of value chain service utilization. We examine the intensity of VC service use using a two-part model (equation 4), complemented by pooled OLS estimates (Table 4), to fully address the second research question. Conditional on participation, decision-makers with higher level of education and households with larger landholding size use 0.011 and 0.04 more VC services, likely reflecting greater awareness and resource capacity to engage (Panel A). A higher time preference, indicating a focus on short-term returns, is associated with the use of 0.08 more services (Panel B), suggesting a preference for immediate beneficial services like input credit.

Regarding regional factors, greater distance to output markets is positively associated with service intensity, reinforcing our earlier finding that market constraints increase reliance on SMAEs' VC services.

Among value chain characteristics, prior engagements in competing crops like beans is associated with the use of 0.11 fewer services, aligning with evidence of crop prioritization and competition for resources.

Consistent with earlier results, prior exposure to FLT and IMS is strongly associated with the use of 0.29 and 0.38 more services, respectively. In contrast, prior participation in competitor's FLT is associated with 0.13 fewer services, suggesting possible exclusion by SMAEs. A prior visit from an extension expert is associated with the use of 0.16 more services. Households enrolled in the first season use 0.14 more services than later enrolees. Furthermore, households linked to ALITO Joint and OKEBA use 0.34 and 0.50 more services, respectively, compared to those linked to ACILA. These disparities likely reflect supply-side differences among the SMAEs, including variations in business models, staffing, and extension capacity, which influence service quality and reach.

6. Conclusion

Integrating smallholder farmers into agricultural value chains (AVCs) remains a central strategy for building resilient, productive, and sustainable food systems. Yet, achieving inclusivity in value chain development continues to be a significant challenge. This study aimed to deepen our understanding of how participants engage in value chains, why some join later while early participants remain engaged, why others drop out, and why certain service packages intended to support marginalized farmers remain underutilized.

The study highlights how participation in value chains is influenced not only by resource availability but also by institutional and behavioural factors. While early engagement is facilitated by improved service availability and information access, ongoing participation requires stable institutional relationships and timely service delivery. Farmers often make strategic choices based on competing livelihood options, particularly where land and capital are limited.

Barriers such as insecure land tenure, limited education, poor access to credit, and distance from service points may hinder inclusive participation. In addition, commercial actors in the chain, including the SMAEs, may seek to minimize their exposure to risk through selective service provision. Such exclusionary practices, though rational from a business standpoint, can constrain broader inclusion by sidelining resource-poor households.

VC service delivery operates as both a mechanism for selecting more viable participants and a means of aligning them with agribusiness expectations. However, if food systems are to become truly inclusive and resilient, policy and programming must offer incentives for service providers to take on more risk. Solutions may lie in strengthening trust, improving service reliability, and introducing shared-risk mechanisms such as bundled input-insurance contracts or "pay-upon-supply" models. Transparent, long-term partnerships that balance risk between farmers and agribusinesses can foster stronger and more durable relationships.

Table 4. Intensity of value chain service use.

	Pooled OLS		Two-part model			
			Selection equation		VC service use intensity	
	Coef.	SE	Coef.	SE	ME (dy/dx)	SE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. *Individual and farm-household characteristics*						
Female head	−0.044	0.048	−0.024	0.124	−0.056	0.048
Age	0.001	0.002	−0.001	0.004	0.001	0.002
Education	0.012*	0.006	0.024	0.015	0.011*	0.006
Household size	0.003	0.007	0.008	0.018	0.005	0.007
Landholding	0.040**	0.019	0.099**	0.048	0.041**	0.019
Landholding squared	−0.002	0.001	−0.004**	0.002	−0.002*	0.001
Extra land	0.024	0.040	−0.015	0.080	0.027	0.033
Insecure land user rights	−0.111	0.077	−0.443**	0.177	−0.096	0.077
Phone ownership	0.064	0.051	0.328***	0.119	0.053	0.055
Agric. wage labour	0.028	0.057	0.186	0.139	0.029	0.057
Off-farm employment	−0.042	0.054	−0.157	0.126	−0.049	0.054
Enterprise ownership	0.041	0.043	0.154	0.110	0.047	0.043
Credit from formal source	0.024	0.090	0.087	0.200	0.039	0.082
Panel B. *Behavioural characteristics*						
Risk lover	0.032	0.067	0.224	0.154	0.032	0.063
Risk averse	0.044	0.051	0.123	0.125	0.046	0.052
Time preference	0.074**	0.037	0.166*	0.089	0.075**	0.036
Distrust for the SMAEs	−0.070	0.049	−0.307***	0.116	−0.069	0.049
Risk—missing values	0.026	0.159	0.244	0.485	−0.025	0.162
Distrust—missing values	−0.055	0.167	−0.266	0.472	−0.006	0.179
Panel C. *Regional and community characteristics*						
Urban location	0.092	0.078	0.293*	0.157	0.088	0.066
Road distance	−0.013	0.011	−0.025	0.032	−0.014	0.012
Input market distance	−0.004	0.006	−0.009	0.013	−0.004	0.005
Output market distance	0.012**	0.005	0.016	0.013	0.011**	0.005
Subcounty distance	−0.011	0.012	−0.003	0.028	−0.012	0.011
Subcounty distance squared	0.000	0.000	0.000	0.001	0.000	0.000
Seasonal drought	−0.043	0.041	−0.012	0.101	−0.039	0.042
Seasonal floods	−0.040	0.042	0.047	0.110	−0.040	0.043
Panel D. *Value-chain characteristics*						
Soybean grower—baseline	0.058	0.056	0.093	0.137	0.078	0.055
Grew beans—baseline	−0.097**	0.047	−0.091	0.116	−0.107**	0.049
Grew groundnuts—baseline	0.019	0.044	0.140	0.106	0.021	0.044
Grew sesame—baseline	0.055	0.056	0.071	0.133	0.056	0.056
Grew sunflower—baseline	0.009	0.068	0.152	0.177	0.012	0.067
Grew maize—baseline	−0.060	0.046	−0.167	0.115	−0.066	0.048
Grew millet—baseline	0.003	0.060	0.011	0.137	−0.005	0.057
Grew sorghum—baseline	−0.027	0.053	−0.045	0.131	−0.026	0.055
Grew sweet potatoes—baseline	−0.018	0.054	−0.007	0.112	−0.015	0.050
Distance to SMAE office	−0.002	0.006	0.010	0.013	0.001	0.005
Distance to SMAE squared	0.000	0.000	0.000	0.000	0.000	0.000
FLT—baseline	0.281***	0.062	0.613***	0.161	0.285***	0.067
IMS—baseline	0.452***	0.159	0.356	0.303	0.383***	0.140
OMS—baseline	0.213	0.149	0.033	0.359	0.152	0.150
Competitor's FLT—baseline	−0.137*	0.080	−0.208	0.204	−0.125*	0.075
Participation intensity—baseline	0.194	0.127	0.906***	0.268	0.182	0.111
Expert's visit	0.173*	0.094	0.165	0.211	0.161*	0.092
Enroll season	0.139**	0.060	0.277**	0.128	0.138**	0.054
ALITO	0.354***	0.083	0.970***	0.202	0.342***	0.080
OKEBA	0.498***	0.109	1.289***	0.243	0.502***	0.100
Constant	0.265	0.202	−1.794***	0.462		
Number of observations	2,398		2,398		1,326	
R^2	0.121					
Wald chi-square			168.40			
Prob > chi-square			0.000			
Pseudo R^2			0.087			

*, **, ***denote significance at the 1, 5 and 10% levels, respectively. SE stands for robust standard errors; while ME stands for marginal effects. *dy / dx* for dummy variables is the discrete change from base level.

This research contributes to the broader discourse on inclusive agricultural development by demonstrating that participation in value chains is a nuanced process shaped by an interplay of household capabilities, institutional arrangements, and behavioural factors. The findings suggest that achieving more inclusive food systems requires moving beyond simply providing services to addressing structural barriers that limit participation, particularly for resource-poor farmers. This includes interventions to

strengthen land tenure security, expand rural education, improve financial inclusion, and build trust between smallholders and agribusiness firms.

For policy makers and practitioners, our results highlight the need for more targeted approaches that recognize the heterogeneity among smallholders. Rather than one-size-fits-all value chain interventions, differentiated strategies are needed that accommodate varying levels of readiness and capacity among farmers. This might include graduated participation pathways that allow farmers to engage at different levels, complemented by support measures that address specific constraints such as land tenure insecurity or limited access to credit.

This research was limited by its crop-specific (soybean) and regional (three areas of Uganda) focus, which may affect the generalizability of the findings to other contexts or value chains. Furthermore, while the study identifies key factors associated with participation, causality cannot be firmly established due to potential unobserved variables and the observational nature of the data.

Looking ahead, future research should explore the long-term trajectories of farmers across different value chains, including those who disengage. Experimental or longitudinal designs could help establish clearer causal links and reveal how inclusive models evolve over time. Policymakers and practitioners should also consider how agribusiness incentives can be realigned to serve development goals without undermining commercial viability.

Overall, achieving inclusive AVCs demands a dual commitment—from smallholders to engage and from agribusinesses to accommodate and support a more diverse group of farmers. Only by addressing systemic barriers and creating mutual trust and shared value can food systems transformation be both equitable and sustainable.

Notes

1. For more details about the project, see: https://snv.org/project/climate-resilient-agribusiness-tomorrow-craft
2. These SMAEs fall within Uganda Investment Authority's definition of SMEs – small enterprises employ between 5 and 49 people and have total assets between UGX: 10 million but not exceeding 100 million, while medium enterprises employ between 50 and 100 people with total assets of more than 100 million but not exceeding 360 million (Government of Uganda, 2022).
3. These demonstration sites or FFSs were established by the volunteer trainer of trainees (identified within the same communities where farmers reside) with technical support from the SMAEs' extension officers. The Each village or community had at least one FFS.
4. The baseline survey that had been planned to be conducted in from February was delayed by the lockdown measures against the COVID 19 and started June 2020.
5. We used factor analysis to construct trust variable from the multiple questions (see Appendix A8).
6. Elicitation of risk preferences, time preferences and trust was done at endline because these behaviours are not expected to change over time. However, the sample size at endline dropped further due to attrition, hence we cater for this attrition in our analysis. See Appendices A1, A2 and A3 for details.
7. We combine IMS with OMS since less than 2% of households used OMS at follow-up. Combining IMS with OMS is plausible since these are both situated within an input/output contract.
8. The MNLM parameter estimates and associated standard errors for the covariate in each participation regime are presented in Appendix A6. In all estimations, we need to account for missing values for risk preferences, time preferences and trust variables – the missing values arose due to majorly attrition (given that elicitation was done at endline) and a few refusals to participate in risk and time preference elicitation games due factors such as religious restrictions. We generate dummy variables that we assign a value of one for missing values and zero otherwise, and then replace the missing values for risk preference, time preference and trust variables with zero. These dummy variables are included in the regressions to maintain the full sample at follow-up.
9. The MNLM parameter estimates are shown in Appendix A7.

Ethics statement and institutional approval

An ethical clearance for this study was obtained from Uganda National Council for Science and Technology, and informed consent was obtained from all participants.

Disclosure statement

The authors report that there are no competing interests to declare.

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About the author

Emmanuel Bizimungu is a development economist and researcher at Wageningen University, focusing on agricultural value chains, smallholder market inclusion, and climate resilience in sub-Saharan Africa. His work examines how institutional, behavioral, and structural factors shape farmers' decisions and livelihoods. This study on Uganda's soybean value chain is embedded within the broader Climate Resilient Agribusiness for Tomorrow (CRAFT) project, implemented by SNV and partners to enhance smallholder access to climate-smart services and markets. The research aligns with ongoing initiatives such as AICCRA (Accelerating Impacts of CGIAR Climate Research for Africa), which aims to scale climate adaptation practices. Through field-based evidence and policy engagement, Emmanuel seeks to contribute to inclusive agricultural transformation, poverty reduction, and sustainable food systems in Uganda and similar smallholder contexts.

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