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Article in *Journal of Sustainable Development* · March 2016

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Determinants of Smallholder Farmers' Participation in Zambian Dairy Sector's Interlocked Contractual Arrangements

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Received: December 14, 2015 Accepted: January 13, 2016 Online Published: March 30, 2016

doi:10.5539/jsd.v9n2p230

URL: <http://dx.doi.org/10.5539/jsd.v9n2p230>

Abstract

Linking smallholder farmers to modern value chains through contract agriculture (CA) is one of the rural development strategies being promoted to address the challenge of smallholders' integration in markets. However, the conditions under which CA enhances smallholders' prospects for inclusion in modern value chains is still debatable. This paper examines the determinants of smallholders' participation in Zambian dairy markets through interlocked contractual arrangements (ICAs). A multi-stage sampling design was used to select 266 households from milk shed areas from three districts in Lusaka and Central provinces of Zambia. A double-hurdle model was estimated from data collected through semi-structured questionnaires, key informant interviews and focus group discussions. Key determinants of smallholders' participation in ICAs included ownership of improved breed animals, MCC milk price, access to dairy marketing information, income from other sources and landholding size. While most of these factors also affected the proportion of milk sold, the following were also important: household head education level, cattle rearing culture, extent of supplier's dependency on buyer and trust in the exchange relationship. To enhance smallholders' market participation, there is need to facilitate their access to extension services, infrastructure (breeding centres, MCCs and water) and affordable stock feed, and to offer them an effective milk price that is higher than the spot market price. Promotion efforts should target smallholders that are literate, from a cattle rearing culture, and particularly encourage youth and women participation. There is also need for building trust in the exchange relationship and judicious use of power by processors.

Keywords: contract agriculture, dairy farmers' integration, market participation, smallholders linking, rural development strategy

1. Introduction

1.1 Contract Agriculture and Smallholder Farmers' Integration in Modern Value Chains and Markets

Commercialising of smallholders' production and enhancing their integration in markets and more inclusive value chains remains a challenge for most governments in sub-Saharan Africa. Yet it is critical for enhanced food security and rural poverty reduction, because 80% of the food consumed in sub-Saharan Africa is produced by smallholders (Arias et al., 2013), 70% of whom are poor, living in rural areas (IFC, 2011; Making Finance Work For Africa [MFW4A], 2012) and lacking access to markets. Consequently, linking farmers to modern value chains through contract agriculture (CA) is one of the rural development strategies being promoted by policy makers and development agents in developing countries. Within the context of market liberalisation, globalisation, reduced government support to farmers, changing consumer preferences and procurement systems, CA seems to resolve the persistent market failures for smallholders (Da Silva & Rankin, 2013; Han et al., 2013; Jia & Bijman, 2013) by effectively addressing the high transaction costs, information asymmetry and risks constraining farmers' access to modern value chains and markets. However, evidence regarding the conditions under which smallholders' participate in CA is varied.

This variation could be due to two possible reasons. First, differences in commodity types exchanged influence the form of governance structures and mechanisms that develop (Williamson, 1985; Gereffi et al., 2005), and could result in increased diversity of contractual arrangements, that in turn, could affect the significance of

various explanatory variables in explaining smallholders' participation. This, therefore, necessitates studying different cases. Second, the majority of developing countries where these evaluations have been carried out are characterised by varying cost structures, development levels, institutional advancements and experiences, therefore, making the debate particularly for Africa still open.

This paper, makes the following contributions. First, it adds to the on-going debate about the conditions under which CA, particularly ICAs, where output sale, credit and input supply are "interlinked", provide viable market opportunities for smallholders' integration in modern value chains (Reardon et al., 2009; Narayanan, 2010; Arumugam et al., 2011; Bellemare, 2012; Escobal & Cavero, 2012; Fréguin-Gresh et al., 2012; Michelson et al., 2012; Wainaina et al., 2012; Wang et al., 2011; Wang et al., 2013). Most of the post-liberalisation literature on CA simply perceives it as a private-led initiative (Glover & Kusterer, 1990; Little & Watts, 1994; Key & Runsten, 1999; Kirsten & Sartorius, 2002; Singh, 2002). However, the case of contemporary ICAs in the Zambian dairy sector is particularly interesting in that, they represent a more holistic and sustainable approach to rural development, with diverse actors, including non-governmental organisations (NGOs), the private and public sectors, playing major roles in promoting and structuring these institutional arrangements.

Second, in addition to the often assessed effects of demographic and socio economic factors on smallholders' participation in ICAs, institutional factors such as power asymmetry and trust in the exchange relationships have been considered. Power dynamics within value chains influence smallholders' access to critical inputs and finance by reducing transaction costs and availing upgrading opportunities for smallholders. However, the way trust and power are managed between value chain partners could positively or negatively affect relationship satisfaction and threat of opportunism, all of which could influence smallholders' participation in ICAs.

Lastly, smallholders' participation in ICAs, has been considered as an adoption decision of institutional arrangements in output marketing and rural finance. However, the main problem in using survey data when assessing adoption decisions is the significant proportion of households that report zero adoption/participation. The traditional approach to deal with zero observations has been to use the Tobit model originally developed by Tobin (1958), despite its restrictiveness in that, the variables and parameters determining the probability to participate also determine the levels of participation. Due to this assumption, it is implied that the direction (sign) of a given determinant's marginal effect will be the same for both smallholders' participation and intensity of participation once they have decided to participate (Burke, 2009). However, this is not a valid assumption when modelling smallholders' participation in ICA. Consequently, more flexible models are required to allow separate mechanisms for determination of factors that affect smallholders' participation and intensity of participation decisions.

To overcome these restrictive assumptions, alternative studies in agricultural economics literature have used the Heckman's selection model (Heckman, 1976). Mujawamariya and D'Haese (2011), analysed determinants of choice for interlocking in the gum Arabic sector in Senegal and the effect of interlocking on gum production and market participation. Jagwe et al. (2010), examined the effect of transaction costs on smallholder farming households' participation in banana markets in the Great Lakes region of central Africa. This approach involves estimation of a probit model for selection, followed by the insertion of a correction factor (the inverse Mills ratio) calculated from the probit model into the second ordinary least squares (OLS) model of interest. Whereas, the Heckman procedure allows for flexibility of parameterising the probability and level of participation separately, it yields a less efficient estimator than the maximum likelihood Tobit estimator and performs poorly when the normality assumption is violated (Yen & Huang, 1996).

The double-hurdle model originally developed by Cragg (1971) is used in this study, because it is considered to be less restrictive. Various research that have used the double-hurdle model, have established that the probability to use and extent of usage of improved technology could be affected by different set of factors (Genanew & Alemu, 2010). For instance, Hailemariam et al. (2006), established that different factors influence the decision to adopt and intensity of adoption of poultry technology. Other studies that applied the model include: Gebregziabher and Holden (2011), on fertilizer adoption in Ethiopia, Komarek (2010), on banana market commercialisation in Western Uganda and Bekele et al. (2008), on improved pigeon pea varieties in Tanzania.

It is anticipated that the information generated from this study could provide unique policy and practical insights on the conditions critical to smallholders' participation in ICAs and subsequently inform the process of integrating smallholders in modern value chains and markets.

1.2 Types of Contracts and Background of Interlocked Contractual Arrangements in the Zambian Dairy Sector

CA is a form of vertical coordination, involving an agreement between buyers (agro-processors, exporters or retailers at the end of the value chain) and producers, specifying the conditions for production and/marketing of the

agricultural commodity. Generally, CA is a broad concept comprising different types of contract arrangements and provisions, as well as various services that may or may not be included in the agreement (Jia & Bijman, 2013). The contract typology between farmers and buyers often used in literature is that of Mighell and Jones (1963), where contracts are categorised into (i) market-specification, (ii) product-management and (iii) resource-providing contracts. These contracts differ in their main objective(s), and transfer of risks and decision rights from the farmer to the contractor (Jia & Bijman, 2013).

According to Jia and Bijman (2013), a market-specification contract is a pre-harvest agreement between producers and contractors on conditions governing the sale of the agricultural commodity. Conditions include time and location of sales, as well as product quality. Although farmers' uncertainty and transaction costs of finding a market for their produce are reduced, they still bear most of the production risks. Conversely, the production-management contract gives more control to contractors than the market specification contract, since they inspect the production process and specify input usage. Farmers delegate a considerable part of their decision rights over production and harvesting methods to contractors, since these ones take on most of the market risks. Under resource-providing contracts, referred to in this study as "ICAs", contractors not only provide a market outlet for farmers' produce, but also key inputs, the costs of which are deducted from the point of sale. The extent to which decision rights and risks are transferred from farmers to contractors depends on the contract itself.

1.2.1 Interlocked Contractual Arrangements in the Zambian Dairy Sector

In Zambia, the private sector (milk processors, input, financial and other service providers), with the help of NGOs and the government, have forged productive commercial relations with smallholder dairy farmers as suppliers and customers, instead of perceiving them as risky business partners. NGOs, such as Land O'Lakes, Heifer Project International, Agricultural Support Programme, MUSIKA Zambia Ltd, Zambia Agribusiness Technical Assistance Centre, the Herd Book Society of Zambia and World Vision, have facilitated smallholders' linkages to the modern dairy value chain. They have done this by organising them into producer cooperatives, providing them with improved breed animals, technologies and extension services, and building of milk collection centres (MCCs) installed with milk cooling and testing facilities (CAPRA, 2013).

The subsequent organisation of producers and establishment of MCCs has encouraged processors (Parmalat Zambia Ltd, Zambeef, Nice product and Varun Food & Beverages), input providers (feed, milking equipment, veterinary services), formal financial institutions (Zambia National Commercial Bank, Micro Bankers Trust, CETZAM) and insurance companies to partner with smallholders through ICAs. According to CAPRA (2013), through ICAs, linkages with processors, investment capital for infrastructure development, access to market information, improved technologies, extension services, input and financial markets among other things have been realised.

1.3 Determinants of Smallholders' Participation in Contract Agriculture

Various studies have assessed factors influencing farmers' decision to participate in CA. However, evidence regarding the effect of institutional, demographic, socioeconomic and geographic related factors on smallholders' participation decision is varied. Institutional factors, such as existence of transaction specific assets, membership to cooperatives/farmer groups and incentives have been investigated. Some studies (Berdegué et al. 2007; Milczarek-Andrzejewska et al., 2008) show that smallholders' investments in specific assets is crucial for their inclusion in modern value chains. Meanwhile, membership to effective producer cooperatives may increase smallholders' likelihood to participate in CA since cooperatives reduce transaction costs for both farmers and buyers (Bakshi et al., 2006; Helin et al., 2009; Mugandi et al., 2012). Other investigations reveal that smallholders' participation decision is influenced by incentives such as payment date (Mujawamariya & D'Haese, 2011) and relative price offered by modern channels versus traditional ones (Reardon et al., 2009). Besides, Wainaina et al. (2012), identified a positive relation between CA and farmers' risk aversion.

Demographic factors such as education, sex and age are usually explored in empirical studies. With regards to the education level of the household head and smallholders' participation decision in CA, some researchers identify a significant positive relation (Arumugam et al. 2011; Escobal & Cavero, 2012); while others find a significantly negative one (Miyata et al., 2009; Wainaina et al., 2012). A lower probability of women participating in CA than men in Madagascar and Kenya has been established by Bellemare (2012) and Wainaina et al. (2012), respectively; while other scholars establish insignificant gender effects (Arumugam et al., 2011; Fréguin-Gresh et al., 2012). Meanwhile, Bellemare (2012), documents that younger household heads are more likely to participate in CA, while Katchova and Miranda (2004) find the reverse to be true for soy bean farmers in United States and an insignificant relationship for corn and wheat. Besides, Bellemare (2012) establishes that farmers with more farming experience, measured by the number of years farming are more likely to participate

in CA. On the contrary, Zhu and Wang (2007) find the opposite to be true, while Arumugam et al. (2011) establish an insignificant effect. This variation could be due to the probability of more experienced farmers contracting at a diminishing rate (Ramaswami et al., 2006) or because of commodity specific effects. For instance, BIRTHAL et al. (2005), establish that farmers' experience increases the chances of contracting for dairy and vegetable growers yet decreases it for broiler farmers.

Socioeconomic factors such as household resource endowments, access to production enhancing facilities and farmers' specialisation have been investigated by researchers. Various studies have found a significantly positive relationship between land size and farmers' participation (Bellemare, 2012; Escobal & Caverro, 2012; Fréguin-Gresh et al., 2012; Wang et al., 2013), while Leung et al. (2008) establish a negative link and Wainaina et al. (2012) find an insignificant effect. However, the influence of household labour size on farmers' participation is generally insignificant in most of the studies (Miyata et al., 2009; Bellemare, 2012; Ito et al., 2012). Evidence on the influence of farmers' specialisation, measured as the share of income from the primary crop to that from other farm and non-farm activities on their contracting decision is varied. Fréguin-Gresh et al. (2012) find that farmers' specialisation enhances their participation in CA, while Wainaina et al. (2012) show that it decreases it and Arumugam et al. (2011) find an insignificant effect. Moreover, few studies establish that households owning more productive assets are likely to take part in CA than those with relatively fewer assets (Escobal & Caverro, 2012); while the majority identify an insignificant link (Wang et al., 2011; Bellemare, 2012; Wainaina et al., 2012).

Also, the household's access and proximity to production-enhancing facilities has been found to influence smallholders' participation in CA. In India, access to irrigation water is a prerequisite for farmers' participation in gherkin contract farming (Narayanan, 2010). Leung et al. (2008) establish a positive link between the distance to market and farmers' participation in Laos's rice contract farming, while Wainaina et al. (2012) find a negative association in the Kenyan poultry contract farming. Narayanan (2010) documents that most firms contracted suppliers within a 60-100 km radius of the plant, because gherkins need to be processed within hours of harvest. The author suggests that the possible explanation of these differences could be related to the fact that firms may prefer to contract farmers in remote locations since the risk of side selling is lower than in places where farmers have alternative market opportunities, as well as in peri-urban areas where transport and search costs are lowest.

Other factors found to have an influence on farmers' participation decision in CA include farmers' observed experience of participants' profits from CA (Michelson et al., 2012) and previous experience with CA (Zhu & Wang, 2007). In South Africa, Fréguin-Gresh and Anseeuw (2013) conclude that, without public support, it seems unlikely for smallholders to engage in CA. Meanwhile, Narayanan (2010) establishes a positive link between agro-ecological factors, such as climate and soil conditions and farmers' participation decision, although these vary by crop. Noting, further, that Indian farmers sometimes decline profitable contracts because of health and environmental risk concerns.

1.4 Study Objectives and Research Questions

Based on empirical research on ICAs in the Zambian dairy sector, this paper analyses the determinants of smallholders' decision to participate and intensity of participation in these institutional arrangements.

The research questions the study addresses are:

- (i) What is the criteria used by milk processors and MCCs to select smallholders' that participate in ICAs?
- (ii) What demographic, socio-economic, institutional and cultural factors influence smallholders' decision to participate in ICAs?
- (iii) What demographic, socio-economic, institutional and cultural factors influence smallholders' intensity of participation in ICAs?

2. Method

This study used data from a cross-sectional survey conducted from August-December 2014 in three districts of Zambia with presence of ICAs in the dairy sector. Data was collected in two stages. The first one involved in-depth interviews of key informants from selected dairy processing companies and MCCs. Through these interviews, qualitative insights were gained that helped in interpretation of the quantitative results. The second phase involved a household survey of smallholder dairy farmers having 1-50 animals. Primary data was collected from respondents through semi-structured questionnaires.

2.1 Sampling

A multi-stage sampling design was used, where purposive sampling was employed to select: (i) two milk shed

areas clustered by province; (ii) three districts within the sampled milk sheds, which included Chongwe for Lusaka province, Kabwe and Chibombo for Central province; and (iii) four MCCs from the sampled districts. The milk shed areas and districts were purposively chosen based on their proximity and existence of ICAs, while duration of existence (more than 5 years) was used to choose MCCs. A two-stage cluster sampling design was then applied to randomly pick the primary (standard enumeration areas) and secondary (households) sampling units. Probability proportional to size was used to select the sampled standard enumeration areas, while systemic sampling was employed to choose a sample of 113 households participating in ICAs and 171 non-ICA participants. A ratio of 3:2 of the sample size of control group to treatment group was applied in order to handle the selection biases, since selection of ICA participants was not done randomly. Due to nonresponse, the final sample size came to 103 and 163 for treatment and control groups, respectively, giving a total of 266 households.

Lastly, purposive sampling was used to choose three milk processors. Zammilk, a subsidiary of Zambeef Plc, and Mpima Dairy Producers' Cooperative Society are vertically integrated, controlling the various value chain stages, from production to processing through distribution. However, Zambeef is a public limited company producing 52.25% of the milk it processes, while Mpima is owned by dairy cooperative members. In contrast, Parmalat Ltd is a private limited company that outsources all the milk it processes from local dairy farmers.

2.2 Data and Sources

Both qualitative and quantitative data was collected. Qualitative information from milk processors and MCC representatives comprised of services offered to ICA participants and smallholders' selection criteria. For smallholders, it included dairy management practices, herd composition and land tenure system.

Quantitative data incorporated information on demographic and socio-economic characteristics, distances to key production-enhancing facilities, relationship duration, milk production, sales and consumption and plant capacity utilisation and institutional factors. Multiple scale items were used to operationalise the institutional variables. These items were obtained from past research and in consultation with relevant stakeholders, and were later modified to suit the study context. A 7-point Likert scale with end points of "strongly disagree" and "strongly agree" was used to measure the items. Data regarding institutional variables was collected from both processors and smallholders and arithmetically averaged to reach the final score for each.

Trust, concerns the confidence or belief that one partner possesses about the honesty and benevolence of the other exchange partner (Kumar et al., 1995). Five items developed by Kumar et al. (1995) were used to measure trust. Buyers' and suppliers' power was assessed in terms of replaceability, switching costs, difficulty in changing partner and overall dependence (Kumar et al., 1995; Lusch & Brown, 1996). Power magnitude was then determined by taking the sum of both powers, and power asymmetry was calculated by subtracting the supplier's power (Lusch & Brown, 1996). Attempts were made to test the reliability and validity of the multiple scale items used for this study. The Cronbach α of each multi-item variable is over 0.7 showing internal consistency for each of these variables (see Appendix A).

2.3 Analytical Methods

Data was edited and coded to ensure accuracy, validity, uniformity, consistency and completeness. Characterisation of smallholders' participation in ICAs was done through generating descriptive statistics using Stata12 computer program. Detailed analysis was carried out by employing measures of dispersion and central tendency, as well as data normality tests. Meanwhile, the double-hurdle model (Cragg, 1971) was used to assess factors influencing smallholders' participation decision and intensity of participation in ICAs.

According to Greene (2000), the double-hurdle model is a generalisation of the Tobit model, where the decision to participate and the level of participation are determined by two separate stochastic processes. Whereas, in some aspects, parameterisation of the double-hurdle model is similar to that of Heckman procedure, in that, two separate sets of parameters are obtained in both cases; the double-hurdle model is considered to be less restrictive. This is because in the Heckman model, non-participants will never participate under any circumstances. Conversely, in the double-hurdle model, non-participants are considered as a corner solution in a utility maximising model (Yami et al., 2013). Within the context of ICAs, the double-hurdle model assumes that the zero values reported in the first hurdle arise from smallholders' deliberate choice not to participate in ICAs, while those in the second hurdle come from smallholders that would not have sold milk through ICAs due to their deliberate choice or random circumstances.

The double-hurdle model required the joint use of the Probit and the truncated regression models, where it is assumed that the decision to participate and level of participation in ICAs are determined by two separate stochastic processes. The formal model of the first hurdle or the participation decision equation is estimated with

a normal probit model given below:

$$D_i^* = \alpha'Z_i + v_i, \quad (1)$$

$$D_i = 1, \text{ if } D_i^* > 0 \text{ and } 0 \text{ if } D_i^* \leq 0$$

Where, D_i^* is a latent variable that takes the value 1 if the farmer sells milk through ICAs and zero otherwise; and α is a vector of parameters. Z is a vector of explanatory variables that include: demographic, socioeconomic, institutional and cultural factors, while v is a vector of error terms

The formal model of the second hurdle or intensity of participation equation is given below:

$$Y_i^* = \beta'X_i + \mu_i, \quad (2)$$

$$Y_i = Y_i^*, \text{ if } Y_i^* > 0 \text{ and is } D_i^* > 0,$$

$$Y_i = 0, \quad \text{otherwise}$$

Where, Y_i^* and Y are latent and observed levels of participation in ICAs respectively. The level of participation in ICAs was estimated by the proportion of milk sold through ICA (%); where the numerator equals the quantity of milk sold through ICAs and the denominator equals the total milk sold both to ICAs and other channels. β is a vector of parameters to be estimated and X_i is a vector of variables (demographic, socioeconomic, institutional and cultural factors) influencing the households' level of participation in ICAs, while μ is a vector of error terms

3. Results and Discussion

This section highlights the benchmark used by processors and MCCs to choose smallholders that take part in ICAs. It also compares various characteristics of smallholders that are involved and those that do not take part in ICAs to establish whether there are any significant differences. Lastly, the determinants of smallholders' participation decision and levels of participation in ICAs are presented and discussed.

3.1 Criteria Used by Milk Processors and MCCs to Select Smallholders' That Participate in ICAs

Governance related issues, like membership to a registered dairy cooperative and capacity to adhere to agreed upon contractual terms in terms of quality and quantity of milk supplied and having a healthy herd were the main criteria used for selection of smallholders that supplied milk to the processing companies. Well organised farmer groups reduce transaction costs and risks for both smallholders and milk buyers; thus allowing smallholders to tap into modern value chains and compete favourably with large-scale farmers and agribusinesses. Also membership to a dairy cooperative enables smallholders' develop collective assets, which facilitate their access to production resources such as bulking and storage facilities and even own milk processing plants as in the case of Mpima dairy scheme. It also serves as an effective conduit for accessing services like milk testing, transportation, dairy loans, extension services and improved technologies that increase productivity. Quality issues comprised of farmers meeting the milk safety and sanitation regulations (product safety, acquisition of tuberculosis and brucellosis certification); milk freshness, low microbial count, lack of water adulteration and chemicals/antibiotics.

Meanwhile, the main criteria for farmers' participation in the MCCs included: compliance to the norms of the MCC such as being paid up members, adherence to agreed delivery schedules, milk handling and sanitation practices. In addition to these rules, Palabana dairy cooperative required that members supply a minimum of 11 litres /day, while Chibombo dairy cooperative required that farmers must be trained in dairy management practices and come from a distance of ≤ 50 Km from the MCC.

3.2 Characterisation of Smallholders' Participation in Interlocked Contractual Arrangements

Table 1 presents mean comparison of selected sample characteristics, between ICA and non-ICA participants. Results reveal that there were significant differences ($p < 0.01$) in the level of education of household head, ownership of improved breed animals, number of lactating animals owned, proximity to the MCC, town, milk trader, dip tank, tarmacked road and electricity source. Likewise, significant differences ($p < 0.05$) in value of non-land assets owned and proximity to the input dealer are observed. Also households participating in ICAs and those that do not participate, were significantly different ($p < 0.1$) in the household labour size, landholding size and number of local breed animals owned, and their proximity to veterinary camp and water source.

Generally, households involved in ICAs had household heads with two more years of education than non-participants. A similar trend is notable for labour availability, where ICA participants had above average household labour size compared to their counterparts. Likewise, households taking part in ICAs owned about 3.8

times the number of improved breed animals and double the number of lactating animals than non-participants. Conversely, non-ICA participants had about 1.5 times more local animals, 5 ha more land and their value of non-land assets was 5.65 times that of their counterparts. Moreover, homesteads of households participating in ICAs were closer to MCCs, veterinary camp, dip tank and electricity source than non-participants. In contrast, non-ICA participants' homesteads were closer to town, milk trader, input dealer, tarmacked road, and water source than their counterparts.

Table 1. Comparison of selected sample characteristics between ICA and non - ICA participants

Characteristic	Overall (1) (n=266)	Non-ICA Participants (2) (n=163)	ICA Participants (3) (n=103)
<i>Demographics</i>			
<i>Means</i>			
Age of household head	51.7 (14.0)	51.0 (14.4)	52.9 (13.1)
Household head education level (years)	8.3 (4.14)	7.5 (3.35)	9.7 (4.91)***
Dairy experience (years)	8.0 (7.82)	7.7 (7.77)	8.3 (7.94)
Total labour availability(hired and family labour)	4.2 (1.94)	4 (1.76)	4.4(2.19)*
<i>Socio- economic factors</i>			
Landholding size (ha)	10.8 (21.77)	8.9 (11.53)	13.8(32.12)*
Value of non-land assets owned (ZMK)	101 670.2 (625 618.5)	36 975.3 (52 181.3)	209 063.8** (1 012 164)
Number of improved breed animals owned	4.1(8.88)	2.1 (5.8)	7.6 (11.7) ***
Number of local breed animals owned	6.6 (8.34)	7.3 (6.96)	5.5 (10.15)*
Number of lactating animals owned	2.3 (2.76)	1.7 (1.93)	3.3(3.54)***
Income from other sources (ZMK)	5 167.1 (37 378.0)	6 073.2 (46 692.4)	3 662.8 (10 121.5)
Distance to nearest MCC (Km)	11.53 (15.37)	15.94 (17.65)	4.21 (5.10)***
Distance to nearest town (Km)	15.10 (10.38)	13.34 (9.00)	17.98 (11.79)***
Distance to the nearest milk trader (Km)	14.21 (17.61)	11.13 (15.35)	18.62 (19.69) ***
Distance to the nearest input dealer (Km)	15.13 (12.57)	13.62 (10.03)	17.73 (15.76)**
Distance to the nearest veterinary camp (Km)	8.97 (6.55)	9.53 (6.47)	8.05 (6.61)*
Distance to the nearest dip tank (Km)	6.80 (6.12)	8.03(6.30)	4.38 (4.96)***
Distance to the nearest Tarmacked road (Km)	8.1(7.00)	6.21(5.73)	11.33(7.79)***
Distance to the nearest water source (Km)	0.89(2.34)	0.54 (2.16)	1.11 (2.42)*
Distance to the nearest electricity source (Km)	4.30 (5.18)	5.32 (5.19)	2.90 (4.85)***

Source: the authors. Significant levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard deviations in parentheses.

Table 2 compares percentages for selected sample characteristics between ICA and non-ICA participants. Whereas there is no significant difference regarding gender of household head and youth headed households, overwhelmingly, few female and youth (20-35 years) participated in the modern dairy value chain. This is an issue of concern because majority of the rural poor in Zambia are women and youth, with youths comprising 70% of the country's population, 75% of these are unemployed (CSO, 2012).

Also results show a significant difference ($p < 0.01$) between ICA and non-ICA participants regarding access to production enhancing facilities, extension services and improved technologies. Although, ICAs seem to enhance smallholders' access to improved technologies and extension services, 21% of the ICA participants have never received any dairy management training. Also of concern is that, only 6% of the households taking part in ICAs

reported having had access to discounted dairy inputs such as feed and dairy equipment, yet all the processors indicated that they linked them to input suppliers. One would have assumed that such linkages, coupled with economies of scale enjoyed by cooperatives like bulk purchasing and transportation, would bring down the costs of inputs. In fact, respondents suggested the need to lower costs of feed supplements in order to cut down feeding costs especially during the dry period. Lastly, results show that there is no significant difference between households participating in ICAs and their counterparts regarding access to water throughout the year and whether they come from a cattle rearing tradition or not.

Table 2. Comparison of percentages for selected sample characteristics between ICA and non - ICA participants

Characteristic/Variable	Overall (1) (n=266)	ICA-Participants (2) (n=103)	Non-ICA Participants (3) (n=163)	Pearson chi2 (χ^2) (4)
<i>Demographics</i>		<i>Percentages</i>		
Household head is a youth (≤ 35 years)	13	11	14.5	0.653
Sex of household head (female)	0.1	12	0.5	0.900
<i>Socio-economic factors</i>				
Dairy cooperative member	38.7	83	12.0	132.40***
Access electricity	32.7	43	26.5	7.714***
Access water throughout the year	69.5	67	71	1.054
Received training on dairy management practices	61.65	79	51	20.393***
Access dairy marketing information	16.2	25	10.8	9.229***
Access discounted inputs	3.75	6	2.4	2.223
Uses improved bull	12.8	26	4.8	25.111***
Practice artificial insemination	3.4	8	0.6	10.447***
Practice intensive dairy management practices	31.58	51	19.9	27.973***
<i>Cultural factors</i>				
Cattle rearing culture	60.15	54	63.8	2.529

Source: the authors. Significant levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.3 Factors Influencing Smallholders' Participation Decision in Interlocked Contractual Arrangements

Results from the first stage of the double-hurdle/Probit model are presented in Table 3. Key determinants of smallholders' participation in ICAs are: ownership of improved breed animals, MCC milk price, proximity to water source and MCC, landholding size, gross income from other sources, access to dairy marketing information, number of lactating animals and value of non-land assets owned.

The marginal effects (column 3) indicate that an additional improved breed animal (pure/cross) to the herd was associated with a 58.4% increase in the household's probability to participate in ICAs. Smallholders with improved breed animals present lower risks and costs to the modern channel in terms of volumes produced and reliability of supply than those owning local breeds. Also, ownership of improved breed animals is an indicator of the level of specialisation in dairy farming and extent of use of improved management practices, both of which enhance the milk quantity and quality produced and participation in ICAs.

Likewise, an additional ZMK to the milk price offered by the MCC/processor was related to a 50.4% rise in the household's likelihood to participate in ICAs. The relative price of the product offered to smallholders after controlling for product quality and considering the relative costs and risks incurred in meeting the product quality and transaction requirements of the modern channel compared to the traditional channel, determine the

profit levels and feasibility of a transaction (Reardon et al., 2009).

Similarly, access to dairy marketing information was linked to an increase of 34.9% to the household's chance of participation in ICAs. Access to dairy marketing information about distribution channels, prices, product quantities and quality creates awareness of the available market opportunities and the extent of risks involved.

Equally, an additional ZMK to the value of non-land assets was associated with an increase in the household's prospects to participate in ICAs. Ownership of productive assets such as tools/equipment and farm buildings can be related to the producer's ability to deploy working capital and generate positive cash flows. These farmers may also be expected to commercialise faster and at a larger scale, partly because they have the means to invest in new ventures and can usually bear the risk of failure. In addition, they would probably have invested more in transaction specific assets aimed at increasing productivity and crucial for inclusion in ICAs.

Table 3. Probit estimate of factors influencing smallholders' participation decision in interlocked contractual arrangements

Variable	Parameter estimate (1)	Robust Std. Err (2)	Marginal effects (3)
Constant	-7.8919	4.0416	
Age of household head (Years)	0.1664	0.1300	0.0600
Age of household head squared (Years)	-0.0014	0.0011	-0.0005
Sex of household head ((Male =1, Female = 0)	0.2934	0.4277	0.1058
Education level of household head (Years)	0.0293	0.0427	0.0106
Household size	-0.0194	0.1582	-0.0070
Family labour size	-0.1903	0.2242	-0.0686
Landholding size (ha)	-0.0135***	0.0041	-0.0049
Value of livestock owned (ZMK)	-1.03e-07	8.21e-08	-3.73e-08
Use of improved bull (Yes=1)	0.5357	0.5274	0.1932
Intensity of management practices (1=Intensive)	-0.8297	0.5551	0.0271
Value of non-land assets owned (ZMK)	6.58e-06**	2.87e-06	2.37e-06
Number of lactating animals owned	0.0750*	0.0442	-0.2712
Ownership of improved breed animals (Yes=1)	1.6937***	0.4004	0.5843
Gross income from other sources (ZMK)	-0.00005***	0.00002	-0.00001
Distance to nearest MCC (Km)	-0.0343**	0.0146	-0.0124
Distance to the nearest water source (Km)	-0.1062**	0.0464	-0.0383
Access to dairy marketing information (Yes=1)	0.9666**	0.4536	0.3487
Access to electricity (Yes=1)	-0.6357	0.4430	-0.2293
MCC milk price (ZMK)	1.3960***	0.2042	0.5036
Household emanates from cattle rearing culture (Yes=1)	0.5862	0.4428	0.2034
Number of observations	266		
Log pseudolikelihood	-24.9412***		
Pseudo R2	0.8584		
Predicted probability	0.3268		

Source: the authors. Dependent variable: whether the household sold milk to MCC (= 1) or not (= 0). Significance: *** p<0.01, ** p<0.05, * p<0.1.

Conversely, the results show that an additional kilometre to the distance from the homestead to the nearest water source was associated with a 3.8% drop in the household's probability to participate in ICAs. Water is a critical resource in dairy farming. When animals travel long distances looking for water, it not only lowers their productivity but also affects the smallholder's ability to meet the strict MCC milk delivery schedules. Likewise, an additional kilometre to the distance from the homestead to the MCC would decrease the household's chances to participate in ICAs by 1.2%. This finding resonates with that of Narayan (2010) and Wainaina et al. (2012) but conflicts with that of Leung et al. (2008). The negative relationship could be due to increased transportation costs. In fact, one of the MCC officials indicated that one of the criteria for selection of ICA participants was that farmers should come from a distance of ≤ 50 Km from the MCC.

Results further reveal that an additional lactating animal to the household herd would decrease the household's chances of participating in ICAs by 27%, holding other variables in the model constant. Smallholders that own more lactating animals would probably produce higher volumes of milk and therefore, would have the capacity to exploit other markets besides ICAs or even directly forge linkages with milk processors at reduced costs per unit.

An additional hectare to the landholding size was associated with a 0.5% decrease in the household's probability to participate in ICAs. This could be due to differences in intensity of management practices where ICA participants tend to practice zero and/fenced or paddock grazing which require less land compared to extensive management practices employed by their counterparts. Lastly, an additional ZMK to gross income from other sources was linked to a decline in the household's likelihood to participate in ICAs. This could be explained by differences in levels of specialisation, where increase in income from other sources could be an indication of reduced specialisation in dairy farming.

The effect of the rest of the variables on smallholders' decision to participate in ICAs was insignificant. Nonetheless more male headed households were more likely to participate in ICAs than female headed households. Besides, a positive relation is associated with smallholders' participation in ICAs and the use of improved bull, age and education level of household head and households coming from a cattle rearing culture. In contrast a negative relation was established between smallholders' participation in ICAs and household size, availability of family labour, value of livestock owned, intensity of management practices and access to electricity.

3.4 Factors Affecting Smallholders' Intensity of Participation in Interlocked Contractual Arrangements

Table 4 presents results for the second stage of the double-hurdle model/truncated regression regarding determinants of proportion of milk that smallholders' sell through ICAs. The key determinants are: education level of household head, access to dairy marketing information, proximity to MCC and water source, household coming from cattle rearing culture, level of trust within the exchange relationship and extent of supplier dependency on milk buyer.

Results show that an additional year to the educational level of the household head would lead to 2.2% increase in the proportion of milk that the household sells through ICAs, other variables in the model held constant. It is expected that household heads that are educated can easily understand contractual terms and access various information sources needed to enhance and sustain their levels of participation in ICAs.

Results further reveal that the use of intensive dairy management would increase the proportion of milk that the household sells through ICAs by 8.0%, other variables in the model held constant. Enhanced use of intensive dairy management practices increases productivity, which subsequently influences competitive priorities such as reliability, efficiency, milk quality and volume produced. With these competitive advantages, the smallholder would gain more by selling most of the milk through ICAs since he/she would be rewarded for product quality. Moreover, an increase in the distance from the homestead to the nearest MCC would increase the milk that the household sells through ICAs by 1.1% other variables in the model held constant. Smallholders that are far from MCCs are probably also distant from town and other alternative milk markets. Therefore, they would resort to selling their milk to the only available market which is the MCC.

Results also reveal that an increase in the level of trust within the buyer-supplier exchange relationship would increase the proportion of milk that the household sells through ICAs by 1.4%. The more the exchange partners trust each other, the more they are committed to and cooperate with each other. They also resist attractive short-term alternatives such as side selling, in favor of expected long-term benefits. Besides, households that come from a cattle rearing culture are likely to sell a higher proportion of their milk (7.2%) than their counterparts, other variables in the model held constant. People coming from a cattle rearing culture have a keen interest in dairy farming since rearing these animals is their way of life. This coupled with skills and knowledge

to improve their productivity, their level of participation in ICAs is likely to be higher than their counterparts.

Table 4. Truncated regression estimates of factors influencing the proportion of milk smallholders' sell through interlocked contractual arrangements

Variable	Parameter estimate (1)	Robust Std. Error (2)
Constant	42.9616***	14.0524
Age of household head (Years)	0.1082	0.1483
Sex of household head (Male =1, Female = 0)	7.9632	5.7706
Education level of household head (Years)	2.1970***	0.4520
Landholding size (ha)	0.0592	0.0588
Intensity of management practice (1= Intensive)	7.9530*	4.4740
Value of non-land assets owned (ZMK)	-2.49e-06	1.97e-06
Ownership of improved breed animals(Yes=1)	2.7307	4.4294
Income from other sources (ZMK)	-0.0001	0.0002
Distance to nearest MCC (Km)	1.1114***	0.3728
Distance to the nearest water source (Km)	-2.4375***	0.9282
Access to dairy marketing information (Yes=1)	-12.0422***	4.3670
Access to electricity (Yes=1)	-3.3249	3.9807
Extent of supplier dependency on milk buyer	-2.9521*	1.7211
Level of trust between milk supplier and buyer	1.4066*	0.7749
Household comes from cattle rearing culture (Yes=1)	7.2179*	3.8570
Number of observations	101	
Log pseudolikelihood	-431.1949***	

Source: the authors. Dependent variable: proportion of milk sold through ICAs. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

In contrast, an increase in the household's income from other sources is likely to decrease the proportion of milk that the household sells through ICAs, other variables in the model held constant. This could be explained by differences in levels of specialisation. It is expected that farmers that are less specialised in dairy farming would have more income from other sources than from milk sales compared to their counterparts. Likewise, a unit increase in the level of smallholder's dependency on the milk buyer would reduce the proportion of milk that the household sells through ICAs by about 3.0%. The results seem to suggest that increased power asymmetry could have a negative effect on the relative milk quantities smallholders sell through ICAs. This is probably due to relationship dissatisfaction and threats of opportunism, especially where the more powerful firms in a value chain are likely to exploit the less powerful (smallholders) and receive the greatest benefits from the business transactions. Whereas increased access to dairy marketing information raised the chances of smallholders participating in ICAs, it decreased the proportion of milk that they sell through ICAs. This is because such farmers would be knowledgeable of available market opportunities and would exploit them especially if they offer better incentives than ICAs.

The rest of the variables had insignificant effects on the proportion of milk that smallholders sell through ICAs. However, male headed households are likely to sell a high proportion of milk through ICAs. Age of household head, landholding size and ownership of improved breed animals had positive effects on the proportion of milk that smallholders sell through ICAs. While a negative relation was established between the proportion of milk that smallholders sell through ICAs and the value of non-land assets, income from other sources and access to electricity.

4. Conclusion

Commercialisation of smallholder production and enhancing their integration in markets and more inclusive value chains remain a challenge for most countries in sub-Saharan Africa like Zambia. Linking farmers to modern value chains is seen by many as one way to address this challenge. This study determined the factors influencing smallholders' participation in ICAs in the Zambian dairy sector. Data were from a survey of rural households, MCCs and dairy processing companies in three districts with presence of ICAs in the dairy sector.

The criteria that MCCs and processors used to select smallholders that participated in ICAs included: membership to dairy cooperative, adherence to contractual terms with regards to delivery schedules, quality and quantity of milk supplied and having a healthy herd. Results further showed that whereas ICAs facilitate smallholders' integration in modern value chains, participation of women and youths is overwhelmingly low, yet they comprise majority of the rural poor in Zambia. Comparison of ICA and non-ICA participants indicates that households of ICA participants had more labour, improved breed animals and households with above average level of education than their counterparts. Their homesteads were also closer to production enhancing facilities such as MCCs, veterinary camp, dip tank, electricity source than non-ICA participants. In contrast, non-ICA participants were closer to town, milk trader, input dealer and water source than ICA participants. They also had more local animals and land, and a higher value of non-land assets than their counterparts.

The double-hurdle model results concerning the determinants of smallholders' participation and intensity of participation in ICAs revealed that these two sequential decisions were influenced by different set factors, with the exception of access to dairy marketing information, proximity to MCC and water source. In this regard, the other factors that influenced smallholders' participation decision in ICAs included: ownership of improved breed animals, MCC milk price, landholding size, gross income from other sources, number of lactating animals and value of non-land assets owned. In contrast, additional determinants of smallholders' decision regarding intensity of participation in ICAs (proportion of milk sold) were education level of household head, cattle rearing culture, extent of supplier's dependency on milk buyer and level of trust within the exchange relationship.

Therefore, to enhance smallholders' participation in ICAs and modern value chains, it is important that the government, private sector and other supporting agencies increase their efforts aimed at enhancing smallholders' productivity such as access to extension services, dairy marketing information and animal breeding programs. Specifically the government, probably with the help of other stakeholders, need to invest in infrastructure such as breeding centers, water and MCCs so as to bring production enhancing facilities closer to the communities. Cooperatives should not only focus on assisting members market their milk but also facilitate their acquisition of relatively cheaper stock feed by exploiting economies of scale through bulk purchases and transportation. Capacity building of cooperatives is also critical in negotiation and business skills so that the smallholders' voice can be heard. This would subsequently reduce power asymmetry in the buyer-supplier exchange relationships and positively influence rewards derived from business transactions. On the other hand, processors (powerful buyers) need to judiciously use their power to create a more integrated value chain that benefits both themselves and their suppliers. Particular attention should be placed on incentivizing smallholders by offering them a net milk price that is above the spot market price. This is because smallholders incur additional costs in supplying a high quality product to processors than to the spot market. Also, it is important that milk buyers and smallholders build trust in the exchange relationship since trust yields commitment to long-term relationships and enhances value chain performance. Lastly, promotion efforts of ICAs in the dairy sector, should target smallholders that are literate, from a cattle rearing culture and particularly encourage youth and women participation.

Acknowledgements

The authors are grateful to: African Economic Research Consortium for their research support; Management of Zambeef Plc, Parmalat Zambia Ltd and Mpima dairy producers' cooperative society and their respective MCCs for permission to undertake the study in their respective catchment areas; and insightful comments received from staff from the Department of Agricultural Economics and Extension, University of Zambia and Department of Agribusiness and Natural Resource Economics, Makerere University, Uganda.

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APPENDIX A

Table A.1. Construct reliability test for multi-item variables

	Cronbach α	
	Buyer (B)	Supplier (S)
<i>Trust</i>	0.80	0.80
TST01: We believe in the supplier (buyer) because s/he is sincere		
TST02: Though the circumstances change, we believe that the supplier (buyer) will be ready and willing to offer us assistance and support		
TST03: When making important decisions, the supplier (buyer) is concerned about our welfare or interests		
TST04: We can count that the supplier (buyer)'s future decisions and actions will not adversely affect us		
TST05: When it comes to things that are important to us, we can depend on the supplier's (buyer's) support		
<i>Power Asymmetry</i>	0.88	0.87
PWA01: It would be difficult for the buyer (supplier) to replace the milk sales and profits realised from your business with another supplier's milk (buyers).		
PWA02: The buyer's (supplier's) total costs of switching to another comparable supplier (buyer) would be prohibitive		
PWA03: The buyer (supplier) is strongly dependent on the milk supplied(bought) by your firm		

Notes: B stands for milk buyer (processing firms), S connotes milk supplier (smallholders).

Table A.2. Measures of Fit for Probit model of factors influencing smallholders' decision to participate in ICAs

Log- Lik Intercept only	-176.103	Log- Lik Full Model	-24.941
D (245)	49.882	LR (20)	302.324
		Prob > LR	0.000
McFadden's R^2	0.858	McFadden's Adj R^2	0.739
Maximum Likelihood R^2	0.679	Cragg & Uhler's R^2	0.925
McKelvey & Zavoina's R^2	0.970	Efron's R^2	0.893
Variance of y^*	33.796	Variance of error	1.000
Count R^2	0.974	Adj Count R^2	0.930
AIC	0.345	AIC*n	91.882
BIC	-1318.074	BIC'	-190.654

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