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Vertical Coordination to Smallholder Small Grain Growers in Zimbabwe: Benefits of Contract Farming and Policy Implications

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ABSTRACT

Zimbabwe's agro-ecological regions IV and V lie in low rainfall areas and food security is a perennial concern. Vertical coordination strategies and market institutions provide hope for building farmer resilience in regions affected by climate change in Zimbabwe. This study focused on four districts (Binga, Chiredzi, Hwange, Matobo) which are in regions IV and V. A questionnaire was used to collect data from 281 respondents. Probit and Multiple linear regression models were used to evaluate the determinants. Results show that contract farmers allocated more than 3 hectares to small grains agricultural enterprise. The research established that long distances to markets, access to credit, extension services and affiliation to farming groups are some critical determinants which influence market participation and yields sold.

Keywords: *Vertical coordination; contract farming; market participation; credit access; small grain.*

1 Introduction

Globally, agriculture remains the mainstay of economic activity and a key driver for sustainable livelihoods. In Zimbabwe the majority of the population lives in rural areas where livelihoods are hinged on agriculture. In spite of past measures to stimulate rural food production and incomes, food insecurity remains highly prevalent in the low rainfall communal areas of Zimbabwe. Millets' vital nutrients and the protein content of millets grains are regarded as equal to or superior in comparison to wheat (*Triticum aestivum*), rice (*Oryza sativa*), maize (*Zea mays*) and sorghum (*Sorghum bicolor*) grains (Kajuna, 2017). Due to the richness of millets in polyphenols and other biological active compounds, they are also considered very important in lowering rates of fat absorption, slow release of sugars (low glycaemic index) and thus reducing risk of heart disease, diabetes and high blood pressure (Kumar *et al.,* 2018). Similarly, the study is in tandem with ICRISAT International Crops Research Institute for the Semi-Arid Tropics' (ICRISAT) (2021) findings which reported that millets have high levels of essential elements such as iron, zinc, calcium and protein. Sorghum grain contains 11.3% protein, 3.3% fat, and 56–73% starch (Nciizah *et al.,* 2021). Thus, small grains have the capability of providing the nutritional value that can boost the immune system.

Bang *et al.* (2003) point out that small grains are generally the most drought-tolerant cereal grain crops as they require little inputs during growth. Furthermore, sorghum and millet also have deeper roots than maize and can withstand higher temperatures without damage to the crop (Orr *et a*l., 2016). Adoption of drought-tolerant small grain varieties in semi-arid regions holds hope for the realization of food security in Zimbabwe. Despite the importance of small grain as an adaptation measure from climate change crisis, very little sorghum and millet is commercially processed compared to maize. In order to increase commercialization of the sorghum and millet sector there is need for effective participation of key actors involved in the production-to-consumption chain.

Marketing opportunities are limited for small grains. The perennial absence of strong and responsive market linkages among value chain actors is a problem since it has a close relationship with compromised livelihoods (Escobal *et al.,* 2015). There are limited formal marketing opportunities for sorghum, millet, and rapoko, although a lot is being done to support the crops (Phiri *et al.,* 2019). Research must address the challenges these value chain actors face and foster linkages between them in a way that will achieve commercialization. Value chain addition for small grain initiatives is lacking both from government and non-governmental organizations. Vertical coordination is the missing link that needs to be addressed. Although efforts have been done by some partners to link farmers to niche markets such as brewing companies, a big consumer of sorghum as well as non-governmental organizations involved in seed distribution programmes in Zimbabwe, it has not yielded significant results.

This study investigates the factors influencing vertical coordination strategies in four districts (Binga, Chiredzi, Hwange, and Matobo) in Zimbabwe's low rain fall regions IV and V. In the four case study sites, a particular emphasis was placed on vertical coordination mechanisms in the small grain value chain that impede marketing by smallholder small grain farmers. The paper includes a brief background, an outline of the theory that guided this study, a brief outline of the guiding methodology, a discussion of the results, and conclusions and recommendations for action and future research.

2 Background

2.1 Overview

Government and Non-governmental Organizations have a long way to go in terms of adding value to small grains through vertical coordination mechanisms. Small grain is the crop of choice in semi-arid regions, but there is limited use of vertical coordination and effective marketing of the crop remains low. Despite the various past intervention measures to stimulate rural food production and incomes, food insecurity remains highly prevalent in low rainfall areas of Zimbabwe. While the Government of Zimbabwe (GoZ) and its development partners have realized the importance of small grains production from a climatic adaptation point of view, development of small grains value chain (from production all the way to processing and consumption) remains an issue of deep concern (United Nations Development Program (UNDP), 2018). In fact, small grains have received little support in terms of both the promotion and financing their production in dry regions of Zimbabwe as compared to maize which was the mainstay of nutrition and staple food of choice for most Zimbabweans (Phiri *et al*., 2019; Mathew, 2015).

According to Rukuni *et al*. (2006) farmers in low rain fall districts continue growing maize crops notwithstanding the fact that small grains perform better under dry conditions. Reasons contributing to low adoption of small grains in semi-arid regions include: inadequate seed production and delivery systems for small grains, unpredictable markets, and lack of appropriate processing technologies like threshers and milling machines. Recent studies have raised concern over the limited formal marketing opportunities for small grains such as sorghum, pearl millet and finger millet (Phiri *et al.*, 2019). It is apparent that, like other economic production, sustainability of small grain production hinges on assured markets

without which farmers have little incentive to produce. In order to reverse the farmers' loyalty to maize production despite the perennial low yields, there was need for pragmatic policy interventions and strong incentives to expand the production of small grains in low rainfall areas.

While efforts have been made by the GoZ and its partners to link farmers to niche markets such as brewing companies who are the big consumer of sorghum as well as non-governmental organizations involved in seed distribution programmes in Zimbabwe, these measures were piece meal and have not yielded significant results. In other words, little has been done to promote vertical coordination mechanisms such as production contracts across upstream and downstream stages. Agricultural policies and institutions encourage production of maize, not small grains. Rukuni *et al.* (1994) argue that lack of government support in Zimbabwe for production, processing, and use of crops that are tolerant to drought has resulted in people in the drier areas changing their tastes from small grains to maize. This study provided this missing link by examining small grains vertical coordination strategies in Zimbabwe's agro-ecological regions 1V and V. It is therefore against such a background that the study was carried out to analyse the impact of small grain productivity under contract farming versus non-contract farming on food security and livelihoods of communal farmers in Zimbabwe with particular reference to Binga, Chiredzi, Hwange and Matobo districts.

2.2 Research Objectives

The research objectives aim at

a) determining the vertical and horizontal coordination mechanisms between small grain smallholder farmers and other value chain actors in the drought prone areas of Zimbabwe,

b) identifying factors affecting market participation in smallholder small grain farmers in Zimbabwe, and

c) recommending a policy that will promote marketing small grain in Zimbabwe.

2.3 Conceptual Framework

The study adopted the Vertical Coordination framework to examine the determinants for small grain market participation by smallholder farmers in four districts (Binga, Chiredzi, Hwange and Matobo) in natural regions IV and V of Zimbabwe. We considered that vertical coordination was the appropriate theoretical framework in explaining the factors that affect market participation of small grains in our four case study sites. Thus, in this study we conceptualised vertical coordination through use of contracts. Barrett *et al*. (2012) describe vertical coordination as the activities that are employed to harmonize the various stages that are involved in the production and marketing of small grains (Adam *et al*., 2019; Mathew, 2015). We considered that the problem of hesitancy to adopt small grains production by smallholder farmers in our research sites was not so much about lack of information on the rationality of adopting these varieties, but something to do with lack of effective vertical coordination mechanisms. Our view aligned with Adam *et al*. (2019) who observed that vertical coordination improves the fit between necessary and available administrative arrangements for putting policies effectively into practice. Therefore, the use of vertical coordination conceptual lens helped us to focus on various factors that promote or hinder the adoption of small grains as a strategy to enhance food security in the four case study sites. Through the vertical coordination conceptual framework, we managed to understand the relationships between market participation of smallholder small grains farmers and the participating smallholder farmers' demographics. Beyond mere determination of the factors, we managed to recommend mechanisms that could be used to address uncertainties that perpetuate the weak market linkages in the small grain value chain which prevailed in the studied districts.

3 Literature review

Vertical coordination is a highly complex process in the agricultural sector, particularly so in the small grain adoption practice and research. For this reason, vertical coordination requires systematic patterns of communication and coordination of activities across all stages and processes of production and marketing. While a lot has been done to promote the adoption of small grain varieties in semi-arid regions, resistance by farmers in these regions could be attributed to the mismatch between evidence supporting these measures and the low rate of small grain adoption by smallholder farmers in semi-arid rural areas. Therefore, the focus should shift to mechanisms that promote adoption of small grains to ensure food security in communities with low rainfall patterns. The sustainability of seed and grain production hinges on assured markets (Phiri *et al.,* 2019). Without assured markets, farmers have little incentive to produce. There is clearly a lack of infrastructure to market the buying and processing of small grains, especially in dry areas. Furthermore, large imports of cheap wheat and rice including policies to subsidize the production of these crops in developing countries have had a considerable adverse impact on the production of sorghum (Mengistu *et al.,* 2018).

In the greater part of Africa, there is a missing link of government allocation of subsidy funds towards small grain-based value chains in semi-arid areas where maize performs poorly (Ricker-Gilbert *et al.,* 2011). Notably, in Southern Africa

including Zimbabwe, extension service delivery for small grain is mainly inefficient with limited effective interaction between extension agents and farmers. There is limited information on small grain production as well as on value addition which demotivates the farmers to grow small grains. There is need to find alternative solutions to enhance extension services with adequate response mechanisms in the wake of evolving value chain indicators including prices and consumer preferences (Mabiso *et al*., 2014). Information related to production practices and associated changes in innovations is an indispensable ingredient in effective decision making on enterprise choice by smallholder farmers (Shiferaw *et al.,* 2015). In smallholder farming communities, small grain production is mainly affected by poor and dysfunctional networks at all levels and thus has remained rudimentary, uninformed and subsistence-oriented. In light of the above, there is need to examine the knowledge gaps from input supply to marketing of the small grains. The intricate channels and associated institutional arrangements through which products flow from the rural farm gate to the consumer need to be examined.

The value chain actors should shape the nature, value and direction of benefits emanating from their relationships. Yet, being a member of any cluster does not imply the ability to extract equal and maximum possible value (benefits). Several studies (Khonje *et al*., 2015; Mutenje *et al.,*2016) also identify the impact of policy on the crop mix in resource-constrained smallholder farming systems which often forces farmers to grow crops that they may not have preferred, thus distorting the structure and conduct in value chains. For example, in Zimbabwe, the over dependency on maize even in areas where it is not suitable for cultivation, has undermined food security and income gains due to the higher frequency of droughts in recent years (Bola *et al.,* 2013; Rukuni *et al.,* 2006). This has also persisted in a number of countries in Africa (Di Falco *et al.*, 2013). In Zimbabwe, a number of red sorghum commodity value chain nodes including domestic consumption, seed, local opaque beer and commercial beer breweries are currently functional to various extents and scale. Other small grain products including stock-feed, bio fuel and silage still need to be explored and supported so as to broaden the marketing channel options for farmers.

Traditionally, contract farming has been the domain of commercial agriculture due to the perceived high risk associated with extending such schemes to the smallholder sector. After the land re-distribution programme which drastically reduced commercial farming activities, many companies had to look for other alternative suppliers of agricultural produce and this presented an opportunity for smallholder farmers (Chisango *et al.*, 2016). In Zimbabwe many contract farming schemes involving smallholder farmers have collapsed, even when farmers had been provided with all the necessary inputs essential to meet the production frontiers of cropping ventures. The unfavourable policy environment prevailing in the country exacerbated the situation as farmers felt that there was lack of transparency in the way producer prices were set by contractors hence depriving them of their bargaining powers and that the output grading systems actually worked against them (Chisango *et al.*, 2016). Mutambara *et al*. (2013) reported that the transportation through the use of road facilities has been associated with high transport costs compared to the alternative of rail. Contracting companies, however, perceived that the major challenges they faced in contracting smallholder farmers were a result of low yields and poor produce quality due to poor management, poor timing of operations and side marketing of the produce (Phiri *et al.,* 2020).

Successful unlocking of small grain-based value chains has been reported by a number of studies (Makindara *et al.,*2013; Mason, 2010; Rohrbach *et al.,* 2007). Similarly, Dicko *et al.* (2006) also advocates for the use of sorghum grain as food for human consumption in Africa. Learning from these experiences can help to strengthen the currently existing nodes and tapping into potential avenues. This will establish a concrete foundation for small grain to contribute towards household and national economy of Zimbabwe. More small grain marketing channels will increase the appetite for production and pricing efficiency due to competition.

The perennial absence of strong and responsive market linkages among value chain actors is a problem since it has a close relationship with compromised livelihoods (Escobal *et al.,* 2015; NEPAD, 2003). Therefore, there is need for designing of more appropriate market networks if the value chain approach is to bear fruit especially with currently marginalized crops such as pearl millet, sorghum and finger millet.

In Zimbabwe, the economic performance of agricultural markets can generally be classified as poor with signals of a decrease in the number of stakeholders in most platforms since 2000 (Poulton *et al.,* 2006; Makamure *et al.,* 2001). There is evidence showing that the underlying problem of weak and unsustainable market linkages, flow of resources and information in value chains for small grains remains engraved in most smallholder farming areas of Africa (Asogwa *et al.,* 2012; World Bank, 2008; Musara *et al*., 2018). Mutambara *et al.* (2013) report that the entire sorghum and millet value chain network is not producing at full capacity because of pending problems. The small grain marketing is still relatively low and so are the volumes of the grain being produced and traded in the sparse markets (Rukuni *et al*., 2006). In Zimbabwe, there is a current gap in research on market linkages that exist in small grain value chains, the associated challenges, their responsiveness to change and their appropriateness in various contexts. According to Mugiya *et al.* (2017), farmers in Zimbabwe complained that the GMB normally delays to pay farmers, a situation which further complicates their adaptation to climate change, as their purchasing power remains poor.

Regardless of their strategic orientations, the processors have to keep up with the market requirements toward steady volumes and high quality of products. Since the costs of holding stocks are high, the tendency of these processors is to hold more conservative levels of stocks (Musara *et al.*, 2020). In this context, well-functioning linkages between the processors and smallholder farmers, are the key to success. Moreover, processors should be the initiators of such cooperation. The reviewed case studies demonstrate that long-term and trustful vertical relationships indeed exist but the smallholder farmers are often regarded as difficult partners that tend to behave very opportunistically as they always have the choice to consume their products within a household instead of selling to the market (Musara *et al*., 2019). This study attempts to ascertain the challenges and map a way forward on how government and other players could assist to solve the prevailing anomaly.

Farmers' market participation is directly related to distance to the nearest output market (Yameogo *et al*., 2018). Yameogo *et al*. (2018) goes on to say that farmers located far away from the central markets in major cities would have to bear high transaction costs due to the transport and exchange costs. These farmers may be discouraged to sell their output if prices in local markets are not competitive. A study by Yameogo *et al*. (2018) show that the lack of secured market outlets for rice justifies self-consumption of rice produced in lowlands. In the same vein, small grain growers' decision to participate in the output market is also affected by the existence of a local market. In support of the above study Omiti *et al.* (2009) noted that rural farmers travel nearly three times the distance covered by their peri-urban counterparts in search of market channels. Transport costs are therefore potential constraints, particularly for the rural farmers.

4 Methodology

We used a mixed methods cross-sectional approach triangulated with multiple data sources to consider the vertical coordination determinants in relation to small grain adoption by smallholder farmers in agro-ecological regions IV and V of Zimbabwe. Probit regression was used to model the farmers' market participation and seller-type equations. The level of participation for on-farm and off-farm sellers, and for all the participants, was estimated using the Heckman selectivity model.

These models are specified as follows:

$$Probiti(seller, non-seller) = \gamma_0 + \gamma_i X_i + \delta_i$$
$$Probiti(sellertype) = \beta_0 + \beta_i X_i + \varepsilon_i$$
$$smallgrainvalue(sellertype) = \alpha_0 + \alpha_i X_i + \theta_i$$

Where

Probit (seller, non-seller)=seller=1, and Non-Seller=0
Probit (seller type)=probit (on-farm seller=1, and off-farm seller=0)
Small grain value (seller type)=value of small grains sold in USD
γ_0=constant for market participation equation
β_0=constant for seller-type equation
α_0=constant for the level of participation equation
X_i=variables for estimation
γ_i=vector of parameters to be estimated for market participation
β_i=vector of parameters to be estimated for seller type
α_i=vector of parameters to be estimated for level of sales
ε_i=error terms for seller type equation
δ_i=error terms for market participation equation
θ_i=error terms for the estimated grain values

4.1 Market participation

The market participation equation used was modelled as follows:

$$Probit(seller, non-seller) = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \cdots .. + \gamma_{10} X_{10} \ldots . + \gamma_{14} X_{14} + \delta_i$$

γ_0=Constant for market participation equation
$\gamma_1 - \gamma_{14}$=Regression coefficients to be estimated for market participation
$X_1 - X_{14}$=Variables for estimation
δ_i=Error terms
X_1=Affiliation to farmers group (dummy variable; (dummy variable; *1*=member, 0=non-member)

X_2=Marital status (dummy variable; 1=single (Ref Population), 2=married 3=divorced, 4=widowed)
X_3=Level of education (in years)
X_4=Gender (dummy variable; 1=male, 0=female)
X_5=Age of household head (in years)
X_6=District (dummy variable; 1=Matobo, 2=Binga, 3= Hwange,4=Chiredzi (ref population)
X_7=Cultivated area small grains (in hectares)
X_8=Household size (number)
X_8=Distance from the farm to the market (km)
X_9=Small grain yield (kgs)
X_{10}=Credit access (Dummy, 1=yes, 2=no)
X_{11}=Distance to the tarmac road (km)
X_{12}=Distance to the gravel road (km)
X_{13}=Distance to the extension office (km)
X_{14}=Extension visits (Dummy, 1=No visit (ref), 2=2 visits, 3=3 or more)

The dependent variables were the vertical mechanisms (spot market, contract farming and market participation) such that the chosen mechanism was assigned a value of 1 and 0 otherwise. A small grain farmer was considered a market participant if he/she was on contract farming or have sold some of his/her small grain to recognized contractors or Grain Marketing Board (GMB). If a farmer sold grain, it was coded 1 and 0 otherwise.

4.2 Multiple Linear Regression Model (MLRM)

MLRM was used to identify the transaction cost related factors that may affect the quantity of grain sold by small grain farmers. The following is the linear regression model utilized;

$$Y_{ij}=\alpha_0+\alpha_1X_1+\alpha_2X_2+\alpha_3X_3+\alpha_4X_4+\alpha_5X_5+\alpha_6X_6+\alpha_7X_7+\theta_i,$$

Y_{ij} − is the small grain quantity sold in US$
α_0 − α_7-regression coefficients
X_1 − X_7-Explanatory variables
θ_i − error term
X_1 − Distance to the market(km)
X_2-Affiliation to farmer group (Dummy ,1=yes ;0=no)
X_3-Failure to sell (Dummy,1=yes ;0=no)
X_4-Sale arrangements (Dummy,0=Individual arrangements ;2=group arrangements)
X_5-Waiting time to sale the produce (Dummy,0=1/2hour ,1=1hour ,2=more than 2 hours)
X_6-Distance to the extension office (Km)
X_7-Seller type (Dummy 0=on farm; 1=off-farm

4.3 Data Collection and Sampling Procedure

We used observations, structured and semi-structured questionnaires, interviews, key informants and focus groups to collect our study data. A representative sample was used with a specific sample size per district calculated proportionally as follows: Binga-60, Chiredzi-95, Hwange-72 and Matobo-54, giving a total of 281 farmers. Purposive sampling was used to select districts (Hwange and Matobo) that were not into contract farming. The same was used to select districts (Binga and Chiredzi) who were into contract farming. Stratified random sampling was used to select value chain actors (Ministry of Agriculture, Seed breeders and Input suppliers) depending on their function in the value chain. Convenience and judgmental sampling were used to select local leadership that were from the four case study sites.

Statistical package Stata version 16 was used for statistical computations for household data. Descriptive statistics was used to present data in frequency distribution tables, means (SD) and median (IQR). Chi-squared test was used to test for the association between outcome variables and the independent variables such as extension services, education level, age, farm size, family size, sex of household head). The Probit regression model was used to compare farmers who participated in marketing of small grain to see if the differences offered insights into the rationale for market participation. MLRM was to determine the level of participation which was measured by the total small grain yield sold in USD. Effect size was reported using regression coefficients and 95% confidence intervals. Adequacy of the models were also performed. A p-value of less than 0.05 was considered statistically significant.

5 Results and discussion

5.1 Sample characteristics

A total of 281 smallholder small grain farmers participated in this study. The data that were collected relates to the 2015/2016- 2020/2021 growing seasons, a period stretching 5 years back. The survey gathered information from farmers on personal, household and farm-level characteristics and access to credit and marketing activities such as vertical coordination mechanisms and transaction costs. All farmers sampled for the study engaged in small grain production and sales using vertical coordination mechanisms such as contract farming, on-farm sale, off-farm sale or spot market transaction. Farmers who were on contract farming sold their small grains to contracting companies as per sale agreements entered into at the beginning of the growing season. All farmers on contract farming were market participants and they sold their produce on the farm.

5.2 Contract farming

Results show that in Chiredzi District, Delta and Ingwebu companies were the dominant contractors. The Figure 1 below shows the percentage distribution of the contracting companies by district where 50% of the farmers in Binga were contracted by Delta and Ingwebu. Similarly, 31.5% of the farmers in Chiredzi were contracted by Delta and Ingwebu. In addition, Reapers had 22.1% of the farmers under contract farming and only 14.7% were contracted by Tongaat Hullets.

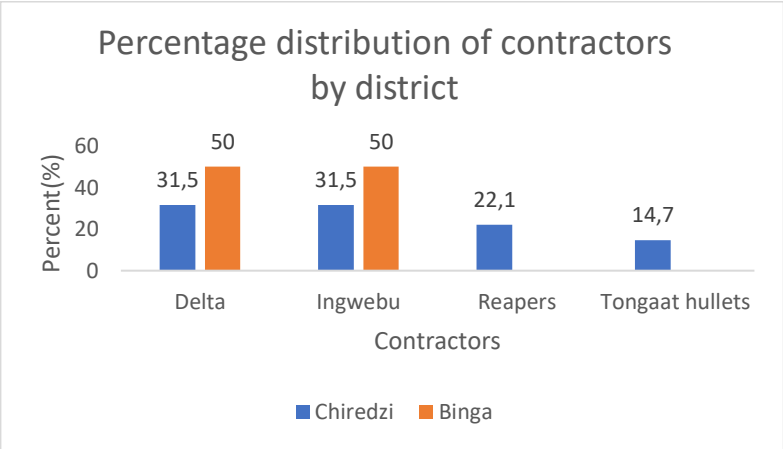

Figure 1: Percentage distribution of contractors by district (Source: Survey Data (2021)).

In terms of contract marketing, the results show that 53% of the market participants were under contract marketing while 43% were not under any form of contract marketing. An average of 56% of farmers who were on contract allocated above 3 hectares to contract farming while the other 40% used between 2-3 hectares. However, there were variations on the land allocated to contract farming with Chiredzi district had the highest allocation. Land size significantly, influenced farmer participation in contract farming. A possible explanation to this could be that farmers with large arable land size have the opportunity to grow large tracts of sorghum grain with adequate financing from contractors as it is the case in Binga and Chiredzi districts. Jackson *et al.* (1994) supported this by stating that the size of the land is important because the transactional costs are largely fixed cost that are spread across more potential output on large farms. On self-selection, literature has found that contractors do not randomly sign contract arrangement with farmers. As a result, contracts are not randomly distributed to farmers in a given farming community hence contracted farmers tend to have certain attributes resulting in firm-selection and self-selection biases (Minot *et al.*, 2015; Barrett *et al.*, 2012). Contracting firms look at certain background farmer characteristics before they decide to engage the farmer in contract farming. The selection criteria that small grain contracting firm used included the following; access to land, farm size and experience in small grain production.

The study is supported by the observations of Brown *et al*. (2018) who state that it is often assumed that larger-scale farmers will be more likely to adopt a technology, especially if the innovation requires an extra cash investment. It may be that a certain threshold farm size is necessary before the investment in a technology is worthwhile. Similar findings were reported by Khoza (2019) who found out that there were large land holdings for market participants compared to non- market participants. Furthermore, the same farmers participated more on marketing than their counterparts who were not on contract farming. In terms of profitability, 56% of the sampled households reported moderate profitability rate. However, farmers were not happy with contractual arrangements. In support of the study Mudavanhu *et al*. (2016) conclude that designing contracts that are inclusive of all relevant matters is almost impossible and expensive. Contract farmers had access to improved seed varieties as they were loaned by the contractors. This motivated the farmers to accept the technology of improved small grain varieties. This concurs with Barrett (2008) who argues that a household's

production technology choices affect its market participation choices by affecting its productivity. Technology directly affects market participation in that the productivity of a household greatly influences its net marketable surplus. Improved production technologies therefore, provide a reliable driver of increased market participation.

Socio-economic characteristics in relation to market participation

The following sections discuss results of the relationship between participants' demographic characteristics and market participation. We observed systematic differences in farmer characteristics with respect to the vertical coordination mechanisms. Table 1 shows these differences in characteristics and statistical significance tests on equality of means or medians between farmers who participated and those who did not participate in markets.

Table 1.

Market participation in relation to socio-economic and access to infrastructure characteristics

Variables	Overall median	Market participant		Non-market participant		P-value
		Median	**IQR**	**Median**	**IQR**	
Distance to nearest tarmac(km)	30(96)	15	98	33	88	0.02∗
Distance nearest gravel road(km)	30(96)	15	95	33	96.5	0.74∗
Distance to farm input store(km)	27(55)	25	50	27	53	0.20∗
Distance to nearest market(km)	14(40)	12	40	14	32	0.25∗
Distance nearest financial institution(km)	61(88)	60	88	75	50	0.09∗
Distance nearest mobile money agent(km)	61(88)	60	88	75	50	0.09∗
	Overall mean	**Mean**	**SD**	**Mean**	**SD**	
Years in education(years)	1(2)	3	3.5	2.7	3.2	0.51∗∗
Age(years)	50.5(12.4)	49.4	12	51.7	12.8	0.13∗∗
Household size	4.9(1.9)	5.2	1.7	4.6	2	0.01∗∗
Arable land(ha)	0.8(1.1)	0.9	1.1	0.8	1.1	0.38∗∗
Total small grain yield(tonnes)	2(0.89)	3.6	2.3	1.9	0.2	0.03∗∗

Source: Primary data (2021), ∗-Wilcoxon rank sum tests, ∗∗-Two sample independent t-test

The average quantity of yield was 2 tonnes (SD=0.89) with the least farmer selling 1 tonne and highest 10 tonnes. Market participants had higher total yields with average of 3.6 tonnes as compared to non-market participants with an average of 1.9 tonnes. Yield was significantly different between these two groups (P=0.03). The results are in agreement with Burke *et al*. (2015) who reported that sorghum farmers who had higher yields participated in market compared to those who did not participate. The high yields by market participants in the study could have been promoted by accessibility to improved seeds and an assured market from the contractors. From the observations, farmers who had low yields were food insecure hence could not sell the limited stock they had. Instead, they needed interventions on food assistance from the government and other partners. The majority of these farmers were non-contract farmers.

In terms of household size, the results shown in Table 1 indicate that mean of the household size for the market participants was significantly high (P<0.01) as compared to non-market participants. The household size had a positive and significant effect on the market participation decision. This greatly reflects on the high labor requirements of small grain production during winnowing as compared to other crop enterprises. The higher the effective labour available the more likely the household is to be contracted since chances of labour shortages during peak times are low. This enhances the chances of favourable yields and ability to repay the contractor. This is in agreement with Mmbando *et al*. (2016) who reported that the higher the number of dependents, the more likely the household is to participate in markets.

Access to infrastructure versus market participation

Descriptive and inferential statistics of access to infrastructure in relation to market participation presented in Table 1 above will be discussed in the section below.

The overall median distance to tarmac road was 15km (IQR=98) for market participants and 33km (SD=88) for non-market participants. Distance to tarmac road significantly differs between market participation (p=0.02). Non-market participants had a longer distance to market compared to market participants. The study findings are supported by other researchers who found that distance from the farm to point of sale, and market information were found to be major challenges to the intensity of market participation (Omiti *et al.,* 2009; Bahta *et al.*, 2007; Montshwe, 2006; Goetz, 1992). Omiti *et al.* (2009) also found that for sales to increase, output price was a key incentive. However, distance to the financial institution was marginally significant (p=0.09) between market participants and non-market participant.

The current study found out that proximity to markets is critical in market participation. This is in agreement with Birachi *et al.* (2013) who reported that longer distances have a disincentive effect on decisions made by farmers. Farmers located closer to markets were more likely to participate in the markets. These findings indicate that market delivery systems must be strengthened, roads upgraded, retail outlets with improved market facilities be established in remote rural villages.

5.3 Probit model results for Market Participation

Variables for market participation of probit results were discussed in the section below.

Table 2.
Probit Regression analysis for market participation adjusted for clustering effect

					95% CI	
Variable		**Coefficient**	**SE**	**P**	**Lower**	**Upper**
	Male	Base				
Gender	Female	-0.625	0.554	0.259	-1.71	0.46
Age		-0.012	0.015	0.42	-0.041	0.017
Education		-0.093	0.035	0.007	-0.161	-0.026
	Single	Base				
	Married	0.502	0.423	0.236	-0.328	1.331
	Divorced	0.492	0.405	0.224	-0.301	1.285
Marital	Widowed	0.512	0.652	0.433	-0.766	1.79
	No	Base				
Affiliation	Yes	0.008	0.568	0.989	-1.105	1.121
	No	Base				
Credit access	Yes	0.723	0.229	0.002	0.274	1.172
Land size		0.034	0.057	0.55	-0.078	0.146
Household size		0.248	0.052	<0.001	0.146	0.351
Distance to extension		0.027	0.014	0.053	-0.0001	0.054
Distance to market		0.005	0.001	<0.001	0.004	0.006
Distance to tarmac		0.014	0.008	0.085	-0.002	0.0029
Distance to gravel		-0.003	0.003	0.3	-0.008	0.002
Yield		-0.002	0.001	0.012	-0.004	-0.001
	0 visit	Base				
	1 visit	-1.078	0.565	0.056	-2.186	0.029
	2 visits	0.061	0.323	0.851	-0.573	0.695
Extension visits	3 or more	-0.799	0.527	0.13	-1.833	0.234
Constant		0.405	0.923	0.661	-1.404	2.213

SE-Standard error, CI-Confidence interval, P-p-value

Source: Primary data (2021)

5.4 Education in market participation

The coefficient of education was found to be negative and statistically significant at 5% level (P>0.05). This indicates for every one-year increase in number of years spent in school leads to a corresponding decrease by 0.093 in the level of participation (Table 2) in small grain markets by farmers $[\gamma_3 = -0.093(95\%CI: -0.61\ to -0.026)]$. The more the educated farmers are, the less likely to participate in small grain markets holding other variables constant. The higher the education level, the lower the level of participation in small grain markets by farmers. Similarly, Osmani *et al.* (2015) reported a significant but negative effect of education on market participation from their study. The authors went on to say that it was attributed to a motivation among educated household heads to seek other non-farm occupations. This is contrary to studies (Eneyew, 2012; Asmah, 2011) whose findings reveal that the level of education positively influenced both the decision to participate in marketing and that of the level of participation (significantly negative), which implies that smallholder farmers with secondary education are more likely to participate in marketing. However,

they were less likely to increase the extent of market participation. This implies that households with more years spent at school are more likely to diversify their livelihood from production to off-farm activities.

5.5 Affiliation to farmer group in market participation

The coefficient for affiliation to farming groups was positive indicating that affiliation to farming groups increases market participation. Farmers who belong to farmers' groups were more likely to participate in the market than their counterparts who do not belong to farming groups. This is in agreement with other studies (Adenegan *et al.*,2012; Batha *et al.*, 2012), who reported improved quantities of output sold in the market among cooperative members. In their view, membership of a cooperative improved the production and marketing capabilities of farmers by strengthening their bargaining and lobbying power. Furthermore, Lapar *et al.* (2003) supports the study by highlighting that the inability of smallholder producers to take advantage of economies of scale in production and marketing impedes their market participation. In contrary, study by Haugum *et al.* (2017) state that the producers' choice to use the network depends on the advantages that the producers gain from joining the network. The producers' goals and motivations to take part in a network are different, and many producers are hesitant to join the network. This corresponds to Grande (2011) findings, who found that companies from agriculture tend to stay with their former networks; in that study, farmers' challenges in marketing and sales were not sufficiently solved using existing networks. Affiliation to farmer groups served as a conduit of information to farmers which ultimately increased their participation in markets. Mathenge *et al*. (2010) reported a significant positive influence of cooperative membership on market participation. Some studies however, have reported a significant but negative relationship between membership of a cooperative and participation in markets (Abayne *et al.*, 2013; Montshwe, 2006), where farmers did not have an affiliation to any commodity group.

5.6 Access to credit in market participation

Results of the study indicate that access to credit was significantly (p<0.05) associated with market participation. The coefficient is positive indicating that households with access to credit facilities were 0.723 times more likely to participate in small grain markets than those without access $[\gamma_6 = 0.723(95\%CI: 0.274\ to\ 1.172)]$. Having access to credit increases a household's chances of selling its small grain by a greater amount than due to other factors. The study is supported by Mutambara *et al*. (2013) who reported that the major constraint facing the food chain is access to credit due to creditworthiness considerations. Similarly, Kanyenze *et al*. (2011) indicated that a lot of empirical and theoretical literature on the finance growth nexus shows that a well-developed financial sector plays a pivotal role in promoting development of all sectors. In the same vein, a study by Mutambara *et al.* (2013) retaliated that the current uncertainty on landownership rights in Zimbabwe has made it difficult for the financial sector's ability to mobilize financial resources from savings for lending to the productive sector at reasonable interest rates.

The majority of farmers on contract farming had access to credit as contractors loaned them seed at the beginning of the farming season. During the course of production there was win-win relationships between farmers and contractor as some contractors monitored the production as well as supporting farmers with competitions in the form of field days. In this symbiotic relationship the farmers benefited from improved seed, prizes as well as assured of markets of their produce. On the other hand, the contractors benefited from assured volume and quality of product from farmers.

5.7 Household size and market participation

The coefficient for household size was found to be positive and significant at a 1% level (P<0.001). This result indicates that for every one-member increase in the family leads to a corresponding increase in the level of participation in small grain markets by 0.248 holding other variables constant $[\gamma_8 = 0.248(95\%CI: 0.146\ to\ 0.351)]$. Similarly, Boughton *et al*. (2007) reported a positive influence of household size on market participation. This is in disagreement with Ugochukwu (2020) who reported that households participated equally in markets irrespective of size and agrees with Arega *et a*l. (2007) who reported that household size was insignificant in influencing market participation. In some studies, household size negatively influenced participation in markets (Martey *et al.*, 2014; Siziba *et al.*, 2011), whereby the size of households had an inverse relationship with market participation. This indicates that the propensity to participate in markets declined with increase in household size.

5.8 Frequency of extension visits and market participation

Farmers who had 2 extension visits in a year had an increased level of participation by 0.06 compared to those without visit$[\gamma_{10} = 0.061(95\%CI: -0.573\ to\ 0.695)]$. Farmers who had more extension visits in a year had an increased level of participation compared to those without visit. This is in agreement with Musara *et al.* (2020) who found out that the frequency of extension contact had a positive and significant effect on the marketing method preferred. Similarly, in access to market information, Montshwe (2006) concludes that to increase farmer participation in mainstream markets, farmer training in issues pertaining to production and marketing was crucial. The low extension services in this study could be due to long distances travelled by extension staff and inadequate resources like motor bikes to enable services

to be reached out to the farmers. This shows a gap in extension services. Generally, the extension contact visits in this population was very low.

5.9 Yields and market participation

The coefficient for small grain yields was found to be negative and significant at a 5% level (P<0.05). This indicates that decreasing yields leads to a corresponding decrease by 0.002 in the level of participation in small grain markets[$\gamma_{12} = -0.002(95\%CI: -0.004\ to -0.001)$]. Findings of the study reveals that farmers with high yields are more likely to participate in small grain markets than those with low yields. Similar results by Burke *et al.* (2015) who reported that sorghum farmers who had higher yields participated in market compared to those who did not participate. Farmers with low yields could therefore not participate in the market. They produced their grain for subsistence farming.

5.10 Multiple Linear Regression Model (MLRM)

MLRM was used to identify the transaction cost-related factors that may affect the quantity of grain sold by small grain farmers. Quantity of grain sold in (USD) indicates the level of market participation. Results of MLRM on the effect of transaction cost related factors on quantity sold are presented on the Table 3 below.

Table 3.
Multiple Linear Regression Model results

Variable		Coefficient	SE	P	95% CI	
					Lower	Upper
Distance to the market		-0.064	0.016	0.055	-0.132	0.004
Affiliation	No	Base				
	Yes	5.759	1.541	0.065	-0.871	12.39
Failure to sell	No	Base				
	Yes	-0.867	1.135	0.525	-5.751	4.017
Sale arrangements	Individual	Base				
	Group	3.158	1.037	0.093	-1.305	7.621
Waiting time	1/2 hour	Base				
	1 hour	-3.182	1.076	0.098	-7.813	1.45
Distance to extension office		-0.012	0.004	0.095	-0.03	0.005
Seller type	Off-farm	Base				
	On-farm	0.098	0.018	0.033	0.02	0.177
Constant		0.663	0.143	0.043	0.049	1.277

SE-standard error, CI-Confidence interval, P-p-value

Source**:** Primary data (2021)

The results show that quantity of small grain sold decreases by 0.06 for every one km increase in distance to the market holding other variables constant [(α_1=-0.06; 95% CI: -0.13 to 0.004)]. Distance to the market is a predictor of market participation in this study. Quantity sold increased by 5.7 units (Table 3) for farmers who were affiliated to farming groups compared to non-members. Affiliation to a farming group could be a determinant of market participation in this study, though the relationship between quantity sold and affiliation was marginally significant at 5 % [(α_2=-5.7; 95%CI: -0.871 to 12.39] as shown in Table 3.

6 Policy implications

The production of small grains in low rainfall ecological regions cannot be over emphasized. Researchers (Phiri *et al*., 2019; UNDP, 2018; Abdul-Rahaman *et al.*, 2018; Mathew, 2015) have shown that small grains, especially sorghum and millet are drought tolerant and perform better in semi-arid regions as compared to other cereal crops such as maize. This study focused on factors that influence the vertical coordination of small grain value chains. In order to ensure food security and ameliorate poverty in low rainfall southern regions of Zimbabwe, the production of small grains should be intensified in order to increase yields. In this regard, findings of this study are vital because they illuminate the factors that government and its development partners should focus on in order to address the vertical coordination challenges that hinder the productivity of small grains by smallholder farmers in these regions. The study found that small grain yields was high among market participants compared to non-market participants. Therefore, effort should be directed towards increasing the number of small grain market participants. This measure will translate to the overall increase in aggregate production of small grains in low rainfall regions. The key factors that hold potential to increasing market participation include access to credit, encouraging smallholder farmers' groups, more extension visits in the regions and

bringing small grain markets closer to smallholder farmers. These factors are critical aspects in the enhancement of vertical coordination, which are vital in the promotion of wide adoption and production of small grains in low rainfall areas in the face of increasing risks of climate change. In addition, effort should be directed towards improving and strengthening small grain market delivery systems such as upgrading access roads and establishing collection point facilities in remote areas to reduce transportation costs due long distance to the markets.

7 Conclusion

There were variations on the land allocated to contract farming with Chiredzi district having the highest allocation. Small grain yield was higher among market participants compared to non-market participants. Results have shown that distance to market, access to credit and access to extension services influence market participation. Contract farmers had access to improved seed varieties as they were loaned by the contractors. Quantity of small grain sold decreased for every one km increase in distance to the market. Farmers who have a long distance to travel from the farm to the tarmac road or more distance in gravel road had high crop transportation costs and are more un-likely to participate in the market. Quantity of small grain sold increased for farmers who were affiliated to farming groups compared to non-members.

8 Recommendations

The Government and its development partners should increase access to credit facilities because it significantly increases market participation. Government should open more collection points to cater for smallholder small grain farmers in distant and remote areas. Market decentralization is vital in reducing distance to markets and associated transport costs thereby reducing transaction costs. Government should upgrade roads in remote areas so that smallholder small grain farmers could have access to small grain markets. Improved road networks are also bound to motivate buyers to reach out to farmers. Smallholder small grain farmers should be encouraged to be affiliated to farmer groups so as to increase their price bargaining power in order to maximise return on investment on small grains production. Horizontal farmer market linkages should be enhanced given that combining the yields would push volumes required by the buyers. This in turn will result in win-win relationships for both farmers and buyers.

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Conflict of interest

The authors declare no conflict of interest.

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