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A Framework For The Analysis Of Integrated Agricultural Value Chains In The Context Of Smallholder Farmers

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Abstract: Agriculture remains the best opportunity for the majority of people worldwide living in smallholder farms to trade their way out of poverty. Growth generated by agriculture is four times more effective in reducing poverty than growth in any other sectors. Future growth in the agriculture sector relies heavily on diversification and promotion of opportunities for the addition of value. Smallholder farmers rarely engage in single enterprises, but on agriculture as a complete economic system, where a couple of crops and different livestock are integrated on the same farm. However, the reality of smallholder farmers has been understood mostly from fragmented single value chain analysis. In this paper, we develop a theoretical framework that uses the transaction cost and system dynamics theories to study interdependent agricultural value chains. Relevant articles were downloaded from internet and value chain analyses theories were reviewed. We conclude that the integrated value chain provide both income and food security for smallholders in a way which cannot be understood with the application of a single theory. We recommend the validation of the integration of these two theories in future research on smallholder value chains.

Keywords: keyword 1; smallholder farmers 2; integrated agricultural system 3; value chain 4; transaction cost theory 5: systems dynamics.

1.0. Introduction

Around 2.6 billion people in the developing world are estimated to make a living on less than $2 a day (Chen & Ravallion, 2008) and about 1.4 billion are classified as ‘extremely’ poor who live on less than $1.25 a day. The highest incidence of extreme poverty, estimated to be one in two (50%), is highest in sub-Saharan Africa (Chen & Ravallion, 2008; World Bank, 2007) and around one billion of these people live in rural areas (World Bank, 2007). Agriculture remains the best opportunity for the estimated 1.5 to 2 billion people worldwide living in smallholder households in rural areas to work and trade their way out of poverty (World Bank 2007). Growth generated by agriculture is up to four times more effective in reducing poverty than growth in other sectors; through creation of multiple pathways, increased productivity, real incomes changes, employment generation, rural non-farm multiplier effects and food prices effects (Schneider & Gugerty 2011). However, in the smallholder sector, productivity is low, and is compounded by lack of understanding of the interactions of interdependent enterprises. Efforts to ensure efficient production systems and value addition of agriculture produce in the smallholder sector are critical. However, to realize meaningful benefits from agriculture requires deep understanding of the potential of agricultural enterprises, their interdependent dynamics and ways of improving value of produce, incomes and food security of smallholder farmers. There is growing realization that future growth in the agriculture sector relies heavily on diversification and promotion of opportunities for the addition of value, particularly at local level (Seville et al, 2011). Hendrickson et al (2008) and Boller et al (2004) remind us that integrated agriculture is a mixed enterprise approach to farming that uses natural resources through combination of crop and livestock units to promote environmentally beneficial farming systems. It is a given fact that smallholder farmers rarely engage in single enterprises, but on agriculture as a complete economic system, where a couple of crops and different livestock are integrated on the same farm and other income generating occupations. The benefits of integrated agriculture are not doubtful. For example Walters et al (2016) show the inherent ability to distribute, minimize risks through the diversification of enterprises, and allowing farmers to exploit a higher spectrum of marketing channels as clear benefits of engaging in integrated agriculture. To the contrary, the reality of smallholder farmers has been understood mostly from fragmented single enterprises/ value chain analysis ignoring the interconnectedness and dynamic interaction of different agricultural enterprises. Despite the fact that integrated agriculture greatly minimizes overall household risk, it presents a substantial challenge in determining the complex trade-offs of individual farming enterprises following the argument put forward by Walters et al (2016). Examples of these challenges include timing of operations, environmental limitations, and agriculture markets (Hendrickson et al, 2008), which should be managed in a manner that meet food and income requirements of households. At the core, challenges in the production, value addition and marketing of multiple enterprises exist, and and necessitates an understanding of dynamic interaction to contribute to both food and income security of the smallholder households. An obvious challenge in investigating complex and integrated agricultural system is application of the rigor of reductionism and comprehensiveness of holism (Wu & David, 2002). A theoretical framework that combines both the above attributes provides great opportunity to understand smallholder farmers' reality. Also, the social, environmental, and market drivers that influence enterprise integration at smallholder household level in unique landscapes are often tenuous and difficulty to identify and quantify. This paper was motivated by the need to develop an analysis framework that gives a complete understanding of performance of agriculture as an integrated system, not as single enterprises, to improve smallholder households' food security and incomes. To that end, we seek to develop a theoretical framework underpinned by the value chain analysis (VCA) in combination with the transaction cost theory (TCT) and system dynamics (SD) theory to study interconnected and interdependent agricultural value chains. The paper is based on review of literature on VCA which were accessed on the internet between March 2016 and March 2019. The search terms used were value chain analysis studies, conceptual framework for value chain analysis, use and application of transaction cost economics, also transaction cost economics, application of transaction costs economics in value chain analysis, application of systems dynamics on value chains, conceptualization of value chains as systems, conceptualization of value chains, application of value chains to reduce poverty, increase food security and incomes of smallholder farmers, asset-based approach to understand food security and poverty alleviation, etc. Relevant articles were downloaded and the conceptualization of value chains, and analysis framework was developed. Due to the long search period, it became difficult to enumerate the number of articles reviewed. However, the predominant value chain analyses studies were assessed and used to develop the theoretical framework in this paper. We propose that TCT elements and systems dynamics features can be combined to analyse the interdependent agricultural value chains that give better prospects of improved incomes and food security. The key features of the two theories are isolated, conceptualized and operationalization is articulated to show application into value chain research. This paper shows how agricultural value chains are linked, the transactional relationships between enterprises, and the potential joint contribution to food security and incomes for smallholder farmers.

2.0. Conceptualization of smallholder farms as systems

In the current value chain analysis, researchers have assumed modularity and decomposability of enterprises and functional interdependence of processes as suggested by Hagedorn (2008). Very few studies if any have operationalized the interdependence and complementarity of enterprises. Yet a system reaches a certain level of complexity or interconnectedness through dramatic transition (Kauffman, 1995), and agriculture system that sustains smallholders resemble a system that has undergone transition and display intrinsic interconnectedness. Even though Kauffman (1995) cautions that such systems overcharge the intellectual capacity of humans that usually breaks down large problems into smaller sub-problems, for smallholders' households, agriculture operates as a whole system to generate food and incomes. Breaking down the agriculture system into sub-components consequently fails to capture reality of smallholders. Rather modularity exists in terms of benefits derived from the entire system. It is appropriate to create income and food security modules that benefit from different agricultural enterprises. Even though full modularity and decomposability strategy is dominant in economic analysis, this paper argues that separating individual value chains is inappropriate modularization that gives rise to transaction costs. Hagedorn (2008) warns that totally atomistic modularization entails complete absence of transaction costs, which is in our view desirable but impossible in the context of smallholder farmers. Also, nearly decomposable systems show only weak interactions between modules and allow sub-systems to behave nearly independently, a feature difficult to conceive in the circumstances of smallholders. Watson (2002) qualifies that modular system cannot have strong significant inter-module interactions, a view that has two equally important implications for smallholder households. On the one hand, we view a modular system as stream of benefits that accrue to smallholders as they engage in various farming enterprises. On the other hand, we recognize a modular system to denote a single enterprise or value chain for the obvious reason that such conceptualization fails to capture benefits derived by smallholders from different intertwined enterprises. Analysing individual enterprises is too simplistic and following Watson's line of thinking, we argue for the separation of structural modularity from functional modularity. Given functional interdependence of agriculture system, we accept the later view of modularity. Smallholders' livelihoods exhibit low modularity, simply put; survival of smallholders is based on a wide range of interconnected agriculture enterprises. Smallholders engage in multifaceted and complex interconnected transactions. In this paper, a value chain is conceptualized as a stream of benefits accruing from different enterprises engaged by smallholders. Jungcurt et al (2005) in their stylization of common resource perspective, identify a group or series of transactions that are closely associated; take place at the same time and involve at least one actor. Transactions are clustered because either they do not take place in isolation or they are inextricably connected. This view share common features with modularity, decomposability of structures and functional interdependence of processes. Many aspects of decisions of transaction X may in fact be related to the attributes of the good that are relevant only in the context of another transaction Y (Hagedorn, 2008). Jonngcurt et al (2005) give a typical example;

"A farmer would not buy seed if they would not have the plan of selling the produce. In such cases we have to allow for the existence of influences and causal ties between the transactions. These interdependencies complicate and even prohibit their analysis in isolation. The grains a farmer buys for use as seed and the ones they sell as food have identical physical attributes. However, the farmer's perception of these may differ substantially. A hard grain shell may indicate a high germination rate of seed, but it may be also be detrimental to its quality as food source. If so, the farmer faces a dilemma. They can buy high quality seed and accept a likely lower price for his produce, or they can opt for high food quality and accept the risk of lower productivity. If we analyse the transaction of buying seed in isolation, how are we to understand which of the options the farmer prefers?"

Thus, there is an implicit link between two transactions that would be ignored if we were to analyse each transaction in isolation (Jungcurt et al, 2005). In this paper, an agriculture system is a surrogate of transactions that are inextricably 'connected; decisions taken by smallholders regarding one enterprise may be related to the attributes relevant only in the context of other enterprises. Analysing each enterprise in isolation does not reveal the linkages between enterprises and often leads to inadequate understanding of smallholder farmers' realities. Actions taken in one enterprise might affect other related enterprises negatively, or positively and create joint risks or benefits and thus influence the well-being of smallholder households. To articulate our argument on the conceptualization of smallholder farmers as a system we present working definitions of system and demonstrate how they closely relate to integrated agriculture system.

2.1. Smallholder farms as complete systems

A system is a set of any interrelated elements of any kind (Ackof, 1974 in Maluleke 2015), and can be broken down into components, but the performance and outcome of the system is bigger than the sum of the individual components. It is an entity, which is a coherent whole (Ng, Maull & Yip, 2009 in Mele et al, 2017) such that a boundary is perceived around it in order to distinguish internal and external elements and to identify input and output relating to and emerging from the entity. A systems theory is hence a theoretical perspective that analyses a phenomenon seen as a whole and not as simply the sum of elementary parts (Mele et al, 2017). The focus is on the interactions and on the relationships between parts in order to understand an entity's organization, functioning and outcomes. This analogue is amenable to smallholder farmers' context; who engage in multiple agricultural enterprises to generate incomes as well as ensure food security. This perspective implies that researchers have to focus on holism than reductionism. Focusing on individual enterprises implies reducing and oversimplification of smallholder realities. To Kramer and de Smit (1977) a system is a set of interrelated entities of which no subset is unrelated to any other subset. Agricultural enterprises are seldom unrelated. The production of one enterprise is undertaken in relation to the other enterprises. Crops grown in fields are intrinsically integrated with livestock produced by the same household. Operations carried out to produce and sell on markets for all the enterprises are undertaken in manner that ensure success of the whole farm, and rarely individual enterprise, unless there is clear motivation to focus on certain enterprises. Agriculturalenterprises thus have to be assessed relative to other enterprises supporting the farm. Agricultural enterprises are undertaken as a whole; smallholder farmers depend on a variety of agriculture activities that as a unit produce benefits that would not be possible if they were undertaken in isolation. It is therefore important to understand that the purpose of agricultural system for smallholder farmers goes beyond the narrow recognition of single enterprises. For smallholders, the agricultural system is an economic system of a household, community, society, land scape or region within which agriculture operates. The paper examines the world of smallholder farmers, and takes their reality as a complete system. A system is an assemblage of objects united by some form of regular interaction or interdependence (Mele et al 2017) and is a collection of interrelated elements forming a meaningful whole (Barlas, 2007). This gives meaning to investigation of agricultural value chains as a system beyond focusing on one enterprise to propel economic growth and sustainable livelihoods. Understanding the interaction and interdependence of farm enterprises present best opportunity of developing strategies and policies that benefit smallholder farmers. The paper expands the meaning to include feedback indicators and structure following the line of thinking of Maluleke (2015). The International Council of Systems Engineering (INCOSE) defines system as a construct of or collection of different elements that together produce results not obtainable by individual elements (INCOSE,ca, 2010). In smallholder farms, the contribution of different enterprises to income and food availability is not the same as that obtained from mixed enterprises. In the event of shocks and adverse weather, some enterprises may be affected while some might give better yields. When market shocks are experienced producers suffer, and those who diversify face the least risk. The ability of households to cope is influenced by the level of diversification and such results are not obtainable if only one enterprise sustained households. Systems dynamics theory emphasizes linking systems to reality and purposefulness. Without complimentary enterprises, smallholder livelihoods would not have a meaning, and would not sustain households in a way they do as a unit. We are not suggesting that researchers do not recognize the importance of interconnected and interdependent farm enterprises, but the deliberate focus on single enterprises in value chain studies is our major concern. Understanding the impact of upgrading of smallholder value chains thus is only possible if interactions and behaviours are premised on the whole agriculture system.

Hypothesis

Smallholder farms are integrated agricultural systems which as units sustain households in a way that is not possible with single enterprises.

3.0. Theoretical framework

Theories are sets of hypotheses that provide a cognitive frame for describing, explaining, understanding, predicting, and controlling real systems (Größler et al, 2008). They can be classified along many dimensions, but the two dimensions that proved to be relevant in this paper are (1) whether a theory is about the content or the structure of a social system (Lane 2000) and (2) the range of phenomena a theory claims to cover. Content theories of social systems contain hypotheses about the number and nature of elements (of which humans are the most important ones) within a system, their relationships, the processes going on, and the effects of these processes—all of which depend on certain contingencies. Structural theories of social systems make statements about how elements in a system can be configured and how they causally relate to each other. Given that content and structural theories focus on two distinct elements in a system (humans and configuration of elements), combining them provides an opportunity to understand interdependent systems. As suggested by Homans (1978), a theory should be selected in terms of its coverage of studied phenomena. Concentrating on the human elements and ignoring the causal relationship between farm enterprises fails to capture reality of smallholder farmers. In the subsequent sections of this paper, a theoretical framework comprising of two distinct but complementary theories, TCT and SD theory to analyse interdependent value chains is presented. Understanding of value chains in a holistic way and in a landscape context requires careful selection of the most appropriate theoretical framework. Given the reality of smallholder farmers who rely on the agricultural system comprising many enterprises from livestock, crops and non-farming activities, application of one theory is unlikely to provide a complete revelation. To produce results that closely resemble the plight of smallholders, use of complimentary theories is essential. In this paper, a case for the use of value chain analysis framework, TCT and SD is presented. Overlaps, diversions, convergences and enhancements of the application of the conceptual framework are highlighted.

3.1. Value chain analyses (VCA) framework

Developed and popularized in 1985 by Michael Porter, a value chain is "a system made up of several components; a sequence of activities such as production, processing and transport, and a network of functional relationships that work together to reach an objective" (Moir in Cromme et al, 2010). These components interact through dynamic linkages such as contractual arrangements and coordination, and determine opportunities for investment along the value chain". Farm enterprises are intrinsically linked and executed collectively by smallholders as a system. VCA describes a full range of activities required to bring a product or service from conception, through different phases of production, involving a combination of physical transformation and the input of various producer services, delivery to final consumers and final disposal after use (Kaplinsky & Morris, 2002). Value chains do not exist in the sense of tangible reality but are simply a framework for trying to understand how the world works; a way of understanding the interaction of people and firms with markets (Mitchell et al, 2009). This interpretation is relevant and aid the understanding of smallholder farmers' reality and other actors within studied agricultural enterprises. In addition, the understanding of the interaction between enterprises at firm (farm) level is of paramount importance. As with any other approach, VCA has limitations (Mitchell, Shepard & Keane, 2011). In the view of Mitchel et al (2011), first, as a methodological tool, VCA is highly eclectic with a diverse application that is far from standardized. Second, it is highly sector, firm and temporally specific – it offers a 'snapshot' of the organization of production and consumption at a point in time, but a limited guide to monitoring over time. As a standalone framework, VCA cannot show trends over time, thus it needs to be complemented with other approaches and theories. Third, VCA is, by definition, heuristic and needs adaptation in order to become a tool to generate interventions. The paper recognizes these limitations, but its lack of standardization lends VCA inadequate to model smallholder farmers' realities. Sector specificity offers an opportunity to understand individual enterprises, but fails short of addressing integrated agriculture system. Temporal specify is avoided by complimenting value chain analysis with SD that allows historical understanding of systems as well as prediction of future performance. In VCA, the profitability of a firm depends on how effectively it manages the various activities that create value added (FaBe et al, 2009). In this paper, the firm is a collection of the smallholder farmers' activities, thus profitability of integrated agricultural enterprises involving smallholder farmers and how they can manage different activities and enterprises to create value added is made possible. Smallholders' farms resemble firms, and performance of these individual firms has to be studied and aggregated to describe performance of collective firms. This paper also recognizes relevance of the windmill approach developed by Leornado et al (2015) which shows the vanes as single enterprises which coalesce in the middle as a farm value chain. The value chain could be either food security or income generated for smallholder households. VCA enables the assessment of the linkages between and amongst productive activities (Dolan & Humphrey, 2000; Hess, 2008). Thus, the VCA is a suitable framework to analyse the nature and determinants of competitiveness of different agricultural enterprises in which smallholder farmers can participate. It is most useful to show the where; that is nodes or stages which have to be analysed and how these relate to the overall food security and income generated for smallholder farmers. At these various stages, various factors that constrain or influence the choices made by households can be identified and well understood. Due to numerous studies that have acknowledged the existence of transaction costs for example Cuevas (2014), Pingali (2005) and Halloway (2000) we argue that households' engagement in integrated agricultural system is largely premised on the existence of transaction costs. Thus, the TCT help researchers to define, conceptualize and operationalize constraining and influencing factors of value chains at smallholder farmers' level.

3.2. Transaction cost theory (TCT)

There is extensive literature defining transaction costs (Allen, 1991; North, 1990b; Stiglitz, 1986; Vatn, 1998; Wang, 2007). This paper reviews relevant literature for application of transaction cost in value chain analysis and performance of smallholder farmers. Belonging to the "New Institutional Economics" paradigm, TCT is a theory of institutions constructed through a combination of human behaviour theory and costs of transacting (North, 1990), and it justifies the existence and roles of institutions in society (Marinescu, 2012). Based on the work of Coase (1937, 1960), who attempted to define the relationship between the firm and a market, TCT is premised on the belief that institutions are transaction cost minimizing arrangements, which change and evolve with changes in the nature and sources of transaction costs (Williamson, 1985). Even though TCT has faced numerous criticisms, there is consensus that the theory transformed economics. For example Marinescu (2013) argues that Coase neither defined the empiric character of the transaction cost nor explained how these could be recognized; but nevertheless emphasizes that the TCT represents the cornerstone of efficiency analysis on comparative institutional arrangements. Even though seemingly abstract, this paper views institutions as important in value chain analysis. Institutions are the rules of the game in a society or more formally are human devised constraints that shape human interaction (Hagedorn, 2008). They are made up of formal constraints for example rules, laws and constitutions; informal constraints for example norms of behaviour, conventions, and self-imposed codes of conduct, and their enforcement characteristics. These institutions are at two levels; macro and micro level (Kherallah & Kirsten, 2002). The macro level deals with institutional environment or the rules of the game that affect the behaviour and performance of actors; the political, social and legal ground rules that establish the basis of production, exchange and distribution. On the micro-level institutional analysis deals with managing of transactions, governance. In this paper, the latter is more relevant to understand the performance of smallholder farmers in markets. In the context of this paper, households, farmers groups and traders are regarded as institutions. Rules are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must be provided and what payoffs will be assigned to individuals dependent on their actions (Olstrom, 1990). Understanding the rules of production, marketing and value addition are important in the analysis of how households prefer some value chains to others Performance of smallholders in value chains is governed and constrained by set of rules (formal and informal), the actions of smallholders along the value chains is studied much better using this essential feature of the TCT. We argue that the interdependence of value chains is incumbent upon institutional arrangements. Since institutions determine the governance structure of transactions, analysis of market participation of smallholder farmers in interdependent, interconnected and complimentary enterprises will be complete if researchers investigate governance modes. In this paper we accept the science of choice as argued by Willliamson (1979) and consider it as important in the selection of value chains, participation and performance of smallholder farmers engaged in a collection of such value chains despite an opposing argument put forward by Buchanan (1975). The most important tenant in this regard, are the factors which influence the identification and preference of certain value chains to others, whether such decisions are made due to cognitive capabilities, or limitations or due to information available. In short, "what are the influential factors for the selection of certain agriculture enterprises in certain landscapes?" Giving satisfactory response to such questions dictates the application of SD theory which is capable of giving more details on the determination of influential factors.

3.2.1. Assumptions of transaction costs and application to smallholder integrated value chains

Williamson (1985) contends that transaction costs rests on the inter-play between two main assumptions of human behaviour or characteristics of transactors (i.e., bounded rationality and opportunism) and two key dimensions or properties of transactions (i.e., asset specificity and uncertainty). We also suggest the use of both assumptions to aid the understanding of agricultural value chains. Bounded rationality is the assumption that decision makers have constraints on their cognitive capabilities and limits on their rationality (Simon, 1957). Simon contends that even though decision makers often intend to act rationally, this intention may be circumscribed by their limited information processing and communication ability. Individuals are not able to act on a rational basis due to their limited perspective of the environment surrounding them and because of limited information (Simon, 1955). In spite of having been exposed to adverse climatic conditions, characterized by frequent droughts and floods and reduced yields and productivity, smallholders in certain landscapes stick to their preferred value chains. It is thus possible to apply the bounded rationality assumption to understand why such phenomenon repeatedly occurs. It is important to understand why households engage in certain value chains or some combinations and not others in spite of in some instances repeated lack of success. It could be limited ability to analyse best combinations or genuine lack of viable alternatives; and the assessment is made possible by using the lenses of transactors behavioural assumptions. Analysis of education and past experiences that improves transactor knowledge can improve understanding of decision-making ability and influence transaction costs as suggested by Libecap (1989); Challen 2000; Ducos et al. (2009) in Corgan et al, 2014). The analyses of decision makers (household heads) experiences, period spent in given landscape (farming area), exposure to other environments (apart from the current context) and education level provide adequate surrogates to measure the influence of transaction costs on interdependent agricultural value chains. Whilst, other surrogates have been widely applied in various studies, it is important to demonstrate how previous exposure of decision makers influence transaction costs. The ability of decision makers to process information (interpret surroundings) is influenced to a great extent by their previous knowledge and experiences. Where some smallholder farmers might not encounter constraints or notice opportunities, because of their prior exposure, others might interpret to the contrary. We strongly believe that isolating previous exposure to different environments aid in assessing how bounded rationality influence the selection of certain value chain combinations. Opportunism is the assumption that, given the chance, decision makers may unscrupulously seek to serve their self-interests, and that it is difficult to know a priori who is trustworthy and who is not (Barney & Hoskisson, 1990). Among the actors involved in key value chains, are there some opportunists who exploit smallholders deliberately or as a consequence of their cognitive limitations. Also, are the service providers genuinely facilitating the realization of increased gains or reduction of risk for smallholder farmers? Assessing the level of trust between smallholder farmers and traders (input suppliers and output buyers) is critical to determine existence and magnitude of transaction costs. Coggan et al. (2013) contend that opportunism generates transaction costs through the time and effort that transactors invest to develop complete contracts or increase monitoring to manage the risks to transactors from opportunistic behaviours. Ducos and Dupraz (2006), Ducos et al. (2009), Mettepenningen and Van Huylenbroeck (2009) and Morrison et al. (2008) in the view of Coggarn et al (2013) all argue that confidence in the information provided by contracting parties as well as relationships formed on trust will reduce transaction costs associated with opportunism. For smallholder farmers, we hypothesize that, whilst they spend time validating information provided by extension services, other service providers and traders to assess how it applies to their context, a higher level of trust will reduce transaction costs. The combined influence of reliability of information provided by extension services across all the value chain stages, in a given physical setting and level household assets endowment on the selection of value chains deserves to be assessed. Analysis of level of trust, frequency of contact between smallholders and extension services, the quality of extension services, and experience of extension service providers and their relationship with traders, knowledge and relationships between smallholder farmers help to investigate the effect of opportunism on enterprise selection and contribution to household food and income security. Having basic information on the traders, buyers, input suppliers give indications of opportunist behaviour. In cases where smallholders lack such basic information, there is high risk of exploitation. Social connectedness refers to the connection of a party with other individuals and or groups (Coggan et al, 2014). It has the potential to reduce the information–collection costs of the private parties associated with learning about, adopting and adapting to a new policy as individuals are exposed to this information in their day-to-day activities which reduces the need to seek out this information specifically (Morrison et al. 2008). Muronda and Tukuta (2016) found that farmers who participated regularly in group meetings (a surrogate of social capital) had a higher likelihood of participating in pigeon pea markets. Thus, analyses of social capital such as membership to groups relevant to specific value chains, frequency of participation in group meetings, activities, existence of collective inputs purchase and marketing of produce give reasonable understanding of the effect of social capital on participation of smallholder farmers in value chains. Social capital is hypothesized to limit opportunism by traders and buyers.

Hypothesis
Bounded rationality and opportunism influence the selection, integration and performance of smallholder agricultural value chains.

3.2.2. Properties of transaction costs
The key properties of transaction costs; asset specificity and uncertainty and transaction frequency (Hagedorn, 2008; Williamson, 2008) are important in investigating effectiveness and interdependence of value chains. Shelanski and Klein (1995) add complexity as a fourth attribute of transaction, a feature that contributes significantly to understanding smallholder farmers selection of agricultural value chains. Complexity of transactions is analyzed using SD theory which is further elaborated later in this paper. Alchian and Demsetz (1972) also consider measurability as an important attribute of transaction costs. Transaction costs measurement is very difficult, and has sometimes created difficulties in the operationalization of the theory. However, in this paper, we argue that transaction costs can be measured, the most important factor is the identification of the appropriate proxies that closely represent the measured costs. We also concur that some researchers imply use of abstract measures, which should be avoided as far as possible.

(a) Asset specificity
Asset specificity represents the firm-specific resources which are critical for creating and preserving strategic advantage (Williamson, 1981; Luo & Suh, 2004) and the transferability of assets that support a given transaction (Williamson, 1985). Assets with a high amount of specificity represent sunk costs that have little value outside of a particular exchange relationship. Williamson (1991) identifies six main types of asset specificity; site specificity, physical asset specificity, human asset specificity, brand name capital, dedicated assets, and temporal specificity (Coggan et al, 2013). Asset specificity attribute is also divided into human, physical and site specificity depending on the object of specificity (Wander, 2013), a narrow view that does not give adequate meaning to smallholder farmers context. Coggan et al, (2013)'s conceptualization of asset specificity resonates well with the case of integrated agriculture systems that sustain smallholder households. Site specificity is when buyer and supplier are involved in an exchange relationship with one another due to the importance of location (proximity or characteristics). Once in place the assets are immobile and costly to relocate. We also argue that site specificity is not limited to buyers and and suppliers, but rather extends across the entire value creation chain. The relative location of inputs suppliers, smallholder producers, service providers and markets constitute a comprehensive operationalization of the site specificity attribute of transaction costs. Also, we suggest the analyses of the influence of geographical area, location relative to main transport networks, main markets, and proximity to service centers (input suppliers, extension services, regulatory services, output markets etc), soil characteristics, rainfall patterns, and other weather patterns. In our view, these elements provide sufficient proxies to determine the magnitude of transaction costs that influence participation in a set of value chains. We argue that transactions in certain contexts are influenced by site specificity. Physical asset specificity or specialized assets denote investments in the physical assets that are tailored for a specific transaction and have few alternative uses owing to their specific design characteristics (Coggan et al, 2013). For example a chicken run cannot be used to keep cattle. In the same context, equipment used for the planting and processing of certain crops can hardly be used to produce other crops. Having an understanding of physical asset ownership of smallholder households gives better opportunity to assess magnitude of transaction costs and aid development of risk mitigation strategies, and generation of sustainable upgrading strategies. Dedicated assets according to Coggan et al (2013) are assets of general purpose for example tractor, hoes and cultivator which have been made in a particular transaction. Implied in dedicated, is difficult to distinguish from specialized assets, but a closer view shows that these are assets that are rather used to carry out specific tasks for example a plough is used for ploughing (land preparation) a cultivator for cultivation, a sprayer for spraying to control pests. Even though smallholders can use such assets in any other farming activity, their use is dedicated to certain tasks and not necessarily specific enterprises. Human capital or knowledge specificity refers to the degree to which skills, knowledge and experience of workers are specific to a transaction. In this paper, investigation of the knowledge and skills of smallholder farmers is hypothesized to aid understanding of how smallholder farmers prefer and engage in some agriculture enterprises. Enterprises that require general knowledge and unspecialized skills have a great potential of addressing vulnerability of smallholders. This paper recommends investigation and interpretation of linkages between physical, dedicated assets and human capital endowment on on smallholder farmers' agricultural value chains. Coggan et al (2013) isolated another important property of transaction, input specificity, which refers to inputs that are specific for a particular transaction and are not easily transferable to other transactions. For example, crop seeds, vaccines and fungicides can only be used to produce specific value chains. Analysis of availability, accessibility and affordability of agriculture inputs relative to value chains in which smallholder farmers are involved provides a better

understanding of their performance. Means of access of inputs have a great effect on influencing engagement in agricultural value chains. For example, at the peak performance of the cotton value chain in Zimbabwe, farmers in cotton growing areas would rarely be concerned about how and where to get seed, pesticides and fertilizers to grow cotton. They focused on value and cost of loans. Due to easy access to input loans, most farmers produced cotton on larger areas and realized reasonable yields relative to other crops. Brand name which essentially refers to reputation is yet another important asset specificity. In some landscapes, some companies might have created reputation by providing essential services to farmers. Smallholder farmers might also create a good reputation for a certain market that gives preference to their products. It is essential to assess whether smallholders in some landscapes or locations have any products that are preferred by the market, and to identify the products. It is incumbent upon researchers to assess how reputation influences participation of smallholder farmers in some value chains. Time or temporal specificity is when the value of the asset is dependent on when the asset reaches the user. It is of great importance to investigate demand trends over time (peaks and depressions). Performance of integrated agriculture system depends on how well consumers are served and smallholders can take advantage of demand trends to realize better rewards. The timing of access to certain inputs also influences enterprise combinations by smallholder farmers. For example, if it is fact that if pesticides are supplied later than expected period, crops susceptible to pest attack would be less preferred. Producers thus incur transaction costs due to the timing of access to inputs, which might influence forgoing of potentially good returns due to delayed access to pesticides. A holistic study of value chains is expected to elucidate how timing of access to inputs and output markets influences smallholders participation in value chains. Although difficult to operationalize, procedural specificity; a sequence of procedures and routines tailored to a particular transaction is used to evaluate the possibility of inclusion of smallholders into vertically integrated value chains. Also, smallholder farmers have to undertake specific operations to produce marketable surpluses. Due to fixed available labour, smallholders might be restricted to certain value chains to meet procedural specificity. A good example is tobacco where key activities such as topping and suckering cannot be postponed as they have a direct effect on quality, yield and ultimate incomes generated by households. Also, for farmers to produce tobacco they need to be registered and meet certain requirements. Obviously farmers involved in tobacco production have a different mixture of value chains relative to those involved in other enterprises. Thus, the existence of procedural specificity give rise to transaction cost and have to be analysed to understand why smallholders prefer some combinations of value chains to others. Are agriculture enterprises selected due to asset specificity? Is it that farmers have specific assets that determine their preference of certain value chains to others?

Hypothesis

Asset specificity determines enterprise integration and smallholder farmers' food and income generation capacities

(b) Uncertainty

Uncertainty is described as a disturbance or negative externality which requires adaption by the organization; whereas frequency refers to the degree of how often transactions occur (Williamson, 2008). As implied earlier, in TCT there are two types of uncertainties; behavioral (assumptions of transactors) has been adequately articulated and environmental uncertainty. Smallholders operate in different physical, economic, political and social environments. While all are important, we propose focus on the physical environment in part due to its stability relative to other environments when analysing value chain combinations. This also links well with the focus on micro institutions, in our case of smallholder households as we seek to develop a theoretical framework to understand the performance of interdependent agricultural value chains.

Hypothesis

The greater the physical environmental uncertainty, the greater the diversification of agriculture enterprises by smallholder farmers.

(c) Governance mode

Depending on the magnitude of transaction costs, the organization or firm has to choose either for pure market, hybrid or integrating the products vertically within own hierarchy. Governance is taken to be the means by which to infuse order, mitigate conflict and realize mutual gains (Williamson, 2008). In this paper, measurement of key transaction attributes is proposed to show how the smallholders and traders end settle for the most efficient governance form, which incurs the lowest total cost as suggested by Shelaniski and Klein (1995). Also, it is important for researchers to investigate the resultant governance mode, and how it eventually unfolds. Governance structures are also important in value chain analysis, particularly on investigating and suggesting upgrading strategies. In analyses of value chains, the governance structure (mode) is taken as a key dependent variable, while asset specificity and environmental uncertainty are independent variables. Therefore governance modes serve as the dependent variables, whereas the key attributes of transaction costs are of independent nature (Shelanski & Klein, 1995).

Hypothesis

Governance structure predominant in smallholder value chains is influenced by dominant features and the magnitude of transaction costs, and have an effect on the benefits or risk derived by smallholder households.

3.2.3. Application of transaction costs in agriculture

Several interpretations of transaction costs are useful in developing a framework for analyses of smallholder farmers' involvement in multiple integrated value chains. Transaction costs are individual household's decision to engage in market exchange (Cuevas, 2013). As implied in the above definition, making a choice to participate or not to participate in potentially rewarding or risk free agriculture enterprises is itself a cost to smallholder households. They are expenses and opportunity costs, both fixed and variable arising from the exchange in property rights (Makhura, 2001), and do not only include the costs of exchange itself, but also encompass costs of reorganization of household labour and other resources to produce enough for the market (Makhura et al, 2001). In selecting some enterprises from a basket, households incur costs, and this conceptualization is the same as when households make decisions to engage in enterprises. Analyses of opportunity costs of engaging in agriculture enterprise help to give a complete picture of the performance of smallholder farmers' households. Hobbs (1995) regards transaction costs as those costs incurred in the process of transformation of inputs into produce and distribution to consumers through various marketing channels and systems. Smallholder farmers transform inputs into various agriculture products. Applying the VCA framework enables the isolation of costs at different nodes of the transformation process through to markets. Hagedorn (2008) argues that transaction costs have physical and social dimension. Implied in the definition are both costs of exchange and the complete set of costs incurred when households reorganize and reallocate labour to generate a marketable surplus (Halloway et al, 2000). Transaction costs are pecuniary and non-pecuniary costs associated with arranging and carrying out an exchange of goods and services. Some costs incurred by smallholder households can be easily quantified in monetary value (pecuniary) while some are not easily quantified (non- pecuniary). To give a clear understanding of the performance of integrated agriculture system, the effects of both costs should be assessed. They are costs of information, search, negotiation, screening, monitoring, coordination and enforcement; distinguished between fixed and proportional transaction costs (Key, et al, 2000). Fixed transaction costs are invariant regardless of the quantity of traded goods and include; searching for a customer with the best price or searching for a market, negotiating and bargaining, screening, enforcement and supervision. Search costs are lumpy and a farmer may incur the same costs to sell whatever quantity of product (Cuevas, 2014). In analysing smallholder value chains, researchers need to investigate and quantify costs involved in searching for a market, negotiating and bargaining costs for various products produced on smallholder farms. Goetz (1992) described it in terms of cost of discovering trading opportunities and operationalized the concept as reduced leisure time. Understanding the time spent transforming inputs into products and selling on markets is paramount in understanding risks and rewards associated with engaging in agricultural value chains. Some enterprises may take more time for households' time relative to others, but smallholders may be compensated by high returns in such enterprises. In analysing integrated value chains considerations must be made to clearly show the benefits or risks involved in integrated agricultural value chains. Some transaction costs are specific to the agri-business firm, farm specific, location specific and crop-specific (Pingali et al, 2005). Farm specific are those costs associated with participation in markets that are unique to the farm given the household and farm characteristics (Cuevas, 2014). These costs can also be the same for all farmers in a particular location such as costs due to quality of land, amount of rainfall and temperature, and can also arise in both input and output markets. The magnitude of such costs are due to variances across regions. When analysing rewards and risks associated with agriculture enterprises, the effect of these costs should be assessed and upgrading strategies need to be developed consistent with such costs. Hayes (2000) views transaction costs as costs incurred when dealing with a large number of small farms, this is a characteristic feature of smallholders in a landscape. In his view such costs include; bureaucratic costs and distortions associated with managing and coordinating integrated production processing and marketing, value of time used to communicate with participating farms and coordinating them, cost of incentives used to convince farmers to voluntarily participate in integrated production and screening costs linked with uncertainties about the reliability of potential suppliers or buyers and the uncertainty about the actual quality of goods. Table below shows the broad categories of transaction costs. Operationalizing these elements of costs has high potential to provide a detailed view of the smallholder farmers. Even though difficult to operationalize all elements of transaction costs, an attempt to identity and assess the most influential factors should be made. While the TCT helps to isolate transaction costs, it however fails to analyse their dynamic interaction and worse the interaction and interconnected nature of integrated agriculture system at smallholder farm level. This requires the integration of the theory with other theories to provide a complete understanding of especially the combined contribution on the behaviour of the agriculture system.

3.2.4. Transaction

Hobbs (1995) defines a transaction as an exchange occurring between the two stages of a production or distribution chain as the product changes in form or in ownership rights. Smallholders acquire inputs, transform inputs into produce, which is either consumed or marketed to generate income. In the process of transformation of inputs into produce and distribution to consumers through various marketing channels and systems, smallholders are engaged in transactions. A transaction is a unit of transfer of legal control (Commons, 1934) and Commons (1932) in Hagedorn,(2008) demands that the ultimate unit of activity must have three principles of conflict, mutuality and order and "this unit is a transaction". Agriculture enterprises possess these three principles as has been shown earlier. Williamson (2005) perceives the transaction as transference of a good or service across a technologically separable interface; that is, it entails the transference of assets across discrete stages of multistage production process. TCT argues that the transaction including its relevant physical dimension is the basic unit of analysis. As agriculture products are produced, they move across different phases where different technologies are used. Transaction does not always imply the movement of a physical object between actors (Schmid, 2004), but an action is a transaction if it affects actors (Hagedorn, 2008).In acquiring inputs, transforming them through production and value addition (processing) farmers are carrying out transactions. These definitions of transaction lend TCT a suitable theory, which however needs to be complimented with other theories as has been suggested earlier.

3.3. Systems dynamics theory

The TCT is important and useful in the identification, definition, conceptualization and operationalization of constraining and influencing factors of value chains at smallholder farmers' level. However, it fails to capture the dynamic interaction of these factors and integrated enterprises. Also, the response of farmers to the limiting factors cannot be explained fully through the application of

TCT. For example, Leornado et al (2015) argue that "TCT is not helpful in explaining why certain arrangements are preferred over others or what makes farmers choose particular value chains. The contribution of TCT is limited mainly because it applies only a cost perspective and it focuses on individual transactions". A complimentary theory that help to demonstrate and explain the dynamic interactions is undoubtedly essential. In the preceding sections we show how SD is the most suitable theory to explain the dynamic interaction among the transaction costs and integrated agriculture enterprises. SD was developed in the mid-1950s by Professor Forrester to provide quantitative and mathematically grounded insights to problems arising in industrial systems (Hamza & Rich, 2015). It is a computer-aided approach to policy analysis and design. and used to analyse dynamic problems arising in complex social, managerial, economic or ecological systems-literally any dynamic systems characterized by interdependence, mutual interaction, information feedback, complexity and circular causality (Hamza & Rich, 2015). They argue that models are developed to understand the consequences of behaviour given interactions and feedbacks between different actors and or decisions. We argue that following this argument, SD modelling is capable of analysing the dynamic interaction between agriculture enterprises on a farm, in addition to the interaction of different actors along a value chain. SD is a structural theory of dynamic systems (Lane 1999); based on the main hypothesis that the structure of social systems is generally characterized by feedback loops, accumulation processes, and delays between cause and effect (Größler et al, 2008). As a structural theory, SD does not offer a content theory about the elements and processes in social systems, does not provide clear understanding of specific social systems, but rather, makes statements about the principal interdependencies of elements in social systems. At the center of SD, dynamic processes in social systems function in feedback loops and that the history of systems accumulates in state variables (Größler et al, 2008). In addition, the accumulated history influences the future development of a system—a process that is often affected by time delays. In this paper, we view the high possibility of understanding the structure and interdependencies among agriculture enterprises on smallholder farms, and argue that historical performance of interdependences between enterprises is critical in value chain analyses. Farm productivity, market performance and contributions to household food security and incomes are the focus of our argument. The central argument is that the farm is the key level at which decisions are made in relation to resource allocation (Giller, 2013) to meet multiple objectives and aspirations. While farmers are highly heterogeneous, repeated patterns emerge among their farm systems, strategies, constraints and aspirations (Giller et al, 2011). These patterns, termed a typology, according to Leornado et al (2015) can be captured using various approaches ranging from simple participatory wealth ranking to more complex approaches using multivariate statistics (Bidogeza et al, 2009; Tittonell et al, 2010). We believe this view is tenable to smallholder farmers who undoubtedly seek to meet multiple objectives; among the most important food and income security.

3.3.1. Relevance of systems dynamics theory to agriculture value chain studies

When accepting SD as a structural theory, the question arises whether and how it can be usefully applied to interdependent and interconnected value chain studies. An attempt to identify criteria that has to be fulfilled for a theory to be considered appropriate in studying value chains failed to get clear guidelines. In this paper we borrow the criteria suggested by Amundson (1998) to assess whether a theory should be applied in operations management, which shares the same features with value chain studies. Amundson argued that a theory should match issues, contain meaningful concepts, possess sufficient explanatory power and match with the underlying assumptions. The criteria can be applied to assessment of suitability of a theory to smallholder farms where multiple operations are performed to produce, process and consume and sell agriculture produce. The phenomena studied in SD are complex and dynamic, in particular, socioeconomic systems. Interdependent integrated agriculture enterprises are as has been shown earlier complex and quite dynamic. Smallholder farming is a "nexus of systems, people, processes and procedures" (Hill et al. 1999) in Größler et al, 2008, where value is generated in the organization of farm. Value chain analysis has to address the changing combinations, input, management, and market requirements of different agriculture enterprises. Thus, SD adequately addresses the issues at the centre of interdependent agricultural value chains at smallholder famers' level. The main concepts used in SD are (a) feedback loops, (b) accumulation processes (stocks), and (c) delays between cause and effect (Größler et al, 2008; Harmza & Rich, 2015). In every SD model, there is a process of feedback defined as the means by which changes in one part of a system affect other parts of it and consequently impacts the original stocked component over time (MacGarney & Hannon, 2004). In the study of interdependent value chains, we argue that these concepts are relevant. In producing some agriculture enterprises, feedback loops are experienced which have either a positive or negative effect to some enterprises. For example, focusing on specialized crops such as tobacco, farmers may be forced to forego other key operations in other enterprises and understanding of such feedback loops is important to assess relevance of any upgrading strategies. The decision to grow such specialized crops is taken in consideration of other enterprises. An example of stocks or accumulators in the context of smallholder farmers' value chains is the available food (food security) and household incomes. Flows represent how available food and incomes for households fluctuate over time. Convertors mediate the magnitude of inflows or outflows within a system. Activities that create food and incomes (production, processing, packaging and marketing) are synonymous to conversion and smallholder farmers and other actors involved in the chain are convertors. We argue that using the value chain analysis framework, researchers are able to examine flow of stock from inputs, up to consumption and disposal, and view convertors as actors and actions that take place along the chain. As shown above, SD concepts resonate well with interconnected and interdependent agricultural value chains which sustain smallholder farmers. The fundamental assumptions of SD are the ideas of systems and causality (Größlerr et al, 2008). Both assumptions define interconnected and interdependent value chains. For example, the effect of increasing area planted to one crop has to be investigated in relation to changes in the agriculture system. In the same view, a change in the price of one commodity on the market has to be analysed in consideration of the whole system's ability to meet households' food and income requirements. The ability of SD to enable analyses of complex systems like interdependent value chains at smallholder level lie in the development of models. Through models, a complete understanding of the different farming systems and their contribution to household food and income security is possible. This feature presents means to analyse how change in one enterprise or a collection of enterprises impact other enterprises along the value chain, and smallholders' livelihoods and food security. SD models can predict different types of individual behaviours based on their patterns of feedback with simulations aimed at unpacking the system –wide effects associated with the combination of many interacting types of feedbacks (Rich & Hamza, 2013). Apart from elucidating the behaviour of the entire agriculture system, SD allows investigation of the individual enterprises if such detail is necessary. In this paper, we argue that prediction of different behaviours is important in the design of strategies and policies that can improve performance of smallholders. As a dynamic model that maps out the flows, processes and relationships between actors and actions that exist within complex system (Sterman, 2000), focus on understanding the evolution of a system and its behavioural feedbacks overtime, SD is capable of contributing to study of the contribution of interdependent value chains to households food and income security. Cramer (2013) proposes six criteria for assessing suitability of a theory; comprehensiveness, precision and testability, empirical validity, parsimony, heuristic value and applied value to judge the merit of multiple theories. Even though Cramer applied the criteria to judge the veracity and utility of personal theories, it can be applied to validating value chain analyses theory for two reasons. First, value chains involve the interaction of different actors, thus human behaviour is at the centre of value chains. Second, the criteria is all inclusive and can be used to judge the merit of theories in any field. A comprehensive theory encompass a greater scope or range of explanation for various phenomena. While some theories offer a limited explanation of phenomena, a comprehensive theory should describe, explain, predict, and control phenomena and behaviour (Cramer, 2013). Judging comprehensiveness of a theory depends on supporting data. The modelling process in SD form the basis of assessing its comprehensiveness. Problem articulation, development of dynamic hypothesis, formulation of a simulation model, testing the simulation model, and policy/strategy design and analysis are the key stages of the modelling process. Problem articulation describes the researchers 'intentional effort to "admire the problem" rather than jumping to conclusions about the underlying mechanisms perpetuating an issue (Goodman, 2006). The development of dynamic hypothesis aims to synthesize all that is known about the problem into an endogenous (i.e., feedback-based) theory upon which to evaluate the quantitative model (Turner et al, 2016). Formulation of simulation model involves the construction of the quantitative model. The model is used to conceptualize the primary feedback mechanisms and describe those using coupled partial differential equations (Richmond, 2001). Model testing involves breaking and exposing it to extreme conditions and/or parameter values far outside the calibrated values which closely correspond to values in the real world). This is effected to investigate if assumed parameter values are realistic, asses if the direction of model responses correspond to expected feedback polarity to check model consistency, and to identify variables that could break the system or improve system function (e.g., potential leverage points). Strategy or policy design involves asking and applying "What if?" questions to the model based on proposed strategy or policy interventions for example "what if government subsidies are raised or lowered?"; "what if different management practices are implemented?", what if one or all enterprises value chains are upgraded to identify places of management leverage or potential, and future tipping points (Turner, et al, 2016). There is no doubt that these stages clearly demonstrate that SD adequately describe, explain, predict and provide a basis for controlling interactions in interdependent value chains. Precision and testability demands that a good theory possess constructs that are clearly defined, tightly interrelated, and readily open to reliable and valid measurement through falsifiable hypotheses (Popper, 1963 in Cramer, 2013). Good theories should also expose themselves to rigorous hypothesis testing. Empirical testability extends beyond the precision of interrelated concepts to the rigor of the instruments used to measure those concepts (Cramer, 2013). Unreliable theories, produce different values under repeated tests which cannot be valid. Implied in this feature is the existence of means of theory testing. In SD, models are repeatedly tested to validate the results, and as such it is easy to judge the merits of findings. Cramer (2013) deduces from (Hergenhahn et al., 2003) that a theory trimmed of excess concepts and needless explanation would likely manifest the correct explanation of the world. Parsimony is the simplistic of a theory, but it should not override the need to present complete explanations. Explaining complex issues using simple theory is undoubtedly desirable but seldom tenable. Even though systems dynamics appears somewhat complex, it is its ability to clearly demystify complex systems into its sub-components that makes it the theory of choice. Empirical validity of a theory is its prowess to correctly predict and control phenomena, in addition to descriptive and explanatory scope (Cramer, 2013). It may also reflect the extent to which a theory manages disconfirming evidence, since studies with negative results carry more weight than those with positive results. In systems dynamics, even though it is difficult to model the real world of smallholders, its ability to predict and control performance of value chains based on historical records lends it the most suitable theory to use. It is possible to predict changes in household income and food security relative to changes in enterprise combinations. As demonstrated by Walters et al (2016), researchers can model various agriculture systems (crop only, crop and livestock) under different environments and contexts. Cramer (2013) argues that a theory's heuristic value involves its ability to generate unique thoughts and perspectives and directions in other fields. Applying SD to the study of the interdependent and interconnected value chains has great potential to inspire researchers into understanding salient features and structural behaviour of value chain systems. A theory's applied value can be measured by the extent to which it offers effective solutions to life's problems (Cramer, 2013). Even though it is difficult to develop effective solutions to smallholder farmers food and income security, SD provides the clearest pathway to understanding the behaviour and dynamic interaction of an integrated agriculture system. Development of upgrading strategies based on the detailed understanding of such a system has high likelihood of success relative to those based on isolating particular enterprises. SD models the future behaviour based on historical trends, thus risk of false conclusions is minimized. The likely impact of interventions can be analysed ex-ante, which as has been shown earlier to be difficult if not impossible if the transaction theory is used as the only theory of analyses.

Hypothesis
The dynamic interaction of transaction costs and their effects on the integration and interconnectedness of agricultural value chains is best explained, understood and upgraded through application of SD modelling.

3.3.2. Examples of application of system dynamics in agriculture value chain studies

SD models are a relatively new feature in value chain analysis, even though early models by Slater et al (1969) and Harrison et al (1974) in the context of the agriculture marketing system in South America demonstrated their potential well ahead of their time (Hamza & Rich, 2015). The relevance of SD models to value chains has been shown by Rich et al (2011) in modelling biological dynamics of livestock that take time to manifest, value chains as complex systems of diverse actors and actions each with different motivations and capacities, where temporal and spatial phenomena are of particular importance, and to combine market dynamics with other dynamic phenomena such as change in environment, drought, change in policy that potentially have different effect. In our case, complexity is observed in the way different agriculture enterprises behave as an integrated unit on smallholder farms and in unique landscapes and how their interconnectedness and mutual interaction influence smallholder food and and income security. SD models for agricultural value chains have mostly focused on livestock focussed (Hamza & Rich, 2015). Examples are beef exports from Ethiopia (Rich et al, 2009), Nowergian salmon and smallholders livestock markets in Southern Africa (Hamza et al, 2014), and beef exports from Namibia (Naziri et al, 2015). However, there has been limited SD modelling on the study of interdependent crop and livestock value chains. For example, Walters et al (2016) used drivers of economic, environmental and social sustainability to analyse the potential of crops only, livestock only and integrated crops and livestock systems. This gives the paper compelling motivation to advocate for the application of SD models in understanding the interactions, interdependence, and feedbacks on multiple farming enterprises in unique environments. Agriculture in the smallholder farming sector takes place in dynamic and unique environments, with a number of important contextual drivers that influence feedbacks within the agriculture system and present. Thus, SD modelling presents a unique opportunity to understand smallholder performance and designing of strategies for improvement of livelihoods.

4.0. Discussion

As means to compliment VCA framework, which is regarded as a static tool by some researchers for example Rich et al, (2009) and the lack of predictive power of the TCT, we argue that SD theory fills the gap due to its predictive power to analyse potential performance of integrated agriculture enterprises. The evaluation of performance of agriculture markets requires much more nuanced analysis than is currently available (Rich et al, 2009). The most limitation of VCA is its inability to analyse specific, chain level interventions and assess their impact. A qualitative value chain approach, in the view of Rich et al (2009) that has dominated for many years is limited in answering questions such as where to invest and the economic impact on different actors from specific investments? Critical in this paper is the determination of type of agriculture enterprises and economic impact of value chains for smallholder farmers, thus the need for alternative analysis methods. The lack of consideration qualitatively, of the role of feedbacks that are present in systems of interaction, is yet another critique of current value chain analysis methods (Sterman, 1989). These dynamic considerations are important in the context of both crop and livestock systems whose production cycles are long and linked in complex ways and whose multiple social and economic roles lead to consequences that challenge development planners (Rich et al, 2009). Integrated crop and livestock farming systems interventions impacts could be counterintuitive and difficult to determine ex-ante, given value addition multipliers, susceptibility to external shocks such as climatic events and government instituted barriers. The resource and environmental components of agriculture systems and local and regional competition add to a complex setting for development interventions. Another limitation of current value chain approaches is that the scale of analysis is too aggregated to conduct specific types of analysis, and yet a more detailed , micro-level of the production cycle and marketing at producer level is required if value chains are to have a meaningful impact on poverty alleviation. SD models are essential in analysing agricultural value chains, as they address most limitations with current analysis approaches. Given limitations of qualitative and some quantitative approaches, the paper argues for the use of SD theory owing to its potential to simulate ex-ante impacts of interventions and activities within value chains, their performance and distribution effects among actors. SD has a long tradition of highlighting dynamic processes that embrace flows of products along a supply chain (Towil, 1996 cited by Rich et al, 2009). SD is a dynamic model of flows and relationships between actors with which one can examine the impact of alternative scenarios over time, and which embody the peaks and lags present in value chains (Sterman, 2000). Having an understanding of previous performance of value chains over time; presents an opportunity to develop appropriate strategies to improve performance of smallholders.

4.1. Integrated value chains analyses cycle

The VCA is the most relevant framework of analysis. It shows the transformation of a product from conception to consumption and disposal. Such is the case of farming systems. Inputs are procured, transformed into products, consumed and surplus sold at markets. As shown in the figure below, we hypothesize that farmers face transaction costs which inadvertently influence agriculture enterprises selection and performance. These enterprises are undertaken as complex interconnected transactions at farm level to form what we refer to as integrated value chain. As we illustrated earlier, any change in one enterprise will have consequences in the whole agriculture system

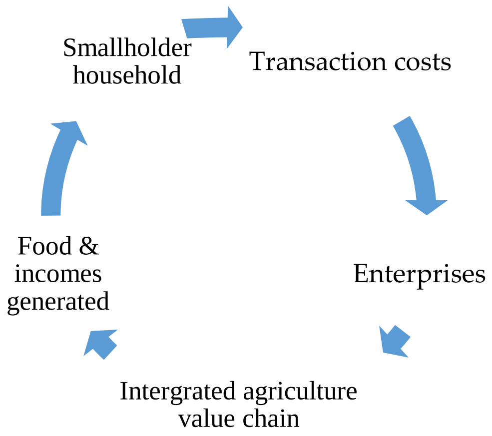

Figure 1: *Integrated agriculture value chain analyses cycle.*

As demonstrated by Hagedorn (2008) a small change to improve one enterprise has to be accomplished by many simultaneous compensating changes elsewhere. For example, an increase in the area put to maize, has to be considered in relationship to area, and seed, of other crops and drugs and medicines for livestock. The interdependence of agriculture enterprises make it difficult to break them down into optimal sub-units, unless with the application of SD models. As a unit, integrated value chains generate food and incomes for smallholders, sustain smallholder households as illustrated in figure 1 below. Ability and capacity of integrated value chain influences smallholders to make decisions on selection of enterprises. Due to existence of bounded rationality, opportunism and transaction costs, households may fail to institutionalize, innovate or improve enterprises thus the whole integrated agriculture system remains static. In studying agricultural value chains, researchers need to apply TCT to identify constraining and influential factors that lead smallholder farmers to select and engage in certain agriculture enterprises, in a VCA framework which is shown in the apex of the proposed analyses framework above. The relationships, interdependence, mutuality and complementarity of these enterprise coalesce into integrated agriculture system, represented by the four interwoven enterprises (A-D). An integrated agriculture value chain is then borne, which smallholder farmers depend on for food and income security. Once households are secure, they maintain the integrated value chain over time as a stable livelihood and modify where necessary. As has been shown earlier, SD enable understanding of the interdependence, joint effects of transaction costs, historical analyses and prediction of future behaviour through modelling of various scenarios.

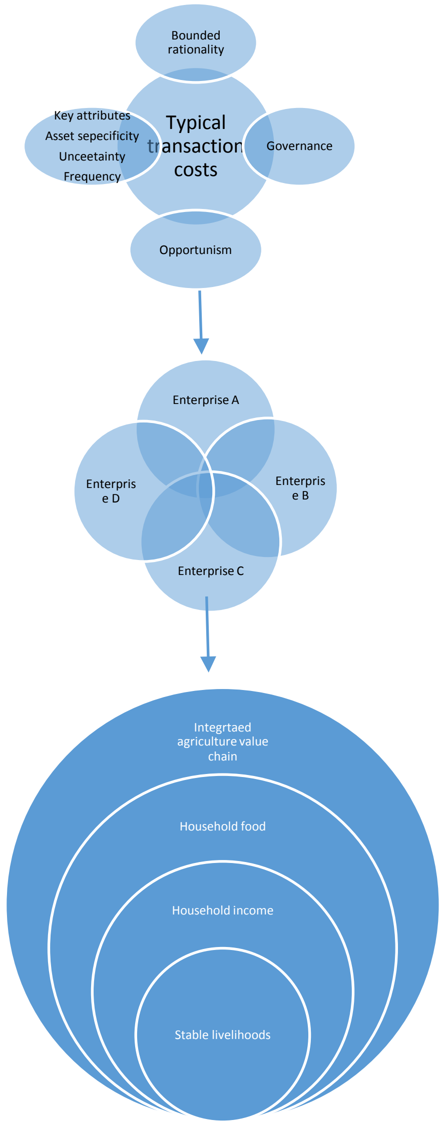

Figure 1: *Vcatctsd theoretical framework*

Also, the likely effect of upgrading strategies is better informed through SD modelling. We propose the application and validation of a theoretical approach that we have termed "Vcatctsd" as shown in figure 2 above.

5.0. Conclusions and implications

This paper has illustrated the need for alternative theoretical framework to analyse smallholder value chains which are based on integrated agriculture systems. The conceptualization of smallholder farms as systems where clustered transaction are typically conducted has been shown. Importance and gaps of VCA as a framework have also been shown. Gaps in the use of single theories in analysing smallholder farmers' value chains have been isolated. Various hypothesis for key elements and factors in value chain analyses have been developed. TCT attributes, typical transaction costs and governance modes have been discussed based on extensive literature review, and their importance in explaining smallholder farmers' participation in agriculture enterprises has been presented. We have also shown the VCA cycle that is initiated when households make decisions on the agriculture enterprises suitable in their context, as they face various transaction costs, and how these coalesce into integrated agriculture value chain, the ultimate source of food and incomes for smallholder households. The dynamic interaction of transactions costs and their effects on the integration and interconnectedness of agricultural value chains is best explained, understood and upgraded through application of TCT and SD modelling. The relevance of SD in the analyses of integrated agricultural value chains has been demonstrated. Use of criteria suggested for assessment of suitability of theory in other fields clearly showed that SD is the most suitable theory to VCA to compliment TCT. The dominance of dynamism within agriculture system and the modelling processes and examples of application in other studies clearly supported the suitability of SD in understanding smallholder agricultural value chains. Our proposed theoretical framework based on the VCA concept, and integrating TCT and SD (Vatctsd) even though needing further refinement and validation, has great ability to contribute research and understanding of integrated value chains, which are typical to smallholder farmers' context.

We recommend validation and application of the VCATCTSD analytical framework in future research.

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Marian Tukuta and Stanley Marshal Makuza guided the development of the research objectives and the conceptualization of smallholder farms as systems. All the authors contributed and guided the preparation of the research article.

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