Concepts, applications, and extensions of value chain analysis to livestock systems in developing countries

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ABSTRACT: The analysis of value chains has augmented our knowledge on the complexities, inter-linkages, distributional benefits, and institutional arrangements of production and marketing channels in developing countries. However, the analysis remains relatively qualitative and case-specific, with limited ability to rank or assess the impact of alternative interventions or to analyze sufficiently the complex market dynamics and feedbacks present in livestock systems. This paper offers insights on ways to improve the analytical rigor of the value chain methodology that combines both qualitative and quantitative approaches.

KEYWORDS: Value chain, livestock, developing countries

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I. Introduction

Value chain approaches have been utilized by development practitioners and researchers alike to capture the interactions of increasingly dynamic (and complex) markets in developing countries and to examine the inter-relationships between diverse actors involved in all stages of the marketing channel (Kaplinsky, 2000; 2004; Dolan and Humphrey, 2000; Fitter and Kaplinsky, 2001; Ponte, 2001; Schmitz and Knorringa, 2000; Giulani et al., 2005; Bair and Peters, 2006; Pietrobelli and Saliola, 2008). They have alerted us to inequities in power relationships based on the governance of the supply chain and have highlighted potential points of entry (and exclusion) for smallholders (Dolan and Humphrey, 2000; Hess, 2008). Moreover, by going beyond firm- or activity-specific analysis, value chain analysis allows for an assessment of the linkages between and amongst productive activities. The value chain approach thus provides a framework to analyze the nature and determinants of competitiveness in value chains in which small farmers can participate. It also provides the basic understanding needed for designing and implementing appropriate development programs and policies to support their market participation. Indeed, many development interventions now utilize the value chain approach as an important entry point for engaging small farmers, individually or collectively, in high value export markets (GTZ, 2007).

Livestock systems represent a potential pathway out of poverty for many smallholders in the developing world. The majority of the world's rural poor, and a significant proportion of the urban poor, keep livestock and use them in a variety of

ways that extend far beyond income generation (Randolph et al., 2007). In many cases, livestock are a central component of smallholder risk management strategies (Bailey et al., 1999). Moreover, livestock systems are characterized by long marketing chains featuring great distances, numerous phases of weight gain and feeding regimes, many levels of traders and transactions, a multitude of steps and stages of processing, and a variety of employment-creating services and inputs. On the consumer side, the delivery of livestock products through informal markets tends to serve poor consumers, creating an even tighter focus on the poor. These linkages (micro-macro and backward and forward), primarily amongst the poor, create multiplier effects for pro-poor development interventions (Pica-Ciamarra, 2005). A further attractive feature of livestock systems in development is the presence of steps-and-stairs of livelihood generation among species (e.g. from poultry to goats to dairy cattle) that are available even to the landless, to women, and to other disadvantaged groups.

Although livestock systems contribute significantly to the development process, an important policy challenge is methodologies that evaluate the performance of alternative interventions in a smallholder livestock system. Contemporary value chain analysis methods provide us with the tools to characterize qualitatively the interactions and linkages found in livestock systems. However, most analyses stop short of ranking and evaluating the impact of alternative policy options. We strongly argue that the multi-functionality, complexity, and development–relevance of the global agricultural and livestock system necessitates an extension of value chain analysis from the diagnostic to the prescriptive.

This paper begins with an overview of value chain analysis, including a discussion of the limitations of currently applied approaches in terms of their

relevance to livestock systems and their applicability to development interventions. From this, we identify a subset of potential quantitative methods that could improve the policy relevance and impact of value chain interventions, particularly as they relate to livestock markets. A discussion of research needs concludes the paper.

II. An overview of value chain concepts: strengths and weaknesses

Value chain analysis has its historical origins in sectoral types of analysis, such as those elucidated by the French *filière* approach (Raikes et al., 2000). In a *filière*, the main idea is to highlight and map out specific physical commodity flows within a sector, including key stakeholders, though usually confining the analysis to domestic markets and ignoring dynamic adjustments to sector characteristics and relationships (Raikes et al., 2000; Kaplinsky and Morris, 2001). The term "value chain" was first used by Porter (1980). Porter defined the "value chain" as a representation of a firm's value-adding activities, based on its pricing strategy and cost structure. Porter's approach highlights actual and potential areas of competitive advantage for the firm. Porter argued that individual firms each have their own value chains that are embedded in value networks (or "value system" in the terminology of Porter), each of which have different functions within an industry or sector that influence (and are influenced by) other actors in the network. The salience of Porter's discussion was to highlight the interdependences and linkages between vertically-arrayed actors in the creation of value for a firm.

The modification and application of value chain ideas to development issues became more formalized in the mid- to late-1990s, particularly in the global commodity chain (GCC) approach of Gereffi and Korzeniewicz (1994). GCC and subsequent approaches focused predominantly on the value network of Porter in terms of looking at the relationships and linkages between firms, rather than solely at value-

creating functions within a firm. GCC analysis further highlighted governance relationships between actors in the value chain. These ideas, along with the characterization of the chain itself and key stakeholders, were codified in a "Handbook" of research (see Kaplinsky and Morris, 2001) and have been applied in a range of development applications (Kaplan and Kaplinsky, 1999; Dolan and Humphrey, 2000; Gibbon, 2000; Kaplinsky, 2000; Ponte, 2000; Kaplinsky, 2004; Giuliani et al., 2005; Humphrey and Napier, 2005; Bair and Peters, 2006; Pietrobelli and Saliola, 2008; GTZ, 2007; Gibbon, 2008)

The approach taken at the Institute of Development Studies at the University of Sussex (IDS) had a sharper targeting on development, although it was not limited to agriculture. The IDS approach, following Kaplinsky (2000: 121), defines the value chain as "the full range of activities which are required to bring a product or service from conception, through the intermediary phases of production, delivery to final consumers, and final disposal after use." Kaplinsky and Morris (2001) distinguish value chains from supply chains by emphasizing the linkages and relationships both between and within actors at each stage of production. This has considerable merit in highlighting the constraints and opportunities at and between stages of the chain and can thus be used to develop integrative policy recommendations that target chain inefficiencies and address distributional issues.

The IDS approach to value chain analysis has four main components. First, it systematically maps the actors participating in the production, distribution, marketing, and sales of a particular product (or products). This characterizes actors, profit and cost structures, flow of goods throughout the chain, employment characteristics, and the destination and volumes of domestic and foreign sales (Kaplinsky and Morris, 2001). Second, it highlights the governance of the value chain, building on the GCC

definitions to address the form of relationships and coordination mechanisms that exist between actors in the value chain (Hess, 2008). The analysis of chain governance is important for policy as it allows for the identification of institutional arrangements that may need to be targeted to improve capabilities, remedy distributional distortions, and increase value-added. Third, it examines the impact of upgrading within the chain. Upgrading can involve improvements in quality and product design, access to new markets, and diversification. An analysis of the upgrading process includes an assessment of the profitability of actors within the chain as well as information on constraints that are currently present. Upgrading further addresses the innovation capability of actors, ensuring continuous improvement in product and process. Finally, value chain analysis can play a key role in identifying the distribution of benefits of actors in the chain. That is, through the analysis of value-added within the chain, one can determine who benefits from participation in the chain and which actors could benefit from increased support or organization. This is particularly important in the context of developing countries (and agriculture in particular), given concerns that the poor are vulnerable to the process of globalization (Kaplinsky and Morris, 2001).

Value chain analyses are conducted through a combination of qualitative and quantitative methods, featuring a further combination of primary survey, focus group work, participatory rapid appraisals (PRAs), informal interviews, and secondary data sourcing. The information is useful in itself to understand the linkages and structure of the value chain and serves as the basis for identifying many of the key constraints and policy issues that require further exposition.

While value chain analyses have provided a number of important insights on the linkages and relationships inherent in developing country markets, there are a

number of limitations in current approaches. In particular, these restrict their full potential for identifying successful development interventions in livestock systems. First, an important drawback of current methods is the lack of quantitative analysis or methods embedded in the approach, which has been cited in other reviews (Raikes et al., 2000). Where it is present is mainly in the analysis of profitability and margins within the channel. Lalonde and Pohlen (1996) observe that available performance measures do not cross boundaries between firms in the chain, and are not focused on individual products or relationships. Raikes et al. (2000) note that the measurement of profits within the chain is problematic and usually confined to the abstract without quantification. Humphrey and Napier (2005) suggest the use of benchmarking indicators to assess performance gaps, estimates of the costs of compliance with standards, the use of margin data, and indicators of incomes and employment. Compared with the supply chain management literature, however, there is generally little defined in the way of performance metrics in value chain analysis (cf., Bailey and Norina, 2004; Beamon, 1998; Lambert and Pohlen, 2001). Advances using balanced scorecards (Van der Vorst, 2005) and quantitative measures of "relationship quality" (Schulze et al., 2006) have not progressed beyond case studies or localized analyses.

Development actors require information on how, and how well, the chain operates. Moreover, the development of good performance metrics for livestock systems is especially important given some of the characteristics of smallholder systems. Because smallholder livestock perform so many functions (draught power, soil nutrient production, a store of wealth, a risk management tool, etc.), marketing patterns are driven more by income needs than by price movements (XXX Ref by

Jabbar et al.). The evaluation of the performance in these types of markets requires much more nuanced analysis than is currently available..

Comment [K1]: Derek to please add

We would argue further that an even more important limitation of value chain analysis is its inability to analyze specific, chain-level policy interventions and assess their impact. The ability to assess objectively and rank the impact of alternative public policies ***and*** optimal entry points for intervention within the chain is limited under current qualitative techniques. A qualitative value chain approach would, for example, be limited in answering the questions: (i) where to invest, and (ii) what will be the economic impact on different chain actors from specific interventions? Related to this critique is a lack of consideration, qualitatively or otherwise, of the role of feedbacks that are present whenever we consider systems of interacting actors (Sterman, 1989). While qualitative approaches recognize that value chains and their relationships are dynamic, less attention has been paid to the potential unintended consequences of interventions or changes to one part of the value chain over time (Lee et al., 1997).

These dynamic considerations are of particular importance in the context of livestock systems, whose production cycles are long and linked to crop systems in complex ways, and whose multiple social and economic roles predispose toward interventions' consequences that challenge development planners. Moreover, given livestock systems' employment and value addition multipliers, and its susceptibility to external shocks such as climatic events and politically-motivated trade barriers, the impacts of interventions could be counterintuitive and difficult to determine *ex-ante*. The resource and environmental components of livestock systems and local and regional competition for them, complete the picture of a highly complex setting for development interventions.

A final limitation of current methods is that the scale of analysis is often to aggregated to conduct specific types of policy analysis. For instance, a recent value chain analysis of the sheep and goat leather chain in Ethiopia highlighted aspects of different function relationships in the chain, including animal husbandry, slaughter, collection, trade, processing, and trade/distribution (GTZ, 2007). However, an analysis of the impact of specific interventions in these components (for example, animal husbandry) would require more detailed, micro-level analysis of the production cycle, breeding, and marketing decisions at the producer level, including incentives to invest and market. Knowledge of these micro-level interventions, decisions, and impacts (including feedbacks) is critical if value chain development is to have a meaningful impact on poverty and market access for the poor.

III. Extensions of value chain analysis through quantitative approaches

An important component of improving the policy and development applicability of value chain analysis in livestock systems is to identify suitable modeling platforms to simulate and conduct *ex ante* analysis of alternative policy interventions. As noted earlier, these must feature the distributional and poverty implications of selected policy and investment options in a chain setting.

Conventional micro-economic policy analysis in the economic development literature has often utilized single-sector, multi-market, or general equilibrium models. Such models are limited in their facility for modeling the dynamic and complex processes and relationships embodied in a value chain. For instance, computable general equilibrium models rely on social accounting matrices to model the relationships within an economy, but between sectors rather than within a sector. Vertically integrated sector (VIS) models as discussed in McDonald (1996) may be a way to examine value chains in a multi-sectoral setting, but have not been applied to

date. Similarly, while multi-market models lend themselves to the analysis of multiple sectors, the data requirements to build and characterize relationships between discrete actors in a value chain can quickly become overwhelming.

Some approaches found in the literature potentially lend themselves to the quantitative analysis of specific aspects of value chains. Early work by Gardner (1975), for example, provides theoretical insights into the impacts of downstream policy or demand shocks on actors within a simple value chain. Building in extensions of such approaches into value chain analysis could alert decision makers to important first-round effects of policy interventions. However, multiplier and dynamic impacts relevant to livestock systems may be missed. In the context of chain governance, the game-theoretic approach taken by Sexton (1986) potentially lends itself to understanding the dynamics and incentives for group action within a value chain. Indeed, a number of game theoretic approaches have been applied in the context of supply chains, including incentives for chain-level investments (Nganje et al., 2008) and contracts between supply chain partners (Van Mieghem, 1999; Cachon and Lariviere, 2001; 2005). Optimization approaches are common in the supply chain management literature to manage inventories, production scheduling, and transport decisions (Shapiro, 2002), but have broader applicability in agricultural markets. Baker (2007) recently developed an optimization model to assess incentives for the provision of food quality attributes in the Danish food marketing chain, including the development of various scenarios. Each of these tools could potentially tease out pieces of the value chain puzzle, such as governance or upgrading. However, their narrow focus may limit their applicability to specific research questions.

A further policy consideration is that smallholder livestock systems feature numerous market failures in the form of high transactions costs, information

asymmetries, limited organization capabilities, externalities, regulatory failures, and the exercise of market power. In addition to considerations of "second best," policies that try to remedy one or more market failures at one stage in the chain, without taking into account the relationships and linkages upstream and downstream, may have unintended effects due to the feedbacks embodied in the chain over time. An improvement to one part of the supply chain, say for instance production, without concomitant interventions in better processing and marketing capacity, could lead to higher production without an adequate market outlet, further depressing prices and incentives for smallholders. This suggests a strong need for systems thinking in value chains, particularly as it relates to the development of policy interventions.

To this end, approaches that simulate the *ex-ante* impacts of alternative policies and their impact on the activities within the chain, its performance, and distribution effects among different stakeholders is warranted. A potential approach to this type of value chain modeling could come from the supply chain and logistics literature, which highlight dynamic processes embracing flows of products along the supply chain (Towill, 1996). Simulation approaches from the supply chain literature have particular relevance to model the dynamic behavior between interacting actors that livestock value chain models demand.

One such technique with a long tradition is system dynamics (SD), pioneered by Forrester (1961). A SD model 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 supply chains (Sterman, 2000). In the context of economic systems, particularly livestock markets, system dynamics tools can further incorporate inter-period relationships within and between firms and chain actors in environments characterized by risk and uncertainty (Scramin and

Batalha, 2003; Ross and Westgren, 2006). Indeed, SD-like approaches are not new in the context of agricultural market chains: Slater et al. (1969) and Harrison et al. (1972) applied quantitative market chain techniques to the study of marketing systems in South America. Furthermore, this type of approach was recently used to understand the impact of policy on livestock systems (Matthews et al., 2006). By explicitly modeling the structure and dynamics of the supply chain, SD models are well-equipped to quantitatively analyze the impact of changing different components of chain-level relationships on individual actors and on the whole supply chain itself, which can provide policymakers with a greater understanding of the impacts of public policies on the complexities of agribusiness.

A recent application used SD modeling techniques to study the feasibility of a proposed two-stage SPS certification system for beef exports from Ethiopia (ILRI, 2008). In this proposed system, animals are brought from pastoral areas, quarantined in an initial holding area for a few weeks (Phase 1), and then moved to a feedlot until reaching export weight (400kg, phase 2), after which animals are sent to a slaughterhouse from which meat products are exported. The goal is to produce certified, high-quality, disease-free meat products for export to the Middle East and, in the medium-term, to more lucrative markets in Europe and beyond. The SD model assessed the benefits and costs over time and identified potential bottlenecks in the livestock value chain. Model results indicated that at current input prices, the system would create high-quality meat at prices higher than those prevailing in target Middle Eastern markets. The main constraint is not SPS compliance costs but rather the high costs of the proposed feeding regimes. Improving feed rations and feed efficiency would lower costs, but would necessitate capacity building in ancillary value chain functions, such as animal nutrition practices and long-run investment in better feed

resources. At the same time, the analysis indicates that disease certification without improved meat quality would itself be unviable. The challenge of the program will be not only to ensure disease freedom but to integrate the livestock value chain in a way that produces and markets a high-value product that is acceptable in target markets (ILRI, 2008).

In some system contexts, the relevant intervention may be at a much smaller scale, though stakeholder linkages may remain complex. If the unit of analysis is the individual farmer, alternative policy interventions may induce different incentives to different stakeholders in a village, based on their initial endowments, capacity for uptake, and so on. Consider, for example, a policy that seeks to induce a farmer to adopt a specific feeding regime pool so that all livestock production may be pooled and marketed together in order to improve market bargaining power for all producers. For certain farmers in a village, this may indeed lead to the adoption of the proposed feeding regime, as it might provide enhanced bargaining power or larger margins. For other stakeholders, particularly those that rely on non-farm sources of income, incentives for uptake may be much lower. Given that the ability of certain farmers to benefit from an intervention will rely on the efforts of others, it is important to have modeling approaches that recognize these nuances.

Agent-based models (ABMs) are a potentially useful approach when modeling systems that are composed of interacting agents, where agents may represent individual farmers, social groupings, or institutions (Axelrod and Tesfatsion, 2006). Specific applications of relevance to value chains include income distribution (Epstein and Axtell, 1996), the dynamics of cooperation (Axelrod, 1997), market design (Marks, 2006), chain coordination (Albino, Carbonara, and Giannoccaro, 2008), and agricultural diversification and land use in developing countries (Berger,

2001; Berger et al., 2006). ABMs are similar to SD models in that they allow the user to capture the complex and macro-level patterns of behavior that develop from non-linear relationships, system feedback, path dependence, and stochastic characteristics, each of which is common in livestock systems. The defining difference between SD models and ABMs is the unit of analysis. In SD models, it is assumed that the unit of analysis is a single, homogeneous agent, which may represent the average agent in the population or may aggregate all agents in the population. For example, an SD model might assume that all farmers have the same production characteristics and follow the same production methods. For ABMs, this need not be the case. In fact, one of the major advantages of the ABM approach is that it allows the user to model a heterogeneous set of agents to capture how individual-level behaviors result in macro level patterns. By contrast, SD models capture how the more aggregated behavior of individuals results in macro-level patterns. Both are equally valid in the context of livestock systems, with the main difference depending on the research question or development intervention in mind.

V. Conclusions: moving forward with value chain analysis

Value chain approaches play an important role in characterizing the complex networks, relationships, and incentives that exist in livestock systems. It further provides a framework to help in the development of new, pro-poor value chains. Value chains are particularly important for livestock systems because of the multi-faceted ways livestock can serve to improve rural livelihoods. At the same time, current approaches remain qualitative and often case-specific. Furthermore, and particularly relevant from a development context, is the inability of current methods in assessing the impacts of alternative technical interventions and where best to target public and private investments. A number of existing modeling and analytical

approaches could be adopted to remedy these gaps in the literature and in practice. Some of these models are appropriate in the context of specific chain issues, including quality, performance, chain efficiency, and governance. We highlight the particular potential of SD and ABM because of their flexibility and comprehensiveness in looking at the diverse, dynamic, and distributional impacts of broader chain-level interventions. Future research needs to build on existing techniques of value chain analysis with more rigorous means of quantitative analysis tailored to the research question at hand.

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