Staff Paper

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EXECUTIVE SUMMARY

Market liberalization in Zambia has led to a rapid and fundamental transformation of its dairy sector. Mainly through foreign direct investment and international partnerships, a new formal dairy sector, characterized by institutional, organizational and technological innovation, emerged from the ashes of abandoned government projects. Sensing the development opportunity that arose from an untapped milk supply potential in Zambia's traditional smallholder livestock production and a growing milk demand from the newly emerging formal dairy processing sector, numerous donor-funded smallholder dairy farmer support programs emerged. At the same time, in order to protect its domestic market as well as to be in a better position to enter demanding export markets, stakeholders from the private, public and NGO sector have recently joined forces to develop technical dairy product standards for Zambia based on the CODEX.

Our survey of smallholder dairy farmers in Zambia's Southern Province focused on how this new formal dairy sector impacted these farmers in terms if their participation and growth. In terms of participation, we found that even within the smallholder farmer population under study, it is the larger, higher-income and technologically more advanced farmers who have entered the modern dairy channel. Although this is partially the direct result of assistance models targeting clusters of higher capacity smallholder farms in the initial stages, the persistence of this capacity difference for the more established milk collection centers investigated in this research indicates that there exists a threshold capital vector at the entry of the modern dairy channel. In terms of growth, we found that farmers in the modern dairy channel, relative to farmers in the traditional dairy channel, grew faster in terms of milk output volume as well as in terms of upgrading with respect to improved breeds, tools and operational management practices. However, we also found that within the modern dairy channel, relative growth in terms of upgrading outstripped relative growth in output volume. This appears to indicate that while participation in the modern channel does have a positive effect on growth it does so below the apparent potential as the efficient and effective use of new technologies and management practices lags their introduction.

Three key implications for development programs follow from these findings. First, the modern processors' use of quality-based premiums for rewarding producers who deliver higher quality milk spurred the farmer's interest in expanding their production capacity through investment and technology adoption. This illustrates how small holder producers in some of Africa's more difficult production environments still have the capacity to respond to economic incentives in their livelihood decisions. It underscores the importance of designing and integrating suitable price incentive schemes in assistance programs. Second, even if specifically focused on smallholder producers, economic development programs are unlikely to assist all targeted farmers in entering modern supply chains. Hence, development programs must be clear from the start on which farmers to include in the business model. Farmers not making the grade will either (1) benefit from the spill-over effects of the growth of the included producers (whose increased incomes are likely to stimulate the local economy) or (2) need to be targeted by social development programs. Third, the integration of smallholder farmers into modern, dynamic markets requires a balanced approach in which numerous complementary program elements need to be implemented with great synchronicity. In turn this requires that development programs involve all relevant stakeholders (private-public-NGO) and coordinate their activities carefully.

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1. Introduction

Since 1991, the Government of Zambia has liberalized its markets leading to fundamental structural change in the agri-food sector. Parastatal companies were privatized, commodity markets were deregulated and foreign direct investment (FDI) was both encouraged and facilitated (Saasa 1996). This resulted in new investments by international firms in some sectors of the country's agri-food system, most notably in retail distribution and food processing. These companies introduced modern procurement strategies that have started to change the institutional, organizational and technological characteristics of the supply chain. In these modern supply chains, relationships have a more "contract"-like nature implying both new benefits (price and volume stability) and new challenges (quality and food safety standards, year-round supply).

Various recent studies have provided anecdotal evidence of the impact of this food system modernization process on smallholder farmers in Zambia. See for example Haantuba (2003) and Emongor et al. (2004) for the impact on smallholder producers of the rise of supermarkets in Zambia's in fresh markets or Coulter (2002) for the direct and indirect effects on smallholder producers of warehouse receipt systems in grain markets.

However, little work has been done in terms of analyzing the impact of the modernization process in Zambia based on detailed, farm-household level survey work. Recent survey-based studies from other countries, just a few years ahead of Zambia in this structural transformation process, provided mixed evidence. Most studies showed that modernization has for the greater part benefited only a small group of high-capacity suppliers and largely excluded smallholder producers (Neven et al. 2006, Reardon and Berdegue 2002, Dolan and Humphrey 2000). On the other hand, some studies indicated that FDI-induced modernization can have positive vertical spillover effects of smallholder farmers (Dries and Swinnen 2004, Key and Runsten 1999).

This paper contributes to the literature on the farm-level impact of the current wave of food sector modernization in developing countries. The strategic question, upon which this paper focuses, is: *what has been the response of smallholder farmers to the emergence of modern, dynamic dairy supply chains in Zambia?* More specifically, our research questions are: (1) "what are the determinants of smallholder farmer participation in modern supply chains?" and (2) "what is the impact of this participation on growth for smallholder farmers?" The analysis presented here is based primarily on interviews with key informants in the private, public and non-governmental sector and on unique data from a survey of 182 smallholder dairy producers.

The dairy sector in Zambia provides an interesting case-study for various reasons. First, Zambia's dairy sector has recently become a battleground for two of the world's ten largest global dairy processors. Parmalat of Italy entered the Zambian market through a direct investment in 1998 which made it the majority shareholder in Parmalat Zambia, Zambia's largest dairy processor. Danone of France has an indirect presence in Zambia through its joint venture

with Clover (South Africa) which in 2004 entered into a strategic partnership with Finta, Zambia's second largest dairy processor. Second, at an estimated nine liters per year, the per capita milk supply in Zambia is amongst the lowest in the world, creating both an opportunity and, from a nutritional point of view, a need to develop a formal dairy market[1]. Furthermore, the combination of (1) even lower milk supply levels in neighboring markets such as Malawi, Mozambique and the DRC, (2) the crumbling dairy sector in Zimbabwe and (3) the implementation of regional trade agreements imply important additional growth opportunities for Zambia's dairy sector[2]. Third, the emergence and growth of large-scale processors and an existing surplus milk supply from smallholder cattle producers in Zambia attracted numerous private and public sector initiatives to facilitate smallholder participation in the formal dairy supply chain.

This paper is structured as follows. In the next section, we present an overview of the changing nature of the dairy sub-sector in Zambia. Section three briefly discusses the changing nature and role of standards in Zambia's dairy sector. Section four discusses our conceptual approach, survey data and analytical findings. Section five summarizes, concludes and provides some recommendations for development programs.

2. The Modernization of Zambia's Dairy Sector

Main Historic Developments

Before 1991, the formal part of the dairy sector was controlled by the government's Dairy Produce Board (DPB). The DPB was responsible for the processing and marketing of raw milk, including the setting of collection and retail prices. The Board's main sources of raw milk supply were parastatal dairy farms and smallholder producers. The main product focus of these smallholder livestock producers was on beef with milk being more of a side product. Surplus milk production (beyond feeding calves and intra-household consumption) was sold either in informal raw milk markets or to the DPB. In order to capture the nutritional and economic development advantages of a growing dairy sector for Zambia's poor, the Government of Zambia (GoZ) initiated various smallholder support programs in the dairy sector. Unfortunately, these programs were characterized by a lack of producer-ownership, poor selection of participating farmers, politicization, inadequate dairy husbandry extension staff, unskilled management, poor marketing infrastructure, inefficiency-masking subsidies and low raw milk prices paid to producers (Cashman 1999, Kamanga 2005). As a result, these support programs were generally unsuccessful, domestic milk production remained very low and a formal dairy industry never really took off.

From 1991, supply and demand side factors have transformed the dairy sector. *On the supply side,* the initial shock was provided by the government, whose structural adjustment policies in the dairy sector included (1) privatization, (2) market deregulation, (3) reduction of financial and

[1] According to FAOSTAT data, Zambia ranks 161st out of 175 ranked countries in terms of per capita supply of whole milk.

[2] The potential and profitability of Zambia's dairy sector was also underscored by a strategic choice made by Parmalat. When Parmalat reduced the number of countries in which it operated from 30 to 22 in order to deal with a $5 billion corporate fraud scandal that emerged in December 2003, it kept Zambia in its portfolio.

technical government support and (4) trade liberalization. This policy shift threw a weak and unprepared dairy sub-sector to the forces of an open market. In the vacuum left by the government, new players gradually emerged and started to re-organize the dairy industry.

(1) Parastatals were shut down or privatized, attracting FDI. In Zambia's dairy sub-sector, the initial FDI came from South Africa's Bonnita which bought the parastatal processing plants from the DPB in 1996[3]. Bonita closed some processing facilities, made significant investments in upgrading the other facilities and generally introduced modern management practices with suppliers (such as contracts and standards). The company also expanded the product line from just pasteurized whole-milk and cheese under the DPB to long shelf-life UHT milk, flavored milk, butter, fresh cream, dairy fruit-juice blends, ice-cream and yoghurt. Cheese production was dropped as it was more efficient to import from Bonita's South African plants. In 1998 Parmalat acquired Bonnita, including its Zambian plants. Parmalat continued the process of change initiated by Bonita and doubled the raw-milk intake from 25,000 liter per day in 1998 to 50,000 liter per day in 2005. In 2004, the competitive landscape was further changed by a strategic alliance between Finta and Clover, South Africa's largest dairy processor. Clover, in turn, already had been in a partnership with Danone (France) and Fonterra (New Zealand), the world's largest dairy cooperative. These partnerships further stimulated the introduction of modern management practices and technologies in Zambia's dairy processing sub-sector.

The FDI-led growth of the dairy industry over the period 1996-2005 was largely made possible to two concurrent changes in the wider market environment. *First,* increased local production was needed to replace reduced imports from South Africa (due to the processors' own regional business strategies) and Zimbabwe (due to a collapsed dairy industry). By 2005, however, this import-substitution had tapered off and future growth of Zambia's processing industry will have to come from increased domestic consumption and/or exports. *Second,* FDI in Zambia's food retail sector supported the development of a modern and formal dairy supply chain. Major South African supermarket chains (Shoprite, SPAR) had entered the market since 1996. These chains not only created a reliable and growing formal market for dairy products (taking market share away from informal retailing), they also drastically increased the use of refrigeration in retailing. The combined emergence of refrigeration and UHT milk (which can be stored up to 12 months without refrigeration when quality produced) drastically increased the distributional reach of milk and other dairy products in both the formal and the informal market channel.

(2) The dairy market was deregulated and prices for inputs and outputs were no longer controlled. This allowed the processors to establish a new quality-based raw milk pricing schedule, similar to that applied in industrialized countries. Price is calculated using complex formulas based on bacterial count and butterfat content amongst others. Prices received by the dairy farmers in 2005 varied from US$0.31 per liter for Grade A milk to US$0.23 per liter for Grade C milk[4]. This Grade A milk price is comparable to the US farm price for milk and represents a strong increase, up from US$0.20 per liter for the best quality milk in 2000 (Gillespie 2000). This created a strong and effective incentive for farmers to improve quality.

[3] Bonnita actually bought a 68% share with the other 32% being held by large commercial dairy farmers and two coops of smaller producers. This equity structure was maintained when Parmalat acquired Bonnita in 1998.
[4] The exchange used throughout this paper is US$1=ZK4,645 based on the www.oanda.com (for January 01, 2005).

Furthermore, a quantity bonus of 3.5% was introduced for farmers who can supply over 3,000 liter per day (attainable only by large commercial dairy farms).

(3) Government support to smallholder producers in the form of subsidies and extension services were drastically reduced and over time replaced by initiatives managed by NGOs and public-private sector alliances. These initiatives helped to (1) organize farmers into groups, (2) build milk collection centers with cooling tanks, (3) introduce and implement new technologies and good practices at the producer and collection center level and (4) establish formal linkages with Zambia's leading dairy processors.

(4) In terms of tariffs and quotas, trade has been increasingly liberalized through various trade agreements (Comesa, SADC) but due to the strategic use of quality and safety standards in member countries, trade flows have remained relatively unaffected. Imports actually decreased for reasons indicated above but also because the GoZ, stimulated by farmer protest, halted cheap, but low quality milk imports (e.g., from Kenya). Exports of dairy products are limited and mostly informal. Unknown, but assumed small quantities of Zambian milk are sold through informal supply channels in the Democratic Republic of Congo[5]. Formal milk exports by Zambian processors are only incipient. For example, Parmalat started to export small volumes of milk to neighboring countries (e.g., 30MT per month to Malawi) [6]. The implementation of technical barriers to trade has also been an important reason for the low volumes of Zambian dairy products exported to the region. For example, Finta faced numerous problems when it wanted to export its UHT milk to Zimbabwe. These problems varied from lengthy risk assessment procedures to far-fetched labeling requirement demands[7]. The costs to comply with these requirements made Finta milk uncompetitive in the Zimbabwean market.

On the demand side, urbanization, rising incomes and related lifestyle changes have increased the importance of the formal market channel part of the dairy sub-sector. For example, Sng (2002) found, in a national consumption survey of 150 households, that urban households consume nearly four times as much milk per capita as do rural households. These urban households not only consume more milk, they are also far more likely to buy milk from the emerging modern retailers who procure from dairy processors in the formal sector. Two important recent trends that will likely have a further positive impact on job creation and household income in Zambia are: (1) the growth of the copper industry due to high demand from China (Moore 2005) and (2) the growth of specific sub-sectors in the agricultural sector due to the entry of white commercial farmers from Zimbabwe (The Economist 2004)[8]. Not withstanding these positive trends, overall milk consumption in Zambia remains extremely low. A major constraint to increased milk consumption is the relatively high and rapidly rising urban retail price for milk in Zambia. Between 2000 and 2005, the retail price for pasteurized milk in Zambia grew strongly from US$0.60 (Gillespie 2000) to US$0.92 per liter, i.e., roughly 10% above the US price of US$0.82 per liter (average for June 2005).

[5] The DRC's second largest urban area (Lubumbashi with a population of over than 1 million) is located just across the border from Zambia.
[6] Interview with Martin Njovu, Quality Manager at Parmalat Zambia.
[7] The Finta milk cartons were required to state "not fit for baby food" in four local Zimbabwean languages, a requirement not asked of the Zimbabwean milk producers (SADC 2002).
[8] The entry of about 340 white commercial farmers has created an estimated 30,000 new jobs in Zambia.

Current Structure of the Dairy Sub-Sector

There are three main types of dairy producers in Zambia: (1) traditional smallholder producers; (2) large commercial dairy farms; and (3) emerging smallholder dairy farms (Table 1). *Traditional smallholder producers* represent 99% of the farms, but given that their cattle consist mostly of local breeds (zebu) for beef production, they represent only an estimated 45% of milk production and an estimated 25% of marketed raw milk in Zambia[9]. Most of this milk is either consumed by the household or sold in informal rural markets and consumed as raw milk. Some traditional smallholder producers sell their milk to milk collection centers who in turn sell their milk either to processors or directly to consumers. *Large, mostly white-owned commercial dairy farms,* of which there are about 70 in Zambia, are capital-intensive and have larger herds of pure-breed dairy cows. This set-up gives them greater control over production and hence commercial farmers concentrate their production on the dry season when prices peak. Commercial dairy farmers sell in both informal and formal markets and supply around 80% of the milk going into the formal dairy channels. Currently, there is a shake-out amongst the commercial dairy farmers as some of the smaller operations (less than 80 cows) have difficulties in keeping their capital-intensive operation profitable. *Emerging smallholder dairy farms* originate either from the ranks of the traditional smallholder cattle producers or they represent new entrants in the sub-sector (e.g., retirees who invested their pension in a dairy farm). Most of these emerging smallholder dairy farms are the outcome of various pre- and post structural adjustment support programs in the dairy sub-sector. While some emerging dairy farmers are sufficiently large and capitalized to supply processors directly, most are organized in associations around milk collection centers from where processors collect the raw milk. These farms use mostly mixed-breed cows and intermediate-capital intensive technologies and unlike traditional smallholder producers, they sell the bulk of their output to processors in the formal market or consumers in the informal market. Raw milk from these three producer types as well as imported milk and milk powder flow to Zambian consumers through five distinct supply channels (Figure 1).

[9] In the absence of reliable data, these percentages are rough estimations by the authors based on key informant interviews.

The informal milk market is estimated at 50% of total marketed production in Zambia, less important than for example in Kenya where through small-scale pasteurization it makes up 70% of all milk marketed to consumers. In Zambia, informal markets basically consist of farmers selling raw milk either directly or through so-called "scoopers" at small retail outlets to consumers in rural areas (Channel A in Figure 1). Given the high perishability of raw milk and lack of small-scale milk processing (pasteurization), supply chains in Zambia's informal market are short both in terms of geographic reach and number of intermediaries.

In the formal milk market, the processors are the channel captains and they are supplied largely by commercial dairy farms (Channel B in Figure 1). For example, Parmalat has 40 suppliers (10 large commercial dairy farmers, 27 emerging smallholder producers, 3 smallholder producer associations) but gets 90% of its raw milk supplies (50,000 liter/day) from its 10 commercial farmers. Smaller processors (200 to 5,000 liter/day) of which there are about 12 in Zambia, also buy raw milk from smallholder and (mostly) commercial producers. These smaller producers focus on cheese or yoghurt production rather than milk production due to economies of scale associated with the latter. Some commercial dairy farms are processor-owned in an integrated supply chain (Channel C in Figure 1). The largest of these companies are Zammilk (25,000 liter/day) and Diamondale (10,000 liter/day), two ambitious and diversified agri-food firms. The top four dairy processors (Parmalat, Finta, Zammilk, and Diamondale) represent roughly 80% of total volume processed in the formal dairy processing sector, thus indicating a concentrated industry.

Dairy imports are important for milk powder and to a lesser extent for shelf-ready milk and other dairy products. Milk powder imports (Channel D in Figure 1) are nearly all related to Finta (20,000 liter per day). Due to its location (further removed from non-nomadic dairy farmers), strategic alliance with Clover (linked to leading global milk powder producers) and product focus (UHT milk which requires high and strictly enforced safety standards), Finta gets 80% of its milk supply from reconstituted imported milk powder and 20% from smallholder farmers. Imported milk powder is also a slightly more economical input than domestically produced raw milk (US$0.28 vs. US$0.31 per liter)[10]. Imports of shelf-ready milk and other dairy products (Channel E in Figure 1) are limited and mostly linked to supermarket procurement. South African chains Shoprite and SPAR who dominate the supermarket sector import private label UHT milk and other processed dairy products such as cheese or butter from South Africa (mostly) and other countries (Ireland, Denmark, Zimbabwe). For SPAR's UHT milk procurement, 50% consists of South African imports and 50% is supplied by Parmalat. Fresh milk in supermarkets is supplied entirely by the formal dairy processors in Zambia.

Milk from domestic processors is sold through a variety of distribution channels. For example, Paramalat sells 20% of its output directly to supermarkets and, 20% to through its own network of 30 formal wholesalers and 60% through (mostly Indian) informal traders who buy from the factory. Supermarkets play an increasingly important role in the processors' marketing strategy as price promotions allow them to move volumes when needed (stocks reach maximum holding

[10] Assuming a price of $2.15 per kg of imported milk powder and a conversion factor of 7.6 liter of milk per 1kg of milk powder.

capacity). Finta sells 40% of its production to supermarkets while 60% is sold through some 40 wholesalers in city markets across Zambia.

The Nature of Smallholder Associations in Dairy Production

Although still representing only a small fraction (less than 10%) of the raw milk supplies to the leading processors, smallholder producers have grown both in absolute numbers and volumes. For example, although Parmalat's supplier base has included the same three farmer associations over 2000-2005, the size of these associations and the volumes they supply have grown steadily. The oldest of the three associations (the Magoye Smallholder Dairy Farmers Association), for example, has grown from 25 members supplying 2,250 liter per month in 1996 to 234 active members supplying 40-60,000 liter per month in 2005. Furthermore, some of Parmalat's 27 emerging smallholder dairy suppliers first supplied through an association but over time grew and "graduated" to a direct supplier.

This growth was made possible through various multi-party development initiatives involving the private, public and NGO sector. For example, the Golden Valley Agricultural Research Trust (GART), partially supported by the GoZ provided first (since 1999) assistance with artificial insemination and then (since 2002) with salary payments for full-time accountants and research technicians to be based at the milk collection centers (MCCs). Donor funded projects provided investment capital to establish infrastructure or access to improved dairy breeds, facilitated linkages with processors and input suppliers and provided assistance in the development of a technical dairy standard and training in the implementation of the codes of good conduct embedded in this standard. These initiatives resulted in organizational, technological/infrastructural and institutional improvements.

Smallholder dairy farmers were assisted in organizing in associations around newly established milk collection centers. Collection center sites were typically chosen in locations where there are sufficient dairy producers and where there is a surplus supply beyond what can be marketed in the informal market (surplus model). The latter is important since prices are often higher in the informal market thus increasing the likelihood of suppliers defecting from the collection center model, even if association bylaws state that members cannot sell their milk outside the MCC. If supplies to an MCC remain below 500 liter per day, transportation (of minimally 1,000 liter every other day) between MCC and processing plant is uneconomical thus causing a break-down of the MCC model. Only farmers within a radius of roughly 30km around a collection center are potentially included in the model. Further growth has come from hub-and-spoke extensions of satellite depots around the collection centers.

From the milk collection center, milk is sold through two channels: consumers in the informal market and processors in the formal market. The distribution over these two channels varies significantly. While some MCCs sell nearly all their milk to processors, one study estimates that across the 17 MCCs around 60% of the milk is sold in the informal market and 40% in the formal market (Mukumbuta and Sherchand 2006). In the formal market channel, the processor's refrigerated trucks pick up the milk at regular intervals (e.g., three times a week) and take it to the milk processing plant. Transportation costs are deducted from the milk payments by the processor. These payments are made to the association which then in turn pays its individual

members. While still partially dependent on donor support, MCCs have almost become sustainable through a variety of income streams, including a mark-up margin of 13% on the milk sold to processors (and higher margins on milk sold over-the-counter or in the informal market), membership fees and a mark-up on the sale of inputs (e.g., feeds). These inputs are typically bought on credit by the farmer, but repayment rates are high as these credit payments are deducted from milk payments. From the processor's perspective, the collection center functions as if it is one large dairy producer thus reducing transaction costs. For example, one of the larger MCCs produces 40-60,000 liter per month, compared to one smallholder milk producer supplying maybe 200 liter per month or one large commercial dairy farmer supplying as much as 200,000 liter per month.

Technological/infrastructural improvements have been implemented at the milk collection center and at the farms. Collection centers are typically equipped with 2-3,000 liter cooled storage tanks and in some cases with a pick-up truck. Farms made investments in mixed-breed or pure-breed dairy cows, stainless steel containers, artificial insemination and milking parlors. Most of these investments are only partially grant based and some involve no grants. For example, in one restocking program, a farmer's purchase of a cross-breed in-calf heifer, selling at a price of $650, is 2/3 financed by the farmer's own capital and 1/3 through an interest free loan provided by the association and again repaid from milk payments over a 3-4 year period.

Institutional changes came in the form of contracts linked to quality standards and codes of good conduct process standards. Parmalat for example has a contract with each of its 40 suppliers (including the three farmer associations) which stipulates volumes and (quality-based) prices. Volumes can vary within a 20% band around the agreed upon volume without further contract negotiation. Since prices are determined by the quality of the milk rather than by supply and demand, and as such they are, relative to the informal market, fairly stable throughout the year. For example, whereas prices in the informal market vary from US$0.13 per liter in the rainy season to US$0.43 per liter the dry season, prices paid by processors are around US$0.27 per liter throughout the year (for grade B quality which is a common quality level for smallholder farmers supplying Parmalat). While not part of the contract per se, contracted smallholder suppliers receive assistance in dairy production from the processor in the form of hygiene training and facilitated access to and training in the use of chemical dairy farm inputs through the companies who supply their products through Parmalat.

3. The Changing Role of Standards

A Changing Public SPS Standards System Mainly Focused on Trade

Changes in Zambia's public SPS standards system are largely driven by the process of trade liberalization and as such mainly focus on traded food items. The liberalization of trade which is part of the structural adjustment program of countries like Zambia basically implied a shift from one type of barrier to trade (non-technical: tariffs and quotas) to another type of barrier to trade (technical: SPS standards, other technical standards such as those related to food labeling, etc.).

Although Zambia's legislative framework covers the essential SPS standards issues in broad lines, its structures for communication and enforcement of these standards are weak at best due to various capacity constraints. An effective SPS and food safety control infrastructure has three basic components: (1) a legislative and regulatory framework which sets the standards; (2) an enforcement unit which inspects and provides analytical services; and (3) a knowledge support unit which provides education, training, information and advisory support and which can provide risk assessments.

Zambia's *legislative and regulatory framework* largely complies with the three main international standards for food safety and quality, plant health and animal health (SADC 2002). The Food and Drugs Act was reviewed in 2000 to bring it in line with the Codex Alimentarius Commission (CAC) standards on food safety (including provisions for expiration dates, accurate labeling and traceability). The Plant Pests and Diseases Act was reviewed in 1996 to bring it in line with the International Plant Protection Commission (IPPC) standards on phytosanitary issues. The Stock Disease Act has not been reviewed for conformity with the International Office of Epizootics (OIE) standards on the safety of livestock and livestock products, but plans are underway to do so[11]. Although the general legal framework is in place, product specific public standards have not been developed for most domestic market food items mainly because such standards cannot be enforced and because there is little demand from the industry or consumers.

Zambia's SPS and food safety *standards enforcement* unit is almost non-functional due to a lack of resources. Not only are the relevant units understaffed, their employees are for the greater part not suitably qualified and lack the logistical and analytical support to monitor and enforce compliance with SPS and food safety laws[12]. Furthermore, communication between these various units is cumbersome at best in part because there is no Food Safety Authority that could facilitate such interdepartmental communication. This state of affairs applies to the trade market, but even more so to the domestic market. There is no or no adequate testing equipment at border points, there are no vehicles to ship away condemned food items from the markets where they were found, there are few food testing labs all of which are in dire need of facility upgrading and only one of which is accredited by international organizations, and so on. As a result, most imported food products are not inspected for compliance with food safety standards while domestic agribusinesses are rarely and irregularly inspected by government inspectors.

SPS *knowledge support services* are very limited in Zambia. Training provision and information dissemination are limited with regard to SPS and food safety standards. Many agri-food businesses are unaware of the standards. The government's capacity to conduct animal health, plant health or food safety related risk assessments of food chains is limited as well.

[11] Although the three Acts described in this paragraph are the most central ones in the context of the SPS and food safety measures, numerous other Acts are of relevance. See SADC (2002) for more detail.

[12] Nine relevant SPS and Food Safety units are: (1) the National Livestock Epidemiology & Information Center (NALEIC), the District Veterinary Office, the Seed Control and Certification Institute (SCCI), the Plant Quarantine and Phytosanitary Service (PQPS), the National Institute for Scientific and Industrial Research – Food Technology Research Unit Laboratory (NISIR-FTRU) and the Sanitary and Phytosanitary Inspection Service in the Ministry of Agriculture and Cooperatives; (2) the Zambia Bureau of Standards in the Ministry of Commerce, Trade and Industry; and (3) the Central Board of Health and the Food and Drugs Control Laboratory in the Ministry of Health.

The general picture regarding public standards painted above, also largely applies to the dairy sub-sector. Zambia's Food and Drugs Act (FDA) provides legal sanitary requirements for milk and milk-based products which conform to OIE and CODEX standards (Valeta 2004). These (mandatory) requirements focus on the nutritional composition, microbiological content, chemical content and treatment history of the milk. The Zambia Bureau of Standards, in collaboration with the private and NGO sector, currently uses these requirements and other dairy specific CODEX standards in the development of its own broader and more detailed (voluntary) technical standards and code of good practices for dairy products which further include specifications for pesticide residues, antibiotics and packaging. In the trade of dairy products, the existing government requirements imply, from a legal point of view, (1) certification that the milk is disease free, (2) laboratory testing of samples and (3) the use of official seals. The relevant government organization related to trade is the National Livestock Epidemiology & Information Centre (NALEIC) at the Ministry of Agriculture which (officially) follows the OIE's international animal health code in its risk assessments. In the domestic market, inspectors of the Ministry of Health have the mandate to inspect the facilities, processes and products of dairy processors and retailers using the FDA requirements. The Food and Drugs Control Laboratory is responsible for testing food samples. Although this laboratory uses WHO and CODEX guidelines for testing, it is not accredited. As indicated above, these mandates and responsibilities do not imply an effective implementation. Raw milk sales are illegal, but commonplace. Government veterinarians inspect animals, but only when new animals are introduced in an area. MCCs are inspected, but not on a regular basis. Even for the largest dairy processors, public health inspectors do not inspect factories on a regular basis to enforce standards (SADC 2002). Certification for HACCP, a key good manufacturing practice in industrialized economies, does not exist in the Zambia's dairy sector (or anywhere else in Zambia's food industry).

The Emergence of Private Standards in the Dairy Industry

Private standard development differs widely across Zambia's agri-food industry. In most sub-sectors, wide-spread unawareness and nearly non-existent enforcement of public food quality and safety standards have simply led to very limited or no implementation of standards by agri-food firms. On the other hand, some agri-food firms with links to industrialized markets (either through FDI or through trade) are very aware of food standards, are actively involved with or already have developed private standards and enforce them as well. These firms, which include the leading dairy processors, take a long term perspective, and cannot afford food safety issues to hurt their reputation and sales. Not satisfied with the level of the standards provided by the public sector, these firms therefore developed, implemented and enforced their own set of standards.

For the dairy sub-sector, two main points must be made regarding private standards. *First*, supermarket chains are currently followers in the development and enforcement of standards. Supermarkets demands relate mostly to the packaging (attractiveness, expiration dates and other labeling requirements, volume) rather than to food safety. Limiting their quality/safety control to cooler temperature control and weekly employee sample tasting, supermarkets trust their suppliers to deliver safe dairy products and only react when consumers complain about milk getting spoiled quickly. When enough consumer complaints come in on a specific dairy product,

standing orders are cancelled and the processor's facility is inspected (checking for hygiene, equipment, worker knowledge). Supermarkets are only recently considering the use of written safety standards for dairy products.

Second, in the absence of supermarket chain leadership, the processors are the leading developers and enforcers of quality and sanitary standards in Zambia's dairy sub-sector because they have both the incentive and the capacity to do so. Milk quality starts at the farm and has to be maintained throughout the supply chain. As processors want to guarantee consumers that their brand stands for high quality and safe diary products, they want to assure that safety standards are implemented at the farm level and maintained further downstream the supply chain. A processor like Parmalat in Zambia uses three milk grades (A, B, C). The A-grade milk standard is twice as strict as the public standard (e.g., the maximum allowable bacterial count is 25,000CFU/ml or half the count required to meet the public standard). With price-penalties for lower milk grades, smallholder producers had a strong incentive to improve quality, thus making the MCC quality system self-regulating. By improving hygienic practices, farmers improved their raw milk quality dramatically. For example, in 1996, when farmers started to supply Parmalat's predecessor Bonnita and private standards had just been introduced, 40% of the raw milk was C-grade and there was no A-grade. By 2005, less than 1% of the milk arriving at Parmalat's processing facility is C-grade and A-grade makes up 86% of the volume supplied. Although processors do not inspect MCCs directly, milk is tested by the milk reception attendant at the MCC using simple tests[13]. Milk not meeting these tests is rejected at the MCC. Milk is then tested again at the processing facility and rejected if not meeting quality grades. This has rarely happened in the case of Parmalat which because of its broader product line can use milk of all grades. Finta, which only produces UHT milk requiring A grade milk, uses stricter standards and tests and has rejected smallholder milk with greater regularity.

4. Empirical Evidence

4.1. Conceptual Framework

For research question 1 *(supply chain modernization and smallholder participation),* we will model the farmer's decision on whether or not to sell to dairy processors (through MCCs or direct) as a standard static adoption decision (i.e., the input demand function as derived from the farmer's profit function; Sadoulet and de Janvry, 1995):

$$\text{channel choice} = f(p, r, \sigma, k, z),$$

where p, r, σ, k and z represent output prices, input prices, risk factors, quasi-fixed capital and shifters respectively. We hypothesize that there exists a threshold capital vector K* at the entrance of the modern dairy channel. Farmers with a capital vector K>K* are expected to enter the modern dairy channel if the incentives (e.g., market reliability) are there while farmers with K<K* are excluded from the modern dairy channel. Group formation and development assistance programs may lower K*, i.e., reduce transaction costs and facilitate access to new technologies.

[13] These tests include a visual test (cleanliness, smell), a water content test (density), an alcohol stability test (freshness) and a lactic acid test (in case the alcohol test was inconclusive).

For question set 2 *(smallholder participation and growth),* we will assess the growth effect of channel choice focusing on both quantitative growth (increased output, herd size) and qualitative growth (improved breeds, upgraded infrastructure and operational management). Basically, we will be testing the following model:

$$\text{growth} = f(\text{channel choice})$$

Our hypothesis is that the relationship is positive: higher growth and upgrading through re-investments and external support (contract-based or grant-based) in the modern dairy channel.

4.2 Data

Population Selection

In order to analyze the response of smallholder producers to the modernization of the dairy sub-sector, we focused on the milk collection centers (MCCs). Farmers who live outside of the catchments area of the MCCs (or processing plants) are constrained to selling their milk unprocessed in informal rural markets. However, farmers who live inside the catchments area of an MCC have the additional option of selling at the MCC. For a given milk collection center, we here compare two types of farmers: (1) farmers who have chosen to primarily supply milk to the collection center (and hence participate in the modern channel) and (2) farmers who have chosen not to supply the MCC (and hence remain in the traditional channel). Out of the 17 MCCs in existence in Zambia in 2005, we selected the two MCCs in the Monze and Kazangula districts for two reasons. First, in the catchments areas of these two MCCs there are sufficient farmers of both types. In the case of some, usually older, MCCs nearly all dairy farmers in the catchments area supply the MCC. Second, although the two selected MCC areas are both located in the main dairy production area (the dry Southern Province), they are situated at different distances from Lusaka (the main market) and supply different processors. The Monze collection center at 200km from Lusaka supplies Parmalat in Lusaka. The Kazangula collection center at 500km from Lusaka and 70km from Livingstone supplies Finta in Livingstone.

Sampling Methodology

We used a two-step stratified random sampling methodology. *First,* we composed a population framework. A list of dairy farmers was developed by first going through the records of the MCCs in Monze and Kazangula. The farmers obtained from the milking centers were then asked about their neighbors who supplied and those who did not supply milk to the center. Maps were used to assist in the further identification and complete listing of the dairy farm households. The list was restricted to the catchments area of the collection centers, which is the area determined by a radius of approximately 30km around the centre. This effort resulted in a population framework list of 350 farmers, divided over the four sub-populations (two districts by two market channels) as indicated in Table 2. *Second,* aiming for an overall sample-size of 200, we calculated the sample size for each stratum proportionate to its size and used interval sampling to obtain a sub-sample for each of the four sub-populations (strata). A total of 200 dairy farming households were interviewed in August 2005. After cleaning, 182 observations remained for analysis (Table 2).

Sample Description

Table 3 provides some statistics on the dairy farmer populations in the two districts. In terms of the age and level of education of the head of the household, there is little difference between the two farmer groups. However, the farms differ quite starkly on other variables. The farm households in Monze are 60% larger and have almost four times the per capita income of the Kazangula households. Relative to the Kazangula households, the Monze farmers started later in dairy production but have over time become more specialized dairy farmers both in terms of the size of their herd and in terms of the importance of dairy in overall household income.

4.3 Econometric Analysis

Channel Participation and Smallholder Producer Characteristics

In this section we will compare modern-channel farmers and traditional-channel farmers with respect to a set of key characteristics. The data indicate that there are substantial differences between modern-channel and traditional-channel farmers in terms of herd characteristics, income, human capital, physical capital and farm management.

Production and Income Related Differences

Table 4 indicates that modern channel dairy farmers have, on average, almost twice as many cows as traditional channel farmers. Furthermore, the herd composition by breed also differs significantly: while 71% of the traditional channel farmer's hers consists of traditional cows, more than half of the cows owned by the average modern channel dairy farmers consist of improved breeds. These two differences are largely the outcome of two factors. First, farmers with larger herds and breeds focused on dairy production have a greater investment in milk production and hence are more likely to enter the more stable modern channel. Second, farmers in the modern channel have been targeted in smallholder dairy improvement programs which facilitated the purchase of mixed and pure dairy breed cows by these farmers. The higher importance of milk sales, both in absolute and relative terms, in the modern channel equally follows from the positive relationship between the farm's dairy focus and its channel choice. The more than 300% higher annual per capita total income is likely the outcome of a greater focus on dairy within the overall farm operation and the more profitable nature of dairy relative to many other farm activities (e.g., grains). Distance to the MCC was not found to be significantly different between the two farmer types. A possible explanation is that farms have to be within a 30km radius around the MCC, i.e., a relatively short distance which can be overcome by most farmers and hence distance is less of an entry-barrier into the modern dairy channel.

Labor, Human Capital and Gender Differences

There are no stark differences between the two farmer types in terms of the analyzed labor, human capital and gender variables (Table 5). Women tend to have less of a presence as heads of dairy farms in the modern channel, confirming a general trend in Sub-Sahara Africa of men getting more involved as soon as an activity becomes more business-like and profitable.

Households in the modern dairy channel also tend to be more educated. A possible explanation here is that better education facilitates participation in training, access to credit, and understanding of written materials accompanying the introduction of various new management and operations tools in the modern channel. The most significant difference between the two farmer types in terms of human capital variables is the level of technical assistance received. This difference is largely the outcome of farmers in the modern channel being targeted by an often bewildering array of donor-funded development assistance programs (linked to the MCCs).

Physical Capital Differences

Physical capital elements are more prevalent in the modern channel than in the traditional channel, although prevalence is generally low across both channels (Table 6). Limited access to the credit required for investing in these physical capital elements for the smallholder farmers studied here is one likely explanation for the general low prevalence. Paddocks and milking parlors are the most common dairy infrastructure investments by farmers in both channels. Except for paddocks in the modern channel, less than a quarter of the farms have invested in a given physical capital element. Running water and feed storage tanks are completely absent on farms in the traditional channel. The difference in prevalence between the two channels can be explained by the same causes presented for production related differences above: (1) the attractiveness of the modern channel for dairy focused farmers for whom investments in dairy infrastructure make more business sense; and (2) the focus of development programs on the modern dairy channel. Or from the opposite perspective, the traditional channel consists mostly of farmers with a focus on beef production which implies they (1) are less likely to invest in dairy and (2) are largely bypassed by development programs who are mostly focused on dairy production.

Differences in Organization and Management Practices

Traditional channel and modern channel farmers differ significantly in terms of their marketing, management and collaboration practices (Table 7). Modern channel farmers market more of their production and market more of it as fresh milk. This follows from their strong dairy focus and more reliable market options (i.e., the MCC in addition to local markets). While some production management practices are equally wide-spread within the two farmer sub-populations (e.g., rinsing udders before milking or calf stimulus), most of these practices are far more prevalent amongst modern channel farmers. To some extent, these management practices are the direct result of the requirement imposed on farmers supplying the dairy processors through the MCCs (e.g., the use of steel pails). Given that these practices are not followed by 100% of the modern channel farmers is an indication that even in this channel the codes of good conduct are not strictly enforced. Another reason for the higher prevalence of the listed management tools in the modern marketing channel is that through the MCC farmers receive facilitated access to training on and assistance with techniques such as for example artificial insemination. In contrast, traditional channel farmers have far less the incentive and the capacity to implement these more advanced operational management tools. Collaboration amongst farmers with regard to buying inputs, production and marketing is significantly higher in the modern channel, as could be expected given their close and systematic contact through the MCC and their membership in the association that manages the MCC.

Determinants of Smallholder Producer Channel Adoption

In this section we use a regression model to assess how farm characteristics determine the participation of the farm in the modern dairy channel (Y). Since negative dependent variables are not possible and assuming non-linear effects of the explanatory variables, we modeled this channel adoption decision as a probit model. The model takes on the following form:

$$\text{Prob}\,(Y=1|X) = G(\beta_0 + X\beta),$$

where G is the standard normal cumulative distribution function and where X is a vector consisting of a selection of variables from the five categories of explanatory variables for standard adoption models: prices of inputs and outputs, risk factors, quasi-fixed capital and shift factors (such as location). Prices of inputs and outputs were not directly included as they are implicit in the channel choice and further determined by the size and location of the farm. Two location variables where included: (1) district (Monze or Kazangula) and (2) distance from the farm to the MCC. It is hypothesized that a location closer to Lusaka (i.e., Monze) and closer to the MCC positively affects channel participation. The risk factor and quasi-fixed capital explanatory variables we want to include here capture risk-sensitivity (size of the dairy operation), access to financial capital (size of dairy operation, education), human capital (age, education, experience, gender, household size) and physical capital (presence of a vehicle and of dairy farm infrastructure such as a milking parlor). Each of these explanatory variables is hypothesized to ceteris paribus increase the probability of adoption of the modern channel. With regard to gender it is hypothesized that men are more likely to enter the modern channel because they (1) are assumed to have better access to the required production factors and (2) tend to get more involved when the transactions become more formal, sizeable and rewarding (Dolan 2001). One departure from the standard adoption model is that for the size of the dairy operation and the presence (or absence) of dairy farm infrastructure we used the 2000 situation. Given that (1) two thirds of the suppliers in the modern channel entered this channel in or after 2000 and (2) most of the MCC development took place after 2000, we basically avoid a potential endogeneity problem (e.g., size could well have been influenced by participation in the modern, processor-led dairy channel). Based on the above, the implementation model has the following determinant variables (X):

(a) the age of the head of the household (AGEHEAD);
(b) the gender of the head of the household (SEXHEAD);
(c) the number of years of schooling of the head of the farm (EDUCHEAD);
(d) a dummy variable for the district with Monze=1, Kanzangula=2 (LOCATION);
(e) the experience in years in dairy of the head of the household (EXPEHEAD);
(f) the size of the household (HH_SIZE);
(g) the distance from the farm to the MCC (KM_CENTR);
(h) a dummy for motorized vehicle ownership (VEHICLE);
(i) the number of cows owned in 2000 (COWS_N00);
(j) the physical capital index, as defined below, in 2000 (UPGR2000).

The *physical capital index (PCI)* indicates the presence of modern equipment and infrastructure at the farm. It has eight different components: a cold storage unit, a milking parlor, a cement floor for the milking parlor, a dip tank, a paddock, a feed tank, a barn and a manure storage unit. A cumulative score is used, adding one point for each piece of equipment of infrastructural

element. A farmer not using any of these components receives a PCI score of zero; a farmer using all components receives the maximum PCI score of 8.

Based on maximum likelihood estimation (MLE), Table 8 presents the probit estimators ($\hat{\beta}_i$) of the above model. Table 8 indicates that the results are mostly as hypothesized, namely, the probability of a farm participating in the modern dairy processor channel increases as the farm (i) is located closer to Lusaka, (ii) is larger and (iii) has a higher PCI. The Monze location also has a strong positive correlation with the probability of entering the modern dairy processor channel because the higher household incomes in this region (relative to Kazangula). These higher incomes imply better access to financial capital which in turn facilitates compliance with the various investments in technology associated with the requirements of the dairy processors. Surprisingly, and seemingly contradicting our findings above, the presence of a motorized vehicle has a negative effect on modern channel participation. The model controls for location and while vehicle ownership is higher for modern channel dairy farmers in Kazangula, the reverse situation exists in Monze. One possible explanation is that in Kazangula market options are limited and even reaching the MCC requires good access to transportation. In Monze, located on the main road from Lusaka to Livingstone and more densely populated, markets are more easily accessible even if farmers do not own a motor vehicle. However, vehicle ownership amongst Monze's modern channel dairy farmers is close to that amongst dairy farmers in the traditional channel (30% vs 32%). Hence, ownership of a motorized vehicle is not necessarily critical for modern channel participation and becomes a key determinant based on the nature of the specific location. Age, gender, education, experience, household size and distance to the nearest MCC did not have ceteris paribus a statistically significant impact on the probability of a farm participating in the modern dairy channel in our sample.

Channel Participation and Growth for Smallholder Producers

In order to analyze the effect of participation in the modern dairy channel on the growth of the smallholder farm, we focused on size and upgrading over the period 2000-2005. As indicated earlier, this is the period during which most of the current modern channel farmers entered the modern channel (two thirds of the modern channel farmers entered the channel after 2000) and because this was the period when most smallholder dairy farmer support programs were initiated. We include two size dimensions, number of cows and milk output volume, and three upgrading dimensions, a physical capital index (PCI, explained above), a breed index and a management index.

The *breed index (BI)* indicates the composition of the herd across three types of cows. The formula used was BI=100 * (0.5xMBC+PBC)/TNC with MBC=number of mixed breed cows, PBC=number of pure breed cows and TNC=total number of cows. This implies that if the herd consists of traditional cows only, the BI value is zero and, at the other extreme, if the herd consists of pure breed dairy cows only, the BI value is 100. All other distributions are associated with a BI value between 0 and 100.

The *management index (MI)* indicates the degree of sophistication in the management of the dairy operation. It looks at 13 different management practices: zero grazing, calf stimulus, artificial insemination, use of improved breed bulls to service cows, suckling cows after milking,

bucket feeding of calves with milk and calf starter, feeding cows with concentrate during milking, using a milking machine, rinsing of udder before milking, use of approved lubricant for hand milking, use of stainless steel pails for milking, use of stainless steel containers for transportation, cultivation of pasture. Like for the PCI above, a cumulative score is used, adding one point for each management tool. A farmer not using any of these management tools receives an MI score of zero; a farmer using all tools receives the maximum MI score of 13.

The *milk output volume* represents the total output in liters per year for a given dairy farm taking herd composition into account. Total output is calculated using the average value of the productivity of the cows for each of the three types as found in our survey: traditional cow = 4 liter/day, mixed breed cow = 7 liter/day, pure dairy breed cow = 14 liter/day[14]. For the latter two breeds, these productivity values are far below the anticipated values, indicating that farmers are not yet able to harness these new technologies to their fullest potential. Although management practices and physical capital differ greatly across between farmers in the two channels (as indicated infra), we found that yields by type of animal were similar. Although in the literature traditional herds are usually associated with shorter lactation periods, our survey data indicated that across channel type and also across farmer type (traditional vs. modern), average lactation periods hovered around 240 days with little variation across either channel type or breed. While these findings warrant further field investigation, this was beyond the scope of this study. Therefore output volume was calculated using the following formula: output volume = TBCx4 + MBCx7 + PBCx14, with TBC=traditional breed cows, MBC=mixed breed cows and PBC= pure breed cows.

Table 9 indicates how these five indicators changed over the period 2000-2005. While for dairy farmers in both channels there was a shift toward smaller herds with a higher percentage of more productive non-traditional breed cows, the net effect on milk output volume was negative for dairy farmers in traditional channel and positive for dairy farmers in the modern channel. Although the MI and PCI increased for both farmer types, they increased more for the dairy farmers in the modern chain, especially with respect to the implementation of management tools. Table 9 further indicates that even for the farmers in the modern channel, the level of sophistication of management and farm infrastructure elements has grown far stronger than the output yield. This implies that farmers have not yet been able to fully extract the benefits of these newly introduced elements.

As is often the case with averages, the negative growth rate of the average herd size in Table 9 hides an important trend toward an homogenization in the size of the dairy farm operations. If we split the dairy farmer population into two size categories (small=those with less than 25 cows, large=those with more than 25 cows) then the data reveal that 64% of the small farms have grown in herd size (cows only) while 64% of the large farms have shrunk. Since there are 3.5 times as many small farms than large farms, the resulting data show that for within both the traditional and the modern dairy channel: (1) around 57% of the farmers have grown in herd size; and (2) the average growth rate is around 38%.

[14] These yields refer to the average over the dry and the rainy period as indicated by the interviewed farmers. For traditional cows, the yield was 5 liter/day during the rainy season and 3 liter/day in the dry season. The respective values for mixed breed cows were 9 and 5 and for pure breed cows 17 and 10.

Although the estimated effects on milk output volume are relatively small (10% decrease for traditional dairy farmers, 4% increase for modern channel dairy farmers), the divergence in growth trends between the two farmer types is significant. As part of our farmer survey we used asymmetrical categorical variables to measure the farmers' perceived trends in terms of the quality and quantity of milk produced. The results indicate that a far greater proportion of the smallholder dairy farmers in the modern channel feel that their farms' milk output and milk quality have improved substantially (Table 10).

5. Summary, Conclusions and Implications for Development Programs

Market liberalization in Zambia has led to a rapid and fundamental transformation of its dairy sector. Mainly through foreign direct investment and international partnerships, a new formal dairy sector, characterized by institutional, organizational and technological innovation, emerged from the ashes of abandoned government projects. Sensing the development opportunity that arose from an untapped milk supply potential in Zambia's traditional smallholder livestock production and a growing milk demand from the newly emerging formal dairy processing sector, numerous donor-funded smallholder dairy farmer support programs emerged. At the same time, in order to protect its domestic market as well as to be in a better position to enter demanding export markets, stakeholders from the private, public and NGO sector have recently joined forces to develop technical dairy product standards for Zambia based on the CODEX.

Our survey of smallholder dairy farmers in Zambia's Southern Province focused on how this new formal dairy sector impacted these farmers in terms if their participation and growth. In terms of participation, we found that even within the smallholder farmer population under study, it is the larger, higher-income and technologically more advanced farmers who have entered the modern dairy channel. Although this is partially the direct result of assistance models targeting clusters of higher capacity smallholder farms in the initial stages, the persistence of this capacity difference for the more established milk collection centers investigated in this research indicates that there exists a threshold capital vector at the entry of the modern dairy channel. In terms of growth, we found that farmers in the modern dairy channel, relative to farmers in the traditional dairy channel, grew faster in terms of milk output volume as well as in terms of upgrading with respect to improved breeds, tools and operational management practices. However, we also found that within the modern dairy channel, relative growth in terms of upgrading outstripped relative growth in output volume. This appears to indicate that while participation in the modern channel does have a positive effect on growth it does so below the apparent potential as the efficient and effective use of new technologies and management practices significantly lags their introduction.

Three key implications for development programs follow from these findings. First, the modern processors' use of quality-based premiums for rewarding producers who deliver higher quality milk spurred the farmer's interest in expanding their production capacity through investment and technology adoption. This illustrates how small holder producers in some of Africa's more difficult production environments still have the capacity to respond to economic incentives in their livelihood decisions. It underscores the importance of designing and integrating suitable price incentive schemes in assistance programs. Second, even if specifically focused on

smallholder producers, economic development programs are unlikely to assist all targeted farmers in entering modern supply chains. Hence, development programs must be clear from the start on which farmers to include in the business model. Farmers not making the grade will either (1) benefit from the spill-over effects of the growth of the included producers (whose increased incomes are likely to stimulate the local economy) or (2) need to be targeted by social development programs. Third, the integration of smallholder farmers into modern, dynamic markets requires a balanced approach in which numerous complementary program elements need to be implemented with great synchronicity. In turn this requires that development programs involve all relevant stakeholders (private-public-NGO) and coordinate their activities carefully.

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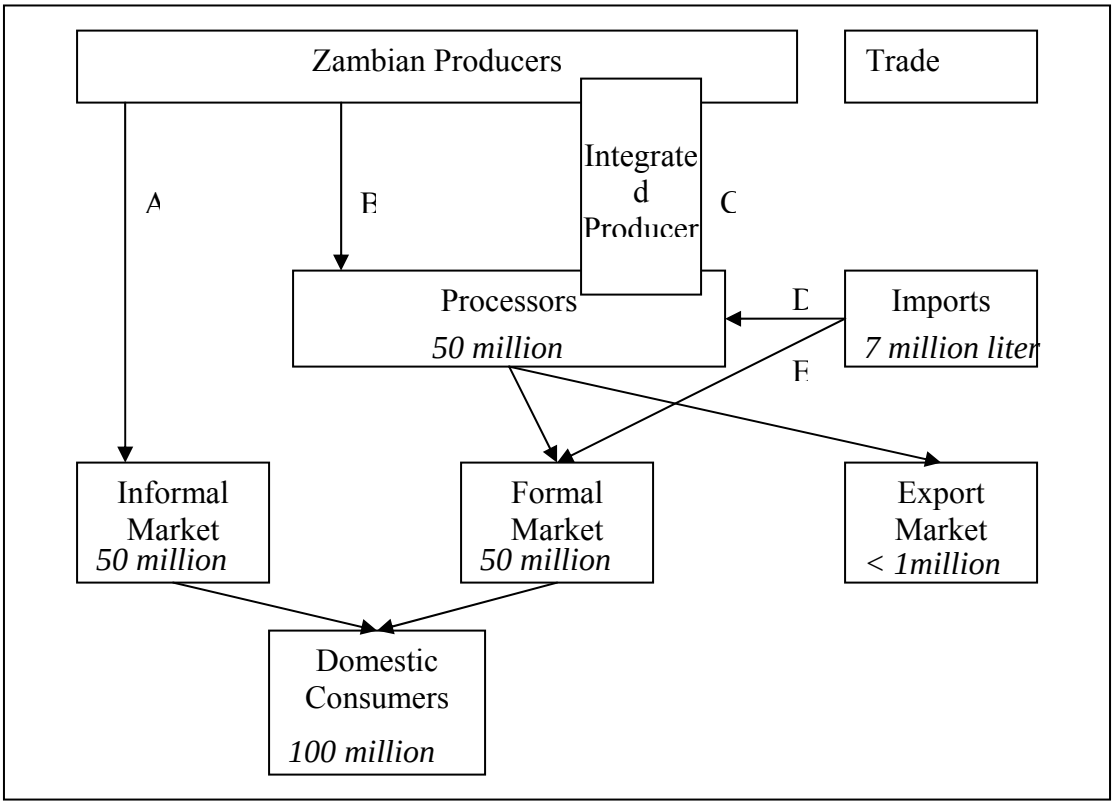
Table 1: Dairy Production by Producer Type

Characteristic	Traditional Smallholder Livestock Farms	Emerging Smallholder Dairy Farms	Large Commercial Dairy Farms
Number of farms	30,000	260	50-70
Average herd size (heads)	30	50	550
Most common breed	Traditional breed (Zebu)	Mixed breed	Pure dairy breed
Yield (liter/cow, day)	2-5	8-15	25-30

Source: compiled and estimated by the authors based on Valeta (2004), Emongor (2004) and key informant interviews.

Figure 1: Zambia Dairy Flow Chart (annual volumes)



Note: (1) reliable data on the size of the informal market and informal trade are not available, hence the indicated volumes are indicative values only; (2) for the imported volume, milk powder imports were converted into the milk equivalent.
Source: estimated by the authors based on Sng (2002), Emongor (2004), Valeta (2004) and key informant interviews.

Table 2: Number of Dairy Cattle Owners by District and Channel (sample size)

District	Informal Market Suppliers	Formal Market (MCC) Suppliers	Total
Kazangula	56 (29)	46 (24)	102 (53)
Monze	42 (22)	206 (107)	248 (129)
Total	**98 (51)**	**252 (131)**	**350 (182)**

Source: authors' farmer survey 2005.
Note: statistics refer to dairy farmers living within a 30km radius around the Kazangula and Monze milk collection centers, not to all dairy farmers in the district.

Table 3: Selected Statistics on the Diary Farmer Populations by District (averages)

Statistic	Monze District (n=129)	Kazangula District (n=53)	Both Districts (n=182)
Age household head	50	51	50
Level of educations household head	Grade 8	Grade 7	Grade 8
Household size	11	7	10
Head's years of experience in dairy	11	15	12
Income per capita	US$444	US$117	US$349
Percentage of income from dairy	45%	39%	43%
Herd size	40	19	34

Source: authors' farmer survey 2005.
Note: statistics refer to dairy farmers living within a 30km radius around the Kazangula and Monze milk collection centers, not to all dairy farmers in the district.

Table 4: Production and Income Related Differences (Traditional vs. Modern Channel)

Farm characteristic	Traditional Channel Farmer	Modern Channel Farmer
Herd size (heads) ***	23	38
Number of cows owned (heads)***	11	23
Percentage of herd that are traditional cows***	71%	43%
Percentage of herd that are mixed breed cows*	27%	41%
Percentage of herd that are pure breed cows***	2%	16%
Annual household income from milk sales**	US$361	US$1,492
Milk sales as percentage of total income	38%	45%
Annual per capita total income household***	US$134	US$432
Distance to the MCC (km)	10.9	12.4

Notes: *=significant at the 10% level, ** = significant at the 5% level, *** significant at the 1% level.
Source: authors' farmer survey 2005.

Table 5: Labor, Human Capital and Gender Differences (Modern vs. Traditional Channel)

Farm characteristic	Traditional Channel Farmer	Modern Channel Farmer
Age of the head of the household (years)	49.5	50.1
Educational level of head of household (years)*	7.1	8.2
Highest educational level any hh member (years)**	9.7	10.5
Head's years of experience in dairy farming	12.9	11.9
Size of the household	9.0	10.0
Technical assistance received 2005 (Index 1-11)***	1.5	2.5
Percentage female household heads*	18%	8%

Notes: *= significant at the 10% level, ** = significant at the 5% level, *** significant at the 1% level.
Source: authors' farmer survey 2005.

Table 6: Physical Capital Differences (Modern vs. Traditional Channel)

Farm characteristic	Traditional Channel Farmer	Modern Channel Farmer
Farms with a paddock	27%	53%
Farms with motorized transportation	18%	27%
Farms with a milking parlor with cement floor	14%	24%
Farms with a dip tank	6%	15%
Farms with a feed storage tank	0%	13%
Farms with running water	0%	11%

Source: authors' farmer survey 2005.

Table 7: Organizational and Managerial Differences (Modern vs. Traditional Channel)

Farm characteristic	Traditional Channel Farmer	Modern Channel Farmer
Percentage of milk production that is marketed*	82%	90%
Percentage of marketed milk sold as sour milk***	17%	8%
Rinsing of udder before milking	78%	87%
Use of stainless steel transportation containers***	37%	81%
Use of stainless steel pails for milking ***	35%	68%
Keeping records***	22%	66%
Suckling cows after milking	63%	61%
Feeding cows concentrate during milking***	24%	61%
Use of improved bulls to service cows	41%	53%
Use of an approved lubricant for hand milking*	33%	47%
Bucket feeding of calves with calf starter***	12%	37%
Artificial insemination***	14%	36%
Calf stimulus	28%	31%
Cultivation of pasture**	12%	27%
Has a bank account***	8%	26%
zero grazing	9%	19%
Using a milking machine	8%	10%
Collaborating with farmers on buying inputs***	16%	43%
Collaborating with farmers on production*	3%	47%
Collaborating with farmers on marketing	46%	51%

Notes: *=significant at the 10% level, ** = significant at the 5% level, *** significant at the 1% level.
Source: authors' farmer survey 2005.

Table 8: Determinants of Farmer Adoption of the Modern Supply Channel (Probit Results)

Independent variables	P(Supplies milk to modern channel) (s.e.)
AGEHEAD	0.00456(0.00868)
SEXHEAD	0.52469(0.33636)
EDUCHEAD	0.02231(0.03640)
LOCATION	0.93743(0.28874)***
EXPHEAD	-0.00134(0.01302)
HH_SIZE	-0.00918(0.03178)
KM_CENTR	0.01252(0.01395)
VEHICLE	-0.56533(0.33143)*
UPGR2000	0.24870(0.12832)*
COWS_N00	0.01154(0.00643)*
Constant	-1.16131(0.67238)*
No. of observations	177
Pearson Chi Square	184.74 (P=0.152)

Notes: *=significant at the 10% level, ** = significant at the 5% level, *** significant at the 1% level.
Source: authors' farmer survey 2005.

Table 9: Growth and Upgrading by Dairy Farmer Type between 2000 and 2005

	Traditional Channel Smallholder Dairy Farmers			Modern Channel Smallholder Dairy Farmers		
	2000	**2005**	**Growth Rate Average (%)**	**2000**	**2005**	**Growth Rate Average**
Herd Size (# of cows owned)	11.6	10.7	-8%	24.8	23.0	-7%
Output Volume (liter per year)	12,182	11,553	-10%	36,661	38,195	+4%
Breed Index (0-100)	14.5	15.4	+6%	29.2	36.5	+25%
Management Index (1-13)	3.3	3.9	+18%	4.6	6.2	+35%
Physical Capital Index (1-8)	0.3	0.5	+67%	1.0	1.8	+80%

Source: authors' farmer survey 2005

Table 10: Farmer Perceptions of Milk Yield and Quality Change over 2000-2005

	Channel	% of Farmers Indicating the Respective Perceived Change since 2000				
		Improved a lot	**Improved a little**	**Status Quo**	**Worsened**	**Total**
Milk Quality	**Traditional**	10%	27%	61%	2%	100%
	Modern	42%	25%	31%	2%	100%
Milk Yield	**Traditional**	2%	45%	35%	18%	100%
	Modern	34%	39%	20%	6%	100%

Notes: both the channel-yield and channel-quality correlations are significant at the 1% level.
Source: authors' farmer survey 2005.