Food and Agriculture Organization of the United Nations

Smallholder farmer participation in modernization of a **food system**

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by
David Neven
Thomas Reardon
Ricardo Hernandez
Gelson Tembo

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Abstract

Liberalization of market and foreign direct investment (FDI) in Zambia in the 1990s led to modernization of the dairy subsector in the 2000s. This took place not only in dairy retail and second-stage processing, but also in the segment with which small farmers directly interact – first-stage processing and local milk collection. In the latter, the modern channel's rural entry point – the Milk Collection Centre (MCC) – has emerged. A national MCC census describes the rapid growth of the MCC model in Zambia in some detail.

This report explores whether farm assets determine the participation of smallholder dairy farmers in sales to MCCs and how their duration as MCC suppliers affects their accumulation of farm capital and technology. A survival analysis approach used constructed panel data for dairy farmers over a 12-year period. Participation in MCC value chains is found to be determined by location, training and cooperative membership, thus having a mixed effect on the inclusion of smallholder producers. Duration as an MCC supplier is correlated with accumulation of capital and changes in technology. The implications are that policy-makers need to facilitate smallholder farmers in engaging in collective action and accessing modern infrastructure.

Keywords: Zambia, dairy, industry modernization, milk collection centres (MCCs), smallholder farmers, participation, duration analysis, technology, accumulation of capital.

About the authors

David Neven is an Enterprise Development Officer at the Food and Agriculture Organization of the United Nations (FAO), based in Rome. He provides technical guidance to projects and governments on agrifood market, agribusiness and food value chain development. He has a Ph.D. in Agricultural Economics from Michigan State University, United States of America.

Thomas Reardon is a Professor in the Department of Agricultural Economics and Distinguished Faculty, Michigan State University, United States of America. He is an Agricultural & Applied Economics Association (AAEA) Fellow and has a Ph.D. in Agricultural Economics from the University of California, Berkeley, United States of America.

Ricardo Hernandez is an Associate Research Fellow at the International Food Policy Research Institute (IFPRI), based in Bangladesh. He has a Ph.D. in Agricultural Economics from Michigan State University, United States of America.

Gelson Tembo is Director of the Center for Agricultural Research and Policy Analysis (CARPA) and a Senior Lecturer at the University of Zambia, based in Lusaka. He has a Ph.D. in Agricultural Economics from Oklahoma State University, United States of America.

Acronyms

ACF	Agricultural Consultative Forum
ADF	African Development Fund
AI	Artificial insemination
CAC	Codex Alimentarius Commission (FAO/WHO)
CARPA	Center for Agricultural Research and Policy Analysis (Zambian NGO)
CEEC	Citizens Economic Empowerment Commission
COMESA	Common Market for Eastern and Southern Africa
CSAs	Census Supervisory Areas
CSO	Central Statistical Office
DAZ	Dairy Association of Zambia
DPB	Dairy Produce Board
EDF	European Development Fund (European Commission)
ESN	Nutrition and Food Systems Division (FAO)
FDA	Food and Drugs Act (Zambia)
FDI	Foreign direct investment
GART	Golden Valley Agricultural Research Trust
IPPC	International Plant Protection Convention
MBT	Micro Bankers Trust
MCC	Milk Collection Centre
NALEIC	National Livestock Epidemiology and Information Centre
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
OIE	World Organisation for Animal Health
PSU	Primary sampling unit
SADC	Southern African Development Community
SEAs	Standard enumeration areas
SPS	Standard Procurement System
SRS	Simple random sampling
SSU	Secondary sampling unit
ZANACO	Zambia National Commercial Bank
ZATAC	Zambia Agribusiness Technical Assistance Centre
ZDPA	Zambia Dairy Processors Association
ZMK	Zambian kwacha
ZMW	Zambian kwacha (ZMK currency code changed from 1 January 2013 to ZMW)
ZNFU	Zambia National Farmers Union

Chapter 1
Introduction

From 1991, the Government of Zambia liberalized its markets, leading to fundamental structural changes in the national food system. Parastatal companies were privatized, commodity markets were deregulated and foreign direct investment (FDI) was both encouraged and facilitated (Neven, Odera and Reardon, 2006; Saasa, 1996). In the 1990s and 2000s, this resulted in substantial FDI by regional and global agrifood firms in Zambia, in particular in the downstream segments of second-stage processing and retailing.

From mainly purchasing initially from large commercial dairy farms, large commercial processors in Zambia are now beginning to buy more from smallholder producers. This shift has been made possible by the creation of milk collection centres (MCCs). Smallholder dairy farmers have transferred from traditional direct sales to local consumers to using the newly constructed MCCs. These centres have also attracted many new entrants into smallholder dairy production. Most MCC milk is sold on to the modern sector (large second-stage processors), and then partly sold on to the modern retail sector (which only sources from the modern sector processors). Hence, MCCs serve as a key initial link in the modern channel of the dairy value chain. This channel provides greater quality control in sourcing milk at the start of the chain, which is an important factor for the efficiency of modern dairy processors.

As these milk collection and first-stage processing centres have spread, two policy issues have emerged – and these give rise to the research questions in this report.

- What determines smallholder farmers' participation and duration in the modern channel (as shown by their choice to market to MCCs rather than only to traditional buyers)? Does this mean that asset-poor smallholder dairy farmers are eventually excluded?
- What is the impact in terms of accumulation of capital and change in technology for farmers who market through MCCs as opposed to farmers who sell only via traditional channels?

These questions are addressed through a primary data set collected during the authors' field survey in Zambia's Southern Province, using a sample of 420 smallholder dairy farmers in the catchment areas of two MCCs. The emergence and growth of the MCC model were examined through a census of MCCs in Zambia. Fieldwork took place from 2012 to 2014.

Various studies have provided anecdotal evidence of the impact of this food system modernization process on smallholder farmers in Zambia. See, for example, Hantuba (2003) and Emongor *et al.* (2004) for the impact of the rise in supermarkets on Zambia's fresh produce markets, or Coulter and Onumah (2002) for the direct and indirect effects on smallholder producers of warehouse receipt systems in grain markets. In Zambia's dairy value chain, studies of a mostly qualitative nature have found that, although *emerging smallholder dairy farming based on grazing and MCCs is competitive, it is still operating below potential* even though it is growing fast (Swanson and Land O'Lakes, 2009; ACF, 2011; World Bank, 2011; Mumba *et al.*, 2012). Nevertheless, there have been no articles on Zambia that address the above research questions with primary farm-level data. The present paper aims to contribute to the Zambian debate.[1]

Apart from Zambia, several strands of recent research have focused on the transformation of the dairy sector in other countries. These form part of the broader set of literature to which this paper contributes.

The *first strand of literature* (1995–2005) focused on African dairy subsector transformation and rapid growth. Initially, these studies assessed the decision of farmers to participate in the dairy market, mainly in marketing to parastatals (Mdoe and Wiggins, 1996). Later, the analysis shifted to

[1] One publication (Neven, Odera and Reardon, 2006) used farm-level data to address the research questions in Zambia. This report is a methodological extension of that work.

the determinants and effects of farmers' choice to market their milk either to local brokers in spot markets or to cooperatives that mainly sell on to local peri-urban processors and urban markets (Owango *et al*., 1998; Holloway *et al*., 2000, 2004; Holloway, Barrett and Ehui, 2005). Unlike the present study, these studies do not focus on farmers selling into the modern channel, but their focus is on farmer interactions with the basic building blocks of a commercializing milk market: a cooperative system and MCCs. The present study may be considered an extension of this work.

Most of this strand of literature considers transaction costs rather than household assets to be the key determinants of farmers' decision to market to cooperatives. The role of household assets in choice was addressed by Holloway *et al*. (2004) and Holloway, Barrett and Ehui (2005), who studied the effects of non-land assets such as herd size. This research did indeed identify a threshold effect in terms of volume/farmer/milk transaction/week determining that farmers sell to a cooperative rather than to spot brokers coming to their farms. The issue of non-land assets and investment thresholds appeared, from this literature, to be crucial information for the design of dairy modernization programmes that are inclusive of small farmers. Consequently, the present report has considered this as central to its analysis of farmer participation in the modern channel in Zambia.

The *second strand of literature* (early 2000s) has not dealt with Africa to date (apart from the present report), but rather with small farmers' participation in modern dairy market channels. The literature has been scant, with several important exceptions, and the results have been mixed.

On the one hand, several papers from Latin America (such as Farina [2002] for Brazil) note that where the dairy industry has rapidly modernized and a strong "dual-scale" farming sector exists, modern dairy operations have tended to shift their sourcing towards medium to large farmers, excluding the smallest farmers, even when the latter are organized in cooperatives. This has been because smaller farmers lack the organizational and physical capacity to meet the quality grades and transaction efficiency targets for milk delivery to first-stage processors. In turn, this reduces their potential to meet efficiency targets for milk processing operations in the modern sector. However, these Latin American papers use broad descriptive data, rather than farm survey data, so they do not test the impact on channel participation of interhousehold differences in ownership of non-land assets such as equipment or cows.

On the other hand, there are some Eastern European countries where small dairy farmers predominate (hence not mainly a dual-scale setting). The relevant publications show that modern dairy operations source from small farmers (rather than sourcing only from a few larger farmers or simply importing powder and reconstituting it) and seek to resolve idiosyncratic market failures facing small farmers through assistance and contracting (see Dries and Swinnen [2004] for Poland). However, these studies have not emphasized interhousehold differences in non-land assets as determinants of participation, or conditioners of impact.

Hence, existing literature has provided several important preliminary steps and background for the present study, but there is a gap in the knowledge about the determinants and impacts of small farmers' participation in the modern channel in Africa. Moreover, only in a few cases did the literature pinpoint interhousehold non-land asset holdings as conditioners of small farmers' participation. The present paper aims to fill this gap.

The paper is structured as follows. Chapter 2 describes in general the recent modernization of the dairy sector in Zambia. Chapter 3 provides an analysis of the emergence of the MCC model, based on census data. Chapter 4 addresses the research questions using statistical and econometric analysis of farm-level data. Chapter 5 concludes with implications for development policy and programmes.

Chapter 2

Modernization of Zambia's dairy value chain

2.1 MAIN HISTORIC DEVELOPMENTS

Before 1991, the formal part of the dairy value chain was controlled by the Zambian Government's Dairy Produce Board (DPB). This was responsible for the processing and marketing of raw milk, including the setting of collection and retail prices. Its 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 as more of a side product. Surplus milk production (beyond feeding calves and intrahousehold consumption) was sold either in informal raw milk markets or to DPB. In order to capture the nutritional and economic development advantages of a growing dairy value chain for Zambia's poor, the Government initiated various smallholder support programmes in the dairy sector. Unfortunately, these were characterized by a lack of producer ownership; a 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 (Kaluba, 1992; Cashman, 1999; Kamanga, 2005). As a result, the support programmes were generally unsuccessful, domestic milk production remained low and a formal dairy industry never really took off (Kaluba, 1992).

Since 1991, demand and supply side factors have transformed the dairy value chain. On the demand side, urbanization, rising incomes and related lifestyle changes have increased the importance of the formal market channel part of the dairy value chain. For example, in a national consumption survey of 150 households, Sng (2002) found that urban households consume nearly four times as much milk per capita as rural households. These urban households not only consume more milk, but are also far more likely to buy milk from the emerging modern retailers that procure from dairy processors in the formal sector. Two important trends since the early 2000s that continue to have a positive impact on job creation and household income in Zambia are: (i) the sustained growth of the copper industry as a result of high demand from China (especially since 2003); and (ii) continued foreign investments in commercial farming operations.[2] Despite these positive trends, overall milk consumption in Zambia remains extremely low.[3] A major constraint to increased milk consumption is the relatively high and rapidly rising urban retail price for milk in the country. Between 2000 and 2012, the retail price for pasteurized milk grew rapidly from US$0.60 (Gillespie and Banda, 2000) to US$1.28 per litre, i.e. approximately 33 percent above the United States of America's price of US$0.96 per litre.[4]

On the *supply* side, the initial shock was provided by the Government, whose structural adjustment policies in the dairy value chain included: (i) privatization; (ii) market deregulation; (iii) reduction of financial and technical government support; and (iv) trade liberalization. This policy shift threw a weak and unprepared dairy value chain on to the forces of an open market. In the vacuum left by the Government, new players gradually emerged and began to reorganize the dairy industry.

Privatization

Parastatals have been shut down or privatized, thus attracting FDI. Initial FDI in Zambia's dairy subsector came from South Africa's Bonnita brand, which bought the parastatal processing plants from

[2] For example, the entry of about 340 white commercial farmers created an estimated 30 000 new jobs in Zambia (The Economist, 2004).

[3] According to FAOSTAT, Zambia ranked 165th of 175 ranked countries in terms of per capita milk consumption in 2011, with 8.3 kg per year.

[4] The 2012 milk prices for Zambia and the United States of America are based on www.numbeo.com. The exchange rate used throughout this paper is US$1 = ZMW5.17, based on www.oanda.com (11 January 2013). Note that from 1 January 2013 the old ZMK currency was rebased on ZMW (ZMK1 000 = ZMW1).

DPB in 1996.[5] Bonnita closed several 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 DPB to long shelf-life UHT milk, flavoured milk, butter, fresh cream, dairy fruit-juice blends, ice cream and yoghurt. Cheese production was dropped since it was more efficient to import from Bonnita's South African plants. In 1998, Parmalat acquired Bonnita, including its Zambian plants.[6] Parmalat continued the process of change initiated by Bonnita and dramatically increased raw milk intake from 25 000 litres/day in 1998 to 75 000 litres/day in 2012. In 2004, the competitive landscape was further changed by a strategic alliance between Finta Farms Ltd of Zambia and Clover Dairies, South Africa's largest dairy processor. Clover was already in a partnership with the world food company Danone (based in 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 subsector.

The FDI-led growth of the dairy industry over the period 1996 to 2005 was largely made possible through two concurrent changes in the wider market environment. First, increased local production was needed to replace reduced imports from South Africa (because of the processors' own regional business strategies) and Zimbabwe (as a result of the collapsed dairy industry). By 2005, however, this import substitution had tapered off and the future growth of Zambia's processing industry had to come from increased domestic consumption and/or exports. At an estimated 8 litres/year, the per capita milk supply in Zambia is one of the lowest in the world, creating both an opportunity and, from a nutritional point of view, a need to develop a formal dairy market. Furthermore, the combination of even lower milk supply levels in neighbouring markets such as Malawi, Mozambique and the Democratic Republic of the Congo; the collapsed dairy sector in Zimbabwe; and the implementation of regional trade agreements implied important additional growth opportunities for Zambia's dairy sector.[7]

Second, FDI in Zambia's food retail sector supported the development of a modern and formal dairy supply chain. Major South African supermarket chains such as Shoprite and SPAR had entered the market in 1996. These chains not only created a reliable and growing formal market for dairy products (taking market share away from informal retailing) but also drastically increased the use of refrigeration in retailing. The combined emergence of refrigeration and UHT milk (which can be stored for up to 12 months without refrigeration when it is quality produced) greatly increased the distributional reach of milk and other dairy products in both formal and informal market channels.

Market deregulation

The dairy market was deregulated and prices for inputs and outputs were no longer controlled. This allowed the larger processors (Parmalat, Zammilk) to establish a new quality-based raw milk pricing schedule, similar to that applied in industrialized countries. Price was calculated by complex formulas based on bacterial count and butterfat content, among others. Prices received by the dairy farmers in 2013 varied from ZMW3.0 (US$0.58)/litre for grade A milk sold to modern processors to ZMW2.2 (US$0.43)/litre for ungraded milk sold directly to consumers. The grade A milk price is comparable with the farm milk price in the United States of America and represents a significant increase, up dramatically from US$0.20/litre for best-quality milk in 2000 (Gillespie and Banda, 2000). This created a strong and effective incentive for farmers to improve quality. Furthermore, a quantity bonus of 3.5 percent was introduced by Parmalat for farmers who could supply more than 3 000 litres/day (attainable only by large commercial dairy farms and a few of the largest MCCs).

Reduced government support

Government support to smallholder producers in the form of subsidies and extension services was drastically reduced and replaced over time by initiatives managed by Non-governmental Organizations (NGOs) and public-private sector alliances. These initiatives helped to: (i) organize farmers

[5] Bonnita actually bought a 68 percent share, with the other 32 percent being held by large commercial dairy farmers and two cooperatives of smaller producers. This equity structure was maintained when Parmalat acquired Bonnita in 1998.

[6] In 2011, Parmalat became part of Lactalis, the third largest dairy processor in the world (Kawambwa *et al.*, 2014).

[7] The potential and profitability of Zambia's dairy sector were 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 US$5 billion corporate fraud scandal that emerged in December 2003, it kept Zambia in its portfolio.

into groups; (ii) build MCCs with cooling tanks; (iii) introduce and implement new technologies and good practices at the producer and collection centre level; and (iv) establish formal linkages with Zambia's leading dairy processors. As the dairy sector takes off, even NGOs have reduced their support, considering their job to be largely over.

Trade liberalization

In terms of tariffs and quotas, trade has been increasingly liberalized through various trade agreements (Common Market for Eastern and Southern Africa [COMESA], Southern African Development Community [SADC]) but, because of the strategic use of quality and safety standards in member countries, trade flows have remained relatively unaffected. Imports of fresh milk actually decreased for the reasons stated above but also because, stimulated by farmer protest, the Government of Zambia halted cheap low-quality milk imports (e.g. from Kenya).[8] However, after the ban on imported condensed and powdered milk was lifted in 2011, imports of milk powder increased sharply as processors could not find sufficient volumes of local fresh milk. By 2014, since supply remained far below demand, some larger processors reconstituted milk and produced yoghurt and ice cream from milk powder as a temporary strategy while the local raw milk supply was built up.[9]

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 the Congo.[10] Formal milk exports by Zambian processors are only incipient. For example, Parmalat started to export small volumes of milk to neighbouring countries (e.g. 30 tonnes/month to Malawi).[11] 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 Farms Ltd faced numerous problems when it wanted to export its UHT milk to Zimbabwe. These problems varied from lengthy risk assessment procedures over a US$0.15/litre of imported milk levy[12] to complex labelling requirements.[13] The costs to comply with these requirements made Finta milk uncompetitive in the Zimbabwean market.

Recent developments

In 2010, two key new developments took place. The first was the Government's enactment of the Dairy Industry Development Act. This was meant to regulate the dairy industry in order to develop an efficient and self-sustaining industry that would effectively contribute towards poverty alleviation, household food security and employment creation. Together with this act, a Dairy Industry Development Board was envisaged but has not yet been established. The Board's functions and powers would include: (i) enhancing milk production to utilize the capacity of processing facilities fully and achieve growth in the processing of safe and wholesome high-value milk products; (ii) providing for the processing, manufacturing, marketing and distribution of milk; (iii) ensuring the collaboration and participation of all stakeholders within the dairy industry and providing a more extensive service to farmers in the industry; and (iv) promoting self-regulation of the dairy industry through the development and use of codes of practice. This shift in government policy to strengthen the dairy subsector has, to some extent, created an environment that is supportive of development.

The second key development was the creation in 2010 of the Dairy Association of Zambia (DAZ), from a merger between the dairy commodity committee under the Zambia National Farmers' Union (ZNFU) and the Zambia Dairy Processors Association (ZDPA). DAZ represents all categories of dairy producers, processors and dairy-related agribusinesses. Through its core function of protecting and promoting the interest of members, DAZ seeks to tackle factors impacting on the performance of the dairy industry in Zambia, by

[8] Under COMESA, for example, Kenya should be able to export its milk to Zambia. However, Zambia demands that imported milk meet Zambian standards, which include a maximum bacterial count of 200 000 cfu/ml. Since Kenya's milk does not meet this low threshold, it was banned from the Zambian market. However, Kenya disputes that Zambian milk itself meets these standards.

[9] While milk powder has its limitations in terms of producing a whole range of dairy products including milk, it does have a cost advantage. According to key informants, it costs ZMW2.8/litre to produce a litre of reconstituted milk at the factory-gate level, while it costs ZMW4.5/litre for local sourcing of raw milk. This is a key driver behind Finta's strategy. Counter to the overall industry trend, it abandoned earlier attempts to obtain milk through MCCs and focused exclusively on milk powder.

[10] The Democratic Republic of the Congo's second largest urban area (Lubumbashi with a population of more than 1 million) is located just across the border from Zambia.

[11] Personal interview with Martin Njovu, Quality Manager at Parmalat Zambia (2005).

[12] According to key informants.

[13] Finta milk cartons had to state "not fit for baby food" in four local Zimbabwean languages, a requirement not asked of Zimbabwean milk producers (SADC, 2002).

engaging government and other industry players, through lobbying and advocacy, and further dairy sector development and growth. To date, DAZ has empowered its membership through appropriate capacity building programmes, donation of equipment (in the case of at least one MCC), and the development of dairy financing schemes aimed at members of dairy cooperatives in collaboration with various banks (e.g. the Zambia National Commercial Bank [ZANACO] and the Micro Bankers Trust [MBT]).[14] Further financial support came from the Citizens Economic Empowerment Commission (CEEC), and international institutions such as the European Development Fund (EDF) of the European Commission, United States Agency for International Development (USAID) PROFIT project and the African Development Fund (ADF).

2.2 CHANGING ROLE OF STANDARDS

Changing public Standard Procurement System to be mainly focused on trade

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

Although Zambia's legislative framework broadly covers the essential SPS standards, its structures for communication and enforcement of these standards are weak because of various capacity constraints. An effective SPS and food safety control infrastructure has three basic components: (i) a legislative and regulatory framework that sets the standards; (ii) an enforcement unit that inspects and provides analytical services; and (iii) a knowledge support unit that provides education, training, information and advisory support, as well as 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 (FDA) was reviewed in 2000 and brought in line with Codex Alimentarius Commission (CAC) standards on food safety (including provisions for expiry dates, accurate labelling and traceability). The Plant Pests and Diseases Act was reviewed in 1996 to bring it in line with International Plant Protection Convention (IPPC) standards on phytosanitary issues. The Stock Diseases Act (2010) has not yet been reviewed for conformity with the World Organisation for Animal Health (OIE) standards on the safety of livestock and livestock products, but plans are under way for this to be done.[15] Although the general legal framework is in place, product-specific public standards have not been developed for most domestic market food items mainly because they cannot be enforced and there is little demand from the industry or from consumers.

Zambia's SPS and food safety standards enforcement unit is almost non-functional because of a lack of resources. Not only are the relevant units understaffed, but their employees are for the most part not suitably qualified and lack the logistical and analytical support to monitor and enforce compliance with SPS and food safety laws.[16] Furthermore, communication among the various units is limited, because there is no Food Safety Authority to facilitate interdepartmental linkages. This state of affairs applies to the trade market, but even more so to the domestic market. Testing equipment is lacking or inadequate at border points; there are no vehicles to take away condemned food from markets; the few food testing laboratories are in dire need of facility upgrading and only one is accredited by international organizations; and so on. As a result,

[14] In 2014, for example, the DAZ Secretariat undertook member sensitization visits to eight MCCs supplying milk to Varun Food & Beverages Ltd in Lusaka with the aim of sharing information in the dairy sector and sensitizing them to the services that DAZ provides. These MCCs had difficulties in maintaining milk supply volumes since they relied on beef animals for milking and they expressed interest in the use of artificial insemination (AI) in order to increase the number of dairy crosses and improve milk production. The farmers also showed interest in the "loan a cow" financing scheme being implemented in collaboration with ZANACO.

[15] Although the three acts described here are the most central in the context of SPS and food safety measures, numerous other acts are of relevance. See SADC (2002) for more detail.

[16] Nine relevant SPS and food safety units are: (i) the National Livestock Epidemiology and Information Centre (NALEIC); (ii) District Veterinary Offices; (iii) Seed Control and Certification Institute (SCCI); (iv) Plant Quarantine and Phytosanitary Service (PQPS); (v) National Institute for Scientific and Industrial Research (NSIR) – Food Technology Research Unit (FTRU); (vi) Sanitary and Phytosanitary Inspection Service in the Ministry of Agriculture and Cooperatives; (vii) Zambia Bureau of Standards in the Ministry of Commerce, Trade and Industry; (viii) Central Board of Health; and (ix) Food and Drugs Control Laboratory in the Ministry of Health.

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 limited in Zambia. Training provision and information dissemination are limited with regard to SPS and food safety standards. Many agrifood 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 also limited.

The overview of public standards given above also largely applies to the dairy subsector. The Zambian FDA provides legal sanitary requirements for milk and milk-based products that 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.[17] Existing government requirements for trade in dairy products, from a legal point of view, imply: (i) certification that the milk is disease free; (ii) laboratory testing of samples; and (iii) use of official seals. The relevant government organization related to trade is the National Livestock Epidemiology and Information Centre (NALEIC) at the Ministry of Agriculture, which officially follows OIE's international animal health code in its risk assessments.

In the domestic market, inspectors from the Ministry of Health have the mandate to inspect the facilities, processes and products of dairy processors and retailers using FDA requirements. The Food and Drugs Control Laboratory is responsible for testing food samples. Although this laboratory uses World Food Organization (WHO) and Codex guidelines for testing, it is not accredited. As indicated above, these mandates and responsibilities do not imply effective implementation. Raw milk sales are illegal, but commonplace. Government veterinarians inspect animals, but only when new animals are introduced into 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). The Hazard Analysis Critical Control Point (HACCP), a key good manufacturing practice in industrialized economies, only exists in Zambia's dairy sector for the largest processors.

Emergence of private standards in the dairy industry

Private standard development differs widely across Zambia's agrifood industry. In most subsectors, widespread unawareness and almost nonexistent enforcement of public food quality and safety standards have simply led to limited or no implementation of standards by agrifood firms. On the other hand, some agrifood firms with links to industrialized markets (either through FDI or through trade) are well aware of food standards, and are actively involved with or have already 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 damage their reputation and sales. Not satisfied with the level of standards provided by the public sector, these firms have therefore developed, implemented and enforced their own set of standards.

In the dairy subsector, two main points should be made regarding private standards. First, supermarket chains currently follow the development and enforcement of standards. Supermarket demands relate mostly to packaging (attractiveness, expiry dates, labelling requirements, volume) rather than to food safety. Limiting their quality/safety control, for example 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 spoiling 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). It is only recently that supermarkets are beginning to consider the use of written safety standards for dairy products.

[17] The Standards Catalogue (2011) of the Zambia Bureau of Standards stipulates standards for milk and milk products that prescribe requirements, methods of sampling and testing of products. Some references for standards are: ZS 730:2010 for pasteurized milk; ZS 731:2010 for yoghurt; ZS 732:2010 for raw cow milk; ZS 733:2010 for butter; ZS 734:2010 for dairy ices and ice cream; ZS 735:2010 for UHT milk; ZS 736:2010 for sweetened condensed milk; and ZS 737:2010 for milk powder. These standards are well defined in the Standards Act. It should be noted that the standard for raw milk in Zambia is higher than that of some other countries in the COMESA region.

The second point concerns processors. In the absence of supermarket chain leadership, they are the main developers and enforcers of quality and sanitary standards in Zambia's dairy value chain, since they have both the incentive and the ability. Milk quality starts at the farm and has to be maintained along the supply chain. Processors need to assure consumers that the safety standards implemented at farm level continue down along the chain. They have to guarantee that their brand stands for high-quality and safe dairy products. A processor such as Parmalat uses three milk grades (A, B and C). The grade A milk standard is twice as strict as the public standard (i.e. the maximum allowable bacterial count is 25 000 cfu/ml, or half the count required to meet the public standard). With price penalties for lower milk grades, smallholder producers have 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 percent of raw milk was grade C and there was no grade A. By 2005, less than 1 percent of the milk arriving at the Parmalat processing facility was grade C, and grade A made up 86 percent of the volume supplied. Although processors do not inspect MCCs directly, milk is tested by milk reception attendants at the MCC through simple tests.[18] Milk failing the tests is rejected by the MCC. It is then tested again at the processing facility and is rejected if it does not meet a quality grade. This has rarely happened at Parmalat which, because of its wider product line, can use milk of all grades. Finta, which only produces UHT milk requiring grade A milk, uses stricter standards and tests and has rejected smallholder milk with greater regularity.

2.3 STRUCTURAL CHANGES

An understanding of the structure of the Zambian dairy value chain and how it is changing is significantly hampered by lack of data. There are no reliable data on milk production and marketing outside the formal channel (i.e. farmers and processors registered with DAZ), and even here data availability is patchy. The same applies to milk consumption, where there are no consumer survey-based data.

In broad terms, the following description gives the picture for 2014. The national cattle herd of three million animals is owned by around 300 000 farms, of which some 100 000 sell milk in the market. Only a small (but growing) number of them are focused on dairy. Total milk production is estimated at between 200 and 250 million litres, of which 65 million litres flow through the formal channel. In addition, there are imports of 5 500 tonnes of milk powder (42 million litres of milk equivalent),[19] a sharp increase from 1 600 tonnes in 2006. Exports are relatively stable at around 1 000 tonnes, consisting mainly of fresh milk exported to Zimbabwe. With an estimated population of 14.5 million (44 percent urban), annual milk consumption is about 15–19 litres per capita, far below the developing country average of 75 litres (FAO, 2013). The overall trend, likely to continue in the foreseeable future, is that of a formal channel growth spurred on by urbanization, growing incomes and increasing per capita milk consumption in a protected market.[20] This can be placed in a global context of demand outpacing supply, resulting in prices trending up and global trade trending down (FAO, 2013).

There are three main types of dairy producer in Zambia (Table 2.1). These are: (i) traditional smallholder producers that have some surplus milk for sale; (ii) emerging dairy farms of small and medium size; and (iii) large commercial dairy farms. There are no accurate figures on the number of smallholder dairy farmers, but NALEIC at the Ministry of Livestock and Fisheries estimates that there were around 3 500 smallholder dairy farmers in Zambia in 2012. This represents a steep increase from the estimated 1 800 in 2000 (Valeta, 2011). Our MCC survey indicated around 4 800 registered members in 2013, but only 2 330 of these were considered active suppliers.

Traditional smallholder producers represent over 95 percent of farms selling milk but, since their cattle consists mostly of local breeds (zebu) for beef production, they produce only small quantities of milk. Any surplus after family needs is sold to informal channels, including direct sales to local

[18] These tests include a visual test (cleanliness, smell), a water content test (density), an alcohol stability test (freshness) and a lactic acid test (when the alcohol test is inconclusive).

[19] The conversion rate used was 7.6 litres of reconstituted milk/kg of milk powder, based on Whipple, 1983. A share of the milk powder is used for ice cream and yoghurt at lower conversion rates.

[20] Imports of fresh milk are prohibited in Zambia because the Government wants to stimulate local milk production (Rabobank, 2013). UHT milk imports are permitted.

TABLE 2.1
Dairy production in Zambia by producer type, 2014[21]

Characteristics	Traditional smallholder livestock farms	Emerging dairy farms	Large commercial dairy farms
Number of farms	300 000	3 500	50–70
Percentage of cattle in Zambia	80 percent	15 percent	5 percent
Estimated production	135–185 million litres	35 million litres	60 million litres
Farm-level production	1–3 litres/day	25–200 litres/day	2 000 litres/day
Most common breed	Traditional breed (zebu)	Mixed breed	Pure dairy breed
Yield (litre/cow/day)	1–3	8–16	20–28

Sources: in the absence of reliable data, these numbers are rough estimates by the authors, based on Valeta, 2004; Emongor *et al.*, 2004; World Bank, 2011; ACF, 2011; and key informant interviews and surveys.

consumers (often as sour milk).[22] Even so, the large number of these producers implies that they still represent the bulk of the milk produced and consumed in Zambia (if national production estimates are correct). There is no information as to whether or not this group is growing in either number of farms or volumes of milk marketed (in response to increased consumer demand). It is only known that some are shifting to the next category.

Emerging smallholder and medium-sized dairy farms originate either from the ranks of the traditional smallholder cattle producers or they represent new entrants in the value chain (e.g. retirees who have invested their savings in a dairy farm). Most of these emerging dairy farms are the outcome of various pre- and post-structural adjustment support programmes in the dairy subsector. While some emerging dairy farmers are sufficiently large and have enough capital to supply processors directly, most are organized in associations around MCCs where processors collect the raw milk. These farms use mainly mixed-breed cows and intermediate capital-intensive technologies. They include a significant grazing component that, given high feed prices, lowers their cost structure and improves their competitiveness (World Bank, 2011).[23] However, this reliance on pastures also implies significant seasonal differences in raw milk production.[24] During the flush season, there are plenty of natural pastures for the dairy cattle to feed on and milk production is high. During the lean season, natural pastures are less available, which results in lower milk productivity and weaker cattle health, especially when dairy farmers have inadequate supplementary feed and water supply. Unlike traditional smallholder producers, they sell the bulk of their output to processors in the formal market. As indicated above, this channel has roughly doubled in number of farmers between 2000 and 2012.[25]

Large, mostly white-owned commercial dairy farms, of which there are 50–70 in Zambia, are capital intensive (zero grazing) and have larger herds of purebred dairy cows. This gives farmers greater control over production and hence they concentrate their production on the dry season when prices peak. Commercial dairy farmers sell in both informal and formal markets and supply around 70 percent of milk going into formal dairy channels. Currently, there is a downturn among commercial dairy farmers since some of the smaller operations (with fewer than 80 cows) have difficulties in keeping their capital-intensive operations profitable.

[21] Key informant interviews.

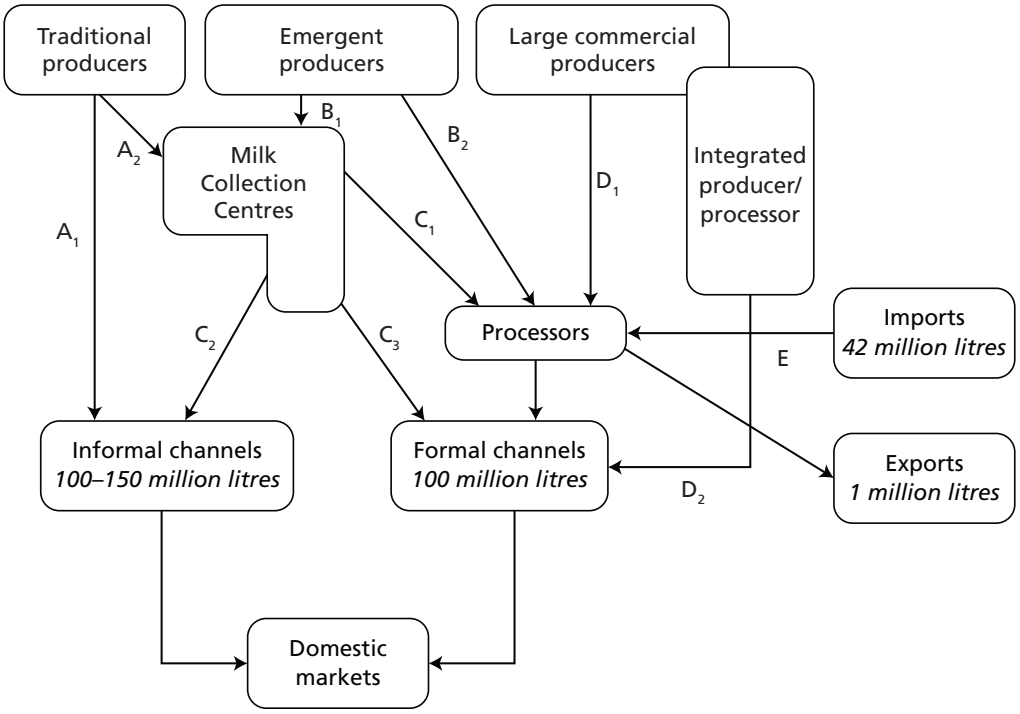
[22] 100 million litres are assumed to be used for household consumption and feeding of calves. It this analysis, 30 million liters are assumed for home consumption, since this is the estimated consumption of 300 000 households with an average of six members and 15 litres per capita of milk consumed.

[23] Cattle still exert a low pressure on land in Zambia (low stocking density), hence emerging dairy farmers depend heavily on free ranching in pastures.

[24] Zambia's rainy season begins in November and ends in March, but natural pastures are usually not available until December, while even after the rains stop in March, there are still some fresh natural pastures available until May. Therefore, there is a so-called "flush season" from December to May (six months) and a "lean season" from June to November (six months).

[25] A big leap forward was made in 2007 when Parmalat, by far the largest buyer of milk from emerging dairy farmers, shifted to using its own trucks to collect raw milk from MCCs, rather than MCCs transporting milk to Parmalat. This reduced the cost of transport dramatically, making dairy farming more profitable, resulting in higher prices and a strong supply response.

FIGURE 2.1
Main channels in Zambia's dairy value chain, 2014 (annual volumes)



Notes: (i) reliable data on the size of the informal market and informal trade are not available, hence the indicated volumes are indicative values only; (ii) milk powder imports were converted into the milk equivalent, for the imported volume.
Source: authors' estimates, based on Sng, 2002; Emongor *et al*., 2004; Valeta, 2004; ACF, 2011; and key informant interviews.

Raw milk from these three producer types, imported milk and milk powder flow to Zambian consumers through five distinct supply channels (A–E in Figure 2.1).

The informal milk market is estimated at 50–60 percent of total marketed production in Zambia. It basically consists of farmers selling raw milk either directly or through so-called "scoopers" at small retail outlets to consumers in rural areas (channel A_1 in Figure 2.1). 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. Increasingly, however, traditional smallholders are selling their milk to MCCs (channel A_2).

In the formal milk market, the processors are the channel leaders and are supplied mainly by commercial dairy farms (channel D_1). For example, Parmalat has 100 suppliers (ten large commercial dairy farmers and 90 emerging producers) as well as 30 smallholder producer associations, but obtains 75 percent of its raw milk supplies (75 000 litres/day) from its large commercial farmers (Valeta, 2011). Parmalat is by far the largest dairy processor in Zambia, with an installed capacity of 180 000 litres/day (in effect, it used only 60 percent of its capacity in 2013). Next in size are Zammilk (135 000 litres/day), Varun Food & Beverages Ltd and Finta Farms Ltd (both 120 000 litres/day) and Diamondale Milk (10 000 litres/day). Varun, a subsidiary of PepsiCo, established its dairy processing plant in 2013. Zammilk is a vertically integrated operation with its own large dairy herd, processing and even retail shops (channel D_2). Smaller processors (200–5 000 litres/day), approximately ten in Zambia (2012), also buy raw milk from smallholder and (mainly) commercial producers. These smaller processors focus on cheese or yoghurt production rather than milk because of economies of scale associated with the latter. The top four dairy processors (Parmalat, Finta, Zammilk and Diamondale) represent approximately 80 percent of total volume processed in the formal dairy processing sector, thus indicating a concentrated industry.

Between the traditional smallholder and large commercial operations that have been around for some time, new specialized dairy producers of a variety of sizes have emerged rapidly, especially since the early 2000s. For example, while Parmalat's raw milk supplies increased from 50 000 litres/day in 2005 to 75 000 litres/day in 2013, the share of milk from emerging producers increased from 10 to 25 percent. This implies an increase from two to seven million litres/year. These emerging farmers supply mainly through MCCs (channel B_1), but an increasing number are graduating from this model to become direct suppliers (channel B_2). In turn, MCCs sell to processors, mostly Parmalat (channel C_1). Some MCCs have set up their own processing facility and sell into both informal (channel C_2) and formal markets (C_3).

Dairy imports are important for milk powder and, to a much lesser extent, for UHT milk and other dairy products. Milk powder imports are especially important for Finta. Because of its location in Livingstone (further away from non-nomadic dairy farmers), strategic alliance with Clover (linked to leading global milk powder producers) and product focus (UHT milk requiring high and strictly enforced safety standards), Finta gets all its milk supply from reconstituted imported milk powder. Imported milk powder is also a slightly more economical input than domestically produced raw milk (US$0.53 against US$0.59/litre).[26] Imports of shelf-ready milk and other dairy products are limited and mainly linked to supermarket procurement. The South African chains Shoprite and SPAR, which dominate the supermarket sector, import private label UHT milk and other processed dairy products such as cheese or butter mainly from South Africa and other countries (Ireland, Denmark, Zimbabwe). SPAR's UHT milk procurement consists of South African imports and supplies 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, Parmalat sells 20 percent of its output directly to supermarkets, 20 percent through its own network of 30 formal wholesalers and 60 percent through mainly 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 (i.e. when stocks reach maximum holding capacity). Finta sells its production to supermarkets as well as through some 40 wholesalers in city markets across Zambia.

[26] Assuming a price of US$4.06/kg of imported milk powder (ITC, 2014) and a conversion factor of 7.6 litre/milk/kg milk powder (Whipple, 1983).

Chapter 3

Emergence and evolution of the Milk Collection Centre (MCC) model

3.1 FIRST MILK COLLECTION CENTRES

The first MCCs emerged in 1995 in Magoye and Monze (Southern Province). These MCCs were, and still are, owned and operated by farmer cooperatives. With the initial MCCs as a benchmark and driven by the factors described previously, support for the development of MCCs and associated dairy farmer cooperatives took off from the early 2000s. This support came through various multiparty development initiatives involving the private, public and NGO sector. For example, the Golden Valley Agricultural Research Trust (GART), partially supported by the Government, provided initial assistance from 1999 with artificial insemination (AI) and then, from 2002, with salary payments for full-time accountants and research technicians to be based at the MCCs. Donor-funded projects provided investment capital to establish infrastructure and access to improved dairy breeds; facilitated linkages with processors and input suppliers; and assisted 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.

MCC sites were typically chosen in locations where there were sufficient dairy producers and there was already a surplus supply beyond that marketed in the informal market (surplus model). The latter is important because, as a result of seasonal fluctuations, prices are at times higher in the informal market and suppliers are more likely to defect from the MCC model, even if cooperative bylaws state that members cannot sell their milk outside these centres. Smallholder dairy farmers were assisted in organizing themselves into cooperatives around newly established MCCs.

3.2 BASIC NATURE OF THE MILK COLLECTION CENTRE MODEL

From the MCC, milk is sold through two main channels: consumers in the informal market and modern processors in the formal market.[27] Distribution over these two channels varies significantly. For a few MCCs, direct sales to consumers are the main sales channels, whereas the bulk of MCC milk (around 90 percent) is sold to modern processors. 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 milk payments made by the processor to the MCC, which in turn pays its individual suppliers (not all suppliers are MCC members). While still partially dependent on technical donor support, all MCCs in our 2013 census indicated that they were financially dependent on outside support. This is the result of a variety of income streams, including a mark-up or service charge on milk sold to processors (and higher margins on milk sold over the counter or in the informal market),[28] membership fees and a mark-up on the sale of inputs (such as feed). These inputs are typically bought on credit by the farmer, but repayment rates are high since these credit payments are deducted from milk payments. From the processor's perspective, the MCC functions as if it were one large dairy producer, thus reducing transaction costs. For example, the largest MCC (Monze) handled over 200 000 litres/month in 2013, compared with one smallholder milk producer supplying perhaps 200 litres/month, or one large commercial dairy farmer supplying perhaps as much as 200 000 litres/month. However, the average amount of

[27] Sales to other buyers, such as traders, institutions or local artisanal processors are marginal.

[28] This service charge ranges from ZMW 0 to 1.5, averaging ZMW0.38/litre. The higher charges were observed in the three MCCs in Western Province, where milk is sold almost exclusively directly to consumers and farmers are paid ZMW3.0–3.5/litre, rather than the national average of ZMW2.48. Those MCCs not charging farmers in cash are paid in kind, with the MCC taking for itself a certain percentage of the milk supplied.

20 000 litres of milk handled by an MCC in a month varies greatly. Two MCCs did not have any milk sales at all in 2013: one had just been established and had not started to receive milk, while the other (Kazungula) depended heavily on sales to nearby Finta, but these were stopped when the processor ran into financial difficulties in 2011.

Technological/infrastructural improvements have been implemented at MCCs and at farms. MCCs are typically equipped with one or more 2–3 000-litre cooled storage tanks and, in some cases, with a pickup truck (16 percent) and a computer (26 percent). Around 90 percent of MCCs are connected to the electric grid, while 70 percent have a generator. Nearly all MCCs have a lactometer to check the purity of the milk. Farms have made investments in mixed-breed or purebred dairy cows, stainless steel containers, AI and milking parlours. Most of these investments are only partially grant based and some involve no grants at all. For example, in one restocking programme, a farmer's purchase of a cross-breed in-calf heifer, selling at a price of US$650, was financed for two-thirds by the farmer's own capital and one third through an interest-free loan provided by the MCC and again repaid from milk payments over a three to four year period (Neven, Odera and Reardon, 2006).

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 100 suppliers (including 30 MCCs) that stipulates volumes and quality-based prices. Volumes may vary with a 20-percent tolerance around the established volumes, without further contract negotiation. Since prices are determined by the quality of the milk rather than by supply and demand, they are relative to the informal market, which is fairly stable throughout the year (Table 3.1). For example, whereas prices for ungraded milk in the informal market vary from ZMW1.8–5/litre, depending on season and location, prices paid by processors are around ZMW2.6–2.7/litre throughout the year (for grade B quality). 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 that supply their products through Parmalat.

3.3 EXPANSION OF THE MILK COLLECTION CENTRE MODEL

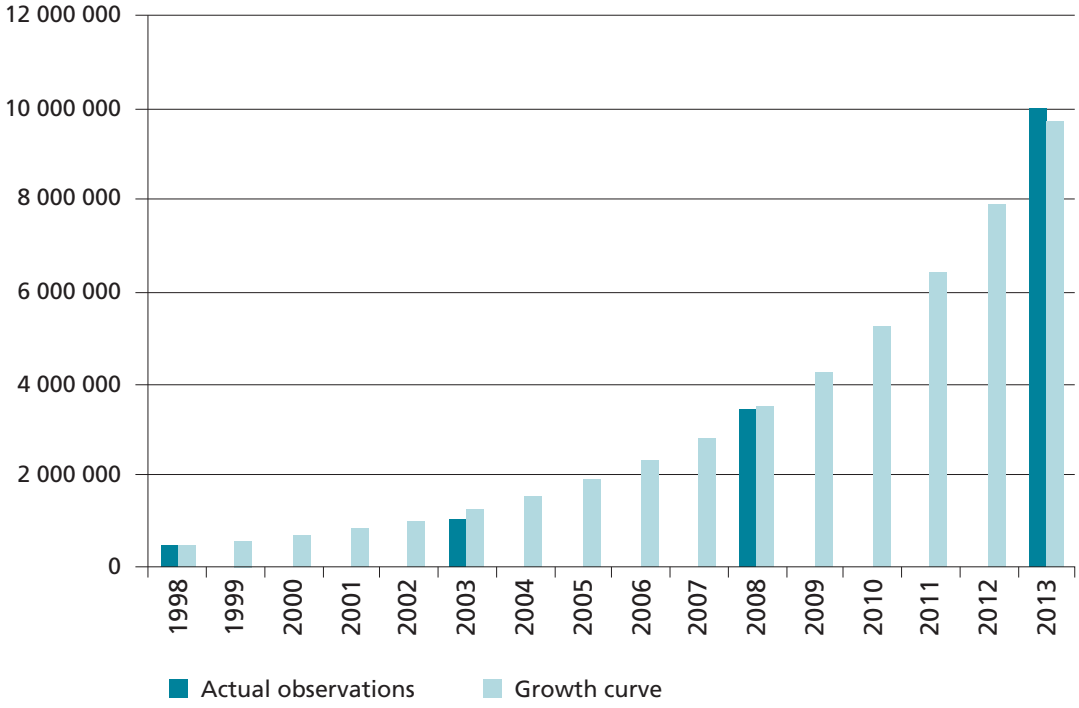
Since 2000, there has been steady expansion of the MCC model, which offers smallholder dairy producers a readily available, reliable market for their milk and links them to modern processors. By 2013, there were 43 MCCs, spread out across seven of Zambia's ten provinces (Southern, Northern, Eastern, Western, Central, Copperbelt and Lusaka), but with a concentration (22 of 43) in Southern Province (see Figure 3.2). Most of this MCC raw milk is sold to Parmalat, which collects

TABLE 3.1
Estimated average price (ZMW)/litre of raw milk, sold by grade

Variable	Mean	Std dev	Min	Max
Grade A				
Wet season	3.05	0.4	2.5	3.9
Dry season	2.94	0.33	2.5	3.9
Grade B				
Wet season	2.68	0.18	2.3	2.97
Dry season	2.64	0.18	2.3	2.9
Grade C				
Wet season	2.5	0.14	2.3	2.6
Dry season	2.5	0.14	2.3	2.6
Ungraded				
Wet season	3.25	0.67	1.83	4.8
Dry season	3.49	0.79	1.83	5

Source: authors' MCC census data, 2013.

FIGURE 3.1
Annual raw milk supplies (litres) from Milk Collection Centres, 1998–2013



Source: authors' MCC survey, 2013.

milk from MCCs in Southern, Lusaka and Copperbelt provinces. Zammilk collects milk mostly from MCCs in the Central Province, close to where it operates its own large-scale dairy operations. Varun Food & Beverages Ltd, as a recent entrant in the dairy business, immediately started by opening five new MCCs in the Southern Province in 2013, supplying these MCCs with 3 000-litre bulk tanks, a generator and other utensils necessary for a smooth operation. Other modern processors buying MCC milk included Kaposhi, Nice Products, Dairy King, Vineyard Dairies and Eastern Dairies.

About half of the suppliers bring in the milk by bicycle. In order to preserve milk quality, farmers typically transport their milk early in the morning (from 4 to 7 am), putting a stainless steel can on an extra strong bicycle. This creates a natural maximum radius of about 30 km that determines the catchment area of an MCC.[29] At the same time, if supplies to an MCC remain below 500 litres/day, transportation (of a minimum 1 000 litres every other day) between the MCC and processing plant is uneconomical, causing the MCC model to founder.[30] In order to bring more farmers into the model while still maintaining efficiency, expanding MCCs started to take on a hub-and-spoke format with new satellite centres being smaller and simpler (just milk collection) and linked with farmer cooperative-owned trucks to the larger, previously established MCCs. The cost of this transportation (petrol only) is deducted from milk payments. Milk is then collected from the central MCC by a larger truck owned by the processor, and where further value added increasingly takes place. For example, there are three of these hub-

[29] Most farmers do not come from such a distance, but some did transport their milk over a distance of 30 km.

[30] In fact, in 2013, only the ten largest MCCs achieved such volumes directly on an average basis throughout the year. The other MCCs operated at lower volumes either because they had only recently been established, or because they supplied indirectly via a larger MCC in the hub-and-spoke model described. Some MCCs achieved the required volumes only during part of the year (rainy season). A few MCCs struggled to survive.

FIGURE 3.2
Expansion of the Milk Collection Centre model in Zambia, 1998, 2003, 2008 and 2013

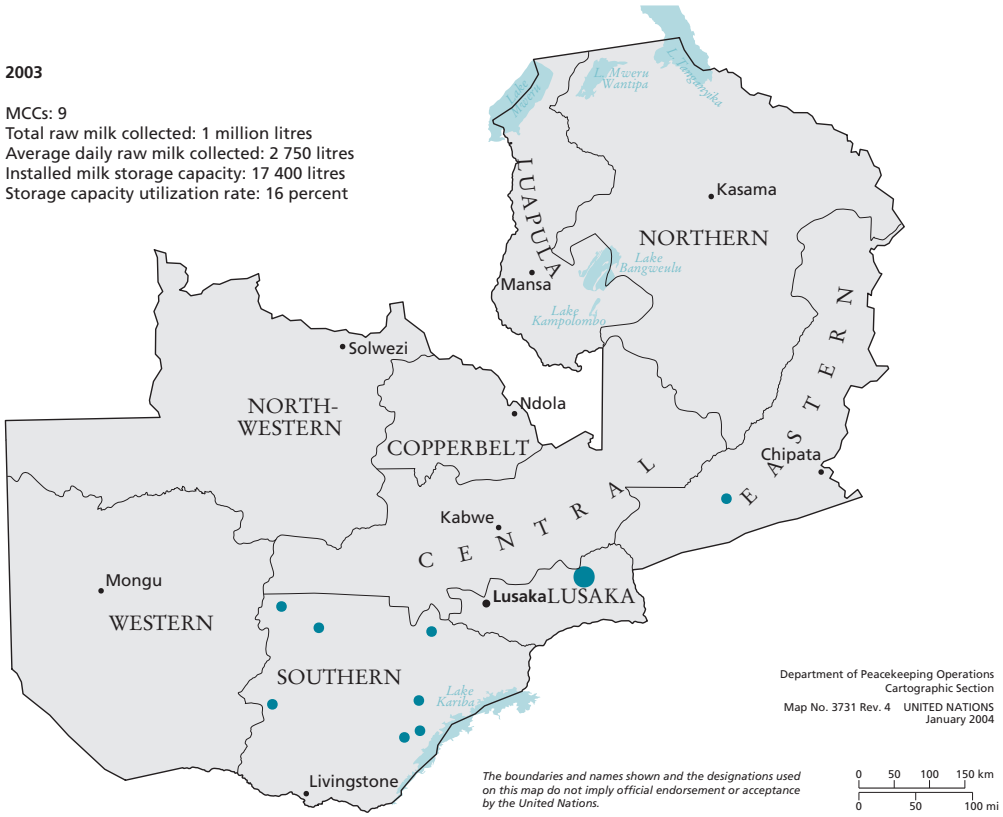
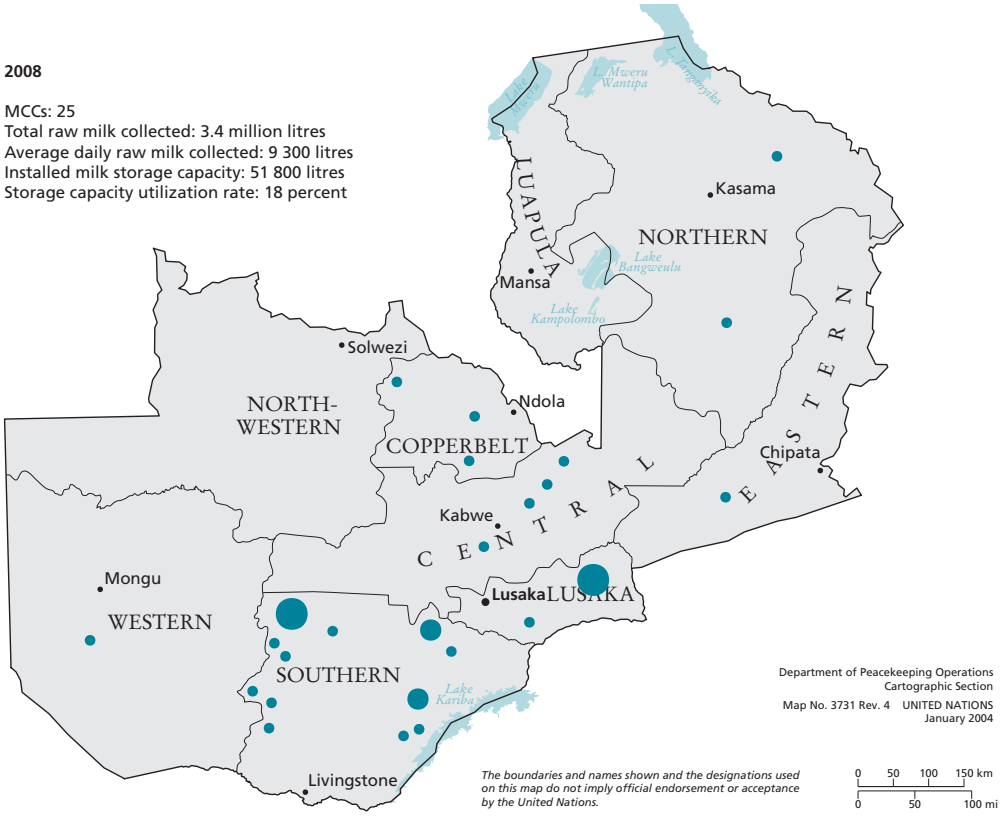
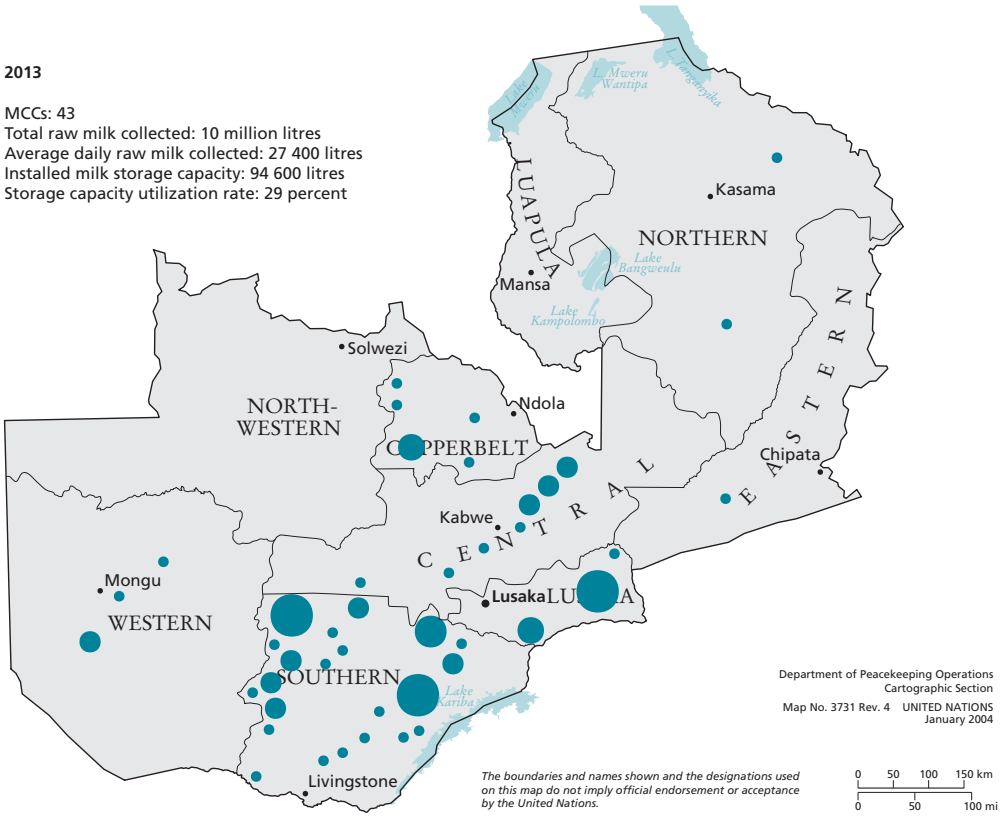


FIGURE 3.2
(continued)





Source: authors' survey.

and-spoke MCCs in the Southern Province: Magoye (one satellite), Monze (two satellites) and Choma (five satellites).

Although some of the established MCCs have disappeared, most of them took root and expanded rapidly. Not only did the number of MCCs increase, but the number of members per MCC and the average volume of milk supplied by each MCC member increased as well. For example, the oldest of the smallholder dairy farmer groups (the Magoye Smallholder Dairy Farmers Association), has grown from 25 members supplying 27 000 litres (about 1 100 litres/member) in 1996 to 280 active members supplying 725 000 litres (about 2 600 litres/member) in 2013.[31] Overall, between 1998 and 2013, raw milk supplies from MCCs increased from 435 000 litres (from two MCCs) to 10 million litres from 43 MCCs, an average annual growth rate of around 23 percent, sustained over a 15-year period (Figure 3.2).

There is great variation in size of the MCCs (Table 3.2). The three largest MCCs represent over 50 percent of all raw milk supplies. In fact, the largest MCC supplied a volume that equals the combined volume of the 37 smallest MCCs in 2013.[32] Increased supply volumes at farmer level are driven by both herd expansion and a shift from traditional to cross-breed or purebred cows, and MCCs also differed greatly in this regard. The percentage of active members with more than ten cows varied between 0 and 90 percent, with an average of 25 percent. The percentage of active members with mainly cross-breed and purebred cows varied from 0 to 100 percent, with an average of 52 percent.

The number of active milk suppliers varies over time, mainly depending on seasonal factors. During the wet season, when there is ample grazing opportunity for cattle on pasture, the number of active suppliers is higher, although this is in part offset by the widespread inaccessibility of rain-drenched roads. In the dry season, only the more capitalized producers that can afford supplementary dry foods and/or practise zero grazing typically remain as active suppliers. The observed average difference between the actual number of cooperative members and those actively supplying milk can further be attributed to the fact that a number of these cooperatives are multipurpose, so not all cooperative members are active in the dairy component. Furthermore, some cooperatives had only just been established. Our MCC census found that even in the rainy season, only 2 330 of 4 773 members (around 50 percent) were active dairy suppliers in 2013 (Table 3.2).

Good governance mechanisms and public infrastructure are key factors in the further expansion of the MCC model. Internal conflicts do from time to time disrupt the effectiveness of the operations of some of the dairy cooperatives, often leading to temporal closure of some MCCs. This in turn results in the milk supplied turning sour and having to be discarded. Such wastage obviously leads to frustration on the part of the dairy farmers. In terms of public infrastructure, roads that are accessible during the rainy season and access to the electric grid are key investments that will have the highest return on investment in the dairy value chain (and beyond) in Zambia.

3.4 EVOLUTION OF THE MILK COLLECTION CENTRE MODEL

As the MCCs (and their association owners) grew in size and gained experience, some began to use part of the supplied milk for value addition and selling these value-added products into local markets, which mainly included direct sales to consumers, as well as (in decreasing order of importance) institutional buyers such as educational and health facilities, local processors, traders and shops. For example, the Choma MCC has continuously increased the level of sophistication of its growing operations. Five farmer cooperatives feed into the Choma MCC, each with their own cooling tank. The central MCC is set up as a processing plant that pasteurizes milk, makes yoghurt and sells its milk in branded plastic bags to local buyers. Furthermore, these MCCs have diversified their operations by selling inputs (feed and veterinary drugs), providing training to members and running other businesses such as hammer mills. Parallel to this, an increasing number of individual members (emerging dairy farmers) increased their dairy operations to the point where the volumes were sufficiently large for the processor to send its truck to pick up the raw milk directly from the farm. These farmers graduated from the MCC model and started to operate independently, rather than through the MCC.

[31] Data are based on Neven, Odera and Reardon, 2006.
[32] This is a somewhat exceptional result, reflecting the unusual fact that nine new MCCs were started in 2013.

TABLE 3.2
Basic Milk Collection Centre data

No.	Province	District	MCC name	Year est.	Storage capacity (litres) 2013	Milk supplies 2013	Number of registered members	Active suppliers 2013	Active suppliers with >10 cows (%)	Active suppliers with mainly crossbreeds or purebreds (%)
1	Southern	Monze	Monze Central	1995	8 000	2 738 310	450	350	75	30
2	Southern	Choma	Choma Union	2002	4 500	1 455 000	600	500	0	50
3	Lusaka	Chongwe	Palabana MCC	2002	5 000	1 275 000	120	60	10	80
4	Southern	Monze	Magoye Dairy Coop	1995	6 000	725 000	187	280	20	25
5	Copperbelt	Luanshya	Fisenga Dairy Coop	2009	3 100	564 500	355	50	0	100
6	Lusaka	Kafue	Mapepe MCC	2005	1 600	547 500	80	50	25	95
7	Central	Kabwe	Mpima Dairy Coop	2005	2 100	236 500	200	38	10	100
8	Western	Senanga	Senanga Dairy Coop	2008	1 500	215 240	150	30	20	3
9	Southern	Monze	Siluwiili	2009	1 280	205 105	72	62	15	75
10	Southern	Mazabuka	Pelusa	2004	1 600	168 725	120	80	50	25
11	Central	Chibombo	Liteta Dairy Coop	2006	1 200	164 000	150	48	0	100
12	Southern	Choma	Masopo	2008	1 500	137 800	318	50	25	40
13	Central	Chibombo	Chibombo Coop	2005	1 600	136 500	60	19	25	100
14	Southern	Kalomo	Kalomo MCC	2003	1 500	110 315	120	57	25	40
15	Southern	Choma	Mutandalike	2011	1 000	109 775	117	69	20	10
16	Copperbelt	Kitwe	Kanfinsa (Kwashama)	2008	500	82 000	26	12	0	100
17	Southern	Choma	Batoka Dairy Coop	2008	1 500	73 815	80	20	50	25
18	Northern	Mpika	Mpika	2004	5 000	72 750	35	20	25	75
19	Northern	Mbala	Mbala Livestock Coop	2005	2 000	72 750	35	25	25	50
20	Southern	Choma	Kkachomba	2003	500	72 750	24	15	25	50
21	Southern	Choma	Pemba	2012	500	70 770	35	23	10	10
22	Central	Chibombo	Protea (Mutaba)	2010	1 000	63 750	30	6	25	100
23	Western	Mongu	Mongu	2009	1 500	63 250	50	14	45	0

TABLE 3.2
(continued)

No.	Province	District	MCC name	Year est.	Storage capacity (litres) 2013	Milk supplies 2013	Number of registered members	Active suppliers 2013	Active suppliers with >10 cows (%)	Active suppliers with mainly crossbreeds or purebreds (%)
24	Southern	Mazabuka	Munjile	2013	1 000	63 000	108	95	5	25
25	Eastern	Chipata	Chinjara	2003	2 500	58 000	118	35	0	70
26	Lusaka	Chongwe	Kanakantapa Coop	2010	1 200	57 275	25	25	10	50
27	Southern	Choma	Zimba Dairy Coop	2005	2 400	56 150	87	28	5	25
28	Copperbelt	Kalulushi	Chibote	2010	2 400	54 750	120	9	0	100
29	Central	Chibombo	Chisamba	2004	2 700	54 500	40	3	50	100
30	Southern	Monze	Kazungula Dairy Coop	2013	3 000	54 000	37	37	90	25
31	Copperbelt	Chingola	Mutenda Dairy Coop	2008	1 500	45 500	65	21	10	100
32	Southern	Monze	Nteme	2002	1 500	32 800	35	30	na	na
33	Southern	Monze	Chivuna Dairy Coop	2013	3 000	31 140	36	25	40	0
34	Central	Mumbwa	Mwembeshi	2013	1 500	30 950	40	30	0	25
35	Western	Mongu	Tukongote	2010	1 500	30 900	83	13	80	5
36	Southern	Monze	St Mary's Dairy Coop	2013	3 000	25 200	100	22	80	80
37	Southern	Monze	Nachibuli Dairy Coop	2013	3 000	23 400	40	14	5	20
38	Southern	Monze	Kaumba Dairy Coop	2013	3 000	15 840	35	17	5	25
39	Southern	Choma	Mbabala	2007	500	14 500	180	32	75	25
40	Central	Chibombo	Chikumbi	2013	1 500	8 100	50	3	5	90
41	Copperbelt	Ndola	Misundu Dairy Coop	2005	1 500	5 635	60	8	0	100
42	Southern	Kazungula	Kazungula	2000	2 400	0	30	5	10	25
43	Southern	Monze	Munyenze	2013	1 500	0	70	na	75	25
TOTAL (first four) or AVERAGE (last two)					**94 580**	**10 022 745**	**4 773**	**2 330**	**25**	**52**

Note: na = not applicable.
Source: authors' MCC census, 2013.

Chapter 4

Smallholder farmer participation in modern dairy channels

4.1 DATA[33]

The decision to sell to an MCC or directly to a modern processing facility was used as a proxy for the participation of smallholder farmers in the modern channel. Farmers who live outside the catchment areas of MCCs or outside the collection routes of modern processors are constrained to sell their unprocessed milk in informal rural markets. However, farmers who live inside the catchment area or along the collection routes of the processors, which largely overlap, have the additional option of selling into the modern channel. For a given MCC, there are thus two types of farmer: (i) farmers who have chosen to supply milk primarily to the MCC (and hence participate in the modern channel); and (ii) farmers who have chosen not to supply the MCC (and hence remain in the traditional channel).

Of the 43 MCCs, the MCC clusters in Monze and Choma districts were selected because these are older units in the Southern Province, Zambia's main milk production area. As such, they have a long enough history and sufficient farmers in both channels to make an analysis of farmer participation feasible in the modern channel over time.

A two-step stratified random sampling method was used. First, 32 standard enumeration areas (SEAs),[34] 16 per district, were selected at random from a complete listing of all SAEs in a 30-km radius around each of the two MCCs that, based on key informant interviews, would most likely have dairy farmers of either type. Second, individual farmers were selected from a complete listing of all households in each selected SEA that owned milking cows and had sold milk in the 12 months prior to the survey. This listing was carried out through field visits by enumerators using a listing form with questions on key issues of interest. This effort resulted in a population framework list of farmers, divided over the four subpopulations (two districts by two market channels). From these listings, individual dairy households were selected at random within each channel (traditional/modern). In the end, 420 dairy farming households were interviewed in December 2012 and January 2014 using the survey instruments in Annex 1[35] (Table 4.1).

TABLE 4.1
Dairy farmers' sample by district and channel

(Channel) District	Informal market suppliers (%)	Formal market suppliers	Total (%)
Choma	57.14 (120)	42.86% (90)	100 (210)
Monze	59.05 (124)	40.95% (86)	100 (210)
Average/total	**58.10 (244)**	**41.90% (176)**	**100 (420)**

Note: statistics refer to all dairy farmers living within a 30-km radius of the Choma and Monze MCCs, not to all dairy farmers in the district.
Source: authors' farmer survey, 2012.

4.2 DESCRIPTIVE RESULTS

In this section, the two subsamples of dairy farmers in the traditional channel and those in the modern channel are compared, in terms of demographics, location and access to services, production practices, landownership and use, physical capital, herd composition, production and production costs, marketing, milk prices received and income.

[33] This section provides a basic description. Specific details on the data collection and sampling process, including how various challenges were handled, can be found in Annex 1.

[34] SEAs are the smallest administrative unit in Zambia. Prior to changes (2013) in which the numbers of districts and provinces increased, Zambia had 72 districts, 150 constituencies, 1 289 wards, 4 400 Census Supervisory Areas (CSAs) and about 17 000 SEAs. However, this study worked with the old classification.

[35] Farmers were surveyed twice. The main survey revealed the need for additional information on feed, which was covered in a second survey of the same farmers. This took place in January 2014.

Demographic characteristics

Although most of the demographic characteristics of the dairy farming households in the two channels are significantly different in statistical terms, the two do not differ in striking ways. Households in the modern channel have heads of household who are slightly older, more highly educated household members and entered milk markets earlier than those in the traditional channel. This may reflect the new entrance of retirees from the government or private sector who are reviving their previously neglected farms as dairy farms targeting formal markets. 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.

Unlike demographics, factors related to location and access to services differ starkly between dairy farmers in the two marketing channels. Those in the traditional channel are significantly further away (50–100 percent) from the MCC, nearest main town, Lusaka-Livingstone road, nearest main road, nearest agrodealer and nearest governmental veterinary camp office. This is largely linked to the multipurpose nature of MCCs located close to or in main towns along the main road between Lusaka and Livingstone. The key factor is distance to the MCC: the closer the dairy farm, the more likely it is to supply the MCC with milk (mainly by bicycle), and to be closer to networks and services. Distance is significant, given the form of delivery and that deterioration in milk quality is linked to the time taken from farm to MCC cooling tank, which has a large impact on growth of the model. The hub-and-spoke model described previously addresses this challenge, but different transportation models (possibly motorbike services) would further help expansion. Distance to the milk processing plant (such as Parmalat) or to the location of the nearest milk trader is not such an important factor.

TABLE 4.2
Human capital and location differences

	Traditional	Modern	Total	t-test
Demographics				
Age of head of household (years)	45.8	50.5	47.7	***
Educational level of head of household (years)	7.6	8.4	8.0	***
Highest educational level of any household member (years)	9.1	10.7	9.8	***
Size of household	9.0	9.8	9.3	ns
Percentage of female household heads	4.7	6.6	5.5	ns
Farming experience				
Head's years of experience in dairy farming	8.5	11.8	9.9	***
Number of years farm in existence	17.8	21.4	19.3	**
Number of years farm selling milk	9.3	9.6	9.4	ns
Distance to facilities (km)				
Milk Collection Centre (MCC)	18.3	8.1	14.0	***
Boma (main town)	31.1	21.1	26.8	**
Lusaka-Livingstone road	21.6	9.3	16.4	***
Main road/rail	9.6	5.5	7.8	***
Agro-input dealer for livestock inputs	27.4	20.2	24.4	**
Veterinary camp office	21.8	16.7	19.6	**
Milk processing factory	48.4	30.7	40.5	*
Milk trader location	9.8	9.0	9.4	ns

Note: * = significant at the 10 percent level, ** = at the 5 percent level, *** = at the 1 percent level.
Source: authors' farmer survey, 2012.

The most significant difference between the two farmer types in terms of human capital is the level of technical assistance and training received (Table 4.3). This difference is largely the outcome of farmers in the modern channel being targeted by an array of donor-funded development assistance programmes (linked to MCCs). It is worthy of note that: (i) the MCCs themselves have become the most widespread source of technical assistance and training, indicating that a commercially viable business model has emerged; and (ii) some farmers who do not sell through MCCs have also received technical assistance from the MCC, indicating a spillover effect of the MCC model on the informal channel.

TABLE 4.3
Technical assistance, free inputs and training received by 2012 (percentage)

	Traditional	Modern	Total	t-test
Share of farmers receiving technical assistance, free inputs and training	18	72	41	***
Assistance by source				
Dairy cooperative/society/MCC	7	45	23	***
NGOs	12	44	25	***
Private sector	5	16	10	***
Fellow farmers	6	29	16	***
Government of Zambia (MAL)	6	18	11	***
Dairy Association of Zambia (DAZ)	4	20	11	***

Note: *** = significant at the 1 percent level.
Source: authors' farmer survey, 2012.

TABLE 4.4
Differences in production practices (percentage)

	Traditional	Modern	Total	t-test
Suckling cows after milking	92	84	89	***
Rinsing of udder before milking	83	85	84	ns
Calf stimulus	86	80	83	*
Use of stainless steel containers	4	69	32	***
Use of stainless steel pails for milking	6	66	31	***
Use of improved bulls to service cows	17	37	25	***
Use of approved lubricant for hand milking	6	34	18	***
Keeping records	4	32	16	***
Feeding cows concentrate during milking	1	26	12	***
Own feed production	7	15	10	**
Practises fenced grazing	2	16	8	***
Bucket feeding of calves with calf starter	1	14	6	***
Artificial insemination	1	11	6	***
Cultivation of pasture	4	7	5	ns
Zero grazing	2	7	4	**
Using milking machine	4	2	3	ns

Note: * = significant at the 10 percent level, ** = at the 5 percent level, *** = at the 1 percent level.
Source: authors' farmer survey, 2012.

Production practices

While some production practices are more or less equally widespread within the two farmer subpopulations (such as rinsing udders before milking and calf stimulus), most of them are far more prevalent among modern channel farmers (Table 4.4). To some extent, these management practices are the direct result of the requirement imposed on farmers supplying the dairy processors through the MCCs (such as the use of steel pails). The fact that these practices are not followed by 100 percent of the modern channel farmers is an indication that even here the codes of good conduct are not yet 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 access to training on and assistance with techniques such as AI. In contrast, traditional channel farmers have far less incentive and capacity to implement these more advanced operational management tools.

Land holdings and herd composition

Dairy farms in the modern channel are clearly different from those in the traditional channel in terms of landownership and use (Table 4.5). Modern dairy channel farmers operate on about three times as much land and, in particular, they have more land available for pasture (about seven times as much – 11 as against 1.5 ha). In both channels, farmers use little land for fodder production, although this has increased somewhat over time. Modern farmers also rent in more land, both in absolute and relative terms, than traditional farmers. Renting out land is almost non-existent in both channels. Even though modern farmers are located closer to the main towns, there appears to be little difference in terms of land purchase and rental prices. In terms of dynamics, modern farmers are expanding their farms relatively faster, against a backdrop of rapidly increasing land prices. They are also slowly decreasing the share of land under rental agreements, possibly because they invest some of their income from milk sales in land purchases.

Modern dairy farmers have, on average, almost twice as many cows as traditional farmers (Table 4.5). Herd composition by breed also differs significantly: about two-thirds of traditional farmers' herds consist of traditional cows, whereas more than half the cows owned by modern dairy farmers are improved breeds (overwhelmingly

TABLE 4.5
Land holdings and herd characteristics

	2000			2006			2012		
	Trad.	*Modern*	*t- test*	*Trad.*	*Modern*	*t- test*	*Trad.*	*Modern*	*t- test*
Land holdings									
Land in operation (ha)	8.1	26.7	**	9.1	34.6	**	9.8	35.8	**
Land owned (ha)	8.0	21.2	**	8.9	30.4	**	9.5	32.2	**
Land for fodder (ha)	0.0	0.1	ns	0.2	0.2	ns	0.2	0.2	ns
Land for pasture (ha)	1.2	9.3	***	1.4	10.4	***	1.5	11.3	***
Land rented out (ha)	0.0	0.0	ns	0.0	0.0	ns	0.0	0.1	ns
Purchase price (ZMW'000/ha)	894	1 012	ns	1 562	1 875	ns	2 922	3 337	ns
Rental value (ZMW'000 /ha/year)	187	194	ns	323	331	ns	616	578	ns
Herd characteristics									
Herd size (heads)	19.2	32.5	***	17.8	31.8	***	24.2	40.2	***
Number of cows owned (heads)	5.6	8.6	***	4.9	8.7	***	6.0	9.9	***
Number of lactating cows (heads)	–	–	na	–	–	na	4.2	6.2	***
Share of traditional cows in herd	67.9	54.8	*	70.0	49.8	***	66.8	41.8	***
Share of mixed breed cows in herd	30.6	42.4	*	29.0	48.5	***	31.7	54.3	***
Share of purebred cows in herd	0.0	0.5	ns	0.0	0.6	ns	0.0	2.9	***
Value of herd (million ZMW)	–	–	na	–	–	na	43.3	90.2	***

Note: * = significant at the 10 percent level, ** = at the 5 percent level, *** = at the 1 percent level.
Source: authors' farmer survey, 2012.

TABLE 4.6
Physical capital ownership of dairy farmers in 2000, 2006 and 2012 (percentage)

	Traditional			Modern		
Farms with …	***2000***	***2006***	***2012***	***2000***	***2006***	***2012***
Dairy-related assets						
Stainless steel milk containers	4	6	10	27	43	78
Barn	37	35	35	53	45	45
Paddock	6	4	4	31	32	30
Milking parlour without cement floor	1	1	1	2	4	8
Milking parlour with cement floor	0	0	1	5	3	6
Dip tank	0	0	0	2	3	4
Stable for cattle	1	1	0	0	1	3
Feed storage tank	0	0	0	0	0	3
Animals						
Cattle	100	100	100	100	100	100
Goats	28	41	61	53	59	69
Sheep	0	1	2	2	1	4
Donkeys	0	1	1	0	0	1
Non-dairy production assets						
Bicycle	68	81	85	86	87	94
Plough/harrow	74	87	94	89	84	91
Oxen/donkey cart	45	46	53	71	69	70
Borehole	2	1	0	20	17	16
Truck/pickup/car	1	1	3	5	11	13
Motorcycle	1	1	2	2	5	11
Water pump	2	1	0	9	9	9
Treadle pump	0	0	2	0	5	9
Planter	4	3	2	10	8	7
Tractor	0	1	2	5	5	6
Hammer mill	0	0	2	2	3	4
Tractor trailer	0	1	1	5	3	3
Sheller/combined harvester	0	1	1	0	0	2
Personal assets						
Radio	50	55	61	63	68	79
Cell phone	9	15	54	21	37	78
Non-electric iron	34	38	38	62	69	62
Television	22	27	36	37	47	57
Solar panel	16	16	31	15	25	52
DVD/VCD player	1	4	6	8	9	16
Satellite dish	2	2	4	2	5	8
Generator	0	0	1	2	2	7
Sewing machine	1	3	1	4	5	5
Refrigerator/deep freezer	0	0	0	0	1	3
Stove (gas or electric)	0	1	1	0	1	3
Electric iron	0	0	0	0	3	2

Source: authors' farmer survey, 2012.

crossbreeds). These differences result from two main factors. First, it may be supposed (and later econometrically tested) that farmers with larger herds and breeds focused on dairy production have a significant investment in milk production and thus are more likely to enter the more stable modern channel. Second, farmers in the modern channel have been targeted in smallholder dairy improvement programmes that have facilitated the purchase of crossbreed and purebred dairy cows.[36]

Physical capital

The survey shows that physical capital elements are more prevalent in the modern channel than in the traditional one, although prevalence is generally low across both channels (Table 4.6). Limited access to the credit necessary for investing in these physical capital elements for the smallholder farmers studied here is one possible explanation for the general low prevalence. Paddocks and barns are the most common dairy infrastructure investments by farmers in both channels. Except for stainless steel milk containers in the modern channel (2012), less than half the farms have invested in a given physical capital element. Stables for cattle and feed storage tanks are non-existent on farms in both channels.

The difference in prevalence between the two channels can be explained by the same causes given above for production-related differences: (i) the attractiveness of the modern channel for dairy-focused farmers for whom investment in dairy infrastructure makes more business sense; and (ii) the focus of development programmes on the modern dairy channel. From the other perspective, the traditional channel consists mainly of farmers with a focus on beef production, which implies they are less likely to invest in dairy, and are largely bypassed by development programmes focused on dairy production.

Production and marketing

Milk production is influenced by many factors, ranging from diseases and management of dairy to availability of feed. In a country such as Zambia, smallholder dairy farmers mainly rely on natural pastures to feed their animals. As a result, there are variations in the quantities of milk produced during the rainy and dry seasons and several significant differences between modern and traditional channel farmers (Table 4.7). First, daily milk production per day appears to be trending down for traditional farmers and up for modern farmers (for both the rainy and dry seasons), resulting in annual production volumes for modern farmers that are approximately twice those of traditional ones (7 900 litres against 4 300 litres). It can further be observed that modern channel farmers achieve significantly higher yields (litres of milk/cow/per day) than traditional channel farmers, not only for crossbreed cows, but also for traditional breed cows. Traditional smallholders appear to achieve better yields with purebred cows, but there is a great deal of variation around the average so that the difference is not statistically significant. This finding probably results from the fact that purebred cows still play a minor role in both channels, since they are mostly associated with large commercial dairy herds, and smallholders have not yet learned to manage them to their full potential. Finally, the survey results indicate that producers in both channels fail, on average, to achieve anticipated yields for crossbreed cows (4–7 against 8–14 litres). This indicates that further capacity building and experience are needed.

The higher importance of milk sales in the modern channel, both in absolute and relative terms, follows from the positive relationship between the farm's dairy focus and its channel choice (Table 4.7). The differences between the channels became greater between 2000 and 2012, with modern channel dairy farmers selling on average more than double the volume of milk sold by traditional channel farmers (2 700 against 6 100 litres/day). Not surprisingly, given the difference in market focus, sour milk sales by traditional market dairy farmers are more than four times as important as those of their modern channel counterparts (31 against 7 percent). The marketing-related factors that determine in which channel dairy farmers sell their milk include stability of price, amount of milk that can be readily sold into the channel, payment on delivery and milk price. The first two factors are more advantageous in the modern channel, the third factor in the traditional channel and the last (the actual milk price) is somewhat seasonal, sometimes higher in the modern channel and sometimes in the traditional one.

[36] For example, Heifer International and Land O'Lakes have implemented pass-on programmes in Zambia. These are schemes whereby each recipient of an improved dairy animal passes on the first female animal to another beneficiary household. In the authors' survey, it was found that 40 percent of dairy farmers around the Choma MCC received a female calf through these programmes and for 25 percent of these (21 of 84), it was when they first started selling milk. For Monze, the numbers are 11 and 30 percent (seven of 23).

TABLE 4.7
Production- and marketing-related differences, in 2000, 2006 and 2012

	2000			2006			2012		
	Trad.	*Modern*	*t-test*	*Trad.*	*Modern*	*t-test*	*Trad.*	*Modern*	*t-test*
Production characteristics									
Milk produced in rainy season (litres/day)	16.3	20.0	na	14.7	18.9	na	14.1	26.0	***
Milk produced in dry season (litres/day)	10.7	14.1	na	9.6	13.5	na	9.4	17.4	**
Total milk produced in rainy season (litres)	2 975	3 643	na	2 682	3 441	na	2 560	4 739	***
Total milk produced in dry season (litres)	1 958	2 573	na	1 748	2 469	na	1 713	3 183	**
Annual milk production (litres)	4 898	6 216	na	4 371	5 892	na	4 273	7 922	***
Milk yield, rainy season (litres/cow/day)	–	–	na	–	–	na	4.0	5.5	***
▪ traditional cows	–	–	na	–	–	na	3.8	4.5	***
▪ crossbreed dairy cows	–	–	na	–	–	na	4.3	6.5	***
▪ purebred dairy cows	–	–	na	–	–	na	6.5	9.9	ns
Milk yield, dry season (litres/cow/day)	–	–	na	–	–	na	2.3	3.3	***
▪ traditional cows	–	–	na	–	–	na	2.3	2.7	*
▪ crossbreed dairy cows	–	–	na	–	–	na	2.5	3.9	***
▪ purebred dairy cows	–	–	na	–	–	na	6.5	7.2	ns
Marketing characteristics									
Share of milk sold in the rainy season	61.0	74.5	***	64.2	75.8	***	67.7	78.3	***
Share of milk sold in the dry season	54.6	69.2	***	55.4	69.7	***	58.6	75.5	***
Volume of milk sold annually (litres)	2 884	4 495	ns	2 691	4 328	*	2 738	6 115	***
Share of milk sold annually	58.8	72.8	***	61.6	73.6	***	64.7	77.8	***
Share of milk sold as sour milk	–	–	na	–	–	na	30.6	6.6	***

Note: * = significant at the 10 percent level, ** = at the 5 percent level, *** = at the 1 percent level.
Source: authors' farmer survey, 2012.

Milk prices

In terms of prices received by dairy farmers for their raw milk, the following three observations can be made (see Table 4.8).

- Prices appear to be stable between seasons, contrary to expectations for the traditional channel.
- On average, prices are higher in the modern channel. This probably reflects the value added of higher-quality (grade A) milk.
- Prices are increasing for farmers in both channels, from the year they started their dairy operations (which varies from farmer to farmer) to 2012 (year of the survey).

Household income

The farmer survey shows the far higher importance of milk sales, both in absolute and relative terms, in the modern channel than in the traditional channel (Table 4.9). This follows from the positive relationship between the farm's dairy focus and its channel choice. The 61 percent share of milk sales in annual income in the modern channel is mainly the outcome of a greater focus on dairy within the overall farm operation and its more profitable nature relative to many other farm activities (such as grains). The results further pointed out that there is little difference in terms of income from off-farm activities between farmers in the two channels in absolute terms.

TABLE 4.8
Average milk prices (ZMW/litre)

	Traditional price	Modern price	Average price	t-test
2012 rainy season	1.93	2.16	2	***
2012 dry season	1.98	2.13	2.03	**
At startup – rainy season	1.02	1.53	1.19	***
At startup – dry season	1.05	1.47	1.19	***

Note: ** = significant at the 5 percent level, *** = at the 1 percent level.
Source: authors' farmer survey, 2012.

TABLE 4.9
Household revenues, 2012

	Traditional		Modern		Total	
Source of annual income	***Mean** (ZMK)*	***Share** (%)*	***Mean** (ZMK)*	***Share** (%)*	***Mean** (ZMK)*	***Share** (%)*
Milk sales	5 354	45	14 380	61	9 149	55
Other farm activities	5 327	45	7 876	33	6 399	38
Off-farm activities	1 093	9	1 315	6	1 186	7
Total	**11 774**	**100**	**23 571**	**100**	**16 734**	**100**
Per capita annual income	1 484	–	2 580	–	1 945	–

Source: authors' farmer survey, 2012.

4.3 ECONOMETRIC MODELS

General theoretical framework

This section looks at the determinants and effects of farmers' adoption of and entry into the modern market channel, and the time between entry and exit (duration) in the domestic dairy market in Zambia. The farming household decides the allocation of its resources between traditional channels (less risk, lower returns) and modern channels (more risk, higher returns). Furthermore, modern market entry costs are perceived to be higher than those of traditional markets, since modern markets demand higher quality and consistent supply throughout the year, which can imply capital-led investments (such as in improved breeds). Factors that need to be taken into account for both decisions (entry and exit) include: required investments, milk prices, input costs, household assets (human, physical, social, community) and the household's other sources of income.

The study analyses the "time to adopt" (the household's waiting time before adoption, also called the "adoption spell" in duration literature) and, if the household adopts, the time to withdraw (or duration). The effects of duration itself on dairy households will also be analysed, with particular focus on effects on use of different types of feed as modern technologies in dairy production. A more detailed discussion of the theoretical model can be found in Annex 2.

Regression specification, first stage

Following are the two regressions used to determine: (i) how long (in years) it takes a household to adopt the modern channel once it has been exposed to the option to adopt – *ta*; and (ii) how long the household stays in the modern channel before (potentially) withdrawing from it once it has adopted the channel – *tw*.

The two regressions *ta*, *tw* are specified as a function of:

- milk price
- distance to the MCC, alternative market, road, nearest agricultural input store
- gender, age, marital status and education of household head
- average level of education (years) attained by adult members of household
- number of adults in household
- number of training sessions received by household
- household membership in a cooperative
- amount of pastureland
- number of livestock animals, cows

- water availability
- off-farm employment
- farm and non-farm assets
- potential earliest year for adoption – in the equation for *ta* only, and the year of adoption – in the equation for *tw* only.[37]

The dependent variables for these regressions are defined as follows.

- ***Time to entry (adoption spell,* ta*).*** This variable is defined as the time (in years) that the household takes from initial exposure to the possibility of adoption of the modern market channel, to the time when it adopts the MCC channel. Duration analysis accounts for right censoring, as the value of *ta* is not always observed. Some households that are exposed to the possibility of adoption do not adopt at the time of the survey, and therefore information is truncated.
- ***Duration (withdrawal spell,* tw*).*** Once households have adopted the MCC market channel, this variable is defined as the time (in years) that the household takes from initial time of adoption of the MCC channel to the time when it withdraws from the channel. Similar to the definition of *ta*, not all households that have adopted the modern channel withdraw from it before the time of the survey, and therefore withdrawal is not observed for some households and thus resulting again in truncated information. However, duration analysis accounts for right censored data.

The (independent) explanatory variables are defined and assumed to impact the above two decisions as follows.

- ***Output prices***: district-level traditional market milk price (time invariant, 2011). Households recalled the raw milk price for the year to 2011. Since the current period price can be endogenous, a one-year lagged price is used since the expected price is formed assuming a naive price expectation.
- ***Input prices*** charged by the vendor are generally similar over households for a given input, as the geographic zone is not broad. To obtain variation in input prices subsequently, the distance from the household to the nearest agro-inputs store is used instead, measured in kilometres (time invariant).
- ***Human capital***
  - *Number of adults in the household* from 2000 to 2012 (time varying): the availability of household labour each year is posited to increase the probability of adoption and delay the decision of withdrawing from the MCC channel, presumed to be more labour demanding to meet quality requirements.
  - *Age of household head* at the time of adoption (time invariant): the hypothesis is ambiguous. Younger household heads may be less risk averse and willing to change new market channels. However, older household heads have more experience that allows them to address the requirements of adapting to the modern channel.
  - *Years of education of household head* at the time of adoption (time invariant): the *a priori* effect on time to adoption is ambiguous. Further education could help the dairy farmer to adapt to the more demanding channel's technology and commercial requirements. However, more education can

[37] The first-stage equations were estimated as follows. Duration models are based on the implementation of hazard rates, used to analyse decisions over time. The hazard rate can be specified by using both parametric and non-parametric methods. Our estimation was performed using maximum likelihood. A parametric approach was chosen using a Weibull distribution. Drawing on Carletto *et al.* (2010), the hazard function is specified as follows:

$$h(t) = \lambda(x)^{\rho} \rho t^{\rho-1} \qquad (4.1)$$

where

$$\lambda(x) = e^{-\beta' x} \qquad (4.2)$$

λ is the scale parameter, a function of the vector of covariates (x), and
ρ is the shape parameter, which captures the monotonic time dependency of the event.

The accelerated failure time (AFT) transformation of the proportional hazards model was used, as it yields easier results for interpretation. The AFT coefficients reflect the acceleration and deceleration effect on time to adoption and time to withdrawal, which is an analogous interpretation of common regression models. The AFT model can be written as follows:

$$\log(t) = \beta' X + \sigma\varepsilon, \qquad (4.3)$$

where
t is a non-negative random variable denoting the time of the event (adoption or withdrawal)
X is the vector of explanatory variables
β is the vector of coefficients
ε is the error term
σ is a scalar that is equivalent to the inverse of the shape parameter ($\sigma = 1/\rho$).

also increase the household head's options to work in non-farm employment (Taylor and Yunez-Naude, 2000) and thus not depend on upgrading the dairy market channel. The *a priori* effect on duration is also ambiguous. More education confers more flexibility in activity choice and thus would facilitate options, should the household head wish to withdraw from the modern channel. However, more education could help dairy farmers to adapt to the evolving requirements of the modern channel and prolong their participation in it.

- *Average years of education of adults in the household* (time invariant). This is included to ascertain the education level of other adults, since it may not only be the household head who decides on or effects participation in the MCC channel.

- ***Non-farm physical capital***
  - *Non-farm (productive) assets* from 2000 to 2012 (time varying). Factor analysis of the principal component was used to calculate an asset index (using the Thomson scoring method). Its effect is posited to be similar to the share of adults working in off-farm employment. However, non-farm productive assets are important for participation in off-farm self-employment, while the share of adults working off farm is related to participation in off-farm wage employment and self-employment.
  - *Durable consumption assets* from 2000 to 2012 (time varying). This index includes items such as a bicycle, refrigerator, television, solar panel, stove and computer. Factor analysis of the principal component was used to calculate an asset index of durable consumption assets, and it proxies household wealth, which in turn reflects access to credit and risk aversion.
- ***Farm physical capital***
  - *Total pastureland* (ha) owned each year from 2000 to 2012 (time varying). Land owned is posited to decrease time to adoption and increase duration through wealth effects (increasing access to credit and reducing aversion to risk [Newbery and Stiglitz, 1981]).
  - *Non-land dairy farm assets* from 2000 to 2012 (time varying). This study posits that these assets decrease time to adoption and increase duration because they allow the farmer to meet quality and consistency requirements and may embody previous farming experience and performance (Carletto *et al*., 2010). Factor analysis of the principal component was used to calculate asset indexes (using the Thomson scoring method).
  - *Total number of livestock animals owned* in 2000, 2006 and 2012 (time varying). The effects posited echo those of other assets.
    - Total number of cows owned in 2000, 2006 and 2012 (time varying)
    - Water availability throughout the year in 2012 (time invariant)
- ***Community capital***
  - *Cooperative participation* from 2000 to 2012 (time varying). This variable is defined as a dummy variable for the participation of any adult in the household in a production cooperative. Cooperative participation is expected to reduce time to adoption as both smallholders and MCC procurement officers benefit from production cooperatives. Smallholders can overcome asset thresholds of participation in modern markets (for example the need for cold rooms, or transportation), while procurement officers greatly reduce their costs by dealing with a cooperative for coordinating transactions (deliveries, production schedules, payments) rather than with dozens of farmers.
- ***Off-farm employment***
  - The household has *at least one adult working in local off-farm employment* in 2000, 2006 and 2012. The effect of this variable is a priori ambiguous. In the presence of credit constraints, off-farm earnings in principle can fund investments to participate in the modern channel and offset market risk. However, off-farm employment can also act as a substitute for new farm technology adoption (Huang, Wu and Rozelle, 2009) or the need to upgrade to a modern market channel.
- ***Time variable***
  - T0, *the first year in which adoption was possible* (for the ta equation only), is either the earliest year that an MCC was opened for a farmer in its catchment area, or the year that the household began milk production, if that happened later. Note that about 79 percent of households began milk production after 1996, so there is significant variation in this variable. This study posits ambiguous effects of this variable on time to adoption: it can shorten it since those being exposed later enter a situation where many other households

have adopted and they can more quickly assess the risks and learn the techniques from them. On the other hand, however, a later exposure also means that they enter a situation that may have – this cannot be tested – greater competition and requirements relative to the situation faced by those exposed earlier.

- ***Instrumental variables***
  - Both time to MCC adoption and duration as an MCC supplier can be endogenous determinants of the use of modern feed technologies. One can posit that, for example, natural ability (an unobserved household characteristic) can influence not just the decisions to adopt and remain as modern market suppliers, but can also influence the decision to adopt modern technologies. Therefore, at least one instrumental variable needs to be found that is on the one hand correlated with the decision of participation in a modern market (as supplier), after controlling for other factors, but that is on the other hand not correlated with the error terms (unobserved household characteristics).

    Two predetermined time-invariant variables were chosen as instruments: *distance from the farm to the nearest alternative processor and distance from the farm to the nearest paved road*. These variables have been chosen as instruments for the following reasons: (i) direct sales to nearby consumers are the main alternative traditional market where dairy farm households sell their milk – shorter distances to any of the traditional alternatives represent lower transaction costs and will negatively impact the decision to adopt a modern market; (ii) there is no economic reasoning for why these distance variables would be correlated with unobserved variables that could affect the decision to adopt modern technologies (feed) or the choice of inputs used in dairy production; and (iii) traditional alternative markets (and their respective distances) are exogenously predetermined to the individual household.

Effects equations, second stage

The second stage models the effects of farm households' duration as MCC channel suppliers, among other variables, on the use of different types of feed over time in dairy production, broken down into three technology groups.

- Use of *improved traditional feed*, for the years 2000, 2006 and 2012. This includes cut fodder from fields, growing own fodder crops, buying fodder and growing grain feed and combining with purchased ingredients to assemble own rough feed.
- Use of *semi-modern feed*, for the years 2000, 2006 and 2012. This includes purchasing ingredients and milling own feed, and purchasing milled rough feed.
- Use of *modern commercial feed* for the years 2000, 2006 and 2012. This includes purchasing commercial concentrated feed geared to specific types of animals and ages.

The adoption of a particular feed technology is modelled here as determined by the following factors:[38]

- duration (fitted value from the first stage)
- farm productive non-land assets
- age, gender and education of household head (time invariant)
- number of adults in household (current)
- pastureland, cows and livestock holdings (current)
- participation in farmer cooperatives or associations
- maximum years of education attained by any member of the household.

4.4 ECONOMETRIC RESULTS

The main econometric results are presented below (Tables 4.10 and 4.11). In the first-stage estimation, on the adoption decision, the factors that most determine how many years it takes before the farmer decides to enter the MCC channel were found to be:

- milk price at district level (-)
- distance to the MCC (+)
- training received related to dairy (-)
- cooperative membership (-)
- amount of pastureland owned (-)
- number of years of exposure to the modern channel/MCC (-).

This is in line with expectations – the higher the milk price; the shorter the distance to the MCC;

[38] Panel data methods were used to estimate the effects equations. Specifically, random effects were used, since there were both time-varying and time-invariant explanatory variables. Since two variables not actually observed were used (duration and first-stage residuals), a bootstrapping procedure was used to obtain the correct standard errors (Wooldridge, 2002).

TABLE 4.10
Duration analysis

	Adoption spell	Withdrawal spell
Price of milk at district level	-0.002***	0.000
	(0.000)	(0.000)
Distance to nearest MCC (km)	0.051***	-0.037*
	(0.008)	(0.023)
Distance to alternative market (km)	0.003	-0.050***
	(0.002)	(0.019)
Distance to nearest paved road (km)	-0.002	-0.005
	(0.006)	(0.031)
Distance to nearest agri-input store (km)	-0.005	0.016
	(0.003)	(0.011)
Head of household (HHH) is female (yes=1, no=0)	-0.114	0.160
	(0.172)	(0.251)
Age of HHH	-0.002	-0.015
	(0.003)	(0.011)
HHH is married (yes=1, no=0)	0.249*	0.251
	(0.144)	(0.238)
Years of education of HHH	-0.016	-0.026
	(0.017)	(0.034)
Maximum years of education attained by any household member	-0.029*	0.052
	(0.017)	(0.074)
Number of adults in household	-0.021*	0.050
	(0.013)	(0.039)
At least one member of household received training in dairy farming (yes=1, no=0)	-0.253**	0.329*
	(0.100)	(0.196)
At least one member of household participates in a farmer cooperative or association (yes=1, no=0)	-1.605***	-3.795***
	(0.143)	(1.119)
Total pastureland (ha)	-0.006**	0.003
	(0.002)	(0.006)
Number of livestock animals	-0.006*	-0.009
	(0.003)	(0.021)
Number of cows	0.017*	0.026
	(0.009)	(0.066)
Water available throughout the year (yes=1, no=0)	-0.036	-0.286
	(0.121)	(0.437)
At least one member of household works in non-farm employment (yes=1, no=0)	0.129	3.013***
	(0.176)	(1.156)
At least one member of household works in agricultural wage employment (yes=1, no=0)	0.137*	-0.119
	(0.077)	(0.084)

TABLE 4.10
(continued)

	Adoption spell	Withdrawal spell
Farm assets (index)	0.078	0.256
	(0.063)	(0.373)
Durable assets (index)	0.048	-0.080
	(0.043)	(0.107)
Non-farm assets (index)	-0.037	0.006
	(0.036)	(0.138)
Year of exposure to modern market	-0.138***	–
	(0.010)	–
Year of first adoption of modern market	–	-0.148***
	–	(0.041)
Constant	283.101	306.346
	(19.450)	(80.322)
ρ	1.876	4.858
$\sigma = 1/\rho$	0.533	0.206
Observations	2 086	958
LR Chi squared (23)	1 623	72.80
Prob > Chi squared	0.000	0.000

Note: * = significant at the 10 percent level, ** = at the 5 percent level, *** = at the 1 percent level.
Source: authors' survey.

the training in dairy received; being a cooperative member; owning more pastureland; and having less exposure to the MCC; the sooner the farmer will adopt the channel (shorter adoption spell).

In terms of the withdrawal decision, the factors that most determine farmers' decisions to continue in the MCC channel were found to be:

- cooperative membership (-)
- distance to an alternative market (non-MCC) (-)
- having non-farm employment (+)
- year of first adoption of the modern market (-).

These findings are more surprising. While it was to be expected that earlier adoption leads to longer withdrawal spells (the most promising farmers join first), it was perhaps less to be expected that not being a cooperative member, having several local alternative markets and a higher non-farm income increase the withdrawal spell (longer duration in the channel). Possible explanations include the following:

- *cooperative membership*: the presence of traditional cooperatives, not entirely associated with dairy, and the fact that there is no need to be a member of the MCC cooperative to be a supplier;
- *local alternative markets*: spacious correlations (closeness to road means closeness to many alternatives) with regular MCC suppliers also being best placed to sell into spot markets for quick cash (as opposed to monthly payments under the MCC scheme); and
- *non-farm income*: the impact of having non-farm income to finance investment associated with modern dairy farming and, given the cultural importance of cattle in Zambia's Southern Province, more non-farm income translates into increased investment in cattle and increasing milk supplies.

In the second-stage estimation, duration as an MCC supplier has a significant positive impact on the use of improved feeds (semi-modern and modern) and on farm assets owned by the farmer. This finding clearly reflects the strong positive development outcome of participation in the modern channel for smallholder farmers in Zambia's dairy value chain.

TABLE 4.11
Effects of duration on feed use as a Milk Collection Centre supplier

	Improved trad. feed	Semi-modern feed	Modern feed	Farm assets	Non-farm assets	Durable assets
Head of household (HHH) is female (yes=1, no=0)	-0.000	-0.002	-0.001	0.021***	0.009	-0.001
	(0.003)	(0.003)	(0.003)	(0.005)	(0.008)	(0.005)
Age of HHH	0.166	0.141	0.157	-0.371	0.205	0.623***
	(0.129)	(0.129)	(0.132)	(0.244)	(0.354)	(0.235)
Years of education of HHH	0.014	0.009	-0.001	0.079***	0.082**	0.073***
	(0.013)	(0.013)	(0.013)	(0.024)	(0.035)	(0.023)
Maximum years of education attained by any household member	-0.021	0.004	0.018	0.001	0.130***	0.035
	(0.017)	(0.017)	(0.017)	(0.032)	(0.046)	(0.031)
Number of adults in household	0.002	-0.018	-0.013	0.057***	0.017	0.065***
	(0.012)	(0.012)	(0.012)	(0.022)	(0.032)	(0.021)
Total pastureland (ha)	0.001	-0.002*	0.001	0.002	-0.008***	0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)
Number of livestock animals	-0.000	0.001	-0.001**	0.009***	0.002	0.002*
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)	(0.002)
Number of cows	-0.000	-0.001	0.004**	0.017***	0.009*	0.006
	(0.002)	(0.001)	(0.002)	(0.004)	(0.005)	(0.005)
At least one member of household participates in a farmer cooperative or association (yes=1, no=0)	0.080***	0.083***	0.096***	0.492***	0.333***	0.859***
	(0.014)	(0.014)	(0.016)	(0.029)	(0.039)	(0.038)
Farm assets (index)	0.026**	0.077***	0.037***	–	–	–
	(0.011)	(0.010)	(0.012)	–	–	–
Duration as MCC supplier (years)	-0.002	0.022*	0.019*	0.037*	-0.026	-0.036
	(0.013)	(0.013)	(0.012)	(0.023)	(0.036)	(0.024)
Constant	0.405	0.393	0.266	-2.258	-2.531	-1.39
	(0.198)	(0.198)	(0.204)	(0.373)	(0.541)	(0.359)
Observations	1 942	1 942	1 942	2 275	2 275	2 275
Number of households	175	175	175	175	175	175
Wald Chi squared (10)	57.49	196.5	88.15	1 544	175.6	750.3
Prob > Chi squared	0.000	0.000	0.000	0.000	0.000	0.000

Note: * = significant at the 10 percent level, ** = at the 5 percent level, *** = at the 1 percent level.
Source: authors' survey.

Chapter 5

Summary, conclusions and implications for development policy and programmes

Liberalization of market and FDI in Zambia in the 1990s led to modernization of the dairy subsector in the 2000s. This took place not only in dairy retail and second-stage processing, but also in the segment with which small farmers directly interact – first-stage processing and local milk collection. In the latter, the modern channel's rural entry point – the Milk Collection Centre (MCC) – has emerged. Our national MCC census describes in some detail the rapid growth of the MCC model in Zambia.

Using a survival analysis approach, this report explored whether farm assets determine the participation of smallholder dairy farmers in sales to MCCs and how farmers' duration as MCC suppliers affects their accumulation of farm capital and technology. It was found that participation in MCC value chains is determined by location, training and cooperative membership, thus having a mixed effect on the inclusion of smallholder producers. Furthermore, duration as an MCC supplier was found to be correlated with accumulation of capital and changes in technology.

The implications for policy-makers are twofold. First, there is a continued need for capacity building and the creation of an enabling environment to facilitate collective action by smallholders, especially in the initial stages of development. Second, there is a need to facilitate investment in modern infrastructure at the production and initial processing stages, and in building the capacity of farmer collectives to manage these infrastructures. Key to the sustainability of the smallholder dairy support programmes in Zambia were: (i) initial verification that a viable business model exists; (ii) collective action; (iii) design and application of integrated solutions around the MCCs; and (iv) sufficiently long and intensive support, gradually phased out once farmers reached certain thresholds.

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Annex 1
Data collection process[39]

INTRODUCTION

Our survey used a two-stage cluster sampling scheme. In this design, primary sampling units (PSUs), or clusters, were selected at random in the first stage, and secondary sampling units (SSUs) were selected at random in the second stage. The scheme has been used by most large-scale studies around the world, including the Living Standards Measurement Study (LSMS) (Grosh and Munoz, 1996). Based on statistical and budget factors, a sample size of 420 dairy producers in the vicinity of the two clusters of selected milk collection centres (MCCs), around Monze Central (210 producers) and Choma Union (210 producers), was determined.[40]

INSTRUMENT DEVELOPMENT

The survey used two types of instrument – a listing form and a household questionnaire. Both were carefully designed to capture all the relevant data on project indicators and covariates. A list of the names of MCCs and their participating farmers in the two study districts was developed to provide continuous guidance to field staff throughout the fieldwork. Draft instruments were also pre-tested and revised on the basis of observations from the testing.

SELECTION AND TRAINING OF FIELD STAFF

Enumerators and supervisors were drawn from an existing database of field staff who had worked with CARPA on a number of other studies. Nevertheless, they were all subjected to a rigorous selection process. This involved recruiting more than the required number and subjecting them all to critical observation during the course of training.

Experienced master trainers were used to train the field staff. A combination of training techniques was used to maximize the impact of training. These included:

- simultaneous reading and correction of the questionnaires and enumerator manuals;
- front-of-class demonstration interviews by trainees;
- mock interviews (pairing trainees and letting them interview each other); and
- field practice/pre-test.

The objective of the evaluation was to identify general difficulties and provide a basis for selecting successful enumerators and supervisors. Only the best performing individuals were selected for fieldwork. The training enhanced, among other things, enumerator knowledge about and understanding of the survey as a whole and the importance of all its modules. Such training helped to ensure that each enumerator could explain the survey and its modules competently to both communities and households, should they be asked to do so. By the end of training, enumerators were expected, at the very least, to be able to explain that the selected households and individuals had been chosen because they owned milking cows and had sold milk in the last 12 months through traditional or modern marketing channels. The enumerators were also trained on survey confidentiality issues associated with the study.

[39] Data were collected by CARPA, a Zambian NGO contracted by FAO.
[40] See section 4.1 for the reasons behind this selection.

FIELD SUPPLIES

To ensure the success of the fieldwork, CARPA made the following materials and supplies readily available for field staff:

- maps and household listing forms
- letters of introduction
- household questionnaires
- pens/pencils/erasers for interviewers
- backpacks
- wrapping paper or envelopes to store completed questionnaires.

Other preparations for fieldwork included making sufficient funds available for fuel and minor vehicle-related incidentals, other field incidentals and communication.

AWARENESS CAMPAIGNS

In order to ensure that the teams won the confidence of the communities and households, efforts were made to contact the relevant authorities not only during fieldwork but, whenever possible, also prior to visits. In particular, advance contacts with community members such as schoolteachers, village heads and chiefs were found to be very helpful. This enhanced the chances of cooperation since emphasis was placed on ensuring that these leaders were enlightened about the importance of the survey and the need to cooperate with the data collectors. Courtesy calls at the district level were also made and the survey was explained to the district commissioners in the two districts where the survey took place.

SAMPLE DESIGN AND SAMPLING

Sample design

Administratively, Zambia is divided into ten provinces, each further subdivided into districts. For statistical purposes, each district is subdivided into Census Supervisory Areas (CSAs) which, in turn, contain standard enumeration areas (SEAs). During the mapping exercise from 1998 to 2000, CSAs were demarcated within wards, wards within constituencies, constituencies within districts and districts within provinces. Thus, for data collection purposes, the SEA is the smallest geographic unit above the household. Prior to recent changes where the numbers of districts and provinces increased, Zambia had 72 districts, 150 constituencies, 1 289 wards, 4 400 CSAs and about 17 000 SEAs. Following Central Statistical Office (CSO) practice, CARPA used the SEA as a PSU. This study worked with the old administrative boundaries.

In the first-stage sampling frame, all SEAs within a radius of 30 km from each of the two MCCs were included. This was done by taking the global positioning system (GPS) coordinates of the MCC and overlaying them on SEA digital maps from the CSO. The SEA frame from the 2010 Census of Population and Housing (CSO, 2011) was used. Because smallholder dairy production is not uniformly distributed within the region of interest, the eligible SEAs in each district (i.e. those within 30 km) were further put into two groups/strata, divided between: (i) those that were believed to be dairy producing areas and (ii) all other SEAs. This stratification was necessitated by the concern of the wards that the dairy producing areas might not have enough traditional channel farmers. Sampling itself was then carried out in two stages – first, a selection of SEAs/PSUs and second, a selection of households/SSUs.

Selection of primary sampling units

Using simple random sampling (SRS), sample SEAs were selected within each stratum. A total of 24 and 26 SEAs were selected from Choma and Monze, respectively. Only 16 of these were needed per district, based on optimal sample size computations. The first 16 sampled were initially included in the study. The additional SEAs were for any necessary replacements, for whatever reason. In the end, there would still be 16 SAEs included per district. Of the 8–10 additional SEAs per district, 7–9 were permissible replacements in areas believed to have high dairy concentration. The remaining SEA was a replacement for all other areas within the 30-km radius.

Listing of secondary sampling units

Within each selected PSU, a listing was used to provide the frame for the second sampling stage. Experienced field staff and community key informants listed all dairy farming households in each selected

SEA, ensuring that the lists were as complete as possible. Over time, these procedures have been shaped by best practice suggestions in the literature (see Grosh and Munoz, 1996) together with CARPA experience. One strategy used, which was found to be effective, was to ensure that field personnel moved in teams. This meant that listing (and sampling) in each PSU was done by all members of the team under the constant supervision of the team supervisor. A listing form was specially designed not only to list all eligible households but also to collect basic data on milk production and marketing status, as well as other basic household information relevant for sampling and identification.

The listing exercise was preceded by preliminary community inquiries among key informants in order to obtain a rough idea of the number of cattle owners who had sold milk 12 months prior to the visit. These key informants also acted as guides during the actual listing exercise. Moreover, each listed household was asked to identify other farmers owning cattle who sold milk within the SEA.

Selection of secondary sampling units

Upon completion of the listing exercise, the lists of dairy producing and selling households were carefully checked and put in order to ensure that neighbouring dwellings were listed close to each other. In each cluster, the listed households were then grouped into two strata – one for households selling their milk through the traditional channel, and the other for those selling through the modern marketing channel. Within these strata, each household was then assigned a unique sampling serial number. The sampling serial numbers were assigned sequentially within each stratum, starting from one.

The initial plan was to use systematic sampling to select 16 dairy selling households in each SEA, 50 percent of which were modern channel farmers. However, this was not always possible because of the small numbers of dairy farmers found in some SEAs. If the total number listed was less than 16, all listed households would automatically be selected and interviewed. Moreover, if the farmers listed in either category were fewer than eight, then the other category with more farmers would be oversampled so that the total number interviewed per SEA was approximately 16. In extreme situations, where the selected SEA had too few or no dairy farmers, the entire SEA was replaced. This was made possible by the fact that SEAs were oversampled during the first-stage sampling.

The following criteria were most significant when deciding the time to replace an SEA.

- Very few or no dairy farmers sold milk at all in some sampled SEAs. In such cases, the SEAs were replaced with those established as having the desired target group. Moreover, it was found that in some sampled SEAs most, if not all, dairy farmers selling milk serviced only one of the two marketing channels.
- Many selected SEAs could not meet the required number of eligible households, which was 16 (eight traditional channel and eight modern). In such cases, the field teams interviewed all available eligible households, regardless of the channel. Any shortfalls in one or both channels were filled by oversampling in subsequent SEAs. There were very few cases where there was some kind of balance between those supplying the traditional channel and those supplying the modern channel. Ultimately, the number of farmers interviewed in an SEA varied from four to 26.
- Fieldwork took place in December 2012, at the peak of the rainy season. As a result, most roads were bad and in, some cases, impassable, even with the 4x4 vehicles used in the survey. Some SEAs could not be accessed as a result and were replaced. This was experienced in both districts. Fieldwork undertaken in the rainy season also meant that the teams sometimes had to follow respondents to their fields, which was not an ideal way of doing a survey. All SEA replacement decisions were taken in full consultation with MCC managers, their survey coordinator, heads, chiefs, schoolteachers and farmers.

FIELD OPERATIONS

There were two field teams, each comprising one field supervisor, four enumerators and a driver. The supervisors were directly answerable to the master trainers. The latter performed unannounced spot checks on the field teams, sampling completed questionnaires and overseeing the work of the supervisors. An inter-team communication system was established to ensure that observations and changes implemented in each team were uniformly applied by the other.

By design, each supervisor was instructed to observe the interviews and quality of the completed questionnaires closely during the first few days of the fieldwork. Where necessary, the two would call their enumerators and explain the errors and consistency problems observed. All enumerators whose errors

could not be corrected at camp were sent back to the households for clarification and/or re-interview. The goal was to ensure that all field procedures and administration of the questionnaires were carried out according to expectations, to provide technical advice for any problems encountered by the field staff in the initial stages, and to advise on situations that did not arise during training or field practice.

Although more critical and intense during the initial stages of fieldwork, quality checks by the supervisors continued throughout. On a daily basis, the supervisor would collect all the questionnaires that had been satisfactorily completed for eventual submission to the master trainers. The supervisors were also responsible for assigning work to the enumerators, ensuring that everyone did their work, making spot checks and regularly communicating progress to the master trainers. The overall survey manager provided another layer of quality assurance through unannounced spot checks on the master trainers and the teams. The survey manager also coordinated all other activities related to the survey, including data entry, cleaning and collation.

During the course of the fieldwork, a number of unexpected challenges were encountered and dealt with in the best way possible, on a case by case basis. Major challenges were the following.

- For the most part, there were long distances between SEAs and between dairy farms within the SEA, as would be expected in the Southern Province. Consequently, fieldwork took longer to complete than was initially planned. It took 22 days in both districts, ten days more than planned.
- There was a mixed reception from communities, where some households were more welcoming than others. Either way, the teams were largely successful in managing to get the interviews done. Many communities mistook the survey teams for people through whom they could air their wishes to the government. Most communities asked for dams, dip tanks and MCCs to be constructed closer to their communities. Others asked for access to high-yield dairy animals.

Both teams carried out their fieldwork in Monze before proceeding to Choma. With the experience from Monze, they were more proactive and showed more expertise in Choma. In most cases, while the teams were editing their questionnaires, the master trainers would be making arrangements for the next areas.

Annex 2
Theoretical model

Since the focus is an empirical contribution, the study does not present a new theoretical model, but rather draws heavily on the conceptual framework laid out in Carletto, de Janvry and Sadoulet (1999) and Carletto *et al.* (2010). Although their work focused on entry in the non-traditional horticulture exports market by adoption of crops for that market, it is directly relevant to our treatment of adoption of (entry in) and duration in the modern market channel in the domestic dairy market in Zambia. Thus this report merely summarizes their conceptual model in this annex.

Carletto *et al.* (2010) specify a farm household model where a household decides the allocation of its land endowment (A) between traditional market (crops), A_0, and non-traditional (modern) market crops, A_1. Participation in the traditional market is perceived as less production risky but it also has a lower expected return compared with the modern market. However, modern market entry costs are perceived to be higher than those of traditional markets, since modern markets demand higher quality and consistent supply throughout the year, which can imply capital-led investments (such as cold storage). With the vector of variable inputs valued at the cost w_x, the income/ha can be written as follows.

For traditional market (crops):

$$\Pi_0(p_0, w_x, z_0) + \theta_0 \tag{2.1}$$

For modern market (crops):

$$\Pi_1(p_1, w_x, z_1) + \theta_1 \tag{2.2}$$

With

$$E(\theta_0) = E(\theta_1) = 0, \Sigma(\theta_0, \theta_1) = (\sigma_0^2, \sigma_1^2, \rho_{01}\sigma_0\sigma_1) \tag{2.3}$$

where

- p_0 and p_1 are the expected prices in the traditional and modern markets, respectively;
- Π_0 and Π_1 are the expected incomes/ha of the product sold to the traditional and modern market;
- Σ is the variance-covariance matrix of the risk terms θ_0 and θ_1; and
- z_0 and z_l are household assets that affect expected income from each market channel.

If the household decides to allocate production to the modern market channel ($A_1 > 0$), then the household's total income is:

$$Y = (\Pi_0 + \theta_0)A_0 + (\Pi_1 + \theta_1)A_1 + T - c_1, \tag{2.4}$$

where

- c_1 is the fixed entry cost of modern markets; and
- T represents other sources of income.

Assuming that the household is risk averse, it will decide to adopt the modern market channel when the change in utility due to adoption (ΔUa) is positive, given an optimal level of allocation to the modern market (A_1). That change in utility is determined by the following function:

$$\Delta U_a = \frac{1}{2\phi(\sigma_0^2+\sigma_1^2+2\rho_{01}\sigma_0\sigma_1)}[(\Pi_1 - \Pi_0) - \phi(\rho_{01}\sigma_0\sigma_1 - \sigma_0^2)]^2 - c_1 > 0 \qquad (2.5)$$

Next is the specification of the regression model and estimation procedure used to implement the conceptual model.

The theoretical model is "translated" into an implementation model that has the general form of the equations and the general categories of variables used by Carletto *et al*. (2010). Following the theoretical model presented, equation 2.5, the change in utility from adoption, can be rewritten as follows:

$$\Delta U_a = \Delta U_a(p_0, p_1, w_x, FK, HK, SK, CK, T_o, t_a) \qquad (2.6)$$

In an analogous way, the decision to withdraw is determined by the change in utility that determines withdrawal ΔU_w; initially this change is negative, but may become positive ($\Delta U_w > 0$) and encourage the household to withdraw.

$$\Delta U_w = \Delta U_w(p_0, p_1, w_x, FK, HK, SK, T_a, t_w, V) \qquad (2.7)$$

Equation 2.7 is similar to 2.6, with the difference that the earliest time for withdrawal is the time when the household adopts the supermarket market channel (T_a) and the duration of the withdrawal spell is included as t_w.

The equations show that the change in utility from adoption or withdrawal is a function of the following:

- exogenous output prices
- exogenous input prices
- household assets: human capital (HK), farm capital (FK), social capital (SK) and community capital (CK)
- time, which enters the duration equations in several ways:
  - T_0, the potential earliest year for adoption, which is either when the modern market becomes accessible to the household or when the household is formed;
  - t_a, the household's "time to adoption" which is the time period between T_0 and the year the household adopted (T_a);
  - t_w, the time from adoption to the time of withdrawal, or the "duration," which is the time spent as a supplier, if adopted, but note that withdrawal may have not occurred or may never occur.

In most duration models, observations on t_a are of two types.

- The household has adopted the supermarket market channel, then the value of t_a is directly observed.
- The household has not yet adopted at the time of the survey, so that information is truncated, since the length of the duration spell (t_a) is greater than the length of the observed pre-adoption spell.

The study analyses the "time to adopt" (waiting time of the household before adoption, or "adoption spell") and, if the household adopts, the time to withdraw (or duration). Therefore, equations 2.6 and 2.7 are manipulated to express t_a and t_w) as functions of the explanatory variables in these equations. This will be a prelude to specifying the regression equations in the next subsection. Thus,

$$t_a = t_a(p_0, p_1, w_x, FK, HK, SK, T_o, V) \qquad (2.8)$$

Since the study analyzes farm duration as supermarket supplier (waiting time before withdrawal, also known as the withdrawal spell), it is as follows:

$$t_w = t_w(p_0, p_1, w_x, FK, HK, SK, T_a, V) \qquad (2.9)$$

The study also analyzes the *effects* of duration itself on dairy households, with a particular focus on the effects on use of different types of feed as modern technologies in dairy production, which can be modelled as follows:

$$\Delta Tf = \Delta Tf(p_0, p_1, w_x, A_0, A_1, t_w, HK, V) \tag{2.10}$$

$$\Delta Sf = \Delta Sf(p_0, p_1, w_x, A_0, A_1, t_w, HK, V) \tag{2.11}$$

$$\Delta Mf = \Delta Mf(p_0, p_1, w_x, A_0, A_1, t_w, HK, V) \tag{2.12}$$

where (ΔTf) is the change in the use of improved traditional feed, (ΔSf) is the change in the use of semi-modern feed, (ΔMf) is the change in the use of modern feed and is the predicted duration from the first stage.

Smallholder farmer participation in modernization of a **food system**

The dairy value chain in Zambia

Liberalization of market and foreign direct investment (FDI) in Zambia in the 1990s led to modernization of the dairy subsector in the 2000s. This took place not only in dairy retail and second-stage processing, but also in the segment with which small farmers directly interact – first-stage processing and local milk collection. In the latter, the modern channel's rural entry point – the Milk Collection Centre (MCC) – has emerged. A national MCC census describes the rapid growth of the MCC model in Zambia in some detail.

This report explores whether farm assets determine the participation of smallholder dairy farmers in sales to MCCs and how their duration as MCC suppliers affects their accumulation of farm capital and technology. A survival analysis approach used constructed panel data for dairy farmers over a 12-year period. Participation in MCC value chains is found to be determined by location, training and cooperative membership, thus having a mixed effect on the inclusion of smallholder producers. Duration as an MCC supplier is correlated with accumulation of capital and changes in technology. The implications are that policy-makers need to facilitate smallholder farmers in engaging in collective action and accessing modern infrastructure.

Food and Agriculture Organization of the United Nations (FAO)
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www.fao.org

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