Agriculture Issues and Policies

Opportunities and Challenges of Smallholders and Smallholding

Donát Horváth
Editor

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AGRICULTURE ISSUES AND POLICIES

OPPORTUNITIES AND CHALLENGES OF SMALLHOLDERS AND SMALLHOLDING

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OPPORTUNITIES AND CHALLENGES OF SMALLHOLDERS AND SMALLHOLDING

DONÁT HORVÁTH
EDITOR

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PREFACE

Smallholder farms or smallholdings comprise livestock and livestock, livestock and crops and crops and crops farming systems. It involves nutritional inter-relationships of integration and interdependency between livestock and crop systems and crop and crop systems. There are an estimated 500 billion smallholder farms worldwide supporting livelihoods of about 2 billion people, most of who are in Sub-Sahara Africa and Asia. Smallholders make more than 60% of agricultural producers supplying local and international food markets, and employ about 70% of farming communities in Sub-Sahara Africa and Asia. However, these farming systems experience financial, technological, infrastructural, market access, environmental and policy and institutional framework challenges. Considering the importance of smallholder farming systems, attempts should be geared towards mitigating the challenges and promoting productivity and sustainability of these farming systems. This is expected to lead to improved food and nutrition security and food safety and translate to improved livelihoods of smallholder farmers and increased income from agriculture products. The authors' of this book focus on the challenges and opportunities of smallholders and smallholding systems all over the world.

Chapter 1 - For many decades during the Soviet period smallholders, defined as household gardeners (*lichnoe podsobnoe khoziaistvo*), played an indispensable role in food production and improving regional food security. In the 1990s, *lichnoe podsobnoe khoziaistvo* emerged as a survival strategy for nearly all households during the economic collapse. Since 2000, however, economic recovery, the emergence of a stratum of strong commercialized mega-farms, and the development of national and regional supermarket chains raise questions about the societal role for *lichnoe podsobnoe khoziaistvo* in Russian society. This chapter examines state policy, smallholder resilience, and role in society for the Soviet period, the early post-Soviet period, and the contemporary period. The final section speculates on the future for Russia‘s smallholders by considering three scenarios: (1) disappearance; (2) morphing into food sovereignty; and (3) continuation of the status quo. The chapter concludes that the status quo is most likely. The irony of smallholders‘ situation is that they were discriminated against by the state during the Soviet period because they represented market capitalism. In the post-Soviet period, it is capitalism and market forces that have facilitated the decline of smallholders.

Chapter 2 - Most of the milk produced in the developing countries comes from small-scale dairy farms, among which are intensified dairy regions of sub-Saharan Africa. Ethiopia has huge potential to be one of the key countries of East Africa in dairy production. A number of market-oriented smallholder dairy farms have appeared due to the rapidly growing demand for milk and milk products. To be competitive, smallholder livestock production needs to intensify and be able to provide higher value products. Dairy intensification provides both opportunities and challenges that need to be managed accordingly in order to improve milk production in a sustainable way. However, little is known of how dairy intensification driven by socioeconomic issues and dairy development efforts works as well as the challenges of changing production systems. Thus, this paper synthesizes information based on recent research and Ethiopian dairy farming as a case study to describe dairy intensification (productive livestock rearing, forage production and manure management) and associated factors, characteristics of changing dairy farms/ households and challenges associated with the intensifying dairy production systems and options to enhance its sustainability. Finally, recommendations are forwarded that would contribute to designing and implementing more attentive/contextual dairy development policies and intervention areas/programs in the intensified dairy regions of sub-Saharan Africa and other developing countries.

Chapter 3 - This chapter outlines the importance of evaluating a smallholder cooperative project‘s outcomes within the historical path of its nation‘s political and economic institutions. This permits realistic expectations for project planners and evaluators and comparisons of project results in different countries. Two smallholder development projects in two East African countries, Kenya and Rwanda, are used to illustrate how differences in the historical path of colonial rule and post-colonial leadership present different opportunities and challenges for smallholder cooperatives. These include what kinds of incentives will attract cooperative members, the competition between cooperatives and other firms, types of institutional structures that facilitate cooperative development and regional market constraints that affect project outcomes. British colonial rule and post-colonial political and economic developments have provided more potential economic gains for Kenyan cooperatives, but also more risks. Belgian colonial rule and the post-genocide Rwandan government have led to a ―guided‖ institutional approach to cooperative development.

Chapter 4 - Smallholder farming systems comprise keeping of livestock and crops. It involves nutritional inter-relationships of integration and interdependency between livestock and crop systems and crop and crop systems. There is nutrient circulation between crops and livestock when there is the feeding of crops and crop residues to livestock and livestock manure use as fertilizer on crops. When there are no nutritional leaks, an equilibrium is created between the various systems. However, normal nutritional leaks are expected to occur when livestock manure is used to fertilize crops for human consumption. To avoid reduction of nutrients in one component of the system, there must be nutritional replenishments. There are an estimated 500 billion smallholder farms worldwide supporting livelihoods of about 2 billion people, most of who are in Sub-Sahara Africa and Asia. Smallholders make more than 60% of agricultural producers supplying local and international food markets, and employ about 70% of farming communities in Sub-Sahara Africa and Asia. However, these farming systems experience financial, technological, infrastructural, market access, environmental and policy and institutional framework challenges. Considering the importance of smallholder farming systems, attempts should be geared towards mitigating the challenges and promoting productivity and sustainability of these farming systems. This is expected to lead to improved food and nutrition security and food safety and translate to improved livelihoods of smallholder farmers and increased income from agriculture products.

Chapter 5 - To assess the effects of farming systems on household maize sufficiency and farmer involvement in off-farm activities, relationships involving maize production, maize retained for household consumption, household maize requirement, time spent on off-farm activities such as gardening, petty trade, and casual work were performed. Data for the study was collected from farmers using structured interviews and key informant interviews. Data was collected from basin conservation agriculture (21 farmers), ripping conservation agriculture (43 farmers), conventional hand hoeing (62 farmers) and conventional ploughing (167) farmers during land preparation (October), weeding (January), harvest (April) and dry season (July) periods. Despite producing enough maize for annual household consumption, 98.4% of conventional hand hoeing farmers, 95.2% of basin conservational farmers, 60.4% of conventional ploughing farmers and 30% of conservational ripping farmers had less maize retained for household consumption than their annual household maize requirement after selling off about 50% of their maize produce. Conventional hand hoeing farmers spent significantly more time on off-farm activities than did basin conservational, conservational ripping and conventional ploughing farmers, especially in July. Conventional hand hoeing farmers also spent a significantly higher amount of time gardening than did basin conservational farmers and conservational ripping farmers. Engagement in petty trade and casual work did not significantly differ among farmers. Diversification of livelihoods by the farmers was reactive and farmers who engaged in farming systems that recorded low maize production had a high involvement in off-farm livelihood activities. Sustainable livelihood diversification should be encouraged as it would result in diversified income sources for farmers and lessen the pressure on maize as a sole important cash crop. Off-farm livelihood diversification could be a viable option for managing risks and shocks associated with food insufficiency among smallholder farmers and contributes to stable food systems as diversified livelihoods are less vulnerable.

Chapter 6 - Contract farming can create new market opportunities and enhance income for smallholder farmers. This study identifies opportunity for contract farming for vegetable growers in relation to cucumber production in Quang Nam province, Vietnam. The study uses data collected from secondary sources and a survey conducted among selected contract and non-contract farmers in Binh Trieu commune in Thang Binh district, Quang Nam province, Vietnam. Benefit-cost analysis was employed to measure the profitability of cucumber production under contract and non-contract farming at farm level. Socioeconomic characters of the contract- and non-contracts farmers were then compared for their economic performance and to identify the constraints surrounding the promotion of contract farming. The results show that there are several benefits in contract farming. In terms of socio-economic characteristics, there are no differences between the contract and the non-contract farmers except their participation in farmers‘ organizations. Large holding farmers and grower-based cooperatives are much more likely to be selected for contractual arrangement than other farmers. This implies that entrepreneurs tend to be interested in contracts with groups of farmers rather than with individual farmers. Acting collectively is likely to increase bargaining power of the contract farmers and reduce transaction costs. Vegetables can be purchased with higher prices which provides higher net return and profit cost ratio for the contract farmers than those of non-contract growers. Although there is a range of benefits in contract farming, an increase in input prices is one of the obstacles of contract farming and not all farmers can fulfil the requirements for production processes and output quality standards. Delays in payment and limited access to market information are also likely to reduce the participation in contractual agreements. It is recommended that farmers' organizations should be formed to enable a group of farmers to enter the value chain and deal effectively with contract farming situations. Market information should be delivered to farmers through local media and the contracts should be made in the form that farmers can easily understand and comply with them. This study also considers a dual supply chain structure in which farmers either operate independently or in partnership with others. Other actors in the value chain, such as middlemen, entrepreneurs as well as end consumers also have important roles to play.

Chapter 7 - Animal husbandry in Indonesia is still dominated by smallholder farms. Almost all of the cattle population are smallholder livestock businesses with relatively low levels of production and productivity. Beef cattle smallholder farming on the Island of Lombok, West Nusa Tenggara Province, is carried out using a group of collective cages, making it easier to manage and develop them. The development of beef cattle smallholder farming based on collective cages is a model of intensive beef cattle maintenance. This model is built by implementing integrated farmer group management by integrating various aspects (technical, social, economic and cultural) in the fields of management of maintenance, feed, breeding, animal health services, marketing, livestock manure management and livestock security systems. This study aims to analyze the sustainability status and development strategy of collective cage-based beef cattle for smallholder farming on the Island of Lombok, Indonesia. The method used to determine the sustainability status is *Multidimensional Scaling (MDS)* with the *Rapid Appraisal Beef Cattle Smallholder (RAPBCS)* approach. Sensitive attributes that affect the sustainability index and the effect of errors are determined based on Leverage analysis and *Monte Carlo Test*. The results of the sustainability analysis show that the dimensions of technical requirements collective cage 56.84; dimensions of collective cage management 58.04 and dimensions of animal health 56. The multidimensional analysis of the sustainability of the development of beef cattle smallholder farming is based on collective cages on the island of Lombok, obtained a combined

dimension value of 57.0 with a fairly sustainable category. Determination of the 6 key factors of sustainability is obtained by prospective analysis to determine the future strategy for the development of collective cage-based beef cattle smallholder farming. The conclusion is that the sustainability status of the development of collective cage-based beef cattle smallholder farming on the island of Lombok Indonesia is in the fairly sustainable category with two recommended development strategies, namely: strategies to improve beef cattle health management and strengthening farmer institutions, farmer economic institutions, extension institutions and the role of community leaders.

Chapter 8 - Coffee is one of the important cash generative crops in the mid hills of Nepal. Coffee, being an important high value crops, is mostly grown in marginal areas with minimum use of improved technologies. In line with the focus of agricultural policies, the concerned have not taken adequate initiatives for the promotion of coffee cultivation. In Nepal majority of coffee is wet processed, which is considered best method for good quality coffee. However, there is lack of updated manpower and improved technologies to work in this regard. As a result of which, quality of Nepalese coffee is below international standard. Around 65 percent of Nepalese coffee is exported, and the rest amount is processed and supplied in the domestic market. Majority of coffee is exported through personal contact of traders rather than institutionalized marketing channel. Therefore, there is gap between what policies have stated and what implemented in the real fields for the promotion of coffee. A study was conducted among smallholder organic coffee producing farmers at Chandanpur and Thuladurlung villages in Lalitpur district of Nepal which is very famous for producing coffee. The data collected from a total of 70 respondents during the period 2019-2020 was assessed for the purpose of improving processing, marketing and export potentiality of organic coffee. These results reveal that though coffee was produced in upland with less care, it had contributed some portion of household income. Farmers should follow better management practices to ensure higher return from coffee cultivation since it is their main source of income. Further, the wet processing method was followed by coffee growers due to its quality and time involved. Though in small quantity of coffee was processed by dry method for home consumption. The cost of processing in wet method is however very high due to expensive machines used. The export of Nepalese coffee indicated that there was impressive growth in the export of Nepalese coffee due to its high value in international market. However there found to be several constraints in processing, pulping, marketing and export of coffee and they should be addressed for the commercialization of coffee sector in future.

Chapter 9 - This study investigated the effect of inputs on the production and variability of introduced chicken strains. The study applied the developmental research design which involves provision of 25 six-week old chicks to 20 farmers in 12 on-farm testing sites. The study was carried out in Dodoma, Morogoro and Njombe regions to assess the effects of agro-ecological differences on production and production variability. Data used were gathered by using a structured questionnaire, direct measurement, farmers�begin and extension officers‘ records. A semi log multivariate regression model according to the Just and Pope Framework was applied in this study. Results from the mean function revealed that maize bran, rice bran, sunflower cake, minerals, frequency of medication, vegetables and house condition had significant effects on production in the production of both live chickens and eggs. Also, there is production variability attributable to inputs use and hence exposing farmers to risk. However, there was an inconsistent effect of input on production performance variability since some inputs were both variability increasing and reducing; that is, reducing in production of birds but, increasing in egg production for the same strain and vice versa. Therefore, it is likely that the full potential of the introduced strains requires standardized inputs for reduced variability. It is important to design strategies that will lead to performance stability. Such strategies should include the design of trials at farm level to evaluate the input mix for chicken with minimum effects on output variability.

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Chapter 1

HISTORY, PROSPECTS, AND SCENARIOS FOR SMALLHOLDERS IN RUSSIA

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ABSTRACT

For many decades during the Soviet period smallholders, defined as household gardeners (*lichnoe podsobnoe khoziaistvo*), played an indispensable role in food production and improving regional food security. In the 1990s, *lichnoe podsobnoe khoziaistvo* emerged as a survival strategy for nearly all households during the economic collapse. Since 2000, however, economic recovery, the emergence of a stratum of strong commercialized mega-farms, and the development of national and regional supermarket chains raise questions about the societal role for *lichnoe podsobnoe khoziaistvo* in Russian society. This chapter examines state policy, smallholder resilience, and role in society for the Soviet period, the early post-Soviet period, and the contemporary period. The final section speculates on the future for Russia's smallholders by considering three scenarios: (1) disappearance; (2) morphing into food sovereignty; and (3) continuation of the status quo. The chapter concludes

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that the status quo is most likely. The irony of smallholders‘ situation is that they were discriminated against by the state during the Soviet period because they represented market capitalism. In the post-Soviet period, it is capitalism and market forces that have facilitated the decline of smallholders.

Keywords: Russia, agriculture, smallholders, food sovereignty, food security

INTRODUCTION

Smallholders throughout the world play an important economic role, with their food production estimated at 70%-80% of world supply (Graeub, et al. 2016; Lowder, Skoet and Raney, 2016). In most countries, smallholders are numerically dominant but use a small percentage of agricultural land. Individual or household plots are quite small, often less than a hectare or two. Previous research has explored how smallholders around the world face common problems (Hazell, Poulton, Wiggins, and Dorward, 2010). Today, Russia‘s smallholders, the subject of this chapter, face many of the same problems that confront smallholders in other countries: access to credit; how to increase integration with food processors; how to enter the supply chains of the commercial food market; access to inputs; labor supply issues; and a host of other obstacles. Yet, Russia‘s smallholders also face unique challenges that this chapter illuminate.

Smallholders in Russia have a long tradition and have played an important economic role over time. One cannot imagine the Soviet agricultural system without also thinking of the ―private plot‖ sector that played a crucial role in national food supply. During much of the post-war period in the Soviet Union, a main agrarian problem was how to feed the urban population, owing to the shortcomings in the Soviet planned economy and the food distribution system. The nature of this particular Soviet agrarian problem (in addition to others), defined a specific role for smallholders. Smallholders‘ role changed in the post-Soviet period and has changed yet again in recent years as the food system has transformed into a modern system with retail chains and supermarkets that offer consumers one-stop shopping.

The purpose of this chapter is to provide a comprehensive overview of the history of smallholders in Russia (*lichnoe podsobnoe khoziaistvo*) and their present-day prospects. My analysis is divided into four main sections: The Soviet Period, The Early Post-Soviet Period, The Contemporary Period, and The Future. The first three sections are structured to analyze state policy, resilience, and role in society. The Future section examines three scenarios for Russia‛s smallholders going forward.

The chapter develops several broad arguments. The first argument is that the economic importance of Russia‛s smallholders has changed significantly in the past 50-60 years, going through cycles of decrease then increase in food production. Smallholders‛ fortunes stem from the economic environment and state policy, and those too have changed over time from discriminatory for most of the Soviet period to embracing smallholders in the 1990s. Since 2000, smallholders have faced a neutral state but in recent years that condition appears to be changing as the politics of markets exert influence.

The second broad argument is that as a consequence of smallholders‛ change in economic importance, smallholders‛ role in society has likewise transformed from subsidiary food production to a survival strategy to economic activity that is increasingly less necessary and less relevant to the average urban consumer. The smallholder continues to have importance in other ways, to rural life, to village interactions, and to rural culture.

The third argument is that going forward, the ―liberal‖ scenario for the evolution of smallholders is unlikely due to Russia‛s political system and an absence of the underlying prerequisites such as a vibrant civil society. Absent an economic shock to the system similar to collapse in the 1990s, the most likely future scenario for Russia‛s smallholders is continued drift toward economic marginalization. Smallholders are unlikely to fare well in Russia‛s competitive economic environment in which mega-farms and agribusinesses are dominant.

THE RUSSIAN SMALLHOLDER

My analysis of Russia‘s smallholders is confined to *lichnoe podsobnoe khoziaistvo*, which is loosely translated as ―personal subsidiary farming.‖ In the Soviet period, this form of production was often referred to as a private plot, which was something of a misnomer because the land was not privately owned but it did convey the fact that food production was outside of state planning. There was a debate during the Soviet period whether *lichnoe podsobnoe khoziaistvo* constituted private property or subsidiary agriculture within the socialist system (Wadekin, 1973, 1-9). In any event, the designation ―private‖ referred to food production, not land ownership. Contemporary shorthand versions refer to *lichnoe podsobnoe khoziaistvo* as household gardens or less frequently kitchen gardens.

The important point is that smallholder agricultural activity has historically represented a subsidiary source of income in Russia, not the primary livelihood of a rural dweller or rural household. In the Soviet period, the operation of *lichnoe podsobnoe khoziaistvo* as the primary source of income was outlawed. Further, in the Soviet period the household plot was supposed to be a subsidiary source of food, one that was secondary to state food stores and rural cooperatives, but in reality the plot was often households‘ main source of food. Medvedev indicates that even as late as the 1980s rural households derived more than one-half of their food from their own production, and for certain products such as meat, milk, eggs, vegetables, and fruit the percentage was about 90 percent (Medvedev 1987, 365). During the 1940s and into the 1960s, the percentage of food derived from own production was much higher than one-half.

Today, a very small percentage of *lichnoe podsobnoe khoziaistvo* operators derive all of their income from such production (Uzun and Saraikin, 2012). Of course, the actual level of income derived from household food production differs based on different factors such as region, profession, size of household, and labor capital (O‘Brien and Patsiorkovsky, 2006; Pallot and Nefedova, 2007; Wegren, 2014). Most households continue to use their food production from *lichnoe podsobnoe* *khoziaistvo* for self-consumption. According to one Russian academic, just 16% of *lichnoe podsobnoe khoziaistvo* operators sell their production in one or another, but the degree to which that is true depends upon different variables (Zhevora, 2017, 21).

Although there are other forms of smallholding in Russia such as dacha plots (Rusanov, 2019), *lichnoe podsobnoe khoziaistvo* is the most economically important and the most widely practiced. Russia‘s 2016 agricultural census found more than 13 million plots specifically devoted to *lichnoe podsobnoe khoziaistvo*, the vast majority of which are located in rural areas.[1] *Lichnoe podsobnoe khoziaistvo* consists of a small plot of land typically located around a rural dwelling, called *priusadebnyi uchastok*. During the Soviet era, collective farm families also had access to a small plot designated from the farm for grazing rights away from the dwelling. In urban areas, *lichnoe podsobnoe khoziaistvo* consisted of use rights away from apartments; in the post-Soviet period additional land is leased from the municipal government.

Household gardening does not occupy much of Russia‘s agricultural land. Russia‘s 2016 agricultural census found that *lichnoe podsobnoe khoziaistvo* used only 1.6% of agricultural land (Rosstat, 2018b, 66), with an average plot size of .8 hectares in rural areas and .3 hectares in urban locales (Rosstat, 2016a). In 2019, according to official estimates, 28% of the ruble value of Russia‘s agricultural production came from *lichnoe podsobnoe khoziaistvo*, consisting of unprocessed vegetables and potatoes, milk, eggs, honey, and meat (Rosstat, 2020). The ruble value of food output from *lichnoe podsobnoe khoziaistvo* has experienced a linear decline since 2004.

The Soviet Period

Before analyzing state policy and other variables concerning smallholders during the Soviet period, it is useful to say a few words about

[1] The total number of land plots numbered over 17 million if other types of smallholder uses are included.

the origins of *lichnoe podsobnoe khoziaistvo*. Prior to the Bolshevik revolution in 1917, Russia‘s agrarian structure consisted of peasants owning about two-thirds of land in European Russia. In 1916 peasants accounted for 90% of total sown land which of course varied by region (Volin, 1970, 110). During the run up to the Bolshevik revolution in 1917, large gentry estates were seized by spontaneous peasant uprisings that distributed land among themselves (Keep, 1976, 200-216). In the immediate aftermath of the revolution, private ownership of land was abolished and all land from landlords‘ estates, the church, and the state was nationalized, but smallholdings of peasants and Cossacks were exempt (Carr, 1952, 35). From confiscated land, about 86% of confiscated land was distributed to peasants and the average size of a peasant plot increased (Carr, 1952, 47). In mid-1918, however, as policies of War Communism were introduced, the Bolsheviks unleased class warfare in the countryside by turning poor peasants against rich peasants (the so-called kulaks), through the creation of committees of poor peasants. War Communism witnessed the seizure of grain and land from kulaks and peasants who had purchased land from estates prior to 1917. Not only were land purchases and sales prohibited, so too was land leasing, and use rights were given only to those workers who tilled the land (Volin, 19790, 129). A few years later, as the disastrous policies of War Communism became unsustainable, the Soviet regime backtracked and the 1922 Land Code strengthened state ownership and prohibitions on the sale and purchase of land, but it allowed land leasing, thereby permitting individual farms to exist (Danilov, 1988, 94). Private ownership of land remained illegal, however, and all land continued to belong to the state. During the New Economic Policy of the 1920s (NEP) the percentage of agricultural land used by individual farms increased; by 1927 individual peasants were using over 98% of sown agricultural land (Nove, 1969, 106).

Stalin‘s collectivization of agriculture starting in 1929 and extending into the 1930s ended land leasing and transformed Russia‘s agrarian structure. Stalin created a system of state and collective farms controlled by the Communist party. He attacked peasants‘ individual farms so that their numbers dwindled before completely disappearing in the 1940s.

Thus, during the 1930s the binary agrarian structure of the 1920s—a robust individual farming sector and a smaller socialized farm sector—gave way to the dominance of socialized farms. By 1935, more than 94% of crop land was collectivized (Nove, 1969, 174). As peasants were driven into collective farms, the majority of their wages were paid in-kind, usually grain and fodder for animals. It would not be until the 1960s that state policy monetized collective farm wages and even then there was considerable variance from farm to farm and region to region.

The discussion below reviews state policy under the four consequential post-Lenin General Secretaries: Josef Stalin, Nikita Khrushchev, Leonid Brezhnev, and Mikhail Gorbachev, eschewing the interregnum leaderships of Yurii Andropov and Konstantin Chernenko. As is frequently noted, the position of party leaders was often ambivalent about *lichnoe podsobnoe khoziaistvo* because it was seen as a vestige of capitalism, a type of production to be eventually eliminated as economic conditions permitted. But those conditions never materialized and thus the regime was forced to tolerate this form of smallholding out of economic necessity. That said, state policy varied over time in the intensity of its animosity toward smallholders until the Gorbachev era when attitudes changed.

State Policy in the 1930s

During the 1930s, Stalin‘s regime wanted to extract resources from agriculture to aid industrialization. For this reason, the state requisitioned ever higher percentages of food produced by collective farms, which meant that there was less food (mostly grain) to distribute as wages to collective farm workers. The regime did not want to completely starve the peasantry because burgeoning cities had to be fed. Therefore, in 1933 rural collective farm workers were given the right to conduct subsidiary agriculture in their spare time. The operation of subsidiary household plots, or *lichnoe podsobnoe khoziaistvo*, for collective farm employees was formally legalized in the Collective Farm Charter of 1935, a concession to the need to allow rural dwellers to feed themselves and to compensate for the acute famine in rural Ukraine during 1932-1933 (Applebaum, 2017). Successive Collective Farm Charters in 1969 and 1988 specified the rights and responsibilities of collective farmers and defined the rules for *lichnoe podsobnoe khoziaistvo*.

Over time, land use rights for subsidiary agricultural production were expanded to include state farm employees, farm service personnel, urban residents, industrial workers, and other workers (Wadekin, 1973, 20-42; Hedlund, 1989, 28-31). On the whole, however, *lichnoe podsobnoe khoziaistvo* was a rural phenomenon and virtually every collective farm household cultivated a plot. In the late 1980s, for example, 98% of collective farm households and 79% of workers‘ and employees‘ households operated *lichnoe podsobnoe khoziaistvo* (Goskomstat SSSR, 1989, 3). The size of the household plot was not equal everywhere and depended on the region and employment status, among other variables, but generally was limited to less than .5 hectares for collective farm households after 1969. Thus, for much of the Soviet period, the operation of *lichnoe podsobnoe khoziaistvo* was a recognition of reality but also an incentive to remain employed on a collective farm. Departure from the farm meant the loss of the household plot. From the mid-1930s, therefore, *lichnoe podsobnoe khoziaistvo* became part of Russia‘s agrarian system. That said, the role of smallholding in the socialist agrarian structure remained contested and its economic importance varied.

State Policy during World War II and After

The terrible destruction suffered by the Soviet Union during WWII and the loss of agricultural resources—men, land, animals, machinery—led the Communist party to shift its strategy. Instead of relying on the state for food deliveries to the population, emphasis was placed on local food sources which relieved pressure on the transport of food via rail, which instead had to be used to move men and material to fight the war. Bread remained the only foodstuff that was centrally supplied by the state (Moskoff, 1990, 94). The shift in state strategy included relaxation of restrictions on subsidiary farming by state enterprises, which were allowed to create subsidiary farms, and by households. Local food autonomy was articulated as official policy as early as July 1941 (Moskoff, 1990, 96). A 1939 government resolution that had placed strict size limitations on *lichnoe podsobnoe khoziaistvo* stopped being enforced, and subsidiary agricultural production spread onto former collective farm land in order to increase food supplies. As a consequence, food production from subsidiary agriculture provided more monetary and non-monetary income for peasant households. Income (monetary and non-monetary) from *lichnoe podsobnoe khoziaistvo* per collective farm household in 1940 constituted almost 54% of their total income, and wages from work on the collective farm only 11%. By 1946, income from *lichnoe podsobnoe khoziaistvo* constituted 65% of household income, with wages from a collective farm just 2% (Verbitskaia, 1992, 142). In a very real sense, therefore, *lichnoe podsobnoe khoziaistvo* provided a lifeline for collective farm families. In addition, subsidiary agricultural production by households not only fed the rural population but also generated food to feed urban residents and people who had been evacuated from western regions as state supply chains were disrupted during the Nazis' advance.

The post-war period witnessed a renewed crackdown on smallholders. A September 1946 decree made clear that postwar agrarian policy was based on the restoration of socialized agriculture. The 1946 decree called for the enforcement of the previous 1939 resolution, which meant that land that had been used for subsidiary agricultural production during the war was returned to collective farms. Accordingly, more than 14 million acres of land were transferred from subsidiary agriculture back to collective farms, although a relatively small portion was returned from individuals (Volin, 1970, 303). Moreover, in 1948, a tax in-kind was introduced on production from *lichnoe podsobnoe khoziaistvo*, similar to state food procurements from socialized farms. Stalin's last attack on *lichnoe podsobnoe khoziaistvo* and collective farm markets came in his book on economic policy, published in 1952 as *Economic Problems of Socialism in the USSR*. In this short book, Stalin called for the elimination of the *kolkhoz* market where household gardeners sold some of their production, which meant that, if enacted, rural households would have no legal outlet to sell their surplus produce (Stalin, 1952, 63-71). Stalin died before this idea came to fruition.

State Policy under Khrushchev

Whereas Stalin made concessions to smallholders who engaged in *lichnoe podsobnoe khoziaistvo* only during the war period, First Secretary Nikita Khrushchev understood that household subsidiary agricultural production was linked to existing economic conditions. Although Khrushchev was committed to expanding and strengthening socialized agriculture, those conditions did not yet allow the elimination of household subsidiary agriculture. Khrushchev‘s approach to *lichnoe podsobnoe khoziaistvo* was dichotomous. During the first few years of his rule, Khrushchev pursued different strategies to increase food production in the socialized sector—increasing procurement prices and increasing land under cultivation through the Virgin Lands project (McCauley, 1976). He also incentivized production from *lichnoe podsobnoe khoziaistvo* by easing some of the restrictions. For example, a 1957 decree (effective January 1958) ended compulsory food deliveries for urban and rural *lichnoe podsobnoe khoziaistvo* and some household debt was written off (Wadekin, 1973, 232).

From December 1958, however, Khrushchev restricted *lichnoe podsobnoe khoziaistvo*, evidenced through a direct attack on privately owned livestock which Hedlund calls the ―nerve‖ of smallholders (Hedlund, 1989, 20). Khrushchev wanted to decrease state dependence on meat raised by households, and he made clear that he preferred most of the growth in livestock herds to occur in the socialized sphere. In a December 1958 speech, Khrushchev claimed that privately livestock owned was a serious constraint on the development of socialized agriculture, and he advocated farm employee households to sell their livestock to the farm where they worked. Although the sale of animals was to be voluntary, it took on the urgency of a political campaign so that sales were often compulsory, a fact that subsequently led Khrushchev to urge restraint by local officials in early 1959 (Wadekin, 1973, 282).

In addition, during 1959 more restrictions were enacted. *Lichnoe podsobnoe khoziaistvo* operators were prohibited from purchasing food such as bread to use as animal feed; and farm sales of feed grain and concentrates to plot holders were discontinued. In addition, payments-in-kind to collective farmers, which had consisted mainly of grain for fodder, were also reduced (Hedlund, 1989, 21). Fodder and grazing rights were restricted. These measures meant that it became very difficult for *lichnoe podsobnoe khoziaistvo* operators to feed their livestock. The impact of these restrictions on *lichnoe podsobnoe khoziaistvo* is indicated by official data showing that in just one year, from 1959 to 1960, the number of privately-owned cattle declined by about four million head; the number of hogs decreased by 1.6 million; and sown area contracted by about one-half million hectares (Hedlund, 1989, 21).

In 1963, Khrushchev‘s attack on *lichnoe podsobnoe khoziaistvo* continued but more damage was done due to a severe drought. The poor harvest led to feed shortages and forced large-scale slaughter of animals in the socialized sector (Hedlund, 1989, 23). The smallholder sector also suffered as hog and sheep numbers declined significantly due to feed shortages. Smallholders‘ stock of pigs fell by three million and the number of sheep declined by 3.3 million by 1964. The decline in smallholders‘ livestock holdings affected their earnings. Earnings from *lichnoe podsobnoe khoziaistvo* fell from 62% of collective farm workers‘ household income in 1958 to 57% in 1963, and continued to decline thereafter (Bronson and Krueger, 1971, 223). Overall, when the Khrushchev period ended in 1964, his legacy was one of significant restrictions on *lichnoe podsobnoe khoziaistvo*.

State Policy under Brezhnev

The next Soviet leader, Leonid Brezhnev, was no less committed to advancing the socialized farm sector than was Khrushchev. Brezhnev increased investment into state and collective farms, raised procurement prices, and expanded farm mechanization and the use of chemical fertilizers (Hahn, 1972, 168-88). As a result, during 1965-1980, the number of tractors rose by 1.5 times, the number of grain combines rose by 1.4 times, the number of trucks rose by 1.7 times, the application of fertilizer per 100 hectares increased by 2.9 times, and the consumption of electricity grew by 8.9 times (Naukhatskii, 2003, 34). Importantly, Brezhnev improved wages for collective farm workers and also monetized those wages. For the first time internal passports were distributed to collective farm workers so that they could move within the USSR. The monetization of income and internal passports may be interpreted as ways to undermine *lichnoe podsobnoe khoziaistvo*. If collective farmers earned more and were paid in actual money, their incentive to operate a household garden would decrease; and the ability to move meant that at least in theory they could move to urban areas and in doing so would give up their rural *lichnoe podsobnoe khoziaistvo*. Those aspects have a degree of validity. But the biggest impact on smallholders was that Brezhnev faced a much more unfavorable economic environment. Whereas Khrushchev faced only one poor harvest in 1963 that forced the Soviet Union to import grain from the West, Brezhnev faced repeated crop failures: in the early 1970s, in the mid-1970s, and in the late 1970s and into the early 1980s. Those repeated crop failures, along with an economic slowdown that turned to stagnation, clashed with state promises for improved food supplies to the growing urban population. In response, Brezhnev eased some restrictions on *lichnoe podsobnoe khoziaistvo*.

Immediately following the resignation of Khrushchev, in November 1964 the tax on livestock owned by urban dwellers was repealed, which had been in existence since 1956. The model charter adopted at the Third All-Union Congress of Collective Farmers in late November 1969 devoted Section 10 to personal plot farming. According to the Model Statutes, a household plot could extend to .50 hectares, including land occupied by buildings, or up to .20 hectares on irrigated land. In some regions, plot sizes up to one hectare were allowed. The 1969 charter also reiterated the right of *lichnoe podsobnoe khoziaistvo* operators to raise cattle, poultry, and bees (Zaitsev, 1969, 18).

The impetus given to smallholders in the late Brezhnev period exemplifies both critical economic conditions and Brezhnev‘s pragmatism. In 1977, a resolution by the Central Committee provided for loans to buy young livestock and to expand the production and sale of tools to operators of *lichnoe podsobnoe khoziaistvo*. In January 1981, a resolution by the Central Committee stipulated that *lichnoe podsobnoe khoziaistvo* operators who signed contracts with state or collective farms for the sale of their production were to be given improved access to feed and fodder supplies. In addition, if the plot operator sold his livestock to a collective farm, it could then use that production to count toward its own plan fulfillment (Wegren, 1998, 42). The January 1981 resolution also rescinded numerical restrictions on animals that could be raised by a household. However, the removal of this restriction applied only if livestock were raised under contract with a state enterprise in which case the purchase price was regulated by the state.

A follow-on Central Committee resolution was adopted in February 1981 that allowed for land to be converted to *lichnoe podsobnoe khoziaistvo* from ―the state land supply, state forest fund, industrial, transport and other non-agricultural enterprises and organizations, and also unused land of collective farms, state farms, and other agricultural enterprises‖ (cited in Wegren, 1998, 42). The effects of Brezhnev‘s measures were not overly impressive but did result in a short-term increase in household animals (see Table 1).

Despite the modest measures adopted under Brezhnev that were intended to stimulate smallholders‘ production, it is important to note that *lichnoe podsobnoe khoziaistvo* remained heavily regulated. Smallholders‘ plots were regulated in size; the number of animals was restricted unless raised under contract with a farm; and plot operators were prohibited from owning horses which could be used for plowing (Wegren, 1998, 43). There was no restriction, however, on state farm workers or other citizens owning horses.

State Policy under Gorbachev

Mikhail Gorbachev inherited a smallholder sector that was in long-term decline. Broadly speaking, the Soviet agricultural sector was in crisis for a variety of policy reasons, from a lack of leadership, poor harvests and rising grain imports, and stagnating food production that affected levels of consumption (Hedlund, 1984). It is beyond the scope of this chapter to review fully Gorbachev‘s agrarian reform strategy but suffice it to say that his policies were more conservative than liberal. Among his main reformist thrusts, one detects innate caution. Many of his –reforms‖ had been tried before: revitalizing the non-black earth zone; raising procurement prices; the implementation of a *prodnalog*, or food tax; and the use of links (*zvena*) in production (Wadekin, 1987). Even one of his ―progressive‖ reforms, increasing farm autonomy, suffered from bureaucratic pushback which eventually undermined the original intent. Essentially, Gorbachev tried to modify farm behavior by creating new incentives but fundamentally did not depart from the state and collective farm structure; and he retained production quotas and state procurements from farms although at a reduced level.

To the end of Gorbachev‘s rule, he allowed only land leasing for collective farm workers—a return to the days of NEP in the 1920s—and he favored peasant farms based on leased land, not private ownership of land at the federal level. In 1990 regional legislation in the RSFSR surpassed what national land laws allowed (Brooks, 1990). At the federal level, agrarian reform under Gorbachev never went as far as the Hungarians in 1968 and he refused to embrace systemic change of the agricultural sector. The Russian Republic, in contrast, adopted much more radical reform policies that embraced private ownership and a departure from socialized farming, which is discussed in a separate section.

Gorbachev‘s predilection for conservative reform was seen as well in his policy toward the operation of *lichnoe podsobnoe khoziaistvo*. As early as 1987, the Politburo called for increasing food production from *lichnoe podsobnoe khoziaistvo* on state farms and collective farms (Wegren, 1998, 44). At first glance, Gorbachev‘s approach to *lichnoe podsobnoe* *khoziaistvo* appears to be a liberal reform—deregulating the ―private‖ sector and reducing restrictions on it—but in fact his policy was conservative in that it did not change or threaten to change the agrarian structure that continued the dominance of state and collective farms. Further, *lichnoe podsobnoe khoziaistvo* remained based on land use rights, not private ownership of land. In other words, ―property rights,‖ were insecure and continued to depend upon farm employment. Inasmuch as *lichnoe podsobnoe khoziaistvo* operated *within* the socialist agrarian system prior to Gorbachev, it continued to do so during his tenure. In essence, policy reform toward *lichnoe podsobnoe khoziaistvo* was a relatively easy and inexpensive way to increase food supply in the countryside with trickle down effects to urban areas.

Despite innate conservatism, Gorbachev receives credit for removing several important restrictions. In the Collective Farm Charter adopted in March 1988, a more favorable attitude was reflected in section 9 devoted to *lichnoe podsobnoe khoziaistvo*. For the first time, point 57 referred to *lichnoe podsobnoe khoziaistvo* as ―a component part of socialist agricultural production‖ (Primernyi Ustav, 1988). Further, points 58 and 59 of the Charter reaffirmed the right of collective farm members to use their land for agricultural purposes; they could own the house which sits on the land plot and own animals and machinery used for agricultural purposes; the size of the plot and number of animals allowed would be determined by a general meeting of the collective farm; the farm would be allowed to sell animals and machinery for *lichnoe podsobnoe khoziaistvo* production, or they may be leased by contract; and the parent farm was allowed to provide various forms of assistance to households in terms of plowing, providing fertilizer, seed, animal feed, or making veterinary services available (point 61). Conspicuously absent in the statute was a restriction on the permitted number of livestock and poultry, which in the 1969 Charter had been explicit (Hedlund, 1989, 29). In May 1988, Article 37 of the USSR Law on Cooperation was adopted, and this law codified the right of collective farms to provide assistance to *lichnoe podsobnoe khoziaistvo*; and for plot operators to sign contracts for the sale of their production to collective farms, consumer cooperatives, and other enterprises (Zakon

SSSR, 1988). Thus, essentially, from 1988 onwards, factors inherent to production on *lichnoe podsobnoe khoziaistvo* were decentralized and no longer regulated by the federal government or the Communist party.

By the time of the important March 1989 plenum on agricultural reform, *lichnoe podsobnoe khoziaistvo* had gained equal stature with other forms of farming, at least rhetorically, indicated by reference to household plots as part of the ―multiplicity‖ of legal forms of farming in the USSR. Acknowledging *lichnoe podsobnoe khoziaistvo* as a component part of the agrarian structure and including household plots in the multiplicity of farming options was merely a recognition of reality and did not require additional state expenditures. In that sense, it was less than a radical reform. When Gorbachev‘s tenure came to an end in December 1991, and along with it the Soviet planned economy, *lichnoe podsobnoe khoziaistvo* enjoyed unprecedented legitimacy. It was also a jumping off point for analysts who argued that private agriculture and small family farms were the future of Russian agriculture.

Resilience

As indicated in the previous section, until the very last years of Soviet rule *lichnoe podsobnoe khoziaistvo* did not have a secure status in the Soviet agrarian system. To survive, smallholders had to be resilient. If we wanted to place a label on smallholders‘ resilience, they were *moderately resilient* during the 1940-1990 period. This section measures resilience during the Soviet period in three ways: (1) through weapons of the weak; (2) through land use; (3) and through food output.

Soviet leaders‘ frequent discriminatory policies against *lichnoe podsobnoe khoziaistvo* were combined with collective farm behavior that ranged from mild harassment to illegal action. But it is important to note also the existence of a symbiotic relationship between farms and collective farm workers. The strength of the symbiotic relationship varied from farm to farm, by farm manager or director, and by the resources of the farm itself. Essentially, this relationship meant that collective farms provided various kinds of assistance such as plowing; sale of fodder; providing agricultural tools and small equipment that can be used on household plots of land; the sale of small animals; allowing household animals to graze in common meadows; purchases of household surplus production, usually of perishables such as milk; and assistance with transportation of produce to urban markets (Wadekin, 1973, 181-246).

In addition to this informal symbiotic relationship, *lichnoe podsobnoe khoziaistvo* operators took matters into their own hands by using so-called weapons of the weak, a phrase coined by James Scott to indicate how peasants engage in low-intensity resistance against regime discrimination (Scott, 1985). Weapons of the weak are actions that are difficult to quantify so are best known anecdotally. In the Soviet context, weapons of the weak refer to ways to increase production from *lichnoe podsobnoe khoziaistvo* by engaging in illegal behavior. Examples include stealing time by working on the plot instead of for the farm; stealing inputs such as fodder; stealing construction materials to be used for animal shelters; or expanding the plot size onto farm land beyond the limits allowed in the Collective Farm Charter.

A second indicator of resilience is the amount of land legally registered for use in *lichnoe podsobnoe khoziaistvo*. As we saw above, income from *lichnoe podsobnoe khoziaistvo* declined over time as farm wages accounted for more of household income. Animal holdings on *lichnoe podsobnoe khoziaistvo* also declined for several decades. But despite regime discrimination and regulations, *lichnoe podsobnoe khoziaistvo* did not disappear and millions of Soviet households engaged in subsidiary food production. For the USSR as a whole, Hedlund estimates that almost 47 million families, equal to more than 160 million people and more than one-half of the Soviet population, had access to *lichnoe podsobnoe khoziaistvo* in the early 1980s (Hedlund, 1989, 32). Moreover, plot operators were highly sensitive to state policy. When the policy environment turned against *lichnoe podsobnoe khoziaistvo*, operators reacted rationally and curtailed livestock and land. But when the policy environment improved, private producers responded favorably by expanding land and animals, a dynamic that is illustrated with reference to the Russian Republic (see Table 1).

The third measure of resilience is households‘ capacity for food production. Table 1 shows that despite frequent regime discrimination over time, the household sector still raised many millions of cattle, pigs, goats and sheep, which served as an important source of animal husbandry production.

Table 1. Households’ Land and Animals in the Russian Republic, 1940-1989

	1940	1965	1970	1975	1979	1982	1983	1984	1986	1989
Sown land (million hectares)	3.2	3.0	3.0	2.9	2.5	2.5	2.6	2.5	2.3	2.4
Cattle (million)	13.6	13.8	11.3	10.6	9.7	9.5	9.8	9.6	9.3	9.5
Pigs (million)	5.2	7.7	6.6	5.3	6.0	5.8	6.7	5.7	5.5	6.2
Sheep (million)	21.0	17.2	17.4	13.2	13.1	12.4	12.9	12.7	12.5	13.0
Goats (million)	3.6	2.4	2.3	2.4	2.3	2.5	2.6	2.3	2.3	2.4

Sources: Tsentral‘noe statisticheskoe upravlenie RSFSR, 1976, 134, 147-48; Tsentral‘noe statisticheskoe upravlenie RSFSR, 1982, 142, 154; Tsentral‘noe statisticheskoe upravlenie RSFSR, 1983, 90, 101; Tsentral‘noe statisticheskoe upravlenie RSFSR, 1985, 142, 156; Goskomstat RSFSR, 1987, 161, 175; Goskomstat RSFSR, 1990, 448, 496.

The ruble value of household production declined over time as the socialized sector increased its food production. Even accounting for long-term decline, in 1986 *lichnoe podsobnoe khoziaistvo* produced one-quarter of total meat supply in the RSFSR. Included in that aggregate number was 15% of the republic‘s beef and veal; 32% of its pork; 30% of its poultry; 45% of its lamb (Goskomstat RSFSR, 1987, 179). *Lichnoe podsobnoe khoziaistvo* also accounted for the production of 23% of milk and 22% of eggs in the republic. Household plots also produced about 55% of the republic‘s potatoes and 25% of its vegetables (Goskomstat RSFSR, 1987, 157). Households sold small quantities of their production to the state, but that misses the point because that was not their main role. Thus, resilience is seen by the fact that even after decades of attempts to reduce output from *lichnoe podsobnoe khoziaistvo*, into the 1980s this sector remained indispensable as a source of food for the rural population.

Role in Society

As reflected in the comments above, the role of *lichnoe podsobnoe khoziaistvo* was to serve as a subsidiary source of food, primarily for collective farm workers' households and the rural population in general. The important point is that *lichnoe podsobnoe khoziaistvo* had a role and it was accepted by the Soviet leadership, although begrudgingly at times. Thus, *lichnoe podsobnoe khoziaistvo* had a place in the Soviet agrarian system, especially after 1965. The rhetoric of the late Gorbachev period, which equated the importance of *lichnoe podsobnoe khoziaistvo* with socialized farming, misses the point: subsidiary household agriculture was intended to be and always would be subsidiary to socialized farms. Under Soviet ideology, state and collective farms would always be preferred and the main source of food for the urban population.

THE EARLY POST-SOVIET PERIOD

With the end of Soviet communism, the ideological source of antipathy to the private smallholder sector disappeared. Replacing Soviet-era hostility toward *lichnoe podsobnoe khoziaistvo* was an embrace of capitalism, markets, and private property. Official attitudes toward *lichnoe podsobnoe khoziaistvo* began to fundamentally change, aided by economic conditions. The ―early‖ post-Soviet period is defined as the decade of the 1990s.

State Policy

I start with two broad comments. The first is that during the 1990s, unlike the Soviet period, there is no identifiable, coherent state policy toward *lichnoe podsobnoe khoziaistvo*. During the Soviet period, state policy was often antagonistic toward the private household sector. But at least there was an identifiable policy. The importance of having a policy versus not having a policy is that if there is a policy, at least there is a basis from which to adopt corrective measures.

The second comment is that implicit ―policy‖ in the 1990s toward *lichnoe podsobnoe khoziaistvo* was a byproduct of the general liberalization in economic policy, marked by deregulation of the economy, privatization, and creation of a new system of property rights. The 1990-1994 period in particular was characterized by a series of laws, decrees, and other legislative acts to legalize private ownership of land, which are discussed in detail elsewhere (Wegren, 2009). The larger point is that legislation is not in and of itself policy, but legal acts reflected a new approach to land ownership and to *lichnoe podsobnoe khoziaistvo*. Because land legislation was complex and has been discussed elsewhere, my purpose here is merely to provide a brief recap.

Land legislation in the Russian republic under the leadership of Boris Yeltsin was more radical than Gorbachev‘s USSR. A RSFSR law in November 1990 ―On Land Reform‖ legalized the right of private ownership for *lichnoe podsobnoe khoziaistvo* in the republic at a time that Gorbachev only permitted land leasing for the nation. As part of land privatization and destatization of farms, *lichnoe podsobnoe khoziaistvo* benefitted. The April 1991 RSFSR Land Code codified the private ownership of land for *lichnoe podsobnoe khoziaistvo* (Article 7), although restrictions on the sale of land remained; and it allowed the receipt of free land from state distribution for subsidiary agricultural use up to established norms (Kodeks RSFSR, 1991). Article 36 of the 1991 Land Code gave the right to regulate the size of land plots used for *lichnoe podsobnoe khoziaistvo* to rural, village, and city legislatures.

Not only did Yeltsin‘s government embrace private ownership of land, it also tried to break up state and collective farms, at least for a short time during winter 1991 to March 1992. Yeltsin‘s December 1991 Decree on ―Urgent Measures for the Implementation of Land Reform in the RSFSR‖ transferred almost 18 million hectares of agricultural land from state ownership to regional and municipal governments, who in turn could disperse land to private citizens for use in *lichnoe podsobnoe khoziaistvo*. As a result, not only did the number of registered *lichnoe podsobnoe* *khoziaistvo* plots immediately increase, so too did their average size. In Russia‘s 1993 Constitution, Articles 9 and 36 permitted the private ownership of land for *lichnoe podsobnoe khoziaistvo* and other smallholder agriculture, with rights to dispose of the land as the owner desires. Thus, the regulation of *lichnoe podsobnoe khoziaistvo* passed from the federal level to regional and municipal governments. Several municipalities adopted regulations that allowed plots for *lichnoe podsobnoe khoziaistvo* up to one hectare (Buzdalov and Krylatykh, 2000, 58-60). The era of de-regulated *lichnoe podsobnoe khoziaistvo* began.

Resilience

Smallholders‘ resilience was high during the 1990s as evidenced by several indicators. First, household production potential improved, driven by an increase in the total amount of agricultural land used and the amount of arable land used in *lichnoe podsobnoe khoziaistvo*. Total land use rose from 2.9 million hectares in 1990 to 5.3 million hectares in 1995; and arable land used by *lichnoe podsobnoe khoziaistvo* grew from 2.3 million hectares to 3.4 million hectares (Goskomstat, 1999, 17). In addition, the number of household animals experienced a short-term spike. The number of cattle rose from just under 9.8 million head in 1990 to about 12 million head by 1993 before drifting downward for the rest of the decade to 9.9 million in 1999. The number of pigs likewise rose from 7 million in 1990 to just under 8 million during 1992-1994 before declining to 6.9 million in 1997 and ending the decade at 7.3 million (Goskomstat, 1999, 31-32).

A second indicator of resilience was an increase in food output in absolute volume and relative to other food producers. In the five-year period 1990-1995, beef production rose from 573 thousand tons to 1.1 million tons; milk production increased from 13.2 million tons to 16.2 million tons; and honey production grew from 32 thousand tons to over 48 thousand tons (Goskomstat, 1999, 34). Importantly, compared to the 1990-1991 period, the percentage of production from *lichnoe podsobnoe khoziaistvo* that was sold decreased immediately in 1992 and stayed depressed for the rest of the decade, a reflection that rural households saw their production as a source of food security and survival strategy. Smallholders‘ production of plant products also rose in the first half of the 1990s. During 19990-1995, potato production on *lichnoe podsobnoe khoziaistvo* increased 76%, fruits and berry production rose 43%, and vegetable production grew by more than 2.6 times (Goskomstat, 1999, 30). These production increases did not just happen on their own, they were the result of increased intensity of effort by plot holders, measured by more time per day and week spent on food growing and by a higher participation rate across age and profession.

Table 2. Household Food Production as a Percentage of Total Production, 1990-1998

	1990	1995	1997	1998
Potatoes	66	90	91	91
Vegetables	30	73	76	80
Fruits and Berries	51	77	80	87
Beef and veal	13	41	49	52
Pork	34	64	70	70
Lamb	42	72	78	82
Milk	24	41	47	48
Eggs	22	30	30	30
Honey	69	84	87	88

Note: Percentages have been rounded.
Source: Goskomstat, 1999, 19.

Rising production meant that the percentage of food production coming from smallholders rose steadily throughout the 1990s (in ruble value). In 1990, the ruble value of production from *lichnoe podsobnoe khoziaistvo* accounted for 26% of total food production (24% for plant products and 28% for animal husbandry). The relative contribution from households rose as the decade progressed: to 48% of total production in 1995, 51% in 1997; and over 57% in 1998, when households accounted for 61% of the value of plant production and 54% of the value of animal husbandry (Goskomstat, 1999, 24). These relative increases were due to higher volumes of output from households as well as a decrease in output from state and collective farms. Production of several commodities from smallholders increased during the decade as shown in Table 2.

A third indicator of smallholder resilience in the 1990s was adaptive behavior to the new economic, legal, and financial environment. Unique longitudinal household survey data revealed that within the smallholder sector resilience was multidimensional and varied according to several independent variables: demographic structure of the household, age and gender of respondents, profession, and household labor potential. These (and other) independent variables impacted several dependent variables in the economic realm such as land holdings and expansion; land use; food production and food sales; the creation of household enterprise and revenue from it; and total household income (O'Brien, Patsiorkovsky, and Dershem, 2000; O'Brien and Patsiorkovsky, 2006; O'Brien, Patsiorkovsky and Wegren, 2008; Patsiorkovsky, 2009; Wegren, 2009; Wegren, 2014). Smallholder households that had favorable capital—human, financial, labor, land, and production—were able to benefit from economic opportunities and increase their income and well-being. Advantaged households also had higher community involvement and larger social networks. The net effect of heterogeneous responses to market-based institutions was an increase in stratification between adaptive and non-adaptive households that affected the incidence and depth of poverty, and mental health and satisfaction with life (Wegren, O'Brien, and Patsiorkovsky, 2003; O'Brien, Patsiorkovsky, and Wegren, 2004; and O'Brien, Patsiorkovsky, and Wegren, 2010). The importance of smallholder adaptation during the 1990s was that it put to rest arguments that Soviet socialism had made rural dwellers lazy, bound to collectivism, and opposed to private property and enterprise.

Role in Society

The combination of Russia's collapsing economy in the 1990s and increased importance of food production from *lichnoe podsobnoe khoziaistvo* meant that its societal role changed. Smallholders' role in society transitioned from being subsidiary production that supplemented the family diet in the 1970s and 1980s to a survival strategy for most rural households and many urban ones during the 1990s. Most rural households simply tried to maintain their standard of living, while a minority attempted to raise it. Different survival strategies were attempted by the majority. As many large farms went bankrupt or reduced their workforce, one strategy, alluded to above, was to increase the importance of food production from *lichnoe podsobnoe khoziaistvo* in terms of self-consumption and increased food sales. Households grew more food and some sold more food as a way to compensate for lost income from unemployment or to augment income in the face of high inflation. A second strategy was to increase *lichnoe podsobnoe khoziaistvo* production *and* to take a second job, often non-agricultural (Kalugina, 2000, 124). A third strategy was to increase illegal behavior, which in the economic environment at the time was justified in the minds of many farm employees (Kalugina, 2000, 127). This meant, for example, pilfering various inputs from the farm to be used on *lichnoe podsobnoe khoziaistvo*. There is evidence that this behavior was tolerated by some farm managers as a form of paternalism toward farm employees and as a strategy to lessen employees‘ dissatisfaction with economic conditions on the farm.

The larger point is that during the 1990s *lichnoe podsobnoe khoziaistvo* came to be viewed not merely as subsidiary food production but as a mainstream economic activity that was essential to survival. The changed role for *lichnoe podsobnoe khoziaistvo* reflected both more liberal policies and rational responses to a period of economic desperation for most households. Food production from *lichnoe podsobnoe khoziaistvo* was able to compensate in part for the precipitous decline in production from former state and collective farms. In this regard, *lichnoe podsobnoe khoziaistvo* was a system-stabilizer and probably helped to prevent mass urban unrest.

THE CONTEMPORARY PERIOD

The contemporary period starts in 2000 and continues to 2020. The backdrop to the contemporary period is the rebound in Russia‘s agricultural sector, led by large farm enterprises. The main storyline is the recovery in the large farm sector, which increased its contribution from 45% of output in 2000 to over 58% in 2019; and the ruble value of production from farm enterprises grew from R335 billion in 2000 to over R3.4 trillion in 2019 in nominal rubles (Rosstat, 2020, 354). Particularly important within the large farm sector is the rise of agroholdings (Rylko, Khramova, Uzun, and Jolly, 2008). Agroholdings are vertically integrated companies that engage in agricultural and non-agricultural activity. The largest agroholdings have land holdings of hundreds of thousands of hectares (Uzun and Shagaida, 2020, 429). These farms represent big capital—they earn tens of billions of rubles each year, and they have preferential access to state subsidies and credit. In 2016, agroholdings, which represent a small percentage of Russia‘s 27,000 farm enterprises of all sizes, employed 41% of all workers in agriculture, accounted for almost 54% of all farm earnings, and received 56% of all profits among agricultural enterprises (Uzun and Shagaida, 2020, 427). Those numbers improved after 2016 as Russia experienced a string of large grain harvests during 2017-2020. Moreover, in 21 of Russia‘s regions, agroholdings accounted for 25%-50% of food production, and in eight regions they produced more than 50% of the ruble value of output (Uzun and Shagaida, 2020, 428). In virtually every way, agroholdings have become economic behemoths, and their activity is not confined to food production. They also are involved in storage, processing, and transportation. Importantly, many agroholdings have also entered the food retail business, whereby their own production is sold under private label brands. Although agroholdings and *lichnoe podsobnoe khoziaistvo* are not direct competitors, agroholdings‘ control over market share for many commodities represent an obstacle for household gardeners who may want to expand commercial activity.

In addition to the rise of agroholdings, the private farm sector also began to make larger contributions to national food supply for grain, sugar beet, sunflower seed, and vegetables. Whereas in 2000 private farmers accounted for 3% of the ruble value of agricultural production, in 2019 their contribution had increased to nearly 14% of food output (Rosstat, 2020, 355). A sizable percentage of private farms are less than 20 hectares, and some are very small, less than 5 hectares and these may compete with *lichnoe podsobnoe khoziaistvo*. I discuss state policy in the contemporary period in the next section.

State Policy

At the turn of the century, output from *lichnoe podsobnoe khoziaistvo* accounted for more than one-half of the ruble value of food output, more than farm enterprises (see Figure 1). That is not to say that households were feeding the nation—food imports were on the rise—and household production was unprocessed and unlikely to appear on retail store shelves, but there is no doubt that household production was economically significant. That said, when Vladimir Putin assumed the presidency in his own right in March 2000, he wanted to stabilize the agricultural sector and help it rebound from the lows of the 1990s. Analysis of Putin‘s early initiatives toward the agricultural sector appears elsewhere (Wegren, 2002), so here the focus is on *lichnoe podsobnoe khoziaistvo* and the household sector.

Just as Putin was interested in rebuilding state strength and re-concentrating political power in Moscow, Minister of Agriculture Aleksei Gordeev (1999-2009) saw large farm enterprises as the key to Russia‘s agricultural rebound. In February 2001 at a conference near Moscow, Gordeev stated that the government supported diversity in farming based on different organizational and legal forms. But he also revealed his priorities by discussing trends in the developed world where the future of agriculture is based on large agricultural enterprises and vertical integration in the agroindustrial complex (Gordeev, 2001, 8). He and other speakers made clear that large farms were the ―locomotive‖ for agrarian development, through which cooperative and integrative processes should be channeled. When the state's agrarian strategy to 2010 was revealed a few months later, it was heavy on help to large farms—debt write off, subsidized access to farm equipment, a new credit system and agricultural bank, and other measures that were intended for large farms (Wegren, 2002). The implication was that state policy would not discriminate against *lichnoe podsobnoe khoziaistvo*, but smallholders were not seen as the basis for agricultural recovery or the future of a revitalized, globally competitive agricultural sector.

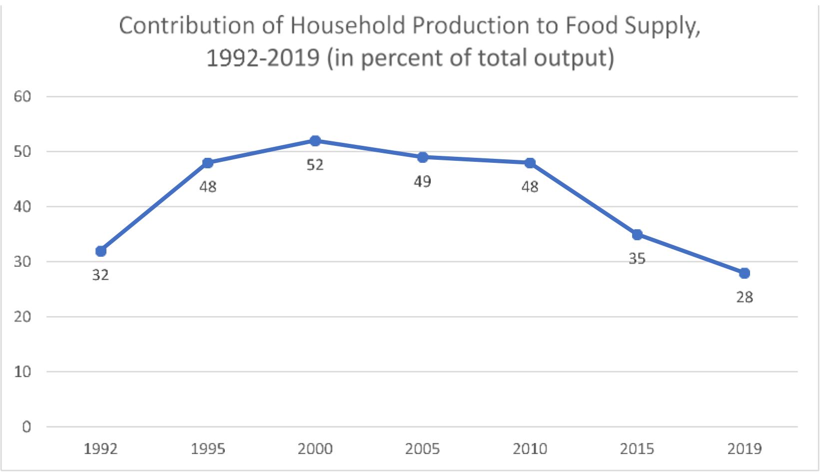

Figure 1. Contribution of Household Production to Food Supply (based on ruble value).

The government's wager on large farm enterprises in the early 2000s meant that *lichnoe podsobnoe khoziaistvo* had secondary importance. Nonetheless, household subsidiary agriculture received attention from the federal government in two ways. First, the 2003 federal law ―On Lichnoe Podsobnoe Khoziaistvo,‖ established boundaries for state regulation of household agricultural production. The law is relatively short by Russian standards, only 11 articles. The original 2003 law was amended in 2008, 2011, 2016, and 2018. The 2018 version includes the following main points of importance:

- *lichnoe podsobnoe khoziaistvo* is non-commercial activity encompassing the production and processing of agricultural products;
- food that is produced or processed belongs to the operator of *lichnoe podsobnoe khoziaistvo*;
- land plots for *lichnoe podsobnoe khoziaistvo* may be located around a dwelling or located within the borders of a population point, in other words, land located away from the dwelling;
- the maximum size of a land plot for *lichnoe podsobnoe khoziaistvo* was established at .5 hectares. Local governments could change the permitted size of a land plot but not by more than five times, or to 2.5 hectares for privately owned land; if the land plot is leased or belongs to the state or municipal government, then the maximum size restriction does not apply;
- state and local organs of government are not permitted to interfere in the operation of *lichnoe podsobnoe khoziaistvo*;
- the operator has the right to own the animals, equipment, buildings and structures, the personal dwelling, and other production inputs for the operation of *lichnoe podsobnoe khoziaistvo*; no restrictions on the number of animals were established in the law;
- an operator of *lichnoe podsobnoe khoziaistvo* is eligible to receive a state pension; and
- the state is responsible for providing infrastructure; creating legal, ecological, and social conditions that stimulate production; and providing access to pedigree animals and artificial insemination services in order to increase the quality and quantity of output from *lichnoe podsobnoe khoziaistvo*.

Overall, the law codifies a reduction in state intervention in the activities of *lichnoe podsobnoe khoziaistvo* and draws clear boundaries that restrict state interference. In establishing that *lichnoe podsobnoe khoziaistvo* is non-commercial activity, the law recognizes that household food production is primarily for self-consumption. Law is not policy, but law defines the parameters for policy, and it is clear that the intent is not to discriminate against production from *lichnoe podsobnoe khoziaistvo*.

A second way that the federal government affected *lichnoe podsobnoe khoziaistvo* came a few years later with the adoption of the ―national projects‖ in late 2005 which included agriculture as one of the state priorities. The national project in agriculture ran during 2006-2007 and included a program relevant to smallholders called ―*sel'skoe podvor'e*‖ (literally translated as ―rural land around the dwelling‖). This program had several components but the most important concerned state-subsidized loans to smallholders. Operators of *lichnoe podsobnoe khoziaistvo* could choose between a two-year loan to be used for acquiring fuel; spare parts for machinery; materials to repair animal sheds; acquire seed and feed; pay for electricity; and a number of other permitted uses. The second choice was a subsidized loan for five years to purchase small equipment and machinery for *lichnoe podsobnoe khoziaistvo*; to purchase equipment for raising animals and processing food; to purchase animals; to construct or modernize buildings for animals; or to get connected to natural gas lines. The two-year loan was capped at R300,000 and the five-year loan at R700,000.

The national project in agriculture expired at the end of 2007, replaced by the state program for the development of agriculture that ran 2008-2012. As Russia‘s agricultural recovery progressed, federal support was directed first and foremost to large farm enterprises, and secondarily to private farms whose production of certain commodities was increasing rapidly. Smallholders had access to state-subsidized credit under the umbrella of state support for ―small forms of farming‖ which includes *lichnoe podsobnoe khoziaistvo* and private farms; in essence smallholders compete with private farmers for financial resources and available evidence suggests that private farmers have priority. That said, some regional governments continued their own program for *lichnoe podsobnoe khoziaistvo*. In the Republic of Bashkortostan, for example, in 2009 operators of *lichnoe podsobnoe khoziaistvo* received R281 million in regional support, which included R118 million for subsidized credit. For 2010, the republican government provided R200 million in financial support to *lichnoe podsobnoe khoziaistvo* (Mazin, 2010, 3). But targeted subsidized credit and loans from the federal government to smallholders disappeared.

Today, smallholders who operate *lichnoe podsobnoe khoziaistvo* and who have privatized their plot are able to use it as collateral for a loan. The 2004 the federal law on land mortgaging deferred to regional and local governments to define the plot size below which mortgaging was not allowed, so there was no general guideline for the nation as a whole. The real criteria for land mortgaging come from banks. Using Rossel'khozbank, the state-owned agricultural bank, as an example, in 2020 owners of *lichnoe podsobnoe khoziaistvo* were able to mortgage their plot for a loan that extended for three months, two years, or five years. The minimum loan offered by the bank is R30,000 and the maximum is R1 million. In September 2020, the interest rate for a loan up to R300,000 for 12 months or less is 10.5% and for 12-60 months 12%. The interest rate for a loan of R300,000 or more that extended 12-60 months is 12%. The two-year loan could be used for acquiring fuel, mineral fertilizer and pesticides, obtaining young animals, pay for electricity, purchase seed, buy gardening tools, and other uses. A five-year loan may be used purchase agricultural equipment such as small tractors, various implements for a tractor, watering equipment, and equipment for animals and processing agricultural products. A borrower must be at least 23 years old and not older than 75, have Russian citizenship, and be permanently registered. In addition, income other than from household gardening must be documented to ensure ability to repay (Kredit, 2020).

That said, although owners of *lichnoe podsobnoe khoziaistvo* have the theoretical right to mortgage their privately-owned land, there are real-life obstacles. One obstacle is that a dwelling is usually situated on the land, and thus in the case of non-repayment of a loan it is very difficult to seize the land that was used as collateral. For this reason, banks are often not interested in mortgaging land used for *lichnoe podsobnoe khoziaistvo*. If a land plot is not occupied by a dwelling the loan process is easier. A second obstacle concerns documentation. In the 1990s, operators of *lichnoe podsobnoe khoziaistvo* received the equivalent of a deed called a *svidetel'stva* to prove privatization and ownership of the land plot. But since 1998, that documentation was no longer sufficient as the basis for a mortgage or land transaction. An owner would need to hire a third party to cadaster the land and then to register the land plot with the local authorities. This process was both costly and complicated. Without the post-1998 documentation, a land plot could not be used for collateral (Shagaida, 2020). Thus, the theoretical possibility to mortgage *lichnoe podsobnoe khoziaistvo* land exists but is difficult.

The larger point is that in the contemporary period the federal government has withdrawn from regulation of *lichnoe podsobnoe khoziaistvo* activity and after 2007 no longer was in the business of providing directed financial assistance to smallholders. The regulation of *lichnoe podsobnoe khoziaistvo* rested on regional and local governments, some of whom did enact restrictive rules on household animals in order to combat swine fever and bird flu. Owners of *lichnoe podsobnoe khoziaistvo* now turn to financial markets for a loan instead of government backed credit. And the private sector also is involved, helping operators of *lichnoe podsobnoe khoziaistvo* integrate with farm enterprises. Skilled specialists from farm enterprises offer advice on marketing and production, meeting market demand, and optimizing social infrastructure. One Russian academic, using Vladimir oblast as an example, argues that the success of *lichnoe podsobnoe khoziaistvo* often depends on experts‘ assistance so that household production is more attractive to processing enterprises and consumer cooperatives (Zhukov, 2013, 55).

In retrospect, the government‘s bet on large farm enterprises was the correct move. Gordeev believed that a nation of 146 million people cannot be fed by small, manually operated plots of land. The wager on large farms paid off in that within 20 years Russia‘s agricultural sector had transformed into the leading wheat exporter in the world, thereby returning it to its historical (pre-Soviet) role, which despite abject poverty among the majority of peasants, accounted for 30% of the world‘s grain exports during 1909-1913 (Volin, 1970, 110). Smallholders account for less than 1 percent of Russia‘s grain production, so their role in the rise has not been significant. Similar to the Soviet era, smallholders are of secondary importance, although for different reasons.

In the past few years there are signs that de-regulation of *lichnoe podsobnoe khoziaistvo* is being chipped away. Some regions have considered requiring households to register their animals with local authorities. Other regional governments began to place limitations on the number of animals that could be raised by households over concerns about unsanitary conditions and the spread of disease from household livestock to animals raised on agroholdings. In the most extreme case, in 2018 the regional government in Kaliningrad oblast banned the raising of pigs on household plots due to concerns over swine fever, leading to a 99% reduction in the number of pigs raised by households (Kvedomosti.ru., 2019a). Thus, the motivation for re-regulation has been economic, not ideological. At the federal level, in October 2019 the committee for agro-food policy within the Federation Council recommended that the 2003 law on *lichnoe podsobnoe khoziaistvo* be amended to establish a maximum number of animals, poultry, and bees that may be kept by households (Kvedomosti.ru, 2019b). Starting in 2021, new veterinary rules replace 2016 rules. The new rules regulate where animals (in particular pigs) may and may not be raised and prohibits wild animals on pig farms. The rules establish that quarantine zones must be at least 200 meters from where pigs are housed (Utverzhdeny novye, 2020).

Resilience

A discussion of smallholder resilience during the contemporary period must take account of two contradictory trends and therefore the overall assessment about resilience is mixed. On the positive side—suggesting high resilience—is unequivocal evidence that some rural households adapted their economic activity to the new institution framework and took advantage of new opportunity, particularly after 2000 when economic conditions began to improve. Households with advantages in human capital and labor capital benefited the most by expanding food output from *lichnoe podsobnoe khoziaistvo*, leasing additional land and increasing the size of total land holdings (although overall land plots remained very small), obtaining more animals, selling more food, engaging in family commercial business, and enjoying higher total income (O'Brien and Patsiorkovsky, 2006; Wegren, 2014). Household adaptation signifies resilience by being able to move beyond the survival and coping strategies that typified the 1990s.

Table 3. Trends number of registered plots by federal district

Region	2006	2016	Net change in registered plots
Russia	13.80 million	13.71 million	-900 thousand
Central	3.66 million	3.48 million	-148 thousand
Northwest	965 thousand	973 thousand	+8 thousand
South*	1.63 million	1.69 million	+60 thousand
Volga	3.58 million	3.52 million	-60 thousand
Urals	594 thousand	613 thousand	+19 thousand
Siberian	1.99 million	2.00 million	+1 thousand
Far East	381 thousand	379 thousand	-2 thousand

*Note: the composition of the South Federal District changed from 2006 to 2016. I have used only the same regions that appear in both years even though that is not full representation for 2006. Further, the 2016 composition includes Crimea which was not part of the Russian Federation in 2006.

Sources: Rosstat, 2008; Rosstat, 2018a.

In addition, despite the decline in the rural population from 39.4 million in January 2000 to 37.3 million at the end of 2018 (Rosstat, 2019, 18-19), the number of registered *lichnoe podsobnoe khoziaistvo* remained basically stable from the 2006 agricultural census to the 2016 census: 13.8 million in 2006 and 13.7 million in 2016 (these numbers are for personal subsidiary agriculture only and do not include plots for housing construction, dacha plots, and other small plots of land for small-scale agriculture). On a regional basis, from 2006 to 2016 the number of registered *lichnoe podsobnoe khoziaistvo* increased in Northwest Federal District; South Federal District; Urals Federal District; Siberian Federal District; and decreased in the Central Federal District; Volga Federal District; and Far East Federal District (Rosstat, 2008, 96-99; Rosstat, 2018a, 70-73). The data for each federal district in Russia are shown in Table 3.

On the negative side, one indicator is the growth rate in the value of production from *lichnoe podsobnoe khoziaistvo*, which has lagged that of large farms and private farms. Since 2000, the annual index of production from households did not exceed that of farm enterprises (Rosstat, 2020, 355). As a consequence, the relative contribution by *lichnoe podsobnoe khoziaistvo* to the ruble value of national food output reached its peak in the early 2000s and then declined through 2019 (see Figure 1).

Production trends reflect the inherent limits of small plots of land, exacerbated by a lack of access to credit and dependence on manual labor. For example, in 2004 in the Republic of Bashkortostan (a strong agricultural region), 80% of plots used for *lichnoe podsobnoe khoziaistvo* were .30 hectares or smaller, and less than 1% were larger than .5 hectares. More than a decade later with adaptation to a new economic environment, the average plot size for rural *lichnoe podsobnoe khoziaistvo* in the Republic of Bashkortostan rose to 1.3 hectares, but in other strong agricultural regions, rural plot sizes remained very small according to the 2016 agricultural census: Krasnodar krai, .2 hectares; Stavropol krai and Republic of Tatarstan, .3 hectares; Belgorod and Voronezh oblasts, .4 hectares; and Rostov oblast, .7 hectares (Rosstat, 2016, 37-38). Small plot sizes are found in regions that are not so favorable to agricultural production as well. In Vladimir oblast, located north of Moscow, 78% of *lichnoe podsobnoe khoziaistvo* plots were less than .25 hectares in 2012 (Zhukov, 2013, 51). Small plots impart inherent limits on production capacity, making it impossible to grow grain or raise cows which require a minimum of two to three hectares for grazing (Davletbaeva, 2004, 23).

A second indictor is the lack of coordination between household production and retail food markets is absent and there is a lack of social infrastructure that would help smallholders (Zvolinskii et al., 2018). In that regard, de-regulation of *lichnoe podsobnoe khoziaistvo*, in effect, led to neglect, so that smallholders experience difficulty with transportation, food processing, and selling their production, aspects that could be improved with more state assistance. The general absence of state support for smallholders means that they miss out on potentially lucrative market niches, for example, the sale of organic fruits and vegetables (Zvolinskii et al., 2018). The fact is that despite an ability to earn more income from *lichnoe podsobnoe khoziaistvo*, for most households it remained a subsidiary activity, secondary to other employment whether it be agricultural or non-agricultural. According to one team of Russian academics, less than 1% of *lichnoe podsobnoe khoziaistvo* is used as the main source of household income (Uzun and Saraikin, 2012, 46). Furthermore, owners of *lichnoe podsobnoe khoziaistvo* face other obstacles such as acquiring animal feed, and a decline in multifaceted assistance from farm enterprises that had been provided in Soviet era (Iliashevich, 2006, 31). For these and other reasons, rural dwellers are interested in joining service cooperatives that provide access to needed inputs, services, and credit (Iliashevich, 2006, 32). Unfortunately, credit, service, and production cooperatives in Russia often operate poorly (Golovina and Nilsson, 2011; Lerman and Sedik, 2014).

Thus, during the twenty years of the contemporary period, smallholder resilience has been mixed: some smallholders profited, the economic condition of other smallholders stayed essentially unchanged, and some fell behind. As a sector, however, the important point is that the inherent limitations of smallholding agriculture which were somewhat obscured during the Soviet period became pronounced in a market economy in which other food producers did not share those limitations. Production from large farm enterprises, led by agroholdings, stabilized, recovered, and then emerged dominant. The smallholder sector as a consequence declined in importance, a topic that is discussed further in the next section.

Role in Society

After 2000, production trends from *lichnoe podsobnoe khoziaistvo* changed in two ways. First, as noted above, smallholder food production trended downward, declining from more than one-half of the ruble value of output in 2000 to less than 30% in 2020. Second, smallholder production transitioned from being a core survival strategy that prevented mass hunger back to secondary importance; and in recent years it transitioned yet again to marginalization for most urban households and even rural households with favorable human capital (Lokshin and Yemtsov, 2004; O‘Brien and Patsiorkovsky, 2006; Wegren, 2014).

The change in the societal role for *lichnoe podsobnoe khoziaistvo* was due to secular events that were not directly related to household production but impacted output nonetheless. The first of these events was economic recovery in Russia that led to a substantial rise in real per capita income. Robust economic growth averaged over 7 percent per annum during 2000-2008. The rise in income was not merely an urban phenomenon, rural dwellers saw their disposable income rise as well. In the fourth quarter of 2001, rural per capita disposable income averaged about R1,360 a month (monetary and non-monetary income), which rose to R8,033 per month in the fourth quarter of 2008 (Goskomstat, 2001, 77; Goskomstat, 2009, 88). For rural dwellers, higher disposable income meant more freedom to buy food rather than grow food. Following the financial crisis 2008-2009, national real per capita incomes grew only 1% annually from 2010-2019, a large drop off from before but one that did not translate to a significant decline in demand for food (although certain cohorts of consumers economized by buying cheaper products and shopping at discount stores).

The rise in per capita income led to a rebound in demand for food after 2000, indicated by a rise in per capita consumption. Demand for animal husbandry began to rise again. Importantly, the greatest increase in demand was for processed food, whereas most smallholder production that is not self-consumed goes unprocessed. Further, food imports began to rise substantially, which was important because imported food in the early 2000s was superior in packaging, value, and quality. In 2000, the value of Russia‘s food imports was $7.3 billion, which rose to a high of $43.2 billion in 2013.[2] The upshot is that food imports ultimately replaced

[2] The deterioration in relations with the West over Crimea in 2014 led to Western sanctions and Russia‘s countersanctions in the form of a food embargo, with food imports dropping to $25.1 billion in 2016 before slowly rising thereafter.

consumers' purchases from *lichnoe podsobnoe khoziaistvo* at urban farmers' markets.

Rising per capita income fueled a rebound in domestic food production, a trend that accelerated after 2004. The ruble value of food production from all producers increased from R742 billion in 2000 to R5.9 trillion in 2019 (nominal ruble value). Similarly, the nominal ruble value of food output from large farm enterprises experienced healthy growth, rising from R336 billion in 2000 to 3.43 trillion in 2019 (Rosstat, 2020, 354).[3]

As incomes rose, consumer expectations changed as they preferred to buy processed and packaged meats and other products at supermarkets. The contemporary urban shopper increasingly does not need to go to farmers' markets for food products as during the 1990s. Instead, everything can be purchased at a supermarket, and food retail chains, both domestic and foreign, proliferated after 2010. In 2017, the city of Moscow alone had a total of 14,500 food stores of different types, including 1,825 supermarkets and over 3,000 specialized food stores. Throughout Russia, at the end of 2017 there were 22,473 hypermarkets and supermarkets, and 272,717 mini-markets (Wegren, Nikulin, and Trotsuk, 2021, 100). That number is constantly changing as retail chains open new stores. Even during the 2020 pandemic, retail food stores saw their profits skyrocket. According to Forbes, among the 200 largest private companies in Russia, the food retailer X5 ranked third with earnings of R1.73 trillion in 2019; in fourth place was Magnit, with earnings of R1.36 trillion in 2019 (DairyNews.ru, 2020). Magnit had a profit of R13.8 billion in the first half of 2020, up 265% over the same period in 2019. Magnit has 472 supermarkets in Russia. Nationally, gross earnings were up 9.3% at hypermarkets and almost 13% at supermarkets.

For a variety of reasons, therefore, the societal role of *lichnoe podsobnoe khoziaistvo* changed in ways that made food production from *lichnoe podsobnoe khoziaistvo* less necessary to urban food security, while remaining important for rural food security. That said, *lichnoe podsobnoe khoziaistvo* still has multiple useful roles to play. First, as already noted,

[3] During the same time period, the nominal ruble value of production from smallholders rose from R383 billion in 2000 to R1.66 trillion in 2019.

food production from *lichnoe podsobnoe khoziaistvo* is integral to social interaction and exchange in villages. That situation is an enduring feature of rural life and is unlikely to change anytime soon. Second, *lichnoe podsobnoe khoziaistvo* transfers tradition and rural culture from generation to generation, and is part of everyday rural life (Agafonov, 2012). Third, production from *lichnoe podsobnoe khoziaistvo* provides food security for lower income households in the event of high inflation, economic crisis, or food shortages. Potatoes in particular are a main crop from *lichnoe podsobnoe khoziaistvo*, from which 80% of national output is produced (Zhevora, 2017, 23). Potatoes are also a key source of subsistence for low-income households. According to Russian official statistics, 69% of rural households grow their own potatoes for consumption; 51% of the lowest income households (bottom 20% of urban and rural) grow their potatoes; and 88% of the lowest income households eat potatoes daily (Rosstat, 2016b, 8, 10, 13). Despite an increase in nominal disposable income that allows consumers more freedom to shop at stores, food production from *lichnoe podsobnoe khoziaistvo* supports food security on a local basis (Sadykov, 2015). This condition is also unlikely to change. Finally, *lichnoe podsobnoe khoziaistvo*, ―absorbs‖ some of the displaced labor in rural areas as farms reduce their workforce or close altogether, and this is particularly true in regions that are distant from the large cities in European Russia where alternative employment is more easily found (Popova, 2011). In that way, *lichnoe podsobnoe khoziaistvo* plays a role in rural development by providing employment and income opportunity.

THE FUTURE

Previous sections surveyed state policy, resilience, and smallholders' role in society from the 1930s to 2020. I now turn to the future, and this section speculates on scenarios for smallholders in rural Russia. The timeframe for the future is defined as the next 10-15 years. I analyze three scenarios, starting with the least likely and proceeding to the most likely.

Disappearance

The first scenario is for *lichnoe podsobnoe khoziaistvo* to disappear. One type of disappearance is associated with villages and rural settlements ceasing to exist, usually because of out-migration or population decline due to age and death. The formal number of villages has declined over time, and often a village may exist only on paper with few if any actual residents, and this occurrence is frequent in northern regions. Further, Russia's rural population declined by about 5% during 2000-2018 (Rosstat, 2019). It is projected to decrease another 12% to 32.9 million by the end of 2035 according to the medium variant (Rosstat, 2017). A second type of disappearance is due to the collapse of a parent farm where villagers may have worked. In this case, sometimes villagers remain and become an association of household gardeners even after the farm has closed. A third type of disappearance occurs when operators of *lichnoe podsobnoe khoziaistvo* convert their land to a private farm or non-agricultural enterprise.

Nonetheless, it is difficult to imagine that *lichnoe podsobnoe khoziaistvo* would disappear completely and as long as there are rural dwellers there will be household gardening. Even if the rural population were to decline to 10 million by 2036, they still would engage in *lichnoe podsobnoe khoziaistvo*. Thus, the disappearance scenario is the least likely outcome in my opinion. There are several reasons why complete disappearance is unlikely.

The first reason why complete disappearance is unlikely is that there is an historical attachment to *lichnoe podsobnoe khoziaistvo* for recreation and relaxation. The historical attachment also invokes tradition as a barrier to complete disappearance. Part of the historical attachment can be seen indirectly by the fact that Russia continues to have a high percentage of its total population residing in rural areas compared to other developed nations. In 2019, Russia had 25% of its population living in rural areas.[4] In

[4] I acknowledge a debate over what ―rural‖ means but I do not allocate space to the debate here. Further, I note that the term ―rural population‖ is subject to manipulation due to

that same year, among G7 countries, the USA, France, Canada, were below 20%; Japan was below 10%; and Germany and the UK were slightly above 20%. Only Italy at 29% of its population living in rural areas was higher than Russia, and Italy‘s total population is less than one-half the size of Russia‘s. Russians reside in rural areas for myriad reasons, one of which is lifestyle and access to *lichnoe podsobnoe khoziaistvo*. Further, there is a contemporary secular trend identified as ―re-peasantization‖ in which urbanites take up at least partial year residence in rural or peri-urban locations to grow food. Mamonova (2013) argues that a good portion of re-peasantization is engaged in dacha plot production. Further, food production from dachas reflects cultural rituals and is an important coping mechanism (Round et al., 2010). Some re-peasantization also extends to *lichnoe podsobnoe khoziaistvo*.

A second reason why disappearance is unlikely is that *lichnoe podsobnoe khoziaistvo* is an integral part of village culture, specifically social interactions and economic exchange among village members. Paxson characterizes the social infrastructure of a village based upon ―*svoi*,‖ which literally means ―one‘s own‖ and pertains to family, friends, or co-villagers (Paxson, 2005, 53). Paxson describes the *svoi* system as one in which status in the village is obtained by being an agent of redistribution; by giving more than one receives; by engaging in informal exchanges that are not exploitative and that encourage economic homogeneity in the community (Paxson, 2005, 67-73). Informal exchanges in the village are non-monetary and usually involve production from the household garden. Thus, *lichnoe podsobnoe khoziaistvo* is central to informal exchange in villages that in turn imparts status and defines social relations with other villagers.

A third reason why disappearance is unlikely is that literal disappearance would have to entail the mass disenfranchisement of rural residents from their dwelling and land surrounding the dwelling. Most household garden plots are located around a rural dwelling, in effect attached to the dwelling, so it is not clear how *lichnoe podsobnoe*

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administrative reclassification changes. Finally, ―rural‖ does not necessarily mean engaged in agricultural employment.

khoziaistvo could disappear without the household disappearing as well. A bank or agroholding would have to take over all of the village land, something that surely would spark resistance and likely involve lawsuits and intervention by local government. Visser and his colleagues argue that land grabbing is an ongoing problem in rural Russia, although they do not provide concrete data to quantify its extent or regional manifestations (Visser, et al., 2012). Land grabbing is more likely to occur with private farmers who have viable farms rather than smallholders with a fraction of a hectare of land. The bottom line is that mass disenfranchisement of millions of people from their home and land is inherently destabilizing, something that the state has little interest in and would likely intervene.

A fourth reason why disappearance is unlikely is that *lichnoe podsobnoe khoziaistvo* is a safety net and has been a source of household food security for decades. Households and individuals would have to voluntarily and consciously decide to give up their food security, a source of food that protects them from inflation, economic downturns, and unemployment. A villager who gave up his household garden is not only endangering his food security, he is also affecting social interaction, building social networks, and strengthening community ties.

Food Sovereignty

The second least likely scenario for smallholders‘ future is food sovereignty. Explicit attempts to apply the concept of food sovereignty to Russia are made by Spoor et al. (2013) and Visser et al. (2015), who argue that food sovereignty may be a viable path for smallholders‘ development in Russia. In contrast, Bernstein argues that food sovereignty does not constitute a food system and is characterized by utopian goals (Bernstein, 2014). Spoor and Visser base their argument on ―quiet‖ food sovereignty, which means that organization and resistance, two key ingredients in the original *La Via Campesina* movement, are absent or undetectable. They dismiss the need for organization even though *La Via Campesina* was a formal organization that attempted to unite with other formal international organizations. From the beginning, *La Via Campesina* represented smallholder resistance to ecological destruction and political and economic oppression from agribusiness and the industrial agricultural system. To remove organization and resistance from the equation is change the entire concept of food sovereignty. Based on their revised definition, Spoor and Visser argue that food sovereignty is found in contemporary Russia.

For Spoor and Visser, the primary behavioral evidence of quiet food sovereignty is small-scale production on *lichnoe podsobnoe khoziaistvo* and other smallholder production. If we accept the idea that food sovereignty is primarily defined by smallholder production based on manual labor and sustainable practices without regard to resistance, movement, or organization, it means that food sovereignty exists *anywhere and everywhere in the world by almost any smallholder engaged in agricultural production*, thereby making the term virtually unusable as an analytical concept. If we apply a higher standard of intellectual discourse, moving beyond ―quiet,‖ it becomes clear that the notion of quiet food sovereignty and its applicability to Russia is flawed as the points below demonstrate.

- Problem of organization. *La Via Campesina* started as a grassroots, bottom-up movement that rejected: (1) industrial agriculture and the ecological destruction that it brings; (2) the domination of food markets by agribusiness; and (3) the alienation of agricultural workers from the land on which they work (Schanbacher, 2010, 53-76; Bernstein, 2014; Clapp, 2020, 205-210). Although original food sovereignty started as a peasant movement, Spoor‘s and Visser‘s quiet food sovereignty dismisses social movements in Russia as ineffectual, a position that turns the original conception of food sovereignty on its head and is counterfactual. Social movements and protest movements in Russia do exist: protest movements express their opinion, they mobilize for change, and they even enjoy success as long as those efforts are not directed at regime change or are overtly anti-government. Mobilization over local economic issues is acceptable (Evans, 2019).

Moreover, there are many formal agriculture-related organizations that exist at the national level that are periodically critical of government policy while remaining loyal to the regime. These organizations are able to express their views without being repressed. Non-state organizations such as commodity-specific unions exist today that represent producers‘ interests on subsidies and trade issues (the Meat Union, Milk Union, Pork Union, and many others). These organizations have a corporatist relationship with the Kremlin. There is also a national organization for organic farming, which also has a corporatist relationship with the government. It is not, therefore, a given that a national-level organization representing rural interests will be suppressed. There is no inherent reason why a food sovereignty movement, if it actually existed, could not enter into a corporatist arrangement with the government similar to other agrarian interest groups.

- Problem of measurement. A fundamental tenet of social science is that something must be measurable for proof of existence. The quiet food sovereignty argument points to smallholders using traditional production techniques as its primary behavioral evidence. The fact is, however, that smallholder production based on manual labor and sustainable agricultural practices has existed for at least the last 100 years in Russia, in other words, *prior* to the advent of industrial agriculture. The question is how can food sovereignty in contemporary Russia be measured if the primary behavior that identifies it has existed during an era that *predates* the capitalist food regime and domination of international markets by global agribusiness? In short, the quiet food sovereignty hypothesis implies that food sovereignty existed *before* the causal events (industrialization of agriculture and the rise of agribusiness) that gave rise to the food sovereignty movement, a position that is illogical.
- Problem of commercialization. Food sovereignty holds that the mode of production should be non-commercialized, and broadly speaking we have noted that *lichnoe podsobnoe khoziaistvo* is non-

commercial activity. At the same time, the vast majority of *lichnoe podsobnoe khoziaistvo* operators sell at least a portion of their production (Uzun and Saraikin, 2012). There is regional variance of course, but in some regions the level of sales approach or exceed 50% (Pallot and Nefedova, 2007). Moreover, the most successful households with the highest standard of living (and higher labor capital) are more commercialized (Wegren, 2014). Households with a lower level of commercialization are more likely to be below the poverty line. In Russia, the younger cohorts who remain in the countryside prefer more commercialization over subsistence farming. For this reason, Agarwal maintains that ‗critical questions [arise] about the realistic nature of the food sovereignty vision' (2014, 1265). The commercialization of some production from *lichnoe podsobnoe khoziaistvo* raises the question of whether Spoor and Visser acknowledge division and divergent pathways for their quiet food sovereignty in Russia.

- Problem of local control. The concept of food sovereignty holds that smallholders should control their own production, which implies control over their land and production capital. Importantly, land and production capital continue to be regulated even in the post-Soviet period. Hence another condition that demonstrates the inapplicability of food sovereignty. In the contemporary period, households do not fully ―control‖ their land and animals, if we mean that households are free to decide the size of land holdings and number of animals. Federal legislation from 2003 allows regional governments to establish maximum size limits on land for *lichnoe podsobnoe khoziaistvo* (Wegren, 2004). If a land plot exceeds regional norms, either excess land must be sold or the operator is supposed to register as a private farm which is a commercial operation that is subject to taxation for food sales. Russia's Ministry of Agriculture supports limits on the number of animals a household may raise, and several regional governments established such limits.

- Problem of present-day reality. Russia‘s agricultural rebound since 2000 has been driven by state programs and policies accompanied by financial assistance to agroholdings and other large industrial agricultural enterprises. There is no state program for food sovereignty; the political leadership does not discuss food sovereignty; and regional governments have not adopted policies that support food sovereignty. Food sovereignty is not identified as a policy issue. For these reasons, to search for non-existent food sovereignty misses the main directions of actual agrarian policies. An analytical prism that focuses on food sovereignty renders analysts unable to interpret actual policies that Russia‘s policymakers discuss frequently: food security, import substitution, the food embargo, expansion of food exports, land reclamation, re-mechanization of farms, digitalization of agriculture, and the development of high-yield seed and animals.
- Problem of the future. Food sovereignty is a not pathway for future development in Russia because smallholder food production has been in long-term decline since 2004 in both volume and as a percentage of total output; this decline continued through 2019 (the latest data available). The idea that food sovereignty is a pathway to future development is problematic for two other reasons. First, because the overwhelming evidence points to Russia‘s agrarian future based on industrial agriculture; and second, a revitalization in the smallholder sector requires changes that are opposite of food sovereignty, for example, more mechanization, better access to supply chains and higher levels of commercialization.

The rebound in Russian agriculture since 2004 has been due to increased production by large farms and particularly agroholdings. The federal government and regional governments are pouring money into agroholdings and vertical and horizontal supply chains associated with them. The payoff for this strategy from the state‘s standpoint is that Russia has become an annual first or second ranking in wheat exports in the world since 2014 and is moving toward becoming a significant meat exporter. In this context, it is important to bear in mind the power aspirations of Russian leaders, who clearly are proud that Russia has emerged as a major grain exporter to more than 135 nations in the world. Food sovereignty plays no role in that rise. Agricultural prowess provides Russian policymakers with leverage to use food as an instrument of foreign policy (Wegren and Nikulin, 2019). Food sovereignty plays no role in that leverage. Thus, food sovereignty does not exist in Russia, quiet or otherwise, and remains an ideal-type food system that is unlikely to be realized on a national scale in Russia.

Continuation of Status Quo

The continuation of the status quo is the most likely scenario for smallholders‘ future because it is the most realistic. If this hypothesis is correct, there are several meanings for Russia‘s smallholders. First, continuation means that the smallholder sector will remain economically heterogeneous and stratified, with some households having larger land holdings and more animals; and some households will develop small-scale business from their *lichnoe podsobnoe khoziaistvo* while other households continue to use their food production as a supplementary source of food or for basic subsistence. Heterogeneity will continue to have a regional dimension. *Lichnoe podsobnoe khoziaistvo* in remote regions of Russia far north or far east, where natural conditions make industrial agriculture and private farming difficult, is likely to be more important to rural household food security than in European Russia where rural households have more options to obtain food.

A second meaning is that it would not be surprising if the economic contribution of *lichnoe podsobnoe khoziaistvo* to national food output continued to decrease. It also would not be surprising to see the ruble value of agricultural production from private farms surpass households within a decade. In the last decade, the ruble value of output from private farms increased from 7% of total production in 2010 to 14% in 2019 (Rosstat, 2020, 355). Private farms produce significant quantities of grain, sunflower seed, and sugar beet, all of which are processed into high value products. Not only do private farms produce commodities that are processed into high value products, they are able to take advantage of global price spikes. At the beginning of September 2020, for example, Russian sunflower oil reached a five-year high of $815-$835 per ton but increased to $940 by mid-September 2020 and some experts forecast that the price could exceed $1,000 a ton (Kulistikova and Maksimova, 2020). In 2019, private farmers produced 35% of the nation‘s sunflower seed by volume (Rosstat, 2020, 356).

A final meaning of the continuation of the status quo is that the gap between the food products that *lichnoe podsobnoe khoziaistvo* produce and what present-day consumers prefer to buy will continue to widen. Contemporary consumers like the convenience of one-stop shopping in supermarkets. They appreciate being able to choose among attractively packaged products: prepared and frozen foods that can be taken home to warm up. They enjoy shopping in clean, modern stores. Consumers develop store and brand loyalty, which brings a form of psychological food security. Thus, retailers within supply chains are not highly motivated to increase linkages to smallholders.

CONCLUSION

The prospects for smallholders in Russia are inherently linked to the broader question of the trajectory of its agricultural sector. It is becoming increasingly clear that big capital is winning over small capital in Russia, a trend that is true in many regions of the world (Bernstein, 2010; Clapp, 2020). Big capital is winning in production, distribution, supply chains, processing, and retailing. While large farm enterprises, agroholdings, and private farms are modernizing and adding to their productive capital (land, machines, and animals), households‘ land plot sizes are limited by law; there is momentum to enact limitations on the number of animals raised by households over sanitary concerns; and *lichnoe podsobnoe khoziaistvo* remains based on manual labor. Further, agroholdings and private farms have preferential access to state-subsidized credit, operators of *lichnoe podsobnoe khoziaistvo* do not. In short, the key ingredients to food production—land, animals, financial capital—are distinctly skewed against smallholders.

The domination of big capital in Russia is supported by the state that benefits from a globally competitive agroholding sector which earns foreign revenue from exports and brings prestige to the country. Needless to say, production from *lichnoe podsobnoe khoziaistvo* does not earn revenue from food exports and does not contribute to the international prestige of Russia‛s agricultural sector. As other producers in the agri-food system modernize, it is hard to escape the notion that smallholders are being left behind. While *lichnoe podsobnoe khoziaistvo* will continue to exist in rural Russia, its heyday has passed and its economic importance is likely to continue to decline. The irony of smallholders‛ situation is that they were discriminated against by the state during the Soviet period because they represented capitalism and operated on market principles. In the post-Soviet period, it is capitalism and the forces of the market that have facilitated the decline of smallholders.

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Publications from the Last 3 Years:

Books:

1) Stephen K. Wegren and Frode Nilssen, eds., *Russia's Role in the Contemporary International Agri-Food Trade System*. London: Palgrave Macmillan, forthcoming in 2021.
2) Stephen K. Wegren with Alexander Nikulin and Irina Trotsuk, *Russia's Food Revolution: The Transformation of the Food System*. London and New York: Routledge Publishers, 2021. 231 pp.
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3) Stephen K. Wegren, ―Can Russia‘s Food Exports Reach $45 Billion in 2024?‖ *Post-Communist Economies*, vol. 32, no. 2 (2020): 147-75.
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Chapter 2

SUSTAINABLE MILK PRODUCTION SYSTEMS IN ETHIOPIA

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ABSTRACT

Most of the milk produced in the developing countries comes from small-scale dairy farms, among which are intensified dairy regions of sub-Saharan Africa. Ethiopia has huge potential to be one of the key countries of East Africa in dairy production. A number of market- oriented smallholder dairy farms have appeared due to the rapidly growing demand for milk and milk products. To be competitive, smallholder livestock production needs to intensify and be able to provide higher value products. Dairy intensification provides both opportunities and challenges that need to be managed accordingly in order to improve milk production in a sustainable way. However, little is known of how dairy intensification driven by socioeconomic issues and dairy development efforts works as well as the challenges of changing production systems. Thus, this paper synthesizes information based on recent research and Ethiopian dairy farming as a case study to describe

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dairy intensification (productive livestock rearing, forage production and manure management) and associated factors, characteristics of changing dairy farms/ households and challenges associated with the intensifying dairy production systems and options to enhance its sustainability. Finally, recommendations are forwarded that would contribute to designing and implementing more attentive/contextual dairy development policies and intervention areas/programs in the intensified dairy regions of sub-Saharan Africa and other developing countries.

INTRODUCTION

Most of the milk produced in the developing countries comes from small-scale dairy farms. Smallholder dairying is a cost-effective and key source of nutrition and income to 300 million farm families globally (Ogola and Kosgey, 2012; World Bank, 2006), playing an important role in alleviating poverty (Somda et al., 2005; Ahmed et al., 2004). Smallholder livestock production will need to intensify to provide higher value products and also to enhance food security and the need for animal protein (Cronin et al., 2014; FAO, 2011), particularly with the increasing demand for livestock products. Smallholder farmers need to increase the production of dairy products to satisfy household demands for nutrition and income, but also to stay competitive in the face of growing competition. This increase in production needs to be achieved through more efficient and sustainable farming systems (Anderson et al., 2016).

Eastern Africa is the most promising region for dairy production (Bennett et al., 2005). Ethiopia has a huge potential to be one of the key countries in dairy production in the region (Staal et al., 2008). Population growth in Ethiopia will trigger consumption for livestock products to increase tremendously: between 2015 and 2050 demand for milk is estimated to grow by about 5.5 million tonnes or 145 percent increase (FAO, 2019). About 80% of this milk is produced by dairy cows (Shapiro et al., 2017). A number of smallholder dairy farms have emerged and become major milk providers to urban consumers. Yet, there remain challenges of enhancing milk productivity within the ever-demanding socioeconomic, demographic, and ecological changes. To this end, a strategy being promoted to support smallholder dairying is the intensification of dairy production through the use of improved agricultural technologies (Staal et al., 2008). Milk groups and cooperatives provide an environment suitable for dairy intensification by means of facilitating the dissemination of productivity enhancing technologies and also provide fluid milk marketing services (Chagwiza et al., 2016).

Intensification draws on technical improvements in livestock production in farm management in addition to genetics, health, feeding, etc., which have contributed to raising resource-use efficiency and higher output per animal (Steinfeld et al., 2006). The labor supply is often one of the key limitations to intensifying agricultural production (Herrero et al., 2014). While the role of women in small-scale livestock production is well recognized, much less has been documented about women‘s engagement in intensive production (HLPE, 2016; FAO, 2013b). This gap is also indicated by the recent review (Gallina, 2016) who stated that factors that limit or promote opportunities for women livestock keepers have received very little empirical analysis. In addition, the role that women play in the management of dairy cattle differs greatly among communities, countries and regions (FAO, 2013b).

Although the growth in the dairy industry can improve the livelihoods of farmers through increased income and sustainability (Ndambi et al., 2007), it is essential to keep in mind the importance of producing a quality product that is safe for the consumer. Quality and safety is also a valid indicator of overall postharvest losses (post-milking waste) (Weaver and Kim, 2001). Good product quality facilitates marketing and is a necessity to intensify production and to attain food security (Francesconi and Ruben, 2012).

The introduction of products with a high milk content has resulted in marked improvements in weight gain, linear growth, cognitive function and reduction in mortality in undernourished children (Dror and Allen, 2011; Moore et al., 2008; Hoppe et al., 2004). Therefore, regular consumption of milk is an easy way for one to help ensure the adequacy of nutrition as it is by far the best single food available to man (Paton et al., 2011). To this end, there is concern in protein-energy malnutrition (WHO,

2009) in the household diets of farming community and also interest in agriculture-nutrition linkage (The Ethiopian Academy of sciences, 2013; IFPRI, 2012; Lemke and Bellows, 2011). In this regard, the linkage between household nutrition and dairy farming is becoming another agenda of intensifying/market-oriented dairy food production system. Dairying contribute to achieving food security and improved nutrition, which is one of the goals of the Sustainable Development Goals.

The potential benefits and trade-offs of livestock intensification place livestock on the sustainability agenda (Udo and Fokje, 2010). Identifying constraints would help in prioritizing research and development needs to improve productivity and thus the welfare of producers (Taneja and Birthal, 2005) and their efforts to adjust to changing production systems. Further, devising a viable dairy development strategy for smallholders calls for a detailed analysis of opportunities and threats posed by the external environment (FAO, 2010).

However, few studies have analyzed emerging needs with respect to smallholder dairying, the farm characteristics influencing the intensification process, how producers can be able to respond to changing circumstances, and entry points for intervention to make the system sustainable. Hence, based on author‘s research in Ethiopia and extensive literature review, this chapter describes factors contributing to intensification of dairy production systems using selected aspects of intensification (forage production, cross breeding, and manure management), extent of dairy intensification, milk production, gender roles and labour allocation in dairy operations, milk quality and safety, milk consumption and marketing and its implication for improved household nutrition, challenges of smallholder dairy production and their implications for sustainable dairying. The case study district/Ada‘a in the Ethiopian highlands is an area with fast-growing smallholder dairy production system and with strong milk marketing cooperative and private dairy processors (ILRI, 2005). The milkshed has also increased opportunities in the Addis Ababa market, where dairy industries and supermarkets are rapidly growing (Moti et al., 2013; Francesconi et al., 2010). Moreover, dairy producers in this area are using various improved production inputs and practices.

FACTORS INFLUENCING INTENSIFICATION OF DAIRY PRODUCTION

Forage Production

Forty-four percent of the sample rural households cultivated improved forage plants (Figure 1). Cooperative membership, herd size, farmland size, and dairy training were significantly associated with improved forage production. This indicated that the probability of participating in forage production was positively and significantly influenced by herd size, land holding size, and dairy cooperative membership. However, dairy training provision negatively and significantly affected the probability of cultivating improved forage crops (Table 1).

The effects of household factors on improved forage production could be explained as follows: First, those farmers with larger herd size (both crossbred and indigenous cattle) were motivated for planting forages on their relatively better land holdings though there were competing land requirements for crop and dairy production in the rural system. Secondly, there was also private dairy processing plants collecting milk from non-cooperative members in this dairy production system as an important emerging marketing channel in case of limited access by the dairy cooperative. Therefore, dairy services including marketing and training provision are the limiting factors in forage production besides the household resource endowments (cattle herd, farm land).

Table 1. Maximum likelihood estimates of the dairy intensification model (forage production)

Variables		β	S.E.	P-value	Odds ratio
Cooperative membership	(2)	1.907	0.823	0.021[a]	6.731
Dairy cow genotype	(1)	-0.739	0.879	0.400	0.477
Major income source	(2)	0.774	0.958	0.419	2.168
Dairy experience	(2)	0.003	1.13	0.998	1.003
	(3)	1.227	1.04	0.238	3.411
Household head age	(2)	-1.046	1.04	0.316	0.351
	(3)	-0.457	1.07	0.669	0.633
	(4)	-1.977	1.22	0.104	0.138
Dairy training	(2)	-3.336	1.24	0.007[a]	0.036
Cattle herd size		0.191	0.06	0.001[a]	1.210
Farmland size		1.095	0.463	0.018[a]	2.990
Labor supply		0.439	0.39	0.265	1.551
Constant		-6.577	2.06	0.001	0.001

[a]Statistically significant at P<0.05; 1.00 reference category.
Source: Author‘s research (Habtamu, 2018)

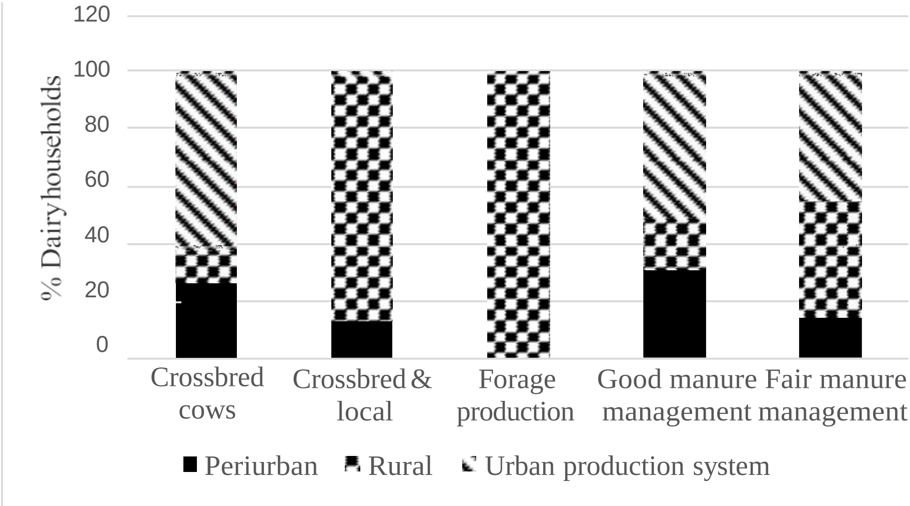
The current study is consistent with the findings by Mapiye et al. (2006) and Hassen (2014) that the intensity of practicing improved forage production was influenced by size of dairy cattle ownership and farm size. Similarly, a study on smallholder dairying in Uganda indicated that farmers with fewer or no improved cows and/or local cows were less likely to use improved forage technology (IFT). There was also a significant and negative relationship between farm size and use of IFT (Martınez-Garcıa et al., 2016; Turinawe et al., 2012). Training, demonstrations, and educational tours can improve the knowledge of farmers about legume-based technologies (Mapiye et al., 2006). Membership in a farmers‘ association did not significantly influence forage production in Southeastern Tunisia (Chebil et al., 2009). On the contrary, it was reported that membership of farmer groups had a significant and positive influence on use of IFT in smallholder dairying in Uganda (Turinawe et al., 2012).

The studied dairy farmers allocated 0.13 ha for forage cultivation (8% of farm land) though most of the farmers (56%) had more than average land size (1.54 ha). Shortage of seeds and extension services were limits to a shift toward intensive feeding. If these were addressed, land might have been used more efficiently to plant forage crops through appropriate cultivating strategies. Otherwise, the use of grain crop by-products and outsourced feed concentrates will continue to be the major feed resources for the foreseeable future. Both crop residues (mainly wheat straw) and feed concentrates (mainly wheat bran, oil seed cake, and poultry litter) were provided to lactating cows, which need to be complemented with forage crops to replace some of the low-quality roughage, costly feed concentrate, and unavailability of grazing land. Therefore, greater participation of farmers in the production of improved forage crops needs to be promoted, including leguminous forage on less fertile border plots of farmland and that can be integrated with soil and water conservation structures in areas with poorly drained land. For instance, in an experimental station, vetch can optimize both the biological and economic response of dairy cows when supplemented at the rate of 50% replacement of a formulated concentrate mix (Getu et al., 2010). Moreover, improving the supply of good quality fodder, particularly when linked to the provision of improved (exotic or crossbred) dairy animals, has the potential to increase milk production, and hence family incomes and nutrition, dramatically (Wambugu et al., 2006). In this regard, farmer-to-farmer extension and demonstration at the Farmer‘s Training Center could be successful methods to promote improved forages. Continued demonstration of the social, economic, and environmental benefits of improved forages can help achieve institutional change (Rao et al., 2015).

Dairy Genotypes

Seventy-seven percent of dairy farmers were identified as rearing only crossbred dairy cows, while 23% of the dairy households had both crossbred and indigenous cows (Figure 1).

Dairy production system, dairying experience, and cattle herd size significantly influenced the likelihood of keeping crossbred cows. This showed that urban dairy producers were more likely to have intensified dairying through rearing only crossbred dairy stock. The participation in only crossbreeding dairy program was less likely in rural dairy production system. Dairying experience positively and significantly affected the likelihood of keeping crossbred cows. The probability of keeping improved dairy cows decreased by 77% as cattle herd size increased by one unit (Table 2).



Source: Author's research (Habtamu, 2018)

Figure 1. Percentage of dairy households and their intensive farm management strategies versus production systems.

In relation to dairy genetics, the result indicated that most of the crossbred dairy cows were reared by (peri)-urban dairy producers, who had more dairying experience than the rural/mixed crop-dairy production systems. The peri-urban dairy producers had begun dairying by only rearing crossbred dairy stock due to market access and land pressure. Although, 25.5% of peri-urban and 49.7% of urban dairy producers had taken dairy training at the beginning, most of them enriched their dairy operations through greater years of experience. Indigenous cattle are also important resource in the moderately intensive rural dairy system as a source of draft power for staple crop farming. Hence, production systems, associated size of cattle holding, and dairying experience of households are important factors in a crossbreeding program.

Table 2. Maximum likelihood estimates of the dairy intensification model (dairy genotypes reared)

Variables		β	S.E.	P-value	Odds ratio
Dairy system	(2)	-1.895	0.96	0.049[a]	0.150
	(3)	3.911	1.76	0.026[b]	49.93
Cooperative membership	(2)	1.130	0.94	0.230	3.09
Major income source	(2)	-1.084	0.92	0.241	0.338
Dairy experience	(2)	1.109	0.85	0.194	3.03
	(3)	1.754	1.02	0.085[a]	5.78
Household head education	(2)	0.781	0.87	0.368	2.184
	(3)	0.338	0.80	0.673	1.402
	(4)	0.034	1.69	0.984	1.034
Dairy training	(2)	-0.447	0.79	0.571	0.639
Labor supply		-0.669	0.41	0.104	0.512
Farmland size		-0.068	0.37	0.853	1.070
Herd size		-0.268	0.08	0.000[c]	0.765
Constant		5.134	1.63	0.002	169.64

[a]Statistically significant at $p < 0.1$; 1.00 reference category;
[b]Statistically significant at $p < 0.05$; 1.00 reference category;
[c]Statistically significant at $p < 0.01$; 1.00 reference category.
Source: Author‘s research (Habtamu, 2018)

The present study is in line with results reported by various authors. According to Dehinenet et al. (2014) and Staal et al. (2002), dairy farming experience was positively related to the keeping of crossbred dairy cattle. The adoption of improved dairy cow technologies was negatively associated with the size of livestock ownership (Moll et al., 2007). However, the current finding is contrary to that reported by Tebug et al. (2014) in that crossbred cattle rearing was independent of herd size and duration of dairy farming. In general, crossbreeding local cattle with higher yielding exotic dairy breeds is an important tool for intensifying smallholder farming (Tulachan et al., 2002). Therefore, structured crossbreeding programs are needed to effectively run crossbreeding and also to retain purebred local breeds (FAO, 2007; Staal and Kaguongo, 2003), which is useful in maintaining genetic diversity in terms of production systems and a changing climate.

In the present study, 80.5% of respondents used artificial insemination (AI) service. The remaining 17% used bull service and 1% used both types of mating in the rural dairy system. In this regard, breeding or reproduction problems were among the major challenges faced by dairy producers that varied across production systems. These problems included the need for repeated breeding, the birth of male calves, lack of superior breeding stock, and irregularity of the AI service. To this end, most (54.8%) smallholder dairy producers purchased their foundation dairy stock from private/local sources and raised replacement heifers on their farms, which calls for a reliable and known genotype source of improved breeding stock (genetic improvement program). The existence of both crossbred and indigenous cattle herds maintains genetic diversity, which may contribute to sustainability on the rural farms, while the (peri)-urban producers need to focus on the strategy of increasing yield per animal (keeping the most productive crossbred dairy cows only) and associated issues to address the environmental concerns.

Manure Management

More than 50% of dairy farms (53.5%) practiced good manure management (Figure 1). Dairy production systems, farmland size and awareness of manure handling negatively and significantly related to manure management. This showed that dairy producers having relatively more land and those with no awareness of manure handling were less likely to intensify dairying through practicing good/better manure management. Likewise, the probability of participating in good manure management practice was lower in rural dairy production system (Table 3). Intensified dairying through practicing good/better manure management was implemented by dairy producers who had smaller land holdings and better awareness of dairy manure handling, mainly in the (peri)-urban dairy production systems. The limited land resources and awareness in these intensive farming systems motivated dairy producers to manage manure in a better way. Similar observations were made by other studies. Training (awareness) of household heads had a significant effect in manure management through biogas adoption (Nguyen et al., 2015; Mwirigi et al., 2009) in Kenya and Vietnam. Knowledge of composting in improving soil productivity (fertility) affected the use of manure in Malawi (Mustafa-Msukwa et al., 2010). In a nutshell, intensification increases the need for technical knowledge and services (Kristjanson et al., 2014). The farming system (zero grazing), size of farm, and management of animal manure (biogas use) were also significantly related according to a study by Mwirigi et al. (2009).

Table 3. Maximum likelihood estimates of the dairy intensification model (manure management)

Variables		B	S.E	Sig.	Odds ratio
Dairy systems	(2)	-1.409	0.72	0.052[a]	0.244
	(3)	0.778	0.43	0.069[a]	0.459
Dairy cow genotype	(1)	0.332	0.57	0.560	1.394
Awareness of manure handling	(2)	-1.165	0.38	0.002[b]	0.312
Dairy experience	(2)	0.220	0.51	0.663	1.247
	(3)	0.218	0.52	0.678	1.243
Cooperative membership	(2)	0.258	0.38	0.496	1.295
Farmland size		-0.526	0.31	0.091[a]	0.591
Cattle herd size		0.063	0.04	0.106	1.065
Labor supply		0.048	0.19	0.806	1.049
Constant		0.676	0.97	0.485	1.967

[a]Statistically significant at $p < 0.1$; 1.00 reference category;
[b]Statistically significant at $p < 0.01$; 1.00 reference category.
Source: Author‘s research (Habtamu, 2018)

In this study, 25% of dairy producers reported that they had manure handling problems, which varied across production systems. The practice of stall feeding, the availability of water source (mainly hand-pumped well), necessity of fertilizer for crops, and firewood shortage in the rural production system provide future prospects for biogas digester technology, which would have environmental and economic benefits. Some urban dairy farmers were also using effective microorganisms with feed to prevent odor, which were supplied by a private company. According to Worley and Wilson (2011), anaerobic digestion (biogas production) is also one solution to odor control. Overall, adequate technical skills on planning manure waste management need to be adopted by smallholder dairy producers to handle the manure-related problems effectively in the stall-feeding system. Moreover, barn floors of some dairy farms need renovation, new biogas digesters need to be introduced, and existing ones require close follow-up and maintenance to utilize this essential resource (manure).

Extent of Dairy Intensification

The extent of dairy intensification measured as milk supplied by producers revealed that mean daily milk yield and associated milk sales were significantly related with crossbreeding and manure management practices in combination, particularly in (peri)-urban dairy production systems (Table 4). In other words, dairy farmers, who practiced crossbreeding and good manure management supplied greater volumes of milk to dairy processing plants than the non-practiced group. Hence, crossbreeding has a positive effect on milk production depending on levels of genetic makeup and management practices employed.

Good manure management is also useful in sustaining the health and comfort of dairy stock and subsequently enhanced milk yield. The greater volume of milk produced in these systems was also attributed to increasing levels of intensification, greater proportion of crossbred dairy cows, better utilization of feed concentrates, greater dairy experience, the provision of alternative (government and private) veterinary and artificial insemination services, and access to information. The use of locally available inputs such as indigenous cattle for crossbreeding and by-products (concentrate feed and crop residues) may contribute to the socioeconomic sustainability of dairy practices. However, the government livestock extension service is not in a position to respond to the changes in dairy production systems, which calls for robust intervention and strengthening of the extension service to enhance management of the systems, mainly through building the capacity of dairy farmers.

Table 4. Means and standard deviations of dairy parameters against the improved dairy management practices[a]

Variables	Dairy management practices					
	Crossbreeding & good manure management			Crossbreeding & forage production		
	Yes	No	P-value	Yes	No	P-value[b]
Daily milk yield/stock (liters) (mean± SD)	15.0±4.33	13.0±4.42	0.04[c]	13.60±3.95	13.93±4.48	0.726
Daily milk yield/farm (liters)	28.58±16.06	20.69±15.86	0.001[d]	22.60±18.92	25.2±16.05	0.460
Milk sold/household/day (liters)	26.75±16.65	19.69±15.57	0.002[d]	20.58±15.57	23.83±16.63	0.357
Number of improved dairy stock	8.08±5.01	5.76±4.29	0.001[d]	7.00±6.15	6.99±4.63	0.991

[a]Number of observations=200; [b]Nonsignificant; [c]$P<0.05$; [d]$P<0.01$.

Source: Author‘s research (Habtamu, 2018)

MILK PRODUCTION

The overall mean for daily milk yield per cow was 13.56 ± 1.34 liters. The mean lactation length was 10.01 ± 0.88 months. The milk yield varied significantly across production systems and labour supply (Table 5).

Greater daily milk yield was found in urban production system (15.13 ± 1.62 liters) followed by 13.12 ± 1.57 and 12.43 ± 1.26 liters peri-urban and rural dairy system, respectively. Lower mean milk yield (12.62 ± 1.34 liters) was observed in the households with lower labor input (1–3) (Table 6).

Table 5. Least square means (LSM) and standard errors (SE) for daily milk yield (DMY), improved dairy stock size (IDS) and labor supply (LS)

Factors	DMY (lt)	IDS (number)	LS (number of people)
Overall	13.56 ± 1.34	8.61 ± 1.44	2.66 ± 0.19
Dairy production systems	**	NS	***
Peri-urban	13.12 ± 1.57[a]	8.46 ± 1.69	2.39 ± 0.22[b]
Rural	12.43 ± 1.26[b]	8.26 ± 1.36	3.38 ± 0.22[a]
Urban	15.13 ± 1.62	9.11 ± 1.74	2.21 ± 0.22[b]
Dairying experience	NS	**	NS
<5 years	13.27 ± 1.48	6.66 ± 1.15[b]	2.48 ± 0.21
6–10	13.94 ± 1.45	9.53 ± 1.19[a]	2.79 ± 0.22
>10	13.46 ± 1.39	9.19 ± 1.14[a]	2.71 ± 0.21
Household-head education	NS	**	NS
Illiterate	13.56 ± 1.45	6.83 ± 1.56	2.46 ± 0.21
Primary	12.70 ± 1.37	7.76 ± 1.48	2.72 ± 0.20
Secondary	14.06 ± 1.29	8.50 ± 1.39	2.61 ± 0.18
Tertiary	13.91 ± 2.01	11.35 ± 2.16	2.85 ± 0.34
Household-head age	NS	NS	**
24–34	13.85 ± 1.38	7.84 ± 1.49	2.22 ± 0.18[c]
35–44	13.48 ± 1.09	7.28 ± 1.18	2.65 ± 0.13[b]
45–54	12.62 ± 1.10	8.20 ± 1.19	2.98 ± 0.15[a]
>=55	12.41 ± 0.98	7.19 ± 1.06	3.01 ± 0.13[a]
Major income source	NS	**	NS
(Dairy farming)			
Yes	14.26 ± 1.40	9.71 ± 1.51	2.71 ± 0.19
No	12.85 ± 1.39	7.51 ± 1.49	2.61 ± 0.21
Cooperative membership	NS	NS	–
Member	13.19 ± 1.40	8.67 ± 1.51	
Non-member	13.92 ± 1.38	8.55 ± 1.49	–
Labor supply	**	NS	
1–3	12.62 ± 1.34	8.44 ± 1.45	
>=4	14.49 ± 1.46	8.77 ± 1.57	
Land size	NS	NS	–
0.05–1.11 ha	14.92 ± 1.00	8.50 ± 1.08	–
1.12–2.18 ha	13.85 ± 1.59	8.46 ± 1.72	–
2.19–3.25 ha	13.88 ± 1.79	9.06 ± 1.94	–
3.26–4.32 ha	11.58 ± 2.69	8.42 ± 2.91	–

LSM with different letters/superscripts within a factor differ significantly (***P < 0.01; **P < 0.05); NS = Not significant). NB. Number of samples studied (N) was 418 for DMY, 1398 for IDS and 200 for LS. Source: Author‘s research (Habtamu, 2018)

Table 6. Regression coefficient (B) for various factors with daily milk yield (DMY), improved dairy stock size (IDS) and labour supply (LS)

	DMY		**IDS**		**LS**	
Variable	B	SE	B	SE	B	SE
Dairy systems						
Peri-urban	−2.01**	0.86	−0.65	0.93	0.18	0.17
Rural Urban[a]	−2.70**	1.30	−0.85	1.40	1.17***	0.21
Dairy experience						
<=5 years	−0.190	0.99	−2.57**	1.07	−0.24	0.18
6–10	0.479	0.79	0.30	0.86	0.08	0.15
>10[a]						
Education level						
Illiterate	−0.35	1.66	−4.52**	1.79	−0.39	0.32
Primary	−1.21	1.68	−3.59	1.81	−0.13	−0.24
Secondary	0.16	1.58	−2.85	1.69	−0.24	0.31
Tertiary[a]						
Household head age						
24–34	1.44	1.13	0.64	1.22	−0.78***	0.21
35–44	1.07	0.83	0.08	0.89	−0.34**	0.16
45–54	0.19	0.82	1.01	0.89	−0.02	0.16
>=55[a]						
Dairying as major income						
Yes	1.41	0.79	2.19**	0.85	0.10	0.15
No[a]						
Cooperative membership						
Yes	−0.73	0.75	0.12	0.81	–	
No[a]						
Labour Supply						
1–3	−1.88**	0.84	−0.33	0.91	–	
>=4[a]						
Land size (ha)						
0.05–1.11	3.34	2.57	0.08	2.77	–	
1.12–2.18	2.27	2.59	0.04	2.79	–	
2.19–3.25	2.29	2.71	0.64	2.92	–	
3.26–4.32[a]						

Significance regression coefficients (****P* < 0.01, ***P* < 0.05).

[a]Reference categories.

Source: Author‘s research (Habtamu, 2018)

The efforts of most smallholder dairy producers to purchase foundation dairy stock from private sources and breed cows up to 5th parity and raise their own replacement heifers on their farms are appreciable, although an organized breeding program is needed. The average herd size (8.61) and number of improved cows (2.09 ± 1.39) in the present study are higher than that reported in the zero-grazing households of Kenya (3.2 and 1.5), respectively (Udo et al., 2016). An average herd size of four was reported in Uganda/Kampala (Prain et al., 2010). The lower number of improved dairy stock in the rural dairy production system in the study area was due to the fact that rural dairy producers also reared dual purpose indigenous cattle and had less improved dairying experience, although they had relatively larger land holdings. Therefore, there is a moderate level of intensification in this system in terms of improved dairy stock holding. The significant difference in the daily milk yield across production systems is probably the result of variations in major income source, feed types, dairy experience, land size and the number of crossbred/improved dairy cows. Therefore, the choice of milk yield as a measure of production intensification is valid as it captures the effects of the factors (improved nutrition, optimal management, reproduction or genetics) in the improved productivity per animal (de Jong 2013). The maximum daily milk yield (27 litres per dairy stock) in the present study also indicates that there is potential to increase milk productivity, particularly in the intensifying (peri/urban) dairy production systems and the associated market demand.

GENDER ROLES AND LABOR ALLOCATION IN DAIRY OPERATIONS

The overall mean for dairying-labor obtained in the current study was 2.66 ± 0.19, which differed significantly among households across production systems and household head ages (Table 5). More labour supply was observed in the rural crop-dairy system and in those dairy households whose heads were older than 35 years (Table 6).

Table 7. Gender division of labour in dairy activities (%)

Type of household labor	**Dairy activities (% labor involved) and *P*-values**											
	BC	*P*-value	CC	*P*-value	FW	*P*-value	M	*P*-value	PS	*P*-value	MM	*P*-value
Husband	32	0.028[b]	35	0.662	34	0.038[b]	31	0.001[a]	58	0.001[a]	11.5	0.451
Wife	52.5	0.004[a]	56	0.005[a]	53	0.001[a]	49.5	0.000[a]	51.8	0.035[b]	55	0.005[b]
Male children	8.5	0.043[b]	7.5	0.249	13.5	0.002[a]	7.5	0.060	21	0.000[a]	4	0.206
Female children	12	0.002[a]	6.5	0.083	9.5	0.696	6	0.036[b]	20	0.049	15	0.002[a]
Relative	10	0.001[a]	6	0.258	12	0.065	9.5	0.007[b]	12.5	0.003[a]	12.5	0.002[a]
Hired labor	28	0.014[b]	19.5	0.000[a]	31	0.011[b]	27	0.000[a]	20	0.114	33.5	0.015[b]

$P < 0.01$; [b]$P < 0.05$; differ significantly across dairy production systems.

Key: BC = Barn cleaning; CC = Caring calves; FW = Feeding and watering; M = Milking; PS = Purchase and sale; MM = Manure management/processing.

Source: Author's research (Habtamu, 2018)

Women participated in all dairy activities: caring/raising calves (56% of dairies), barn cleaning (53%), feeding and watering (53%), purchase/sale (52%) and manure management/dung cake-making (55%) (Table 7). Other activities demanding non-stop attention, such as barn cleaning, feeding and watering, were also carried out by other household members. Of the home tasks, the purchase of inputs (feed) and milk sale were mainly the tasks of husbands and male children in the rural dairy system. Interestingly, the involvement of wives in the purchase of dairy feed and the sale of milk was higher in the urban dairy system in dairy households that had had more than 10 years dairy experience.

In the present study, hired labor (36.7% females) was mainly involved in barn cleaning, calf caring, feeding, watering and milking, next in terms of per cent to the involvement of wife and husband. Hired labor was also more involved in manure management (dung cakemaking) next to women (wives). This varied across dairy production systems. The participation of hired labor (58–77%) was higher in urban dairy production system, which was also combined with family labor.

Women contributed more than men to dairy management practices though it was a heavy burden on them since it was performed on top of their daily routines of preparing food and caring for the family. Dairy production activities, except purchases/sales, relied more on women than men in both the peri-urban and rural systems, which could be attributed to other competing task such as cropping as the main income source even though more middle-aged household heads and relatively more family labor were found in these systems. The higher involvement of wives in the purchase of dairy feed and the sale of milk in the urban dairy system could be due to the fact that women are curious/attentive and also know from their experience that these tasks need care.

The finding of this study is in agreement with a study by Kimaro et al. (2013) that women contribute more to the labor force in dairy management than men, children and hired labor in zero-grazed or mixed production systems in Tanzania. Conversely, in the same country, dairy farmers depend largely on hired labor followed by a combination of hired and family labor for management of crossbred dairy cattle in urban and peri-urban areas (Gillah et al., 2013). In Peru and India, the role that women play is mainly in milking and cleaning activities (Paul et al., 2016; Gómez et al. 2007). In Kenya, women were busier daily than men, doing dairy activities required for dairy cattle (e.g., milking the cow(s), growing, harvesting and giving feed to the cattle, manure management, and transporting the milk to the pick-up locations (VanLeeuwen et al., 2012). Women also contributed more than men to activities required for running dairy units in Uganda (Njarui et al., 2012). In general, different levels of intensification can lead to differentiated impacts on women‘s work burden (Njuki et al., 2016).

The participation of hired labor was higher in the urban dairy production system in the present study. Similarly, in urban dairy farms of Dar es Salaam, Tanzania (Kivaria et al., 2006), and Kisumu, Kenya (Kagira and Kanyari, 2010), hired labor was used intensively in 97 and 76% of households, respectively. In the current study, of total labour, 53.5% was family labor, 2% hired labor and 44.5% of both were involved in dairy activities. Although the involvement of children in dairy activities was not that extensive, 50.5% aged 5–14 years and 49.5% older than 14 years were involved. The reasons for child labor could be due to poor work or shifting culture of supporting parents even though there were some instances of youths wanting to take over dairying from their parents as an agribusiness option.

Changing gendered roles of dairy tasks through community awareness creation can be part of the strategies to alleviate the pressure on women. Dairy technologies that reduce women‘s labor burden need to be introduced, especially in the areas of manure management (biogas digester), feeding and watering (e.g., small-scale feed mixer and water pump) and milking (small-scale milking machine). In this regard, we observed in the rural areas that women dairy producers, with no access to formal markets, were involved in the inefficient and heavy work of traditional processing of milk to extend its shelf life.

This calls for the introduction of small-scale, improved milk churner technology through utilizing a revolving fund or women‘s savings or credit groups. Moreover, the crossbreeding program of Jersey breed with indigenous cattle needs to be promoted as this crossbreed produces milk with a higher fat percent allowing increased butter production. The production of extended shelf-life milk products is also important during the fasting period when the milk quota is reduced in some formal markets.

In the present study, 89% and 50.5% of the dairy producers were married and had secondary education level, respectively. In Ethiopian by-law/principle, household properties (land, dairy stock, etc.) are common property in married couples unless otherwise claimed to be self-owned or when a shared proportion of family resources are predetermined before marriage. Thus, being married together with some training provided for households could contribute to women‘s control over resources.

According to a sample interview that took place in a rural kebele (lowest administrative unit), where greater segregation of women was expected, half of the married rural dairy producers made joint decision on income from milk sales while wives made decisions alone in the other half. The reason for the latter could be attributed to other income sources (e.g., crop farming) where husbands made sole decisions. Joint decision-making regarding dairy income was also reported in a study in Tanzania (Mvurungu 2013). According to Njuki et al. (2016), determining joint decision-making is complex as it is difficult to know whether each spouse has the same voice in the decision, or whether one spouse may just have consulted the other on the decision. Conversely, Farnworth (2012) stated that joint ownership and joint decision-making can increase food security and be transformative, making intra-household relations more productive and empowering women as a result. In the current study, it was witnessed that although 45.09% women had registered as dairy cooperative members, there were no women dairy producers in leadership positions in the dairy cooperative.

In general, increased control over income gives women a stronger bargaining position over economic decisions regarding consumption, investment and production in the household (FAO, 2013b).

MILK QUALITY AND SAFETY

Microbial Quality of Milk

Bovine milk samples had mean values of 2.86: 6.87 log10 cfu/ml and 5.39 log10 cells/ml for TBC, coliform count (CC), and SSC, respectively (Table 8). The practice of treating milk before consumption differed significantly across production systems. Eighty-four percent of the dairy producers boiled milk prior to consumption, which is important to reduce the risk of disease transmission. The remaining small proportion used both raw and boiled milk, especially in rural production systems.

Table 8. Descriptive statistics of microbial counts and water adulteration of milk; CC, coliform count; TBC, total bacterial count; SCC, somatic cell count

Milk quality	Dairy production systems	N	Mean	SD	Minimum	Maximum
CC (log 10 cfu/ml)	rural dairy system	41	3.02	0.39	2.00	4.04
	urban dairy system	43	2.85	0.61	0.00	3.94
	Total	84	2.93	0.52	0.00	4.04
TBC (log 10 cfu/ml)	rural dairy system	27	6.85	0.86	5.08	7.58
	urban dairy system	30	6.96	0.66	5.30	7.59
	Total	57	6.91	0.76	5.08	7.59
SCC (log 10 cells/ml)	rural dairy system	31	5.45	0.45	4.16	5.99
	urban dairy system	31	5.32	1.08	0.00	5.97
	Total	62	5.39	0.82	0.00	5.99
Added water (%)	rural dairy system	37	1.58	-	0.00	8.84
	urban dairy system	44	3.26	-	0.00	15.80
	Total	81	2.49	-	0.00	15.80

Source: Author‘s research (Habtamu, 2018)

The CC was in the range of the Ethiopian standard (<4.69 log10 cfu/ml). The value of TBC found was slightly higher than the standard of bacteriological quality of milk (<6.30 log10 cfu/ml) (Ethiopian Standard, 2009). The SSC value is higher than the US standard (<200,000 cells/ml or 5.30 log10 cells/ml) (Ruegg, 2003), but it is in the range of the EU standard (<400,000 somatic cells/ml or 5.60 log10 cells/ml) (More, 2009).

Different values have been previously reported for microbial counts in milk in Ethiopia, including values of 7.58 log10 cfu/ml for TBC and 4.49 log10 cfu/ml for CC (Asaminew and Eyassu, 2011) and a CC of 8.58 log10 cfu/ml for CC (Gemechu, 2016). The overall TBC and CC of raw milk were 7.32 log10 cfu/ml and 4.84 log10 cfu/ml, respectively, according to Derese (2008).

Even though there were individual household variations on managing milk safety issues in the study area, the secondary level education and dairy experiences of household heads might have contributed to moderate microbial counts, including hand and udder washing before milking, towel (40% of the farms) or other cloth (30%) used to wipe/dry udder, individual use of wiping material (65%), frequency of cleaning milk utensils (72% thrice and 17% four times) and using hot water (43%) in addition to detergent, frequency of barn cleaning (47% twice and 36% thrice daily), floor type (73% concrete), keeping withdrawal period (86%), and water source (87% tap and 13% well hand pump).

Lack of support in mastitis control/prevention and use of aluminum cans or stainless-steel milk containers, tap water and electrical cuts, and manure management affected the efforts of the producers to better improve milk quality, comply with hygienic dairy management practices, and continue market participation. Therefore, milk quality issues need to be managed through understanding the needs of smallholder dairy producers. In this regard, dairy intervention and extension services need to introduce inputs including information on appropriate milk utensils, and knowledge transfer regarding dairy management and safe milk production. Milk collection points should be accessible and strategically located, sheltered and with cooling capacity, and also milk should be transported using refrigerated vehicles to the processing plant.

Some small-scale technologies have been recommended to preserve milk. There are innovative cooling methods such as solar ice-cooling facilities that can help farmers preserve milk immediately after milking and allow them to market good quality milk (Makoni et al., 2013). Bovine milk has a naturally occurring inhibitory system called the lactoperoxidase system. As the system is more effective at 30°C than at 4°C, it is useful to preserve raw milk in case refrigeration is not available (Jay, 1996). Taye et al. (1999) assessed the preservative effect of lactoperoxidase system for preservation of milk for 3 hours longer than the untreated control, and they recommended its use to preserve milk until delivery to the processing plants. In general, prevention of microbial contamination of milk requires a combination of measures such as maintaining animals in a healthy condition, cleaning udders and rear quarters of the cow, cleaning milk contact surfaces and equipment, sanitary milk production practices by milk handling personnel, and avoiding excessive airborne contamination (Ashenaf, 2002).

Food safety regulations and implementation of mitigation strategies are duties shared by dairy stakeholders. For instance, the public- and private-sector stakeholders identified in Ethiopia include the Ethiopian Meat and Dairy Industry Institute; Ministries of Livestock and Fisheries, Urban works/Urban agriculture; veterinary services (government and private); veterinary drug providers, Feed and Animal Products Quality Control Authority; Food, Medicine, and Health Care Administration Authority; dairy producers; dairy cooperatives and private milk processors; feed suppliers; and academic/research institutions. Guaranteeing the food safety systems will need organized actions across policy, regulatory, surveillance, and control measures to reduce the risk of foodborne illness. Every government needs to consider these issues and invest in the appropriate steps from production to consumption. The adoption of better practices for food safety and bringing about change should take into account not only scientific knowledge as to how a safe product can be manufactured but also socio-economic factors.

There are dairy boards in different countries, e.g., Kenya Dairy Board, Irish Dairy Board, and Dutch Dairy Board. However, the establishment of a dairy board in Ethiopia may not be needed as there are overlapping mandates of the Ethiopian Meat and Dairy Institute in coordinating interventions to improve milk safety. Thus, this institute is recommended to be the most fitting public body to organize all dairy industry stakeholders. The regulatory issue can be dealt with by the Veterinary and Feed Administration and Control Authority and Food, Medicine, Health

Care Administration Authority. Livestock or dairy science professionals and veterinarians are integral to alleviate these problems, including designing a dairy intervention project, advising development agencies, informing policy, and other mechanisms that can support the smallholder dairy producers to ensure safe milk production.

A private company in Ethiopia, Hiruth milk production and processing enterprise, showed how a milk processor‘s effort can help alleviate some of the problems associated with improving milk quality. The company made available resources such as feed to its milk suppliers on a credit basis, educated them, and paid a quality based price premium (based on bacterial count and fat) (Steen and Maijersb, 2014). This incentive could motivate milk producers to focus on quality and buy better quality feed, reduce adulteration, and provide better storage conditions for the milk. Similarly, other dairy stakeholders in the milk chain need to contribute to bringing about sustainable results. In fact, the stakeholders would require adequate knowledge and capacity to apply preventive practices and control measures to overcome milk quality and safety problems and share relevant information with others in the chain. They need to work in a carefully planned and integrated manner to create an organized quality and safety control system consisting of appropriate prevention and control measures.

Before enforcement of milk quality standards, there is a need to provide land tenure security, input, and support services including improved dairy management techniques for (peri-) urban smallholder dairy farmers who supply milk to processors. Furthermore, the ultimate quality control will take time to be fully operational, because of the complexity of the animal production and food chains. Thus, a pilot scheme should be implemented to test the adoption by stakeholders of the appropriate quality control measures.

Chemical Composition/Quality of Milk

The overall mean value of the fat (3.82%) was slightly higher than the Ethiopian Standard (EU) value (3.50%) (Ethiopian Standard, 2009) (Table

9). There was a significant difference in fat % between the two dairy production systems and feed types (Table 10). Milk samples taken from rural dairy system had highest fat percentage (4.01±1.02), while that from urban dairy system was lower (3.64±0.65). The mean value of protein and SNF percentages were 3.25±0.32 and 7.73 ±0.86, respectively. The overall mean value of protein (3.25%) is similar with the Ethiopian standard value (3.20%) (Ethiopian Standard, 2009).

Table 9. Descriptive statistics of milk composition (% fat, protein and SNF)

Milk composition	Dairy production systems	N	Mean	Std. Deviation	Minimum	Maximum
Fat	rural dairy system	41	4.01	1.02	2.24	6.14
	urban dairy system	46	3.64	0.65	1.73	4.60
	Total	87	3.82	0.86	1.73	6.14
Protein	rural dairy system	41	3.27	0.38	1.97	3.98
	urban dairy system	46	3.23	0.27	2.37	3.67
	Total	87	3.25	0.32	1.97	3.98
SNF	rural dairy system	41	7.78	1.02	4.22	9.66
	urban dairy system	46	7.68	0.71	5.33	8.94
	Total	87	7.73	0.86	4.22	9.66

Source: Author‘s research (Habtamu, 2018)

The significant variation in whole milk fat percent between rural and urban dairy productions could be attributed to differences in exotic blood/genotype (Holstein-Friesian) level in crossbreeding and concentrate feed supplies particularity oil seed cakes (77% in rural and 52.6% in urban area). Genetic parameters favor fat and protein yields (high heritability, high positive genetic correlation) (Pärnal et al., 2003). Supplementing dairy rations with oilseed and/or other dietary fat sources has a potential for changing milk yield, fat content and fatty acid composition (Chilliard et al., 2002). For instance, rapeseed and linseed oilseeds could be used as dietary supplements in order to increase conjugated linoleic acid and polyunsaturated fatty acids percentage (Ryhänen et al., 2005).

Table 10. Regression coefficient (B) for various factors with fat content

Variable	Fat %		
	β	SE	P-value
Dairy systems			
Rural	1.29	0.39	0.002**
Urban[a]			
Cooperative Membership			
Yes	0.18	0.36	0.63
No[a]			
Feeding frequency			
Twice/day	0.23	0.27	0.41
Trice/day[a]			
Feeds			
Home-mixed	-0.36	0.42	0.39
HM & IF	-1.42	0.53	0.01**
HM & FF[a]			
Water frequency			
Once/day	-0.61	1.05	0.57
Twice/day	-0.62	1.05	0.56
>twice/day	-0.88	1.05	0.41
Free[a]			
Education level			
Illiterate	0.77	0.66	0.25
Primary	0.39	0.65	0.54
Secondary	0.74	0.61	0.23
Tertiary[a]			
Herd size			
2-13	0.34	0.31	0.28
14-25[a]			
SCC	0.38	0.28	0.18
Water consumed/day	0.002	0.01	0.69

Home-mixed=HM; Improved forage= IF; Factory formulated= FF; Significance regression coefficients (**P<0.05); [a]Reference categories.

Source: Author‘s research (Habtamu, 2018)

The milk fat and protein percent of Holstein breed were 3.70 and 3.21% in US (Hutjens, 2011). Other similar finding to the current study was also reported in other parts of Ethiopia by Yoseph et al. (2004) in that fat and protein percentages in milk are 3.95, and 3.73, respectively. Fat, and protein contents for milk from Holstein crossbreds were 3.81±0.34 and 3.33±0.06 in India (Sudhakar et al., 2013). On the contrary, other lower and higher figures were also found. For instance, Nega et al. (2006) and Alganesh (2016) reported 2.91, 2.49% and 3.76, 3.10% milk fat and protein, respectively. The fat percent of milk from Arsi and Holstein-Friesian crosses was 5.02 (±0.25) (Fikreneh et al., 2012). Derese (2008) reported milk fat and protein percent of 4.27 and 3.67% from urban areas of Ethiopia, respectively. Overall, the fat and protein percent found in the current study could be ideal for healthy diets if taken as fresh milk by the milk producing households especially children in complementing the low-fat staple foods (teff and wheat) in the study area. The remaining fat content would also be useful for milk processors as dairy plants processed some five percent of the milk collected into butter. Milk is also considered to be an excellent source of essential amino acids for human nutrition, growth, and development (Kanwar et al., 2009).

MILK CONSUMPTION AND MARKETING

The amount of fresh milk self-consumed per farm per day by producer families varied from 0.5 to 5 liters per day (mean= 1.5 liters; total= 200.5 liters), which is around 6.03% of the mean daily milk yield. The consumption level differed with household religion and consumption frequency. This could be due to the religion of the majority of studied households was Orthodox Christianity, who were not consuming milk during fasting days. Within the household, 85% of children consumed milk. Adults (husbands and wives) mostly consumed some milk in tea/coffee and in the form of fermented milk (ergo). The daily volume of milk for sale was higher (mean= 23.43 liters; total= 4686 liters) and varied among production systems. These were 25.77 ± 16.13, 13.09 ± 7.07, and 28.39 ± 17.95 liters in peri-urban, rural and urban dairy production systems, respectively. The more market share of urban dairy system is due to the intensifying/market-oriented smallholder dairy farms, which are mainly concentrated adjacent to urban consumers in addition to the variation in daily milk yield. Milk sale provides 77% and 20% of the households‘ major income source for urban and peri-urban dairy producers, respectively. It was also supplementing the household income of other dairy farmers.

Much of milk produced per farm per day (94.2%) was sold to dairy cooperative and private milk processing plants that process milk and supply to urban consumers through retailers-supermarkets, shops, etc. The earnings from milk sales were mainly used to cover feed costs. Much lower milk sales were reported in Kenya. For instance, according to Mutua-Kiio and Muriuki (2013), about 35% of total milk produced was consumed on farm by the calves and the farmer‘s family while the balance (65%) was available for sale. In the same country, another study found that about 55% of the milk produced by farmers entered the market (Kebebe, 2015).

Different figures for milk consumption levels were reported. Muia et al. (2011) calculated a daily milk consumption of 1 to 3 liters for dairying households in Kenya. In rural Kenya, farmer households consumed about 1.5 liters a day and there was positive relation between milk consumption and level of education (Hoorweg et al., 2000). Children in high-intensity households (milk yield >6 liters milk per day) received more milk than children in medium-intensity households (Micere et al., 2015). The same authors disclosed that daily household milk consumption was in the range between 1.8±1.2 and 4.9±1.9 liters. Another study in Kenya compared members of a dairy cooperative with non-members and found that women and school-age children (5–14 years old) from member households consumed more bovine milk than non-members (Walton et al., 2014).

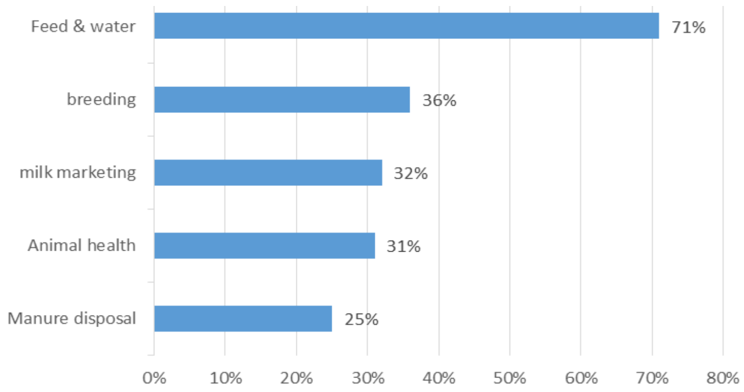
The majority (66.5%) consumed milk, of which 63.1% drank it once a day, 25.4% more than once a day, 6.2% three to six times per week, and 5.4% once or twice per week. The practice of treating milk before consumption differed significantly across production systems. 8.5% of the respondents did not consume fresh but rather fermented milk (‗ergo‘). The majority of these respondents showed symptoms of lactose intolerance (82.35% get vomiting upon consuming milk, 17.67% feel abdominal pain). The percentage of occurrence of lactose intolerance found in this study is believed to affect the milk consumption of milk-producing households in the area.

According to USDA (2016), the daily dairy requirement is 2-3 cups depending on age. Milk consumption level in the present study would be 1500 ml or 6.25 cups (taking 1 cup = 240 ml) and daily requirement of 10-15 cups if on average five of the family members were drinking milk (8.5% lactose intolerant members deducted). Therefore, 1.40-2.85 liters per day of milk was deficient to satisfy the nutrition requirement from dairy foods.

The maximum milk yield obtained by smallholder producers in the present study showed that there is a room to improve milk production through support services and interventions, particularly for women or wives who have great role in dairy activities, taking care of children and food preparation. As dairy households increase milk production, there will be higher probability of keeping milk for home consumption as well as supplying to non-dairy producer urban consumers.

CHALLENGES OF SMALLHOLDER DAIRY PRODUCTION

The major challenges encountered by dairy farmers were a shortage of concentrate feed and water, improved breeding, milk marketing, health of dairy stock and manure disposal, in descending order (Figure 2).



Source: Author's research (Habtamu, 2018)

Figure 2. Frequencies of dairy producers faced challenges.

Feed and Water Resources

Feed and water problems were the first challenges identified by dairy producers. The problem included mainly that of expensive/inconsistent concentrate feed supply (71.1%) and water shortage (26.1%). The reason for the supply gap in terms of both quantity and quality of concentrate feed could be attributed to the absence of large-scale crop production to supply raw materials for feed industries. Adugna (2009) reported that most of the oil seed mills are operating at less than 50% of their capacity due to, among others, inadequate supply of raw materials (oilseeds) as there are competition from export demand and local seed use. Therefore, commercial feed production needs to be promoted through investment on forage seeds and crop production for sustainable feed supply. This would help to meet the high demand of concentrate feed. More rural dairy producers also need to participate in forage production through extension. In this regard, demonstration at Farmer‘s Training center and farmer-to-farmer extension could be successful methods to promote improved forages.

Similar feed related problems are also observed elsewhere. High price of concentrate feed and poor availability of mineral mixtures were constraints reported in smallholder farming of rural Bangladesh (Quddus, 2012). Smallholders in the Kenya highlands ranked lack of feed as the most important constraint to increasing dairy productivity under the intensification process (Bebe et al., 2002). Recently, Udo et al. (2016) stressed inadequate feed availability and feed quality as major constraints confronting the intensification of smallholder dairying. As feed resources come under pressure and as systems intensify, the emergence of a commercial feed trade is expected (Duncan et al., 2010).

Based on the type of supplementary feed purchased/used by dairy farms, all feeds except wheat bran and ground maize were significantly different across dairy production systems. Wheat bran, maize grain, silage and crop residue were used as energy sources. The highest (95.5%) contribution of feed in the ration of milking cows was from wheat bran (equal share of course and fine middling) followed by oilseed cake (60%)

and poultry litter (71%). All feed resources and its diversity had been contributing nutrients to the dairy ration, though some important feedstuffs were inadequate or missing; for instance, bone meal or limestone and improved forages, which could have been produced locally to be added as supplemental feeding or as a free-choice trace mineral mix. The availability of poultry litter in the area is an advantage as it, relatively, contains more Ca and P (2.10 and 1.80% of DM, respectively) (ILRI, 2011).

Forty four percent of dairy producers were cultivating forage in the rural dairy system, which is a viable option to supplement the available crop residue and the costly concentrate feed. But as there is little livestock extension support for peri/ urban dairy production, the feeding option of improved forage crops is almost nil and more rural dairy producers also need to participate in forage production through extension. It was also observed during survey that dairy producers were weighing out concentrate and home-mixing to feed lactating cows based on knowledge gained from some training, experiences, and indigenous knowledge. This could be an entry point to introduce a small-scale method of balancing ration using the existing feed resources for dairy cows.

The volume water consumed by crossbred cows in the present study (64.32 ±2.35) liters/day) was comparable to previous findings. For instance, heavy temperate breed cows have a higher water intake (60-90 liter/day) than Zebu cows (25 liter/day). As estimated by Andreas et al. (2004), crossbred cows consume 52.6 kg of water daily, including the water in the feed. According to the rule of thumb suggested by FAO (2014), one liter water for every ten kilograms of body weight plus one and a half liters per one-liter of milk production supplied. In the present study, cows on average weighed 490 kg, produced 14 liters/day milk and the daily water requirement would be 56 liters. Therefore, sufficient water was provided for the dairy cows though tap water cuts were reported by urban households.

Breeding

Most dairy producers did not have other sources of improved heifer supply and also got inadequate AI (artificial insemination) service. Most (54.8%) smallholder dairy producers purchased their foundation dairy stock from private sources and raised their replacement heifers, which calls for a reliable and known genotype source of improved breeding stock particularly for peri/urban producers that need to focus on the strategy of increasing yield per animal. The major breeding method, artificial insemination, has got a problem with the efficiency of its delivery.

In this regard, the role of inseminators must be stressed as they perform at field level with responsibilities such as semen handling, timing of insemination and insemination technique. The chance of birth of a more male calf (higher male: female calf ratio) was also complained by producers. To address this, the use of sexed semen or sex fixer to get desired sex calves as a technological option has been started in the capital, Addis Ababa area. But due to its high cost, it is out of the reach of the smallholder dairy producers. Therefore, the problem needs to be addressed by concerned body as the birth of female dairy calves is the only option for dairy producers to maintain their herd as there is no supply of breeding stock. Many experienced AI inseminators switch jobs to more satisfying and lucrative careers (USAID, 2013), which needs solution from the government side for addressing the above-mentioned challenges in the dairy sector. But the Ethiopian government/NAIC needs to be appreciated to improve local dairy breeds by enhancing farmer accessibility to breeding services through subsidized AI services. In general, efficient AI delivery needs to be provided on a regular basis including on off-working days (weekends and holidays), and/or organized AI/bull service in addition to improved dairy heifer supply. Moreover, integrating use of AI with adequate nutrition and disease control is required in order to improve the efficiency and sustainability of AI at village level.

Artificial Insemination was the only breeding option in peri/urban production systems in the study area, which is comparable with 90% AI use in Kenya (Vanleeuween et al., 2012). However, similar breeding problems were reported in Ethiopia and elsewhere, the supply of replacement heifers and AI is inadequate and underdeveloped (Ayele et al., 2012; Moti et al., 2013). Ill equipped and negligible services at AI center, and no provision of testing of animals were reported top ranked constraints in smallholder farming of rural Bangladesh (Quddus, 2012). The inadequate and ineffectiveness of AI was also stressed by Shamsuddin et al. (2007) and Imitiaz and Rana (2014). In the same country, problems of lack of high-quality breeds, lack of proper breeding program to improve the existing dairy cattle resource were also reported (Uddin et al., 2010). The major factors that determine AI efficiency are heat detection skills, fertility level of the herd, semen quality, and efficiency of inseminators (Damron, 2000).

Tadesse (2005) observed crossbred calving in the central highlands of Ethiopia got similar calf ratios over four years study but the ratio was lower for calves born to natural mating. And he also reported that calves born from cows served during the wet season had a lower ratio. Another study by Effa et al. (2014) disclosed that AI did not alter the female-to-male calf sex ratio. Natural mating increases the probability of female calves born (odds ratio 1.38) over AI. Heifer/cows that showed estrus and bred during the harsh seasons of the years produced more female calves than those that bred during the good seasons of the year. On the contrary, in Ireland, male calves were more likely to be born in the warmer months of the year and when the sex of the previous calf born to the same dam was male, in older cows. There was also a 1% unit increase in the probability of a male calf being born following AI (Berry and Cromie, 2007).

Accurate insemination technique requires technical and management skills. Technical skill includes concentration, attention to detail, a clear understanding of reproductive anatomy, and the ability to identify the site of deposition and proper position of the insemination rod. Management skills include proper semen storage and semen tank management. Successful AI programs depend not only on proper skill and management but on appreciable knowledge regarding risks and pitfalls. Periodic evaluation of AI parameters, such as number of services per conception and conception rate, should be done, with corrective measures taken as required, which may include seeking professional help. Herd inseminators should periodically attend a retraining course to review their techniques and be updated regarding new developments and recommendations regarding Al technique (Kasimanickam, 2015).

Marketing

There was higher proportion/market share (94.2%) of fluid milk in peri/urban dairy systems, which were intensifying/market-oriented smallholder dairy farms as they are concentrated adjacent to urban consumers besides the variation in daily milk yield. The main milk market related problems found in this study comprised of low milk price and milk payment delay. Even though, dairy cooperative membership plays a role in facilitating marketing, there were lower volumes of milk supplied by members than non-members that sold milk to private milk processors. This could probably be due to the discontinued input supply such as feed by the dairy cooperative on credit-based and producers were obliged to buy the expensive concentrate feed at various levels based on their financial capacity. Therefore, input/support and incentive are needed by extension and (or) dairy cooperative in order to enhance milk sales and to face the tough competition with the private milk collectors/ processors.

In this connection, milk payment delays need to be solved and also production costs incurring dairy producers that affect profitability, particularly the costly concentrate feed purchase and other emergency/health costs need to be considered.

The main milk market related problems found in this study included low milk price and milk payment delay. Bangladesh dairy industry is faced by constraints including poor transportation, and unorganized marketing system (Hamid and Hossain, 2014). In Africa, milk prices are set by processors after lobbying producers. Farmers are never happy with the milk price, consumers complain about the price of milk products and the processors claim to make a loss; however, the industry tends to tick along. There are always dairy farmers going out of business and there may be a downturn in levels of milk received by the processors, but then a new milk price is announced and supplies bounce back (Stewart, 2002). Actually, there was an increment of milk prices in Ethiopia over the years (IFCN, 2012). For instance, it was ETB7.6 (USD 0.41) in 2012 and recently it is 14 birr. However, the reasons for the desire of dairy producers to get more from the sale of raw milk could be that they incur costly concentrate feed and private veterinary service. FAO (2008) identifies among the major factors that influence the success of dairy development efforts is placing a market structure that ensures fair prices. Pasteurization and packing costs nearly double the price of milk to consumers, thus reducing farm gate prices and limiting access by the urban poor (World Bank, 2006). Access to a source of timely and reliable financing is considered by the farmers to be of greater importance than the price received for their milk (Bachev and Manolov, 2007).

In dairy cooperative, there appeared challenges of governance (management), performance efficiency, efforts to work fully for the benefit of members, discontinued supply of inputs and services, and low/delay payment. If these were addressed, it would reduce the tough competition with private dairy processing plants as milk market option in attracting dairy producers. Milk payment delays need to be solved as producers are in need of cash to cover regular production costs, particularly the costly concentrate feed purchase and other emergency/health costs. Research needs to be carried out to set reasonable prices of milk for producers based on their production costs, particularly the costs of concentrates and veterinary. Milk collection centers need to be placed in a convenient location considering proximity to dairy farms in order to improve producers‘ access to the market. The promotion of the nutritive value of milk/ consumption is also useful to enhance milk marketing. Some of the dairy producers need to be advised to breed their cows not to overlap with fasting season.

Health of Dairy Stock

Eighty five percent (85%) of veterinary service was covered by private, 13.5% by government and 1.5% by both. However, the health problem was the fourth important challenge. These included inaccessibility of veterinary service (32.3%), death loss (29%), disease occurrence (19.4%), expensive private veterinary service (17.7%) and 1.5% reported all. The health of dairy stock was affected by the inaccessibility of veterinary service, death, disease occurrence and expensive private veterinary service. Lumpy skin disease, mastitis, lameness and milk fever affected dairy cows, which are diseases associated with intensification. Most dairy producers respected drug withdrawal periods, which would partially respond to concerns regarding antibiotic residues. However, the use of antibiotics to control diseases in intensive systems also calls for effective veterinary services. The government veterinary service faced shortage of budget and resources (no veterinary Laboratory facilities: chemicals, microscopes and accessories). There were also licensed private drug stores/veterinarians and their efforts to engage in retailing drugs and mobile/on-call home-treatment for stall-fed cows were good. But it should be complemented with laboratory based-diagnostic and advisory services to prevent or control diseases.

There were similar reports of veterinary-related problems in Ethiopia and elsewhere. The provision of veterinary service in Ethiopia is inadequate and underdeveloped (Moti et al., 2013; Ayele et al., 2012). Kitaw et al. (2012) also reported that veterinary service is the least commercialized among inputs of dairying with provisions limited to drug vending. On the other hand, service from private veterinarians is expensive and with limited outreach. Distant location or unavailability of adequate veterinary service and high cost of medicines were problems in Rural Bangladesh (Imtiaz and Rana, 2014; Hamid and Hossain, 2014; Quddus, 2012; Shamsuddin et al., 2007) and in India (Mohi and Bhatti, 2006). However, in Bangladesh, there is also experience of Community-based veterinary service delivery, and significant progress has been made in deworming, vaccination and prevention, and control and treatment of diseases, calf health and udder health management (Shamsuddin, 2011). Lumpy skin disease (71%) was reported in Kenya (Kagira and Kanyari, 2010). In same country clinical mastitis (66.7%), Lameness (23%); Lumpy skin disease (23%) were reported as major health problems (VanLeeuwen et al., 2012). In this connection, it is worth mentioning that lameness in dairy cows/Claw lesions probably result from abnormal gaits and excessive exposure to hard or uneven surfaces. Preventive measures include routine foot trimming, foot-bathing, and improving surfaces (Mayne et al., 2011). Excessive use of concentrated feeds, especially during the peak milking period results in metabolic disorders-low conversion of feeds to milk, ketosis, and milk fever (Bao, 2011).

Dairy Manure Handling

Manure disposal was ranked as the fifth constraint in the intensive dairy operation. Twenty-five (25%) of dairy producers (mainly urban) reported that they have manure disposal problem. Manure disposal practices in the current study included storage in the rainy season and sun-drying to make dung cake for fuel in dry season (69.5%), biogas digester (22%), and transportation to another area (8.5%) by donkey-driven carts. It was also observed that some urban dairy farms rented trucks to take liquid manure from their storage every 3 or 4 months. However, it is better to expand biogas digesters in order to address fuel wood shortage and the residue can also be used as fertilizer for crops. Other means such as charcoal making and disposal to rural areas for fertilizing crop farming can also be introduced as part of the sustainable solutions in using this valuable resource.

The above-mentioned good manure practices are also supported by the work of different authors. Manure is among the most important contributions that livestock makes to intensification and sustainability (Ehui, 2000). The adoption of improved manure handling techniques is crucial in stall fed cattle (Paul et al., 2009; Powell and Williams, 1995). Biogas plant (anaerobic digestion) is the most effective and environmentally friendly methods of manure management/ energy generation with regard to reducing methane and odor emission (Siegmeier et al., 2015; FAO, 2013). Smith et al. (2008) also stated that composting the manure, covering manure heaps, and also once manure is collected and dried, methane emissions are negligible/reduced.

The Ethiopian government‘s recognition of urban agriculture as an enterprise creating jobs is a good start. However, the urban municipality or local authorities need to allocate land and establish accessible ‗dairy parks‘, which will encourage proper manure handling and overall improved management, land security and investment in sustainable peri/urban dairying. A number of community-based units or ―dairy parks‖ are set up in China, where smallholders keep and milk their cows (FAO, 2013). An exemplary which worth mentioning is that six high potential districts in Tigray are piloting an urban agriculture program, involving building of urban agriculture villages with rental dairy shades (USAID, 2013), which further need to be incorporated in urban development plan. All of the studied dairy producers kept their stock in separate housing in rural and peri/urban dairy production systems. On the contrary, 70% of households in extensive/mixed crop–livestock system kept their cattle within their own residence compound as pointed by Sintayehu et al. (2008). All of the studied dairy producers kept their stock separately in rural and (peri-) urban dairy production systems. However, in the study area, barn construction needs to be scientific and appropriately designed for smallholder dairy situation, which can make the barn clean, dry and comfortable. This calls for agricultural engineers and dairy scientists to innovate shelter design for small/medium dairy farms, from low-cost and locally available materials, e.g., Bricks made from clay soil.

CONCLUSION

There were moderate to fairly increasing levels of intensification through forage production, crossbred dairy stock holding and manure management in the rural and peri/urban dairy production systems, respectively. This is significantly affected by various factors (dairy production system, cooperative membership, dairying experience, herd size, farmland size and dairy training provision). Women contributed over fifty percent of the household labor force on dairy activities depending on production systems and major income sources. Further analysis of the extent of intensification indicated that mean daily milk yield per cow and household milk market share were significantly related to crossbreeding and manure management practices in combination. The major challenges faced by dairy farmers were: shortage of concentrate feed and water, improved breeding, milk marketing, dairy stock health, manure disposal and milk safety. The dairy household potentials observed include formal milk marketing channels, agro-industrial by-products, optimum daily milk yield, dairy experience, education and dairying as major income source. These could help as spring board to enhance smallholder dairy farming provided that the above-mentioned challenges are dealt with and tackled.

The overall mean value of the milk fat was slightly higher than the Ethiopian Standard while the overall mean value of protein is similar to the standard value. The majority of dairy producers traded and consumed milk at the same time. However, the amount of milk self-consumed per farm per day by producer families was deficient to satisfy the nutrition requirement from dairy foods of intensive milk producing households. To this end, there is room to improve nutrition through consuming sufficient quantities of milk by the milk-producing households and complementing the staple foods (*teff* and wheat).

Policy and gender-balanced dairy extension support needs to be in place for smallholder dairy producers to better engage with intensive dairying; improve milk productivity; remain in farming and endorse the full potential to contribute to dairy food demand and livelihoods while minimizing ecological pressure. Adopting good farming practices including controlled crossbreeding (AI or bull and supply of improved breeding stock) and planned manure management could help to meet the challenges and make the dairy production sustainable at farm level.

Improving milk productivity (sustainable household milk production) will increase the level of milk consumpton, which in turn would be great prospectve as cost-effective household food production strategies/food access to enhance micronutrient intakes or as a complementary to the staple foods. Balancing both livelihood security through creating jobs/income generation from milk sales and improved nutrition through milk consumption, particularly mothers and children would sustain dairy food production systems and be one of the strategies to sustainable household food and nutrition security.

Further, participatory research is required on the performance and challenges of formal milk marketing channels, particularly on private milk processors in different dairy production systems.

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Chapter 3

BRINGING PATH DEPENDENCIES INTO EVALUATIONS OF SMALLHOLDER COOPERATIVE DEVELOPMENT PROGRAMS*

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ABSTRACT

This chapter outlines the importance of evaluating a smallholder cooperative project's outcomes within the historical path of its nation's

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political and economic institutions. This permits realistic expectations for project planners and evaluators and comparisons of project results in different countries. Two smallholder development projects in two East African countries, Kenya and Rwanda, are used to illustrate how differences in the historical path of colonial rule and post-colonial leadership present different opportunities and challenges for smallholder cooperatives. These include what kinds of incentives will attract cooperative members, the competition between cooperatives and other firms, types of institutional structures that facilitate cooperative development and regional market constraints that affect project outcomes. British colonial rule and post-colonial political and economic developments have provided more potential economic gains for Kenyan cooperatives, but also more risks. Belgian colonial rule and the post-genocide Rwandan government have led to a ―guided‖ institutional approach to cooperative development.

INTRODUCTION

A critical shift in development theory and practice occurred when Western donor countries let go of the post-World War II naïve assumption that the introduction of new technology and knowledge from the West would produce ―modernization‖ in less economically developed nations. This shift has produced substantial growth in efforts to understand local cultures, especially in how to link them and local social networks to smallholder cooperative development programs (Brett 2009). Especially relevant here are comparative data sets, like those of The World Bank (The World Bank 2020), the United Nations (United Nations 2020) and the World Happiness Report (Helliwell, Layard and Sachs 2019) which, in addition to econometric data on investments, GDP, etc., also include subjective indicators of bonding and bridging social capital trust of various levels of government and institutions as well as details on specific projects.

A benefit of this change in approach has been an increased focus on the role of smallholder cooperatives in bringing smallholder farmers into national and international development programs. This includes micro-level efforts made famous by Nobel Prize Winner Muhammad Yunus' in building village-level finance and micro-credit cooperatives (Yunus and

Jolis 2007). Some smallholder cooperatives, however, have evolved into much larger entities, either by covering a larger area or by combining local-level cooperatives into federated unions. These larger organizations have the potential to substantially improve the income and overall quality of life of smallholder households. The focus of this chapter is a comparative analysis of path dependent effects on the design, outcome and evaluation of larger smallholder agricultural cooperative development projects in two East African countries, Kenya and Uganda.

The most unique feature of a cooperative[1], is that it is *governed by its members*. Cooperative members elect representatives to a board, which then hires a manager, who, in turn, hires personnel; in larger cooperatives this would include accountants, marketing and human relations support staff, and other technically trained individuals. If the cooperative board thinks that a management team is not operating in their interest they can replace it and the board itself can be voted out of office by the whole membership if the latter is dissatisfied with its performance. In short, cooperatives ultimately require the support of their members. This presents two challenges for cooperative leadership. The first is to identify incentives that will attract members to join *and* to ensure that members *patronize* the services that it offers. Dairy cooperatives, for example, need their members to deliver a sufficient supply of milk in order to be competitive with other firms. The second challenge is for cooperative leadership to understand what kinds of options are available as changes occur in the markets in which cooperatives operate, including competitors that offer services to current or potential cooperative members (Cook 1995; Cook and Burress 2013). The latter is especially challenging in rapidly changing economies.

An important challenge that remains not only for cooperatives themselves, but also for those responsible for funding development projects, is how can the unique historical path of national-level economic and political institutions be brought into expectations of what are appropriate indicators of ―success‖ in any given project? A crucial element in answering this question is to gain a full understanding of how the unique

[1] As distinguished, for example from other uses of ―cooperative,‖ like the *kolkhoz* (collective farm) in the Soviet command economy that did not permit any input from its members.

historical *path dependencies* (North 1990) of formal political and economic institutions in any given country can assist in obtaining a more realistic assessment of project outcomes. The subject of our analysis is how the different institutional path dependencies of Kenya and Rwanda have impacted the potential and actual outcomes of smallholder cooperative development projects in each country. Descriptions of specific projects, in which the authors served on evaluation teams, will be presented later. At this juncture, however, it is essential to look at the larger body of literature on the impact of macro-level institutional path dependencies on contemporary micro-level collective action.

PATH DEPENDENCY OF POLITICAL AND ECONOMIC INSTITUTIONS

One of the most important lessons from research on the capacity of individuals and households to adapt to a rapidly changing world is to look back at the historical paths that have shaped their community‘s, region‘s or nation‘s economic and political institutions. The historical path of a nation‘s institutions includes a mix of both informal and formal norms that regulate the way that human beings are expected to interact with one another and with the outside world. During earlier periods in human history, especially in hunting and gathering or horticultural societies, institutions were exclusively informal and embedded in the cultural traditions of small groups. With the development of agrarian, eventually industrial, and now, post-industrial, societies the proportion of formal institutions that regulate behavior has increased markedly, with the growth in laws and regulations, and, in liberal democracies, designed by legislative bodies and enforced by courts and various policing agencies. But informal institutions still exist. This is reflected in the current attention given to informal norms that provide varying degrees of support for bonding and bridging social capital, which, in turn, produces substantial variations in the economic performance of different households, communities and nations (Marsden 1987; Woolcock and Narayan 2000).

One of the most important observations in Alexis de Tocqueville‘s (2004) early 19th Century travels in the new American nation was the relationship between the experience of the early Protestant settlers in self-governance of their Congregational churches and the world-view that provided citizen support for the U. S. Federal Constitutional Structure. In this historical situation, a formal institution was embedded in an informal institution. Conversely, efforts by the Italian government to introduce administrative reforms to reduce corruption have repeatedly been thwarted in the southern part of the country by an informal institutional structure that generates an extreme form of ―familism‖ and ―distrust of ―strangers‖ that legitimizes resistance to formal institutional norms (Banfield 1958; Putnam, Leonardi and Nanetti 1993).

In his book, *Institutions, Institutional Change and Economic Performance*, Douglass North (1990) describes how the historical development of both formal and informal institutions have shaped the differential levels of economic development in North and South America. He describes how the concept of ―individualism‖ that developed informally in English culture eventually became embedded in formal institutions that provided for the development of secure and expansive economic relationships outside of family and kin networks. This historical path that started as early as the 13th Century, became the foundation for institutions supporting third party enforcement of individual contracts that enabled England to replace Spain as the dominant world economic power in the 19th Century (North 1990: 15-17). North goes on to say, that this historical divergence in the development of institutions had significant ―downstream consequences‖ for economic development in their respective North and South American colonies:

> The divergent paths established by England and Spain have not converged despite the mediating factors of common ideological influences. In the former, an institutional framework has evolved that permits the complex impersonal exchange necessary to political and to

> capture the potential economic gains of modern technology. In the latter, personalistic relationships are still the key to much of political and economic exchange. They are a consequence of an evolving institutional framework that produces neither political stability nor consistent realization of the potential of modern technology (North 1990:117).

CHANGING HISTORICAL PATH DEPENDENCIES

The value of understanding path dependency in accounting for differences in the economic performance of nations does not, however, mean that any given path is destined to continue. This was an essential element in Max Weber‘s (Gerth and Mills 1946) work that provided a counterpoint to Karl Marx‘s economic determinism. New ideas, like the rise of the Calvinist world-view, for example, can have profound effects on changing the course of institutional history (Gerth and Mills 1946: 302-322).

Of special relevance to our later discussion of smallholder cooperatives are examples of where new macro-level formal institutional arrangements have been introduced that have drastically altered historical paths within a nation and groups of nations. Especially noteworthy in the regard is the dramatic post-World War II structural shift in formal economic and political institutions that eventually produced the European Union.

For many centuries the nations of Western Europe fought wars that produced enormous injuries and loss of life, as well as substantial economic costs. As Barbara Tuchman (1990) points out, one of the formal institutional causes of these persistent conflicts was the reliance of individual nations on military alliances, which resulted in wars that citizens, and oftentimes their political leaders, did not want. The most striking example here being World War I, which resulted in 9.7 million military and 10 million civilian deaths (Centre Robert Schuman 2009-2011). The resentments toward the treaty that ended the war, among populations in Germany and some of the territories of ethnic minorities that were transferred from one nation state to another, contributed to the tensions that led to World War II. World War II produced 15 million military and 45 million civilian deaths (National World War II Museum 2019). The war also resulted in large numbers of civilian refugees, civil wars in some places and overall social, political and economic disruption in Europe for a number of years afterwards (Lowe 2012).

The long-term historical trajectory of European political and economic institutions, however, was drastically changed in the post-war years, beginning with French Foreign Minister Robert Schuman‘s plan for the European Coal and Steel Community. This plan replaced military alliances with an institutional arrangement that created a set of mutually beneficial economic interdependencies between former enemy nations, thus decreasing the incentives for war. Usherwood and Pinder describe the underlying rationale of the ECSC:

> The EU of today is the result of a process that began in the wake of the Second World War with the creation of the European Coal and Steel Community (ECSC). The coal and steel industries then still provided the industrial muscle for military power, with Robert Schuman, the French Foreign Minister, affirming on 9 May 1950 in his declaration which launched the project, that ‗any war between France and Germany would become not merely unthinkable, but materially impossible.‘ (Usherwood and Pinder 2018:1-2)

A key to the adoption of the plan was the different incentives offered to France and Germany:

> For France the prospect of a completely independent Germany, with its formidable industrial potential, was alarming. The attempt to keep Germany down, as the French had tried to do after the 1914-1918 war, had failed disastrously. The idea of binding Germany within strong institutions, which would equally bind France and other European countries and thus be acceptable to Germans over the long term, seemed more promising But participation in these European institutions on an equal basis has also given Germany a framework within which to develop peaceful and constructive relations with the growing number of

member states, as well as to complete their unification smoothly in 1990. (Usherwood and Pinder 2018: 2).

One of the most important elements in the formal institutional structure of the European Union, that is especially relevant to our later discussion of institutional structural changes in Rwanda, has been its ―Cohesion Policy,‖ with which one-third of the total Union budget is devoted, to provide infrastructure, training and other resources to enable less economically developed regions within it to prosper (European Union 2012; European Union 2014). With this approach, the EU has addressed and lessened the *intra-national* ethnic-, language- and religious-based inter-communal conflicts that were a source of international tensions that led to World War I and World War II (Ewence and Grady (2017).

Not adequately understanding and taking account of the institutional path dependent constraints before embarking on major efforts to re-structure an economy can produce severe negative consequences. An example of this is found in the naivete of the IMF and the U. S. Treasury in supporting a ―shock therapy‖ approach to liberalizing the Russian economy following the collapse of the Soviet Union at the end of 1991. Instead of creating a replica of Western economies, this approach created an environment where the future oligarchs were able to use their material resources, connections and nefarious skills to buy up formerly state-owned property, including collective farms, natural resources, processing facilities and factories. Simply opening up markets and eliminating subsidies *without any incremental transition steps* produced human misery on an enormous scale during the whole decade of the 1990s. This was reflected in a dramatic increase in unemployment, poverty, mental health crises and a substantial decline in life expectancy, which did not begin to abate very much until after the year 2000. This lack of attention to the path dependent character of Russian economic institutions resulted in Russian voters' distrust of liberal democratic institutions in general and the extremely high popularity of Vladimir Putin, who was recognized by the public as *restoring order* (O'Brien and Patsiorkovsky 2020; O'Brien and Patsiorkovsky 2006: 111-163; Stiglitz 2018: 225-256).

The post-Soviet Russian case also illustrates the crucial point that economic development is not simply a matter of improving education. The Soviet Union had excellent primary and secondary education, but its economic performance was severely limited by the path dependent institutions of Communist rule which limited both individual and voluntary collective efforts to adjust to the demands of globalization (Baumol, Litan and Schramm 2007: 125-126). During the initial post-Soviet period in the 1990s, smallholders in post-Soviet rural villages faced obstacles in developing village-level cooperatives that in some ways were greater than those facing smallholders in many sub-Saharan African villages today. The Soviet Union was the most extreme version of a command economy that destroyed all types of *intermediary associations*, thus producing a high level of distrust among Soviet citizens and created disincentives for them to trust their neighbors, and to rely exclusively on highly dense kin-dominated support networks. This stands in contrast to post-Communist Hungary and Poland, where the regimes did not destroy all intermediary institutions, including the Church and Unions, thus providing citizens with an opportunity to develop social capital trust outside the family and kin network (Szelenyi and Kostello 1998).[2]

Historical Paths of Political and Economic Institutions and Smallholder Cooperative Challenges in Kenya and Rwanda

The Legacies of British and Belgian Colonialism

In 1920 the British East Africa Protectorate was turned into a colony and renamed Kenya. The colony then, and today, contains a large number of different ethnic groups, the largest of which is the Kikuyu (22%). Other

[2] Unfortunately, despite sustained economic growth and gaining membership into the European Union, both Hungary and Poland have increasingly moved in an authoritarian direction that has created serious challenges for the EU. See Boffey (2020).

African ethnic groups include the Luhya (14%), Luo (13%), Kamba (11%) and Meru (6%). The primary goal of the British, was to gain access to land and raw materials, but also to provide opportunities for British white settlers. During the colonial period there also was a significant number of migrant workers from British India. Nonetheless, operating within an *indirect rule* paradigm essentially meant that informal institutional structures and power arrangements embedded in ethnic cultures retained authority to make many day to day decisions, so long as they did not hinder the colonizers main objectives (Britannica 2020a).

British rule also introduced some new institutional arrangements that would eventually have a positive impact on smallholder cooperative development. Cooperatives and cooperative law to regulate self-governed organizations was introduced in Kenya in 1906. Initially Africans were excluded from creating these organizations, but in 1930 they were permitted to create their own agricultural cooperatives. This has left a legacy of formal institutional laws and procedures for self-governing smallholder cooperatives (The Knowledge Tree 2017).

The country now known as Rwanda became a German colony in 1884, but was transferred to Belgian rule after World War I in 1919. Belgian colonial rule was shaped by essentially reinforcing a de facto monarchy, in place since the 18th century, in which the minority Tutsis (14 percent of the population) dominated the majority Hutus (84 percent of the population). One percent of the population of Rwanda was a pygmy group, the Twa. The Belgian rulers' control over the indigenous population was reinforced by identity cards that identified the bearer's ethnicity. Not surprisingly, this exacerbated Hutus' resentment toward the Tutsis (Britannica 2020b).

Post-Colonial Historical Paths in Kenya and Rwanda

In Kenya, the Mau Revolution, composed largely of members of the largest ethnic group, the Kikuyu, but also with some participation by the Meru and other ethnic groups, began the struggle for independence from Britain in 1953. After a long and bloody struggle Kenya became an independent country in December of 1963. Post-independence politics in Kenya was dominated by the Kikuyu and led to charges of corruption by other ethnic groups and international organizations for essentially being a one-party state. Since the early 1990s, the country has struggled with the transition to a multi-party democracy. The over-riding source of resistance in this regard has been the persistence of identity politics based on ethnic group affiliation. A wave of violence in the 2007 election resulted in indictments of political leaders by the International Court. Investigations by international organizations concluded that corruption is rooted in identity politics. Since 2013 there have been significant improvements in the multi-party election system (Kanyinga 2014; The World Bank 2020).

By the 1990s Kenya had achieved enough political stability to shift the focus of its economy from one of ―import substitution‖ to a more ―liberalized‖ model (Ngui, Chege and Kimuyu 2016). In 2014 it achieved the status of a ―middle income country‖ when its Gross National Per Capita Income reached $1,160, surpassing The World Bank threshold of $1,036 (Brookings 2014). The most recent World Bank overview noted that Kenya‘s average economic growth rate was 5.7 percent from 2015 to 2019, making it one of the fastest growing economies in sub-Saharan Africa. In addition, the report points out that the country still faces serious challenges in dealing with poverty, inequality and climate change. These have been exacerbated by the COVID-19 pandemic and a locust attack which is expected to reduce the growth rate for 2020 to 1.5 percent. But, overall, the World Bank‘s assessment of the country‘s economic development prospects is quite positive. The report concludes that:

> Kenya met several of the *Millennium Development Goals (MDGs)* targets; reduced child mortality, near universal primary school enrollment, and narrowed gender gaps in education. Interventions and increased spending on health and education are paying dividends. While the healthcare system has faced challenges recently, devolved health care and free maternal health care at all public health facilities will improve health care outcomes and develop a more equitable health care system. (The World Bank 2020)

This has provided a mixed set of benefits and challenges for smallholder cooperatives. Being a ―middle income country,‖ means that ordinary citizens have increased income to purchase milk and processed dairy products, thus providing the potential of increased income for the cooperatives and their members. But, the introduction of the institutions of a liberal economy has meant that smallholder cooperatives now must operate in a competitive market which includes the largest domestic producers, New KCC and Brookside, as well as international firms, such as Sameer. In 2011 these firms controlled 71 percent of the market for the purchase of raw milk. Moreover, cooperatives no longer operate within a defined geographical boundary, meaning that they can compete with one another. The Kenyan government no longer forgives their debts, so that cooperatives face the real prospect of going out of business altogether. Another effect of the liberalization of the Kenyan economy is that regional effects, especially differences in the presence of competitors and the extent of other opportunities for actual or potential members varies from one place to another (O'Brien and Cook 2016; The Knowledge Tree 2017).

While the post-colonial path of political and institutions in Kenya eventually led to liberalization of the economy and steady economic development in the 1990s, the most significant event in the post-colonial path of political institutions in Rwanda was the genocide in 1994 in which Hutus killed 800,000 Tutsi and their moderate Hutu supporters, and the post-genocide reconciliation period. The precipitating event for the genocide was the shooting down of the airplane of the Hutu President of Rwanda, but, as noted earlier, a significant foundation for this event was the Belgian colonial masters' favoring of the minority population Tutsi and the resentment that created among the subjugated Hutu majority (BBC 2011). A major post-genocide structural change occurred when the Rwandan Patriotic Party assumed power. Its President Paul Kagame initiated a program of ―national reconciliation,‖ which created political stability and provided a path toward economic development. Kagame's leadership, which resembles that of Singapore's transformative president Lee Kwan Yew's can be described as a form of ―benign authoritarianism.‖ Phil Clark, in an article in *Foreign Affairs* calls this:

> … the world‘s boldest experiment in transitional justice, comprehensive land tenure and agricultural reform, forced villagization, a de facto ban on ethnic identity, reeducation of the population, and the systematic redrawing and renaming of Rwanda‘s territory, among other things . . . These policies are set within an institutional framework of the government‘s ―Genocide Remembrance‖ program in which strong laws regulating public behavior are seen as the only way to prevent a re-emergence of inter-ethnic conflict and violence. (Clark 2018)

The aforementioned policies have produced a stable political environment, which even critics admit has led to a reduction of poverty, a marked increase in foreign investment, overall economic growth, and a rise in the standard of living for ordinary Rwandan citizens. In contrast to many other post-colonial nations in sub-Saharan Africa, Rwanda has experienced a very low level of political corruption. The country‘s leadership has received praise from academics and advocacy groups for its policies that mandate a strong representation of women in government. Especially noteworthy is the official gender quotas in government that were embedded in the Constitution in 2003. The law requires that 30 percent of the legislature must be comprised of women. In 2018, 64 percent of the members of the Rwandan National Parliament were women, the highest proportion of any nation in the world (The World Bank 2018).

The official Rwandan government reports showed a decline in poverty from 46 percent in 2010/11 to 39.1 percent in 2013/14 (Fatima and Yoshia 2018). In the decade from 2007 to 2017 the country experienced an annual growth rate of 7.5 percent. A detailed statistical analysis of the government figures, reported in a The World Bank Policy Research Working Paper, supports the government‘s trend line. The poverty rate declined further to 38.1 percent in 2017. There has been a two-thirds drop in child mortality and near universal primary school enrollment (The World Bank 2019).

The historical path of institutions in Rwanda has created a very different set of challenges and opportunities for smallholders in that country than is the case for their counterparts in Kenya. In Kenya the potential benefits of a fairly well established liberalized economy provides a greater potential for gains in smallholders‘ income, but only if they and their cooperatives can learn how to become competitive. In short, as smallholder cooperatives are forced to compete in a more liberalized economy we would expect to find more differentiation between ―winners‖ and ‗losers‖ than was the case when all of the cooperatives were subsidized by the national government. Alternatively, the potential for gains in smallholder household and cooperative income in Rwanda are not as great, given the lesser development of its economy, but there may be less risk of loss for this group than in Kenya, simply because *the ―benign autocracy‖ of the Rwandan government is providing a more guided, gradual movement of smallholders into the national economy.*

Another historical difference affecting smallholders in the two countries is the relative importance of cooperatives as intermediary civil society mechanisms in the two societies. Member governed cooperatives provide support for the civil society norms of liberal democracy in Europe and North America as well as in post-colonial Africa. In Kenya, institutional adjustments to prevent ethnic conflict and violence have focused, with the help of international organizations like the International Criminal Court, on guaranteeing fair elections. Rwanda, which is a de facto one-party state, has created a top-down institutional structure to prevent the re-occurrence of ethnic violence. This covers everything from national holidays devoted to ―genocide remembrance‖ to ―community street cleaning days‖ to the development of smallholder cooperatives and integrating them into the national economy.

THE EFFECT OF PATH DEPENDENCIES ON INCENTIVES FOR MEMBER ENGAGEMENT IN KENYA AND RWANDA

Incentives for Member Engagement in Kenyan Cooperatives

A five-year Cooperative Development Project (CDP) in Kenya from 2011 to 2015 provides insights into the challenges with vertical integration facing smallholder dairy cooperatives who were attempting to vertically integrate into the value chain with milk processing plants. The potential for increasing their members‘ income through vertical integration was possible because of the consistent growth of the liberalized Kenyan economy. The project was funded by USAID. The evaluation component of the project included surveys and focus groups of both members and non-members of the cooperatives. The Land O‘ Lakes International Development team included an agricultural economist, an accountant, two dairy processing plant experts and a rural sociologist. The initial baseline of the project included data on two Ugandan cooperatives, but for the purposes of this Chapter we will only focus on the Kenyan cooperatives. For more details on the project and the evaluation of outcomes, see O‘Brien and Cook (2016) and O‘Brien, Banwart and Cook (2013).

This project was designed to provide support for smallholder dairy cooperatives that were engaged in processing of their members‘ milk, but in most cases were operating with extreme financial difficulty given the competitive nature of the liberalized Kenyan economy and the government‘s decision not to pay their debts. The basic unit in the three Kenyan cooperatives in the project is the smallholder farmer with a small number of cows. The cooperatives themselves, however, were not by any means small. Two of them were Tier II or federated processing cooperatives, in one case made up of 5 primary cooperatives, with a total of 3546 smallholder farmers, and the other was made up of 17 primaries with a total of 20,000 farmers. A third Tier I centralized cooperative had 9,900 farmer members.

The initial task of the evaluation team, was to answer the question, what did individual members see as the most important benefits that they received from joining the cooperative? These individual incentives or, ―selective benefits‖ (Olson 1971: 133-134), are shown in Table 1.

The most interesting finding is what are the most and the least important incentives that attract smallholders to their cooperative. The most frequently mentioned benefit for joining the cooperative is the ability to ―purchase inputs on credit.‖ This is mentioned by more than half of the members in each cooperative. Other incentives, which vary in importance from one cooperative to another include ―timely payment for milk,‖

‒training,‖ ‒convenient payment for milk,‖ and ‒general credit.‖ At the bottom of the table is ‒the high price of milk,‖ ranging from 4 to 7 percent between the three cooperatives. The second least important benefit mentioned is ‒purchase of excess milk,‖ ranging from 14 to 21 percent.

The findings from Table 1 are a reflection of the current economic institutions that affect the decisions made by smallholders in Kenya. The relatively low importance of ―high price of milk‖ and ―purchase of excess milk‖ means that smallholders know that in a very competitive environment they have other buyers for their milk – the large dairy companies as well the local ―hawkers‖ - and that some of those buyers can offer them higher prices, especially during that portion of the year known as ‒the dry season‖ in which there is a shortage of milk and therefore prices for milk are high.

Table 1. Reported Benefits of Membership by Kenyan Smallholder Cooperative Members (In percent)

	Cooperative A (Metro) (N = 692)	**Cooperative B (Rural) (N = 705)**	**Cooperative C (Metro) (N = 172)**
Purchase Inputs on Credit	51.73	65.67	53.45
Timely Payment for Milk	35.98	31.91	41.38
Training Cross-Visits	26.45	42.98	35.63
Convenient Payment for Milk	30.35	37.30	41.38
General Credit	33.82	41.84	27.01
Purchase Excess Milk.	14.02	20.85	14.94
High Price of Milk	6.94	4.54	4.02

Source: Smallholder Dairy Vertical Integration Project.

Incentives for Member Engagement in Rwandan Cooperatives

The situation facing smallholder cooperatives in Rwanda has been quite different than it was in Kenya. Although the Rwandan economy experienced steady growth during the past two decades and has begun to attract considerable foreign investment in recent years, it still remains well below that of Kenya in terms of GDP growth and income received by smallholder farmers.

Thus, rather than having to learn how to compete in a robust market economy like Kenya‘s Rwanda cooperatives are operating within the historical path of political and economic institutions that have until quite recently been consumed with the challenges of avoiding another ethnic conflict that led to the genocide of the 1990s.

The mixed blessing for Rwandan smallholder cooperatives is that they are operating within an environment that does not offer the potential for gains that can be achieved for their counterparts in Kenya, but they also have greater government support. The major focus of the post-genocide Rwandan government is to create institutions to bring the population, in which smallholders constitute a substantial portion, into a growing economy with the ultimate goal of embedding the source of economic gains, in this case cooperatives, in the adoption of civil society values and practices.

The role of smallholder cooperatives in the dual focus of the Rwandan government on economic and civil society development is shown in the cooperative union program. This project involves the government‘s Agricultural Ministry and technical support from Land O‘ Lakes International Development, funded from a USAID grant. A specific focus of the evaluation of the project was to measure what cooperative members saw as benefits that they received from the cooperative unions. For a complete description of findings from the project see Meador and O‘Brien (2019), O‘Brien, Meador and Sanders (2018).

An important feature of this project was that it sought to integrate former ethnic rivals into a larger national agricultural system. In a manner reminiscent of Robert Schuman‘s thinking behind the European Coal and Steel Community, the predecessor to the European Union, the Cooperative Union institutional structure was designed to provide concrete incentives to both the dairy farmers, who traditionally have been comprised of members of the Tutsi ethnic group, and the maize farmers, who traditionally have been comprised of members of the Hutu ethnic group by linking their smaller local cooperatives into larger dairy and maize Federated unions.

The project employed the cooperative unions as a means to build smallholder farmers‘ *bridging social capital,* an essential element in civil society, by providing them with an opportunity to see the practical benefits of trusting and working with individuals outside of their village on mutually beneficial collective efforts.

Table 2 shows how the smallholder members of the locally-based ―primary‖ cooperatives ranked the importance of eight services provided by their respective Maize and Dairy cooperative unions.

Table 2. Mean Rankings of Importance of Union Services by Leaders and Members of Dairy and Maize Cooperatives (Scale = 1-8)

	Type of Cooperative		
	Dairy (n=122)	Maize (n=84)	Total (N=206)
Union Service			
Q1.g. Conflict Resolution	6.42	6.00	6.25
Q1.h. Access to Higher Level Information	6.07	6.39	6.20
Q1.d. Extension	5.65	5.64	5.65
Q1.e. Access to Finance	5.13	5.27	5.19
Q1.f. Advocacy **	3.66	4.45	3.99
Q1.c. Input Purchase & Distribution***	4.32	3.39	3.94
Q1.b. Training*	2.77	2.31	2.58
Q1.a.Access to Markets**	1.94	2.54	2.18

Source: Rwanda Cooperative Union Project.
*p < .05.
**p < .01.
*** p < .001.

Members‘ ranking of the eight most important services that they get from their cooperatives presents quite a different picture that what we observed earlier with respect to incentives for member engagement in the Kenyan cooperatives. One of the clearest indicators of the difference between the historical institutional path of smallholders in Kenya versus Rwanda is that the top listed service provided by the cooperative union among *both* dairy and maize farmers is ―conflict resolution.‖ In focus groups, participants most frequently mentioned resolution of land use disputes.

The effectiveness of the Rwandan government‘s approach to dramatically altering the historic path of ethnic conflict is that there are no statistically significant differences in the rankings of the top four out of eight services provided by the cooperative unions; ―conflict resolution,‖ ―access to higher level information, ―extension‖ and ―access to finance.‖

There are, however, statistically significant differences between the dairy and maize cooperative members on the importance of the four lowest ranked services. These reflect differences in historical and contemporary challenges faced by the dairy and maize farmers. Historically, livestock owners were more likely to be members of the Tutsi ethnic minority favored by the Belgian colonial masters. Maize farmers typically were members of the Hutu ethnic majority. Not surprisingly, the historically less powerful maize cooperative members ranked ―advocacy‖ and ―access to markets‖ higher than did the dairy cooperative members. Dairy farmers gave a higher ranking than dairy farmers to input purchase and training.

Responses to other questions on the baseline survey, not shown in Table 2, are indicators that the unions provide additional support for the more disadvantaged maize farmers. Climate change is a more pressing challenge for the lowland maize farmers than for the upland dairy farmers. Maize cooperative respondents were more likely than their dairy cooperative counterparts to report that their union ―provides useful information on climate change‖; 3.56 for maize farmers compared to 2.46 for dairy farmers on a five-point scale ($p < .001$).

Another area in which the maize and dairy farmers differed was ―does the union encourage women to hold leadership positions?‖; 4.43 for maize farmers and 3.61 for dairy farmers, on a five-point scale ($p < .001$). Again, this is not surprising given that the maize farmer cooperatives contain a disproportionate number of women, compared to the dairy cooperatives. The effectiveness of the government‘s mandate for greater participation of women in leadership positions is reflected in these responses (see, e.g., Meador and O‘Brien 2019).

THE EFFECT OF PATH DEPENDENCIES ON SMALLHOLDER COOPERATIVE COMPETITIVENESS IN KENYA AND RWANDA

Institutional Path Development in Kenya and Regional Effects on Cooperative Business Strategies

The challenge for the cooperatives at the beginning of the project in 2011 was to provide incentives to members that ensure a sufficient supply of raw milk to keep their processing plants operating at level that would be profitable. All three of the cooperatives in the study faced survival problems because they were not able at the beginning of the survey to obtain enough milk from their members to operate their processing plants at a capacity level to remain profitable. The strategies employed by the two cooperatives that survived at the end of the five-year project are most interesting because they highlight the extent to which regional-level market conditions created challenges and different types of organizational adaptations. One of these cooperatives was located in the ―milkshed‖ – i.e., where raw milk is collected from small farmers – close to the capital city of Nairobi. The other cooperative was located in a milkshed in a more rural area of the country. For details on changes in the cooperatives‘ business strategies and outcomes see Meador et al. (2016) and O‘Brien and Cook (2016).

As the Nairobi metropolitan area grew, both in its economy and the location for East African commerce, large national and international dairy companies provided increasing competition for the milk of the smallholders who previously had provided most of their milk. Moreover, smallholders found new opportunities to gain income in poultry, horticulture, and growing the organic insecticide, pyrethrin (produced from the chrysanthemum flower). These changes were not immediately recognized by the cooperative board and management of the cooperative and, as a result, it finally was forced to give up it processing operation and enter into a contract to sell raw milk to one of the large companies.

After a series of missteps, however, the cooperative board hired a new management team and eventually it developed a series of new incentives to retain current members and attract new ones. This included providing credit for the purchase of dairy feed, building a dairy feed mill, providing artificial insemination and veterinary services. Notably, in recognition of the new environment, they built a poultry feed mill. At the time in which the project was completed the cooperative was making plans to create a cooperative credit union. All of these actions required more engagement with members, through elections to the cooperative board and ongoing procedures for feedback from them.

The cooperative in the more remote rural area faced a very different set of challenges and opportunities. At the beginning of the project in 2011 its processing plant was operating at only 20 percent capacity, well below the level necessary to make a profit. This had produced a heavy debt burden for the cooperative. Members could receive a higher price for their milk from competitors, which resulted in a great deal of ―side selling.‖ Workers in the processing plant at this time seemed to be quite unhappy and the project evaluation team‘s observation of the efficiency of the plant operation was overwhelmingly negative.

The evaluation at the end of the project in 2015, however, presented a very different picture of this cooperative, especially the operation of the processing plant and the morale of its membership. From the baseline to the end-line plant capacity had risen from 20 to more than 70 percent capacity. In addition, the price that members received from the cooperative for their raw milk increased by 12 percent. The observation team was amazed at the turn-around in the efficiency in the operation of the processing plant and the much higher morale among the workers. The end-line focus group meetings found an extremely high level of satisfaction among members, not only with receiving higher and more dependable income, but feeling that the cooperative board and management listened to their concerns and were in sync with their long-term objectives. The central question is how was this turn around achieved in a short five-year period?

The environment in which the more remote rural cooperative operated was quite different in some critical ways than it was for the cooperative in the Nairobi milkshed area. The rural area cooperative faced increased competition from large national and international companies for their members milk. But, they did not face the same level of competition with other non-dairy activities that their members might engage in. This was a significant advantage and created an opening for the rural area cooperative to make substantial adjustments in their business plans.

With the assistance of outside business plan assessment experts in the Land O'Lakes team, the reality of the likely demise of the cooperative led to the cooperative's member elected board to hire a new young Kenyan CEO with extensive background in finance and business management. While the ultimate goal of the cooperative board and the new CEO was to increase the efficiency of the cooperative's processing plant, they realized that they could not achieve that objective without greater engagement of the members. There were three basic challenges in this regard: The first was to reduce the amount of cooperative members ―side selling‖ to other milk companies or to the local ―hawkers‖; the second was to increase the efficiency of the routes along which the raw milk from members was collected; and the third was to expand the collection of milk beyond the geographical limitations within which the cooperative traditionally had operated.

Each of these goals required greater engagement with cooperative members. The new management team immediately opened a dialogue with the staff and processing plant workers, including a morning prayer session in which the CEO and top management were available for open communication. This change in human relations made the members of the cooperative more receptive to changes that would bring greater efficiency to the operation of the cooperative. Once the level of social capital trust had improved, members were more willing to support changes such as improving the efficiency of the collection routes and changing the constitution of the cooperative to permits accessing milk from a larger geographical area.

One of the thorniest issues was getting members to deliver more milk to the cooperative and not to competitors. Smallholder cooperatives in some other countries solve this problem by imposing negative penalties on members who do not sell a set amount of their milk to them. This approach, however, ran counter to the local culture. The situation was resolved with the creation of a bonus system for higher levels of delivery, as well as the cooperative‘s new policy of receiving a uniform price for milk throughout year. The latter reduced the anxiety of members‘ having sharp fluctuations in their income due to the fluctuations in the overall supply of milk.

Finally, the focus group participants gave considerable praise to the Extension programs that taught them how to become better dairy farmers, including a special outreach to women. This is especially important because it indicates the main focus of the cooperative, and from the member‘s perspective, the main benefit of cooperative membership was *long-term* (O‘Brien and Cook 2016). Thus, although the econometric analysis of cooperative members versus non-members showed no *per cow* advantage for members, the often heard phrase in the focus groups was, ―we are in the dairy business for the long haul.‖

The remarkable adjustment of the rural cooperatives to the realities of the liberalized Kenyan economy, especially the engagement of cooperative members in what became a major organizational re-structuring was possible only because of an enlightened membership that elected an enlightened cooperative board and the board selection of new management with both ―hard‖ and ―soft‖ management skills. This illustrates the unique role of governance in cooperatives as they face rapidly changing environments. For a detailed analysis of cooperative governance see Cook (1995) and Cook and Burress (2013).

Introducing Rwandan Smallholders to the Market through Cooperatives

The different historical paths of political and economic institutions in Kenya and Rwanda also has had profound effects on the knowledge that smallholders have of how markets operate. As we saw earlier, one of the most important incentives that attracted smallholders to cooperatives in Kenya was access to inputs and veterinary services. In Rwanda, these cooperative services were not nearly as well developed. The Rwandan government viewed agricultural cooperatives not only as a mechanism to provide collective bargaining power for smallholders, but also as a way to provide a trusted setting in which smallholders could learn about rapidly changing agricultural sciences and thus increase their household's income. The plan involved the government in a support role for cooperative development at all levels, including access to inputs, finance, production, processing and sales (Rwanda Ministry of Trade and Industry 2018).

A two-year cooperative hybrid seed program initiated by the Rwandan government, with USAID funding for technical support services, monitoring and evaluation provided by Land O' Lakes International Development. The evaluation team measured the effects of information programs held within five small holder maize cooperatives. For details on the program and survey and focus group findings on its results see Meador and O'Brien (2019).

In the baseline evaluation of the project, the researchers found that members who trusted their cooperatives were much more willing than their neighbors to look at new information about ways to improve their farming techniques. A workshop provided a setting within the cooperatives where members could learn more about new seed varieties and fertilizers, the private input companies that sold them, and government Agricultural Extension agents who could assist in training and access to resources. Individual information programs were conducted by different facilitators; ―lead farmers‖ in their own cooperative, staff from the Rwandan government agricultural board (RAB), district and sector agronomists, zone leaders, Land O‘ Lakes International Development technical staff and representatives of private sector seed and fertilizer input companies.

The project was not a true experiment, because members could decide whether or not to participate in any of the programs. Nonetheless, before and after interviews with participants and non-participants provide interesting results of the overall impact of participation in the programs, as well as variations in the effects of individual programs depending upon who was leading them. The highest attended workshops were staffed by lead farmers, government and Land O‘Lakes personnel, while the lowest level of attendance were those staffed by the private input supply companies. This was not surprising, given the lower levels of trust of the private sector when smallholders were at the mercy of brokers who sold to each household independently. But, the most important finding was the more than 50 percent increase from the baseline to the post-workshop end-line in trust of the large input – seeds and fertilizer - supply companies, as well as the Sector Agronomist, who was an employee of the Rwandan government.

The results supported the overall goal of the project, which was to empower the village-based cooperative as the trusted mediating mechanism that could provide collective bargaining advantages in the purchase of inputs, but also its social capital trust connection to members that could facilitate educational efforts for smallholders to learn about more advanced agronomy practices.

Again, as in the case of the challenges and opportunities of the Kenyan cooperatives to adapt to changing market conditions, it is essential to understand how the unique characteristics of the Rwandan government‘s approach to cooperatives fits within the historical path of its political and economic institutions. The government‘s hand in cooperative development is clearly much stronger than that found in Kenya. But, it is important to emphasize that the authoritarian aspects of the Rwandan government in no way approaches that of the total command economy model used in the Soviet Union or other authoritarian regimes during the Cold War period. Cooperative membership and participation in workshops offered by cooperatives are voluntary. Moreover, the government‘s institutional reforms mandating gender inclusion have increased the participation of women in cooperative leadership and their overall higher levels of satisfaction with cooperatives. This stands in stark contrast to other sub-Saharan African nations, including Kenya. It is most important to recognize that a substantial portion of the smallholder population‘s acceptance of the Rwandan government‘s comprehensive macro-level institutional structure to *guide* cooperative development has to be understand and *evaluated* within the historical context of ethnic genocide and their overwhelming desire to avoid that happening again (See Meador and O‘Brien 2019).

CONCLUSION

The goal in writing this chapter has been to emphasize the importance of understanding *institutional path dependencies* in order to have more realistic expectations not only in planning but also in evaluating the outcomes of smallholder development projects. The remarkable achievement of building the institutional structure of the European Union or the failure of efforts to introduce liberal democracy to post-Soviet Russia have to be understand within the historical path dependencies of these different nations. So too, must our understanding and evaluation of how macro-level national and sometimes multi-national institutional path dependences affect the options and outcomes available to smallholder cooperatives.

The very different historical paths of macro-level national political and economic institutions in Kenya and Rwanda during their respective colonial periods led to different options with respect to post-colonial government institutional adjustments that have, in turn, created different opportunities and challenges for smallholder cooperative development. Nevertheless, the most important lesson, as Max Weber described earlier and Robert Schuman demonstrated more recently, is that *historical institutional paths can be altered*. It was by no means inevitable that the post-Colonial Kenyan government would adjust the country‘s institutions to permit a more liberalized economy. Even more impressive is the post-genocide Rwandan government‘s approach to smallholder cooperative development as a mechanism to create a viable civil society in a place where only a short time earlier genocide had taken place.

But, there is a similar lesson to be found in each country‘s successes with respect to smallholder cooperative development. That is, in order to succeed, institutional adjustments must take account of historical path dependencies. This means letting go of the search for a ―one size fits all‖ approach to smallholder cooperative development. An alternative approach, suggested in this chapter, can lead to smallholder cooperative development planning and especially evaluation that will be more realistic and certainly less stressful for those who must present *outcome* results that justify public or private investments in such programs.

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Chapter 4

SMALLHOLDER FARMING SYSTEMS: CHALLENGES AND OPPORTUNITIES

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ABSTRACT

Smallholder farming systems comprise keeping of livestock and crops. It involves nutritional inter-relationships of integration and interdependency between livestock and crop systems and crop and crop systems. There is nutrient circulation between crops and livestock when there is the feeding of crops and crop residues to livestock and livestock manure use as fertilizer on crops. When there are no nutritional leaks, an equilibrium is created between the various systems. However, normal nutritional leaks are expected to occur when livestock manure is used to fertilize crops for human consumption. To avoid reduction of nutrients in one component of the system, there must be nutritional replenishments. There are an estimated 500 billion smallholder farms worldwide supporting livelihoods of about 2 billion people, most of who are in Sub-Sahara Africa and Asia. Smallholders make more than 60% of

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agricultural producers supplying local and international food markets, and employ about 70% of farming communities in Sub-Sahara Africa and Asia. However, these farming systems experience financial, technological, infrastructural, market access, environmental and policy and institutional framework challenges. Considering the importance of smallholder farming systems, attempts should be geared towards mitigating the challenges and promoting productivity and sustainability of these farming systems. This is expected to lead to improved food and nutrition security and food safety and translate to improved livelihoods of smallholder farmers and increased income from agriculture products.

Keywords: food and nutrition security, income, livelihoods, nutritional equilibrium, sustainability.

INTRODUCTION

Smallholder farms or smallholdings comprise livestock and livestock, livestock and crops and crops and crops farming systems. Generally, the word smallholder farm is used to describe rural producers; who predominantly reside in developing countries; use family labour and their main source of income comes from the farm. Surplus produce is sold when available (Cornish 1998). There are over 570 billion farms worldwide, of which 500 billion are estimated to be smallholder. They comprise 88% of all farms and work on 53% of the global agricultural land. They make about 70% of farming communities worldwide and support livelihoods of about 2 billion people in Asia and Africa, where land is considered as a main life support resource (Nwanze 2011; Soneye 2014; Graeub et al. 2016). Land sizes in smallholder farming systems range between 2 to 4 hectares in Asia and less than 2 hectares in Sub Sahara Africa. Smallholder farms are characterized by small land size (less than 2 hectares) as compared to family farms characterized by family ownership with the inclusion of all farm types. It is estimated that smallholder farms with sizes below 2 hectares operate only 12% of global agricultural land. However, they produce 80% of food consumed (Lowder et al. 2016). Various types of production systems exist in these smallholder farms classified into;

rearing of crops only, rearing of livestock only and mixed crop-livestock rearing, with variations within the production systems (Dixon et al. 2001).

Population growth and policy-institutional factors in third world countries especially Africa, brought about changes in land use, productivity and sustainability over the years. This has resulted in land subdivision for human settlement with an increase in the number of farm holdings, reduction in land sizes and intensification of production (Ebanyat et al. 2010; Vanlauwe et al. 2014; Jayne et al. 2017). The effect is an inverse relationship between land size and land productivity making them important in the achievement of nutrition and food security and improvement of farm household livelihoods (Chand et al. 2011; Larson et al. 2012). However, this has increased their vulnerability to production risks and environmental shocks (Morton 2007). Maintenance of other ecosystems and enhanced resilience to shocks must therefore be practised to ensure the sustainability of these production systems (Vanlauwe et al. 2014).

A large gap exists between productivity and potential productivity of smallholder farms. Low productivity is experienced even when soil management practice as the application of inorganic fertilizer is used. Limited soil responsiveness to the application of conventional inorganic fertilizers and other factors of production is an indication of the need for a more holistic approach to sustainable intensification in densely populated areas (Jayne et al. 2014). These challenges can be mitigated by a proper understanding of the factors that lead to changes in land-use systems and factors that influence the sustainability of these production systems. For efficient operations, intervention strategies (agricultural and rural) employed should be inclusive enough to recognize the diversity and heterogeneity between farms and within farms. To ensure sustainability, explicit policy actions and institutional frameworks as land policy review relating to land accessibility, subdivisions and land-use practices must be put in place to address these challenges (Ebanyat et al. 2010; Jayne et al. 2014; Vanlauwe et al. 2014; Otieno et al. 2020).

There is an urgent need to reduce both their current and future vulnerability to risks by putting in place interventions to reduce their exposure to risks (Harvey et al. 2014). Some of the interventions should be targeting all smallholder farms as businesses, regardless of how small they are. Therefore, they should be provided with proper and sustainable interventions and clear linkages along each value chain, from production (functioning input systems, technology and extension services), proper infrastructure as roads for transport and electricity for the preservation of agricultural produce, agricultural insurance, information connectivity, financial services as credit, and market access (Ebanyat et al. 2010; Zhou, 2010; Nwanze 2011). This can be achieved by creating and developing policies and institutional frameworks that enhance environments to develop cooperatives, farmer organizations, business associations, scientific organizations and other institutions that promote productivity of smallholder farms. These initiatives will encourage and support smallholder farmers, and entrepreneurs to capture and add value to on-farm agricultural products, reduce post-harvest losses, improve marketing and marketing access, increase profits and improve farmer livelihoods (Zhou 2010).

PRODUCTION SYSTEMS IN SMALLHOLDER FARMS

A production system is made up of a population of individual farm organizations, with broadly similar household livelihoods, resource capabilities, enterprise patterns, constraints and opportunities that allow for similar development strategies and interventions. Therefore, classification of production systems is dependent on the natural resources available; the main pattern and farming activities being practised; household livelihoods available; marketing systems and market access; their interactions and interrelationships and the intensity of production activities (Dixon et al. 2001, 2).

Crop Smallholder Farming Systems

A crop production system refers to crop types, crop sequences and the management practices used in a particular agricultural field over time. It includes all spatial and temporal aspects of managing an agricultural system based on available technologies of crop production. This involves the management of tillage, crop residue, nutrients, pests, and soil conservation practices (Blanco and Lal 2008, 167). Different types of crops have varying abilities to absorb, maintain, and supply nutrients to the soil. For instance, corn extract essential nutrients from the soil, legumes supply nutrients to the soil and a combination of corn with legumes reduces nitrogen (N) losses from the soil. In smallholder farms, these crops can be grown as a single crop with no diversity, a rotation or two or more crops grown on the same field at the same time, making crop production systems that vary between and within the subsystems. Management system employed varies depending on the crops grown and their ability to add to or remove nutrients from the soil (Blanco and Lal 2008, 171).

Mixed Smallholder Farming Systems

Smallholder mixed farms exhibit crop and livestock production on the same farm unit with integration and interdependency of the enterprises, the main feature being the optimization of manure use to maintain soil fertility (Smith 1993, 6). The interdependency between livestock and crops, mostly crop residues varies depending on geographical and political locations; farms in Latin America and Africa have four major subsystems and 10 major subsystems respectively. Also, all the subsystems practice grazing on fallow land regardless of the geographical and political differences (McDowell 1988, 4). Using system dynamic modelling, Walters et al. (2016, 59) demonstrated that mixed farming systems were the most productive and sustainable as compared to livestock only and crop only systems. This was due to the interdependency between livestock and crops involved; livestock is used for traction during land preparation, manure for fertilizing crops and crop residues for feeding animals. There is little or no nutrient loss in these systems; nutrients from each enterprise are used by the other enterprise ensuring sustainability (McDowell 1988, 6). In these mixed smallholder farming systems, over 60% of the land is apportioned to crop production with the remainder 40% for livestock farming activities as housing and pasture production (Duguma et al. 2012).

Livestock Smallholder Farming Systems

The intensities and purposes of production, in smallholder livestock production systems, vary greatly within and across regions. They are classified based on geographical location, intensity of production, type of product and demand for livestock products. These systems result in sustainable equilibrium with the environment, especially when under natural conditions with no external application of inputs. Population pressure and rapidly evolving socio-economic situations result in the evolution of livestock systems to satisfy the demand for animal meat. For instance, intensive pig and poultry production systems emerge and develop in middle-income countries due to changes in incomes and growing demand for livestock products (Steinfeld et al. 2006, 507).

EVOLUTION OF SMALLHOLDER FARMING SYSTEMS

Evolution of smallholder farming systems is determined by biophysical and socioeconomic factors as natural resources and climate; science, technology and innovation; trade liberalization and market development; policies, institutions and public goods and information accessibility and human capital availability (Dixon et al. 2001, 4). Smallholder farming systems in sub-Saharan Africa have transformed due to changes in land use, productivity and sustainability. This has been due to political instability, government policy choices, the collapse of cash crop marketing and land management institutions, human population growth, increased incidences of cattle rustling and communal labour arrangements (Ebanyat et al. 2010; Jayne et al. 2014; Jayne et al. 2017). As population continue to rise, more land is subdivided for human settlement, leading to reduced farm sizes and an increase in the number of farms. To supply adequate land for human settlement and feed the growing population, land use systems have evolved resulting in an expansion of cultivated areas and intensification of production (Dixon et al. 2001, 4; Jayne et al. 2017). For instance, in Uganda between 1960 to 2001, communal grazing land nearly disappeared being replaced by small landholdings, that practice subsistence crop farming; the small landholdings increased from 46% to 78% of total land within the same period (Ebanyat et al. 2010). Studies on livestock feeding systems in the densely populated areas of Nigeria show that 77% to 100% of the animals are fed farm-grown cassava roots, while sparsely populated areas of Tanzania, only 8% to 50% of farm animals are fed farm-grown crops and in the absence of land scarcity and population pressure, extensive land use systems evolved as reported in Zaire. As population pressure increases, livestock and crop farming present opportunities for diversification resulting in a symbiotic relationship between crops and livestock; crops providing feeds to animals and animals providing manure to crops. At the same time, there is provision of balanced nutrients by both animals and crops to the human population (De Haan et al. 1997). There is therefore a direct relationship between population pressure and evolution of smallholder farming systems especially in Africa and Asia (Christiaensen et al. 1995). For instance, the emergence of intensive pig and poultry production systems in developing countries is attributed to an increase in population and demand for livestock products (Steinfeld et al. 2006, 507). Also, there is an opportunity for intensification of production on the smallholdings as their sizes continue to reduce while their number continue to rise. There is application of more inputs as labour and other factors of production per unit land (Jayne et al. 2014). Diversification of enterprises produced in smallholder farms has also been as a result of risks and shocks experienced due to changes in land-use systems, and therefore necessitating the development of coping mechanisms by developing multiple strategies. Crop only production systems have diversified into livestock production which is generally more adaptable to environmental shocks and use natural resources more efficiently (Otte et al. 2012, 38).

SUSTAINABLE INTENSIFICATION OF SMALLHOLDER FARMS

Sustainability concept involves profitability in agricultural production without degrading land and environment. It involves meeting the needs of a generation without necessarily compromising the capacity of future generations to meet their needs using the same resources (Greenland 1994; Ebanyat et al. 2010). This can be done by ensuring that social aspects (income, livelihood and equity) for all agents in the value chain are met responsibly while environmental aspects (land, water, air and nutrients) are used responsibly through efficient use of natural scarce resources (land, water and nutrients) by minimizing air and environmental pollution (McDermott et al. 2010, 100). It involves the management of soil, land and environment; avoiding negative and positive nutrient balances, soil erosion, negative consequences to the environment and use of efficient productivity through appropriate use of inputs (Vanlauwe et al. 2014). Practices as conservation agriculture, proper pest management, planting of biodiverse crops while ensuring that the soil is living and healthy can ensure sustainability (Imadi et al. 2016, 5). Agricultural production sustainability is therefore influenced by the complex interaction of multidimensional components and drivers regardless of the scale of production. Sustainability should therefore reduce land degradation; improve soil fertility and crop production (Dixon et al. 2001, 11; Walters et al. 2016, 51). For instance, use of knowledge on previous manure application when using inorganic fertilizers (nitrogen (N), potassium (K) and phosphorus (P)) on soils in smallholder farms in Kenya reported a significant improvement in crop yields due to availability of P and K pools in the soils. This resulted in sustainable and efficient fertilizer use (Njoroge et al. 2019, 56).

Intensification of production in smallholder farms; growing more with less predispose them to production risks as effects of climate change. It is therefore necessary to introduce low risk and resilient production to ensure sustainability (Morton 2007; Agrawal 2008; Zhou 2010). While increasing productivity in smallholder farms, negative effects of other ecosystems must be avoided and these production systems must have enhanced resilience to shocks (Vanlauwe et al. 2014). Some of the characteristics that determine sustainability in smallholder farms include soil productivity indicators, crop or animal yield and nutrient balances (Greenland 1994; Ebanyat et al. 2010). Understanding the factors that influence sustainability can guide allocation and enhance efficient use and management of resources (Ebanyat et al. 2010). Also, there must be conducive policies and institutional contexts for delivery of goods and services. This can be achieved by integrating modern, science-based technologies with local knowledge while ensuring inclusivity across households and facilitation of local innovation through a participatory approach (Zhou 2010; Vanlauwe et al. 2014).

CHARACTERISTICS AND BENEFITS OF SMALLHOLDER FARMS

Some of the characteristics of smallholder farms include; limited land availability; inadequate capital; inadequate technological skills and labour; low technology uptake; orientation to subsistent production and high vulnerability to risks (Ochieng et al. 2020). There are differences in characteristics of smallholder farms depending on the income level of countries; low-income countries have higher numbers of farms with small sizes while higher-income countries have lower number of farms with larger sizes. This implies that smallholder farms are instrumental in sustaining and improving livelihoods in these communities (Lowder et al. 2016). Livelihoods are sustained by the ability of smallholder farmers to respond to market demands by eliminating the production of less profitable enterprises and replacing them with high-profitable ones (Ali 2005, 268). According to Kristjanson et al. (2012, 387), food security and innovation have a direct relationship in smallholder farms. The least food-secure households make few or no changes in response to declining farm production creating a strong negative relationship between the number of food deficit months and innovation.

In crop only smallholder farms, there are several types of subsystems; one type of crop is grown as a pure stand (monocultures); different crops are grown as pure stands during different seasons (crop rotation) and different crops are grown at the same time on the same piece of land (intercropping) (De Haan et al. 1997; Van Asten et al. 2011). In these subsystems, there is extraction and reduction (corn) and addition (legumes) of nutrients depending on the type of crop grown. Use of legumes leads to enhancement of microbial activity in the root nodules, fixation of atmospheric nitrogen (N), supply of non-synthetic N to succeeding crops and improvement of soil fertility. Crop rotations also reduce the loss of nutrients by reducing soil erosion (Blanco and Lal 2008, 174). Intercropping of cash crops and food crops, resulted in economic benefits when intensification in smallholder farms was practised; especially so when leguminous plants are used leading to nitrogen fixation by the root nodule of the legumes (De Haan et al. 1997; Van Asten et al. 2011). Also, there was a significant improvement in yield and therefore economic benefit when double intercropping of maize and beans was practised. This was due to enhancement of biodiversity, soil moisture conservation, reduction of crop diseases and reduction of crop failure risks (Fininsa and Yuen 2002; Tamado et al. 2007).

In mixed crop-livestock smallholder farms, there exists a close interdependency between crops and livestock especially in high potential areas where human population is high and land is limited with (McDowell 1988, 4; Odero-Waitituh 2017). Livestock provides the plant nutrients for large areas of cropland, especially in the tropical irrigated areas where manure provides nutrients of an estimated value of US$ 800 million per year. This creates a nutrient equilibrium that is in balance with nature where there is no nutrient generation or depletion except where there is soil nitrogen fixation by leguminous plants or soil fertilization using inorganic fertilizers. Application of soil fertilizer in mixed systems must be done with caution to avoid nutrient loading, habitat destruction and water pollution (Jansen and de Wit 1996; De Haan et al. 1997). There is a variation of nutrient balance depending on farm size, degree of intensification and ratio of crops to livestock kept. There is a positive nutrient balance in large farms with more cattle and a negative nutrient balance in medium and small farms with or without cattle (Ebanyat et al. 2010). Manure produced by livestock is used for fertilizing crops; livestock draft power is used on cropping areas allowing for intensification of production and improvement of crop yields (Otte et al. 2012, 38). In Kenya where smallholder mixed farms support livelihoods, a typical subsistence farm would have a negative nitrogen balance of about 50 kg N/hectare and is about self-sufficient in P (De Haan et al. 1997). In these farming systems, soils are degraded with low productivity. However, sustainable intensification is expected result in the improvement of soil fertility and health; and improved productivity (Vanlauwe et al. 2014).

A move towards commercializing production would increase the outflow. With cash generated from livestock, a nutrient balance can be achieved through a combination of manure and commercial fertilizer (De Haan et al. 1997). Livestock is therefore instrumental in conserving the nutrient balance within the system and reducing the threat of nutrient losses (Christiaensen et al. 1995). However, in smallholder dairy farms where milk production is the main source of farmer livelihoods, manure and urine management is a challenge leading to environmental pollution (Devendra 2001). This challenge has been mitigated in Indonesia and Malaysia where mixed farming systems practice diversification by integrating sheep, goat and crop production. There is environmental conservation as the livestock feed on the weeds from the rubber farms at the same time sale of livestock provide finances to the farmers (Ismail and Thai 1990). Also, studies in Zimbabwe by Juana and Mabugu (2005) on the contribution of smallholder farms in economic recovery were encouraging. They reported that small-holder farming systems promoted sustainable development and that inclusion of rural communities especially the vulnerable, in smallholder agricultural activities, improved livelihoods and economies of these communities.

CHALLENGES FACED BY SMALLHOLDER FARMS

Smallholder farmers experience multiple constraints, from production to marketing. One of the biggest challenges in the agricultural sector is transforming the smallholder-farms into viable, profitable and sustainable economic activity bearing in mind that smallholder farms support livelihoods of mostly poor people worldwide, half of who are undernourished and three-quarters of Africa‘s malnourished children (Hazell et al. 2007). In developing countries where smallholder farms exist, agriculture land per capita available for cultivation has declined by almost half since the 1960s; to an average of 2.3 persons/hectare in the 1990s. This has been due to rapid population growth during the same period resulting in an inverse relationship between constraint and farm size, such that the smaller the farm size the more the constraints (Dixon et al. 2001, 4; Awotide et al. 2015). This has been worsened by policy, economic and institutional environments that do not create the necessary incentives for agricultural production and favour urban development programmes at the expense of developing the infrastructure for rural public goods and services (Dixon et al. 2001, 10).

Financial

Most farmers have no access to services of financial institutions or have inadequate financial capacity; where available financial institutions could give loans, they consider giving loans to smallholder farms as risky prompting them to require collateral which most of these farming systems are unable to provide. Mobilization of savings is low and the cost of delivery of credit is high. This reduces their degree of competitiveness and growth (Goletti et al. 2003, 13; Odero-Waitituh 2017). According to

Mukasa et al. (2017), 66.6% of smallholder farmers experience finance-related constraints that are risk and transactional cost-related. Also, most smallholder farm activities and families are managed and headed by women who have limited access to land ownership. The requirement of land as collateral for accessing loans reduces the ability of most smallholder farms to develop and grow (Dixon et al. 2001, 7; Odero-Waitituh 2017).

Infrastructural

There is poor infrastructure due to poor roads, low electricity connections and low water availability resulting in poor networks for input acquisition and marketing of the agricultural products. Poor networks also reduce the volume of transactions and the exchange of information among stakeholders (Goletti et al. 2003, 13). There is high post-harvest losses in the smallholder mixed farms due to inadequate and inappropriate investment in cold storage facilities leading to inadequate and inefficient processing facilities. Also, poor road networks and limited accessibility and therefore marketability of products especially perishable ones during rainy seasons resulted in high post-harvest losses (Odero-Waitituh 2017; Ochieng et al. 2020).

Technological

Smallholder farms exhibit low productivity due to technological and skill-based challenges (Zhou 2010; Otte et al. 2012, 34). Research on increasing labour productivity, sustainable land use and integrated technologies for diversifying the livelihoods of smallholder farmers have not been fully exploited (Dixon et al. 2001, 5). There was a strong inverse relationship between innovation and food deficit months especially in the food-insecure households, and relatively little uptake of existing improved soil, water and land management practices (Kristjanson et al. 2012).

According to UNESCO (2019), Sub Sahara Africa and Asia have the lowest literacy level with the highest out of school adolescent at 37% and 15% respectively. Farmers‘ education positively influenced agricultural production and adoption of innovative technologies in agriculture with a positive correlation (r = 0.64) between the household head having higher education and household food security (Mapiye et al. 2009, 201; Harvey et al. 2014). Also, in developing countries where smallholder farms exist and contribute to economic development, girls and young women do not have the same access to education and training as their male peers. However, these smallholder farms are mostly headed and managed by women. This impedes the uptake of innovations. Smallholder farms productivity are therefore affected by low technology uptake due to low literacy level and innovation uptake (Dixon et al. 2001; Odero-Waitituh 2017).

There is poor handling and storage of manure due to inadequate management technology use necessitating inorganic fertilizer application for soil fertility to be improved (Rufino et al. 2007, 286). However, soil fertility and moisture constraints are reported in smallholder farms even when inorganic fertilizer is applied (Jayne et al. 2014; Vanlauwe et al. 2014). This implies that the problem is more complicated and can‘t be rectified by manure application and therefore a proper understanding of the soil microclimate is necessary (Mapiye et al. 2009, 203). A similar trend was observed in smallholder dairy and mixed farms where lack of improved technology and inadequate innovation at farm level resulted in disease outbreaks, pest damage, crop loss during storage and post-harvest farm produce losses impeding increased productivity (Somda et al. 2005; Harvey et al. 2014; Odero-Waitituh 2017). Smallholder dairy farms experienced challenges in the choice of geographically adapted breeds, access to improved breeds due to uncoordinated breeding programmes, feeding systems and management of manure and urine (Devendra 2001; Odero-Waitituh 2017). According to Smith (1993, 2), most smallholder mixed farms in the tropics experience inadequate livestock feed availability and nutritional imbalance, due to the use of crop residues leading to negative feed balance.

Environmental

Smallholder farms are predominantly located in the tropics. This geographical location together with socioeconomic, demographic, and policy trends expose them to and increase their vulnerability to climatic and disease risks and limit their capacity to adapt (Morton 2007; Otte et al. 2012, 34). According to Harvey et al. (2014), the occurrence of extreme weather events characterized by cyclones, floods and droughts led to crop failure, livestock deaths and destruction of infrastructure predisposing the smallholder farmers to loss of livelihoods and food insecurity. Sustainability is important for the survival of smallholder farms; this results in the farmers exploring activities outside the production system to support their livelihoods. For instance, in Malawi, smallholder farmers engaged in deforestation activities as timber selling and charcoal burning to supplement the income from their farms. This resulted in soil erosion, low forest canopy and environmental pollution exposing the smallholder farms to effects of environmental degradation, negatively affecting farming activities and productivity (Munthali et al. 2013). Similar results were reported in Rwanda where there was an inverse relationship between smallholder farm productivity and soil erosion (Byiringiro et al. 1996).

Marketing

The market environment for agricultural products is characterized by high transaction and marketing costs and lack of or inadequate market power for both inputs and outputs (Otte et al. 2012, 34). Agricultural products prices are volatile and are not dependent on input prices but the law of demand and supply applies. They are characterized by frequent price fluctuations, predisposing agents in these agricultural value chains to risks of losing their investments when prices fall. Some of the causes of price fluctuations are identified as changes in climatic and weather patterns; government regulations; poor infrastructures; fluctuations of the currency exchange rate; nature of the product; low production and storage technology and fluctuations in production (seasonal) (Huka et al. 2014; Harvey et al. 2014). Also, inadequate innovation on diversification of agricultural product produced in the same area can create a flood in the market during the harvesting season which brings down the product prices (Harvey et al. 2014). Product price fluctuation is identified as one of the impediments in the marketing of products from smallholder farms and achievement of smallholder farmer‘s development. This results in loss of capital and farmers shift to other production activities (Huka et al. 2014). Studies done by (Epprecht and Robinson 2007, 101) in Vietnam on the relationship of agricultural product market access and poverty showed an inverse relationship. Areas with better market access had lower poverty incidences.

Weak Institutional and Policy Frameworks

Luck of or weak institutional support and inadequate and distorted economic and land policies guiding operations of smallholder farms have reduced productivity of smallholder farms (Somda et al. 2005). Conducive policy and institutional environments are prerequisites for a dynamic farming system. Over the last 3 decades, most of Africa and Asia have undergone through structural adjustment which accelerated the widespread decline of national food self-sufficiency as a dominant element in the shaping of policies for rural areas where smallholder farms exist. Continuous privatization of government institutions has further weakened the ability of governments to monitor and enforce policies that encourage innovations and technological uptake in smallholder farms (Dixon et al. 2001, 6). For instance, institutions dealing with research and extension have left innovative farmers and agro-enterprises without any support. There is also a disconnect of information flow of research and extension (Goletti, et al. 2003, 13). Government agricultural development policies focus more on marketed/processing of products, while livestock keepers attach greater importance to services at the production level in the livestock value chain as inputs services, marketing of by-products as manure, livestock draft power and insurance against risks. The divergence in the priorities of livestock keepers and policymakers results in the development of policies that contribute little to poverty alleviation of smallholder farmers. This has affected the sustainable productivity of these farms (Otte et al. 2012, 55).

OPPORTUNITIES FOR IMPROVING PRODUCTIVITY IN SMALLHOLDER FARMING SYSTEMS

Favourable Geographical Location

Most smallholder farms are situated in the tropics where the rains are bimodal; food and feeds can therefore be grown in two seasons in a year. For instance, in Mexico maize production is dependent on rainfall and production is sustainable due to the bimodal nature of the rains and it is reported that just 10% more rain results in 60% increase in maize yields (Donnet et al. 2017, 141). Various innovations can be employed on best preservation methods to ensure all year round of feed and food supply, while at the same time ensuring that the nutrients are preserved (Smith 1993, 12; Rufino et al. 2007, 278).

Youth Population

It is estimated that by 2060, the youth population will reach 500 million and 600 million mark in Africa and Asia respectively (Prospects 2012). Projections done by Desa (2015) predict that the current youth population figures in these areas will more than double by 2055. According to Fares et al. (2007, 28), the youthful period is a time of intense learning; without adult supervision and support, they can perform innovations through their curiosity and wish to engage with the world around them. This result in solutions to social, environmental, design or technical and scientific problems through development of new ideas and concepts (Sebba et al. 2009, 5). This is the time when the youth acquire important human capital necessary to develop and better themselves and be a positive force for development when provided with the education and skills they need. The knowledge acquired will translate into opportunities and if they are allowed and engaged, contribute to economic growth when given access to the labour force (Desa 2015, 1). In Sub-Sahara Africa and Asia, youths have formed functional farmer groups and organizations to enable them network, pool their farm produce together for marketing and access inputs and other services. These groups are cohesive and can be a channel for networking and innovations (Bizikova et al. 2020). The increase in and high youth population is therefore expected to provide a more innovative and efficient workforce especially in the agricultural sector which will enhance innovations and sustainable development in smallholder farms.

Technological Innovations

Simulations are technological innovations that can be applied to predict expected responses given the present circumstances and therefore help in developing intervention strategies targeted at smallholder farms. This can be achieved by combining knowledge of the agronomic realities of each specific case with the simulation of primary drivers of system performance. More productive and sustainable smallholder farming systems can be developed (Whitbread et al. 2010, 56). According to Van Wijk et al. (2009, 98), to analyse farm productivity in integrated crop-livestock African smallholder farm systems, Nutrient Use in Animal and Cropping systems: Efficiencies and Scales (NUANCES-FARMSIM) (FARM Simulator) model was developed and used. The model was found to be sufficiently robust in identifying the key management options within a smallholder farming system that explain most of the variability in farm productivity, and the long-term consequences of these options. Walters et al. (2016, 59) using farming systems modelling and drivers of agricultural production systems, was able to analyse various systems for productivity and sustainability, and therefore allow for farmers to make choices on best agricultural enterprises to undertake. Also, available technological innovations that promote diversification, environmental protection and resilience as agroforestry can be employed to ensure the sustainability of smallholder production systems. Trees are important in controlling soil erosion by reducing the speed of surface runoff; falling leaves provide humus for soil fertilization and improvement of soil moisture retention and sequestering of carbon from the atmosphere (Quandt et al. 2017, 498). Treatment of crop residues in mixed farming systems can be explored to improve the nutritional value of crop residues and animal performance (McDowell 1988, 16).

According to Krell et al. (2020) in 2017, Kenyan mobile phone ownership was at 88%; above 72% of sub-Sahara African countries (excluding high income) and 68% of least developed countries as per united nations classification. Pilot projects in central Kenya showed positive uptake of mobile phone massaging services for farming activities, especially in farmer organizations and cooperatives in smallholder farms. The farmers used the services for marketing, general extension services, general management on the farms and getting information on meteorological services. In Tanzania, a direct relationship between improvement of crop yields and use of mobile phones for farming activities was reported and suggestion made that there existed significant policy opportunities to leverage use of information, communication technology (ICT) to improve efficiency, yields and profits by redirecting the use of mobile phones in smallholder agricultural production (Quandt et al. 2020). Similar results were reported in Pakistan where smallholder farmers had easy access to market information and financial transaction through mobile phone making the farmers more connected to the mainstream (Khan et al. 2019).

Use of Improved Crop and Animal Genetics

The opportunity for improving local breeds through crossbreeding and selection of locally adapted breeds that have higher production under the prevailing environmental conditions is available in most areas where smallholder farms exist. This is expected to lead to higher animal performance using available resources therefore reducing land pressure. For instance, the benefit of crossbreeding was reported in Bhutan region of Eastern Himalayas where crossbred cows had milk off-take that was 2.4–4.6 times higher than local breeds. This resulted in improved gross margin for dairy production by 1.6 (Samdup et al. 2010). Technology and advances in genetic engineering have allowed for the production of transgenic plants that have higher water uptake from the soil during water scarcity leading to enhanced plant survival. This is due to extensive root systems, larger root biomass and increased leaf water potentials (Park et al. 2005, 18834). In Mexico, maize production in the areas where traditional systems of production are practised increased due to the use of hybrid seeds. Maize yields increased by 50% when hybrid seeds were used as compared to when farmers using their preserved seeds (Donnet et al. 2017, 141).

Presence of Ready Markets

Smallholder dairy projects have great potential because traditionally, farmers have always kept cattle, and the demand for milk in the rural community exists (Somda et al. 2005). Milk production in smallholder systems is viable and therefore investing in milk production under current farming practices is worthwhile. Milk production generates reliable incomes, which gives opportunities for intensification (Somda et al. 2005). The proximity of smallholder farms to urban areas where the population is high has created a demand for agricultural products locally, domestically and regionally (McDermott et al. 2010, 108). According to Dixon et al. (2001, 1), 60% of the 5.1 billion people in the developing world live in the rural areas classified as 85% agricultural and smallholder farms make up 80% of economic activities in these communities (Cornish 1998). This high population in the rural areas is expected to provide a quick and ready market for agricultural products and therefore prevent losses due to spoilage. Also, over the last four decades, population growth in the third world low-income countries has almost doubled with an increase in the average per-capita income; creating a demand for animal-sourced food, significant potential for agricultural growth, economic development, and reduction of poverty in rural areas. At the same time, the ready market for agricultural products in the urban areas due to an increasing population with an improved average income per capita; is expected to create an opportunity for exploring and strengthening the agri-food supply concept, which will allow for quick and efficient delivery of agricultural products to supermarkets (Dixon et al. 2001, 1; Otte et al. 2012, 91; Ates et al. 2018). This is expected to create a ready market for agricultural products locally and regionally.

Inherent Sustainability

Keeping of livestock and crops in mixed farming systems allow for the intensification and sustainable waste management; crop residues are used as livestock feed while manure is used to fertilize crops. Application of manure to fertilize soils increased nitrogen (N) mineralization and therefore availability in the soil compared to when the plant was used for fertilization and was, therefore, more beneficial (Delve et al. 2001, 241). Production costs in such systems are therefore reduced ensuring the improvement of livelihoods and higher incomes (Smith 1993 2; McDermott et al. 2010, 101). Also, management of crop residues to increase their nutritional value and management of livestock to ensure manure is used safely creates an opportunity for employment to the households and neighbours and therefore increase the productivity and profitability of smallholder farms (Devendra 2001). In areas where smallholder livestock farming is practised, there exits rangelands and agroforestry; this can provide opportunities for diversification of income from the smallholder farmers through payments for ecosystems goods and services like water, carbon sequestration, tourism, biofuel production and the development of niche markets (Seré, et al. 2008, 25). The number of smallholder farms is higher in the tropical regions of Africa, Asia and Latin America. Sub-Sahara Africa, South East Asia, South Asia and Latin America each have an annual carbon dioxide (CO2) emission below 2,000 metric tonnes compared to Europe and North America having above 6000 metric tonnes each. There is therefore a niche market for trading carbon emissions and offering opportunities to benefit small farmers through land uses that sequester carbon resulting in improved livelihoods (Zhou 2010; McDermott et al. 2010, 101). Smallholder farms have a competitive advantage for family labour compared to large scale farms; they, therefore, make efficient use of scarce natural resources, diversify their farming activities and optimize the returns from family labour which is usually heterogeneous. This reduces production costs, creates a variety of goods for the market and increases profits (Otte et al. 2012, 34).

CONCLUSION

Smallholder farming systems are important; especially in areas where they exist. Apart from their importance in ensuring food and nutrition security, they support livelihoods, economies and economic reconstruction of countries where population continue to rise and sometimes civil unrest was experienced and continue to be experienced. Therefore, they are instrumental in realizing sustainable development goal (SDG) 2 (zero hunger). However, to mitigate the challenges and ensure the sustainability of these production systems, SDG 12 (responsible consumption and production) must be mainstreamed into these production systems. It is clear that various opportunities exist and can be created to ensure sustainability and improved productivity of these production systems. Diversification of livelihoods in smallholder farms is expected to cushion them from environmental and economic shocks and ensure sustainability.

Also, these farms are heterogeneous between and within farms. Research should therefore be reorganized to produce a diversified range of technical, economic, social, environmental and financial options to suit the needs of farmers with different resource capabilities, management skills, and resilience. This will result in each smallholder farm being treated as a unique entity and therefore allow for the application of unique interventions for improved productivity and sustainability. Also, institutions and policies that promote the formation and development of farmer groups, cooperatives and organizations must be developed. This will ensure that activities that encourage aggregation of farm products, joint value addition and marketing are supported and ensure increased farmer earnings and improved livelihoods.

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Chapter 5

THE FAILURE OF COMMON FARMING SYSTEMS IN PROMOTING LIVELIHOOD DIVERSIFICATION AND FOODSUFFICIENCY AMONG SMALLHOLDER FARMERS: EVIDENCE FROM CHOMA, ZAMBIA

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ABSTRACT

To assess the effects of farming systems on household maize sufficiency and farmer involvement in off-farm activities, relationships involving maize production, maize retained for household consumption, household maize requirement, time spent on off-farm activities such as gardening, petty trade, and casual work were performed. Data for the

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study was collected from farmers using structured interviews and key informant interviews. Data was collected from basin conservation agriculture (21 farmers), ripping conservation agriculture (43 farmers), conventional hand hoeing (62 farmers) and conventional ploughing (167) farmers during land preparation (October), weeding (January), harvest (April) and dry season (July) periods. Despite producing enough maize for annual household consumption, 98.4% of conventional hand hoeing farmers, 95.2% of basin conservational farmers, 60.4% of conventional ploughing farmers and 30% of conservational ripping farmers had less maize retained for household consumption than their annual household maize requirement after selling off about 50% of their maize produce. Conventional hand hoeing farmers spent significantly more time on off-farm activities than did basin conservational, conservational ripping and conventional ploughing farmers, especially in July. Conventional hand hoeing farmers also spent a significantly higher amount of time gardening than did basin conservational farmers and conservational ripping farmers. Engagement in petty trade and casual work did not significantly differ among farmers. Diversification of livelihoods by the farmers was reactive and farmers who engaged in farming systems that recorded low maize production had a high involvement in off-farm livelihood activities. Sustainable livelihood diversification should be encouraged as it would result in diversified income sources for farmers and lessen the pressure on maize as a sole important cash crop. Off-farm livelihood diversification could be a viable option for managing risks and shocks associated with food insufficiency among smallholder farmers and contributes to stable food systems as diversified livelihoods are less vulnerable.

Keywords: conservation agriculture, conventional agriculture, sustainable livelihood diversification, farming systems, off-farm activities

INTRODUCTION

Food security is becoming an increasingly important challenge in both rural and urban communities (Opitz et al., 2015). Among rural farmers, food security challenges are in addition to other challenges such as soil fertility loss (Sanchez, 2002), increased labour demands, low and variable yields, soil degradation (Ngwira et al., 2014), intra-seasonal droughts, late onset of rainfall (Tadross et al., 2009; FAO, 2011), and extreme temperatures during crop germination and flowering (Thornton and

Cramer, 2012), all of which affects crop production (IPCC, 2007). As risks to smallholder agriculture become more frequent and intense, farmers are expected to adapt their farming systems to curb adverse impacts due to various stressors (Câmpeanu and Fazey, 2014).

Diversification of livelihoods could provide adaptation and coping mechanisms during periods of extreme events (Ellis, 2000). Rural livelihood diversification recognizes that rural households engage in a variety of income generating activities for sustenance. They build a diverse portfolio of livelihood strategies involving activities and assets for purposes of improving living standards. Livelihood diversification is done at different scales, across different farm sizes and income levels. For instance, a farmer may also be involved in trade, fishing, charcoal production, bee-keeping, craft making or casual labour. Such diversified livelihoods might cushion the impacts of crop failure or supplement household income. Livelihood diversification brings out survival strategies and techniques. Ellis (2000) defines livelihood strategies as a collection of activities resulting from the interaction between household assets and opportunities that ensure household survival. These livelihood strategies could be natural resource based or not and are responsive and adaptive to changing pressures and opportunities (Umar, 2012).

Diversification of income sources is a characteristic of many rural households (Vedeld et al., 2004; Shiferaw et al., 2014). While farming provides the major source of income earned by many rural households, a proportion of household income comes from diversifying livelihoods. Vedeld et al. (2004) reported that poor households living close to a forest may earn up to 22% of their total household incomes from forests. Hichaambwa and Jayne (2014) estimated that 39% of the income share for smallholder farmers in Zambia is due to off-farm activities which provide an important income supplement for farming households. Such off-farm activities include remittances, petty trade, livestock rearing, gardening, casual work, and fishing. Generally, farmers engage in off-farm livelihoods throughout the year. However, their engagement in these activities heightens during the off-season when farming activities cease. For some farmers whose stored food reserves were depleted before the next harvest season, off-farm activities became important even during the crop growing season as they served as survival mechanisms. At such times, the off-farm livelihood activities tend to compete with farming activities in terms of the farmers‘ time and energy. On the other hand, the labour needs of particular farming systems could result in farmers concentrating on farm activities at the expense of diversification of livelihoods, which could leave them vulnerable to climatic stressors. A proper balance between the choice of a farming system and time apportioned to off-farm livelihood activities could help households attain food sustenance.

Four major farming systems were identified in the study area. Traditional or conventional hand hoeing (CNH) involves cultivation and churning of land using a regular hand hoe. Land preparation is triggered by the arrival of first rains in October or early November. Conventional ploughing (CNP) involves the use of ploughs for land cultivation. Ploughing and planting happen simultaneously and so CNP farmers have to wait for the planting rains before preparing their land for cultivation. Both CNH and CNP are traditional farming systems which have been used by farmers in the study area for decades. Since the late 1990s, conservation farming systems have been promoted in Zambia as a climate smart alternative to the conventional farming systems (Haggblade and Tembo, 2003; Giller et al., 2009; Thierfelder and Wall, 2010; Mazvimavi, 2011; Nyanga et al., 2011; Umar and Nyanga, 2011). Variants of conservational farming systems commonly practiced in Choma include; basin conservation agriculture (CAB) which is the conservation agriculture equivalent of CNH. Basins are made using a *Chaka* hoe which is a specially designed handhoe to make basins dimensions of about 20cm deep and 30cm long (CFU, 2007b). This farming system is practiced on relatively smaller plots as it is labour intensive. Farmers with access to draught animal power utilize a plough-like implement called a *magoye* ripper used to make rip-line furrows 15-20cm deep and spacing of 90-100cm apart (CFU, 2007a). This farming system is called ripping conservation agriculture (CAR). Land preparation in conservation farming systems happen immediately after harvest before soils harden and the prepared land is again made ready for planting just before the first planting rains.

Regardless of the farming system farmers chose, maize is the major food and cash crop they would likely produce. The crop is produced and consumed by over 86% of farmers (Tembo and Sitko, 2013) and accounts for nearly half the calories consumed (Zulu et al., 2006). It‘s the major crop cultivated and is allocated over 68% of the available arable land. From the total grain consumption *per capita* for Zambia of 104 kg, 83 kg is from maize (FAO/WFP, 2010). The various uses for maize coupled with the increased population in the country has resulted in the increase in the demand for maize over the years.

Considering the importance of maize to smallholder farmers, in this study; (i) we assessed how farmers‘ engagement in the four farming systems discussed affected their household maize sufficiency, (ii) we also assessed how engaging in a particular farming system affected smallholder farmers‘ involvement in three off-farm livelihood activities; gardening, petty trade and casual work.

Conservation Agriculture in Zambia

Conservation agriculture involves a series of sound land husbandry practices which minimize soil disturbance, maintain year round organic matter soil cover and use crop rotations and associations to reduce impacts of pests and diseases (Kassam et al., 2009; Baudron et al., 2007). It is premised on the utilization of the three principles: minimal tillage; perpetual organic cover over soils using crop residues or living cover crops; and crop rotation (Chappell and Agnew, 2004; Thierfelder and Wall, 2009; Friedrich et al., 2012). Individual farmers can diversify within the framework of these principles depending on the local soil fertility or financial capacity at hand. The variants of CA promoted among smallholder farmers in sub-Sahara Africa typically include minimum tillage through digging basins, ripping and pot holing. Seeds are planted in these basins, rip lines or pot holes made either with minimal or zero soil inversion, which would otherwise leave it susceptible to agents of erosion and accelerates oxidation of soil organic matter (Johansen et al., 2012).

Promoters of CA have argued that practitioners of CA have better coped with the impacts of climate change as they have been consistent with their yields compared to those who practised conventional agriculture (Haggblade and Tembo, 2003; Giller et al., 2009; Thierfelder and Wall, 2010; Mazvimavi, 2011; Nyanga et al., 2011; Umar and Nyanga, 2011). This is because, CA produce minimal adverse impacts on the environment, reduces soil erosion, reduce long term production costs and improve soil fertility (Haggblade and Tembo, 2003; Hobbs, 2007; Hobbs et al., 2008). However, some studies have contested the assertion of CA improving soil fertility. A study by Nyamangara et al. (2013) in Zimbabwe revealed that CA did not improve such soil parameters as pH, organic carbon and total phosphorus. CA practices such as mulching and crop rotations only improved maize yields when chemical fertilizer was added hence calling into question the role of CA in improving soil fertility.

Adoption of CA could involve either a farmer practicing CA on a portion of land or completely switching to CA farming system on the entire plot. It could also entail partial adoption where farmers adopt only some of the land husbandry practices promoted under CA. The rates of CA adoption in Zambia have been low (Arslan et al., 2014; Andersson and D‘Souza, 2014). CFU (2006) reported that between 125 000 and 175 000 farmers practiced CA in Zambia in 2006. However, by 2008, 95% of the smallholder farmers who had previously adopted CA had dis-adopted it (Arslan et al., 2014).

Study Area

Choma district (Figure 1) covers an area of 7 296 km2 and has a population of 247 860 or 45 733 households (CSO, 2012). The population density of 34 persons per km^2 is twice the national average. The district has 42 000 registered farmers engaged in both crop and livestock farming. Mixed farming is common in the area with cattle, goats, pigs, and donkeys being the commonly reared livestock. This type of agriculture is important for smallholder farmers as it allows them to engage in off-farm livelihood activities such as trading in milk and livestock (Tembo et al., 2014).

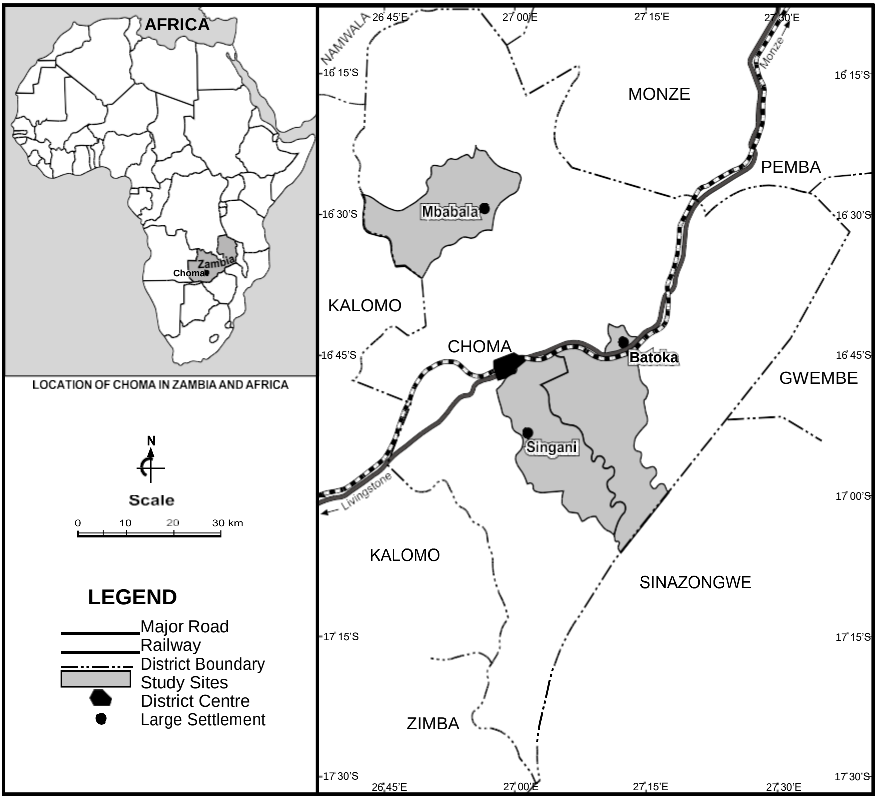


Figure 1. Map of Choma District, Zambia showing the location of the study sites.

METHODS

Sampling

The sample for the study consists of key informants and local farmers in Choma engaged in CA and CN agriculture. The key informants in the study were sampled from the Ministry of Agriculture and Livestock

(MAL), Conservation Farming Unit (CFU) and representatives of traditional authorities. The farmers selected were involved in basin and ripping conservation agriculture as well as hand-hoeing and ploughing conventional agriculture. The sample size varied in the different months selected for respondent interviews but ranged from 223 in October to 292 in July (Table 1). Most of the farmers in the area practiced CNH and CNP. For these farmers, determination of the sample size was through a priori power analysis using GPower 3.1.9.2 data analysis software. This software was fed with the required effect size (p = 0.5), the statistical power (0.95) and the type of tests to be conducted (r, T, and F-tests). With these input parameters, the software was able to calculate the required sample (107 farmers). However, to ensure data accuracy, the study utilized between 223 and 292 farmers over the 4 months of data collection.

Table 1. Sample sizes (n) for sampled respondents from each of the four farming systems

Month	**Sample sizes**				**Total**
	Basin CA	Ripping CA	Hand hoe CN	Ploughing CN	
Jan	8	24	62	151	245
Apr	13	35	57	163	268
Jul	21	43	61	167	292
Oct	18	31	42	132	223

The sample sizes for the CAB and CAR farmers were derived differently. Since the area had few farmers practicing these farming systems, sampling was by snowballing. The interviewed farmers directed the researcher to the farmers who practiced either CAB or CAR. All the available farmers in the area who practiced CAB and CAR were included in the sample. The overall representativeness of the sample size was confirmed again using the post hoc power analysis in GPower 3.1.9.2 statistical software. The software provided statistical power greater than 0.95 for all sample sizes in Table 1 and moderate effect size at 0.05 probability level (Erdfelder et al., 1996) for r, T and F- tests.

All the farmers in the sample also engaged in off-farm livelihood activities. The respondents were drawn from the same population at different times of the year i.e., during the off-season in July, during the land preparation period in October, during weeding period in January and during the harvest period in April (Table 1). Most of the farmers were interviewed in July (292) during the off-season as compared to the other months when farmers were engaged in farm activities such as land preparation, weeding or harvesting.

Data Collection

The field work for this study was conducted from January 2015 to October 2015 during the 2014/ 2015 agriculture season, using a structured interview schedule that was administered to 245 (January), 268 (April), 292 (July) and 223 (October) smallholder farmers in Choma. The difference in the number of farmers interviewed was because some farmers interviewed earlier were not available in later months due to either relocations or a busy farming schedule. Since few farmers in the study area practiced CA, all available CA farmers at the time of the study were interviewed, while CN farmers were randomly sampled using the village registers collected from traditional authorities. Structured household interviews, desk analysis, key informant interviews, and observations were used as data collection tools.

Structured Interviews and Key Informant Interviews

Structured interviews were administered to farmers in the study area. The data collected include types of off-farm livelihoods engaged in by farmers, amount of time spent on off-farm livelihoods and reasons for preference or lack of preference of a particular farming system. The use of interviews enabled the researchers to probe for more detailed information whenever necessary.

Key informants were selected based on their knowledge of smallholder agriculture and farming systems in Choma either as promoters or as land custodians. The interviews were administered to the seven selected key informants from MAL, CFU, and traditional authorities. These involved face-to-face interviews using semi-structured interview schedules. The key informants supplied information on off-farm livelihoods by farmers and the farming systems practiced in the study area.

Observations

The farming systems and livelihoods engaged in by farmers were confirmed by observation. Aspects of the different farming systems such as the use of *magoye* rippers for CAR or the intensive nature of CAB using the *chaka* hoes were also observed. Average time spent on land cultivation in CAR and CNP were also confirmed through observation.

Data Analyses

To assess how farmers' engagement in the CNH, CAB, CAR and CNP farming systems affected their household maize sufficiency, the Pearson correlation and linear regression analysis techniques were performed in order to analyze relationships between maize produced and maize sold, maize produced and maize area cultivated as well as maize produced and household maize requirements among farmers in each of the four farming systems. Assessment of maize sufficiency among farmers utilized a paired sample T-test where maize retained for household consumption and the annual household maize requirement for each of the four farming systems were paired. All the analyses in this study were conducted at a P = 0.05 probability level and were performed in SPSS 22 (IBM Corp., 2013).

In order to assess how engaging in a particular farming system affected farmers' involvement in the three off-farm livelihood activities, gardening, petty trade and casual work, we used the parametric one-way analysis of variance (ANOVA) and Fishers' least significant difference (LSD) post hoc tests to compare differences in the time spent on the three off-farm livelihoods, by farmers engaged in CNH, CAB, CAR and CNP. The LSD test was only used when the parametric ANOVA was found to be significant and the Levene‘s F-test for equal variance not statistically significant. The comparisons helped make inferences as to the intensity of engagement in off-farm livelihood activities by farmers in each of the four farming systems.

Data from the questionnaires involving household financial needs, how income from maize sales was used, and the reasons for farmers‘ preference or lack of preference of a particular farming system, was analyzed using descriptive statistics and presented as percentages. Qualitative analysis was performed in which the responses were isolated into key emerging themes, and a high frequency of a particular theme represented a more common phenomenon in comparison with themes of lower frequency.

RESULTS

Why Off-Farm Livelihood Activities Were Important to Smallholder Farmers

Many of the smallholder farmers sampled in Choma were in a state of maize deficit as the maize retained for household consumption was not enough to sustain their annual household maize requirements (Figure 2). The maize retained for household consumption was the proportion of the maize held back by the farmer and not sold after harvest. The most affected were CNH farmers and CAB farmers were 98.4% and 95.2% of the farmers, respectively, recorded maize deficits during the 2014/ 2015 agriculture season. About 60.4% of the CNP farmers and 30% of the CAR farmers also had maize deficits for the 2014/ 2015 agriculture season (Figure 2a-d). CAR farmers were less likely to suffer food insufficiency as they had the lowest proportion of farmers whose maize retained for household consumption was less than their maize requirements. CNH and CAB farmers were most at risk. The results indicate that most of the farming households did not reserve enough maize to sustain them to the next harvest season. When the stocked maize reserves deplete, farmers survive through income from off-farm livelihood activities.

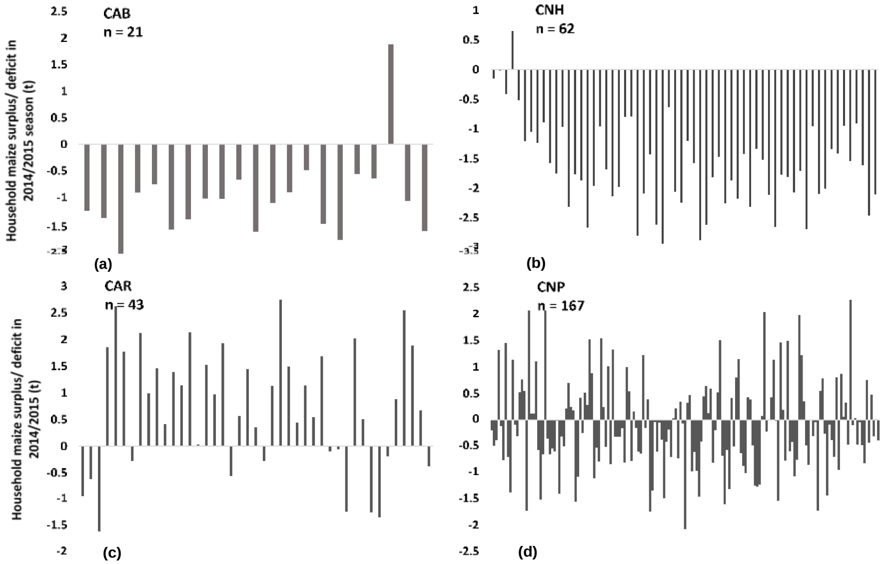


Figure 2. Household maize surplus and deficit among the CAB, CNH, CAR and CNP farmers in Choma, Zambia in the 2014/2015 agriculture season. The maize surplus and deficit were calculated as the maize retained for household consumption minus the annual household maize requirements for each household, for the 2014/2015 agriculture season.

Maize sufficiency among farmers was estimated by determining whether the maize reserved for household consumption was more or less than the farmers' household maize requirements for farmers engaged in each of the four farming systems. This was performed using a paired sample T-test where maize reserved for household consumption and household maize requirement for each sampled household was used as a measure of significant difference. The results indicated that there was a significant difference in maize reserved for household consumption and household maize requirements for all the farming systems (CNH: T = 6.431; p = 0.001, CAB: T = 6.315; p = 0.001, CAR: T = 2.172; p = 0.002, CNP: T = 4.642; p = 0.001). The maize required for annual household consumption was generally higher than the maize retained for annual household consumption, implying that farmers were in a state of maize deficit.

The total maize produced for most of the farmers in Choma was higher than the annual maize requirement (Figure 2). Despite the significant increasing trends in total maize production among the households in Choma (r = 0.444; p = 0.001), the household maize requirements remained fairly constant across the households (r = 0.109; p = 0.062). This implied that the *per capita* consumption for household did not change even when farmers increased their production. However, the amount of maize sold increased with increase in total maize production (Figure 3a-d). In fact, many of the farmers sold over half of their maize produced which left them in a state of maize deficit. If household food sufficiency was prioritized among the farmers, they would have enough for annual sustenance, even though that would mean a reduction in household income from maize sales. This reduction in income could be compensated for by farmers engaging more in off-farm livelihood activities.

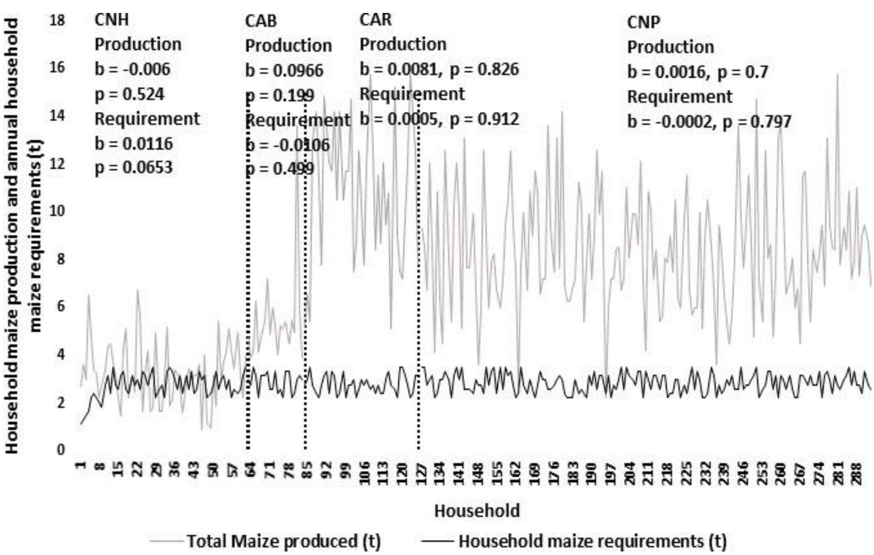


Figure 3. Household maize production versus household maize requirements among the sampled households in Choma, Zambia for the 2014/2015 agriculture season.

Maize Produced and Maize Sold among Different Farming Systems

There was a strong positive correlation between the amount of maize produced and the amount of maize sold among CNH farmers (r = 0.815; p = 0.001), CAB farmers (r = 0.6789; p = 0.001), CAR farmers (r = 0.789; p = 0.001) and CNP farmers (r = 0.775; p = 0.001) (Figure 4 a-d). This implied that the quantity of maize sold by all the farmers increased with increase in maize production. For every additional tonne of maize produced, CNH farmers sold a mean of 0.71 tonnes, CAB farmers sold 0.66 tonnes, CAR farmers sold 0.49 tonnes and CNH farmers sold 0.43 tonnes. Hence maize was an important cash crop among these farmers.

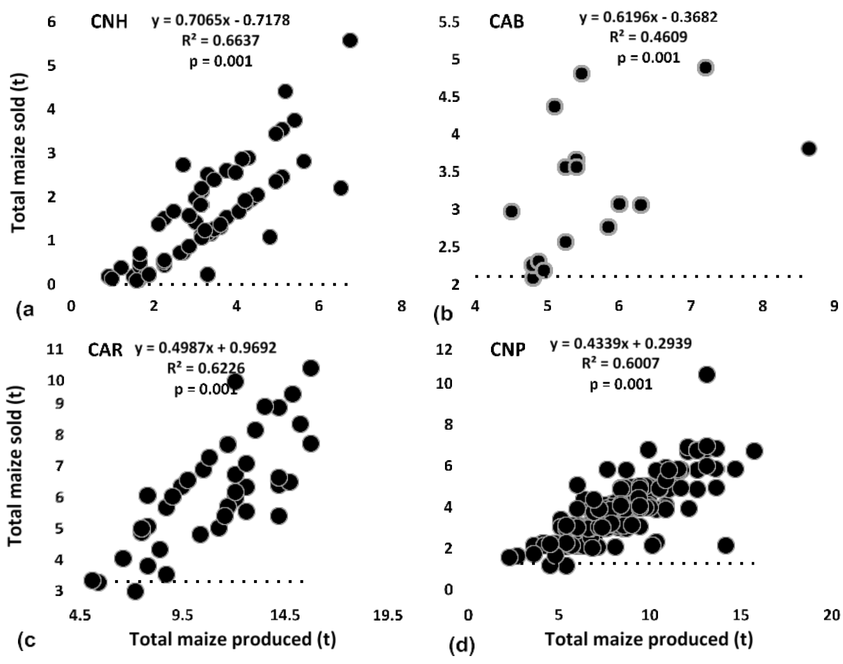


Figure 4. Scatter graphs showing the relationship between total maize produced against total maize sold among (a) CNH (b) CAB (c) CAR and (d) CNP farmers in Choma District, Zambia during the 2014/ 2015 agriculture season.

The high proportion of maize sold among CNH and CAB farmers compared to CNP and CAR farmers could have been because these farmers produced less maize and in order to solve their household financial burdens, they needed to sell more of their produce, an action that adversely affected their household maize sufficiency.

Income from Maize Sold

Part of the money from maize sales was re-invested in farming through the purchase of inputs for the next agriculture season (Figure 5). This was necessary for the farmers because farming inputs in the area were usually delivered late and farmers usually prepared in advance for the next agriculture season. Besides the purchase of agriculture inputs, the money from maize sales was also apportioned to other domestic needs such as school expenses for children, house repairs and upgrade, clothing, recreation and other unplanned expenses such as sickness or death.

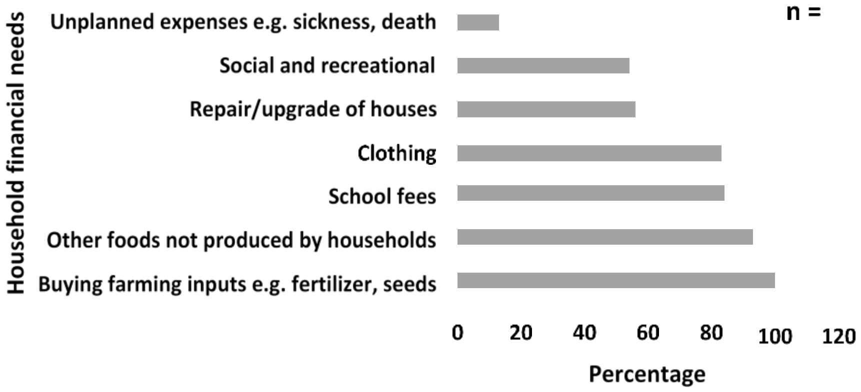


Figure 5. Household financial needs where income from maize sales is apportioned among farming households in Choma during the 2014/2015 agriculture season.

Maize Produced and Maize Area Cultivated among Different Farming Systems

Maize produced and maize area cultivated correlated strongly in the four farming systems (CNH: r = 0.614; p = 0.001, CAB: r = 0.639; p = 0.002, CAR: r = 0.733; p = 0.001, CNP: r = 0.563; p = 0.001) (Figure 6a-d). The rate of increase in maize production per given area cultivated was higher in CAB (0.419 t/ha) and CAR (0.330 t/ha) as compared to CNP (0.236 t/ha) and CNH (0.231 t/ha). Hence, CAB and CAR farming systems appeared to be more productive maize farming systems which encouraged higher maize production per given area cultivated.

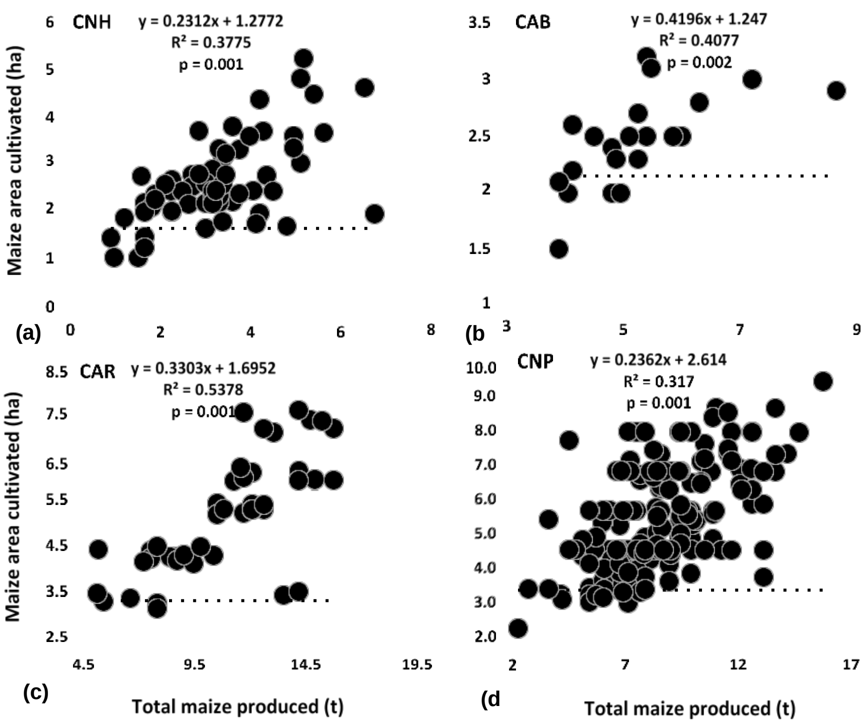


Figure 6. Scatter plots showing total maize production against maize area cultivated among (a) CNH (b) CAB (c) CAR and (d) CNP farmers in Choma District in the 2014/2015 agriculture season.

Involvement in Off-Farm Livelihood Activities by Farmers Practicing Different Farming Systems

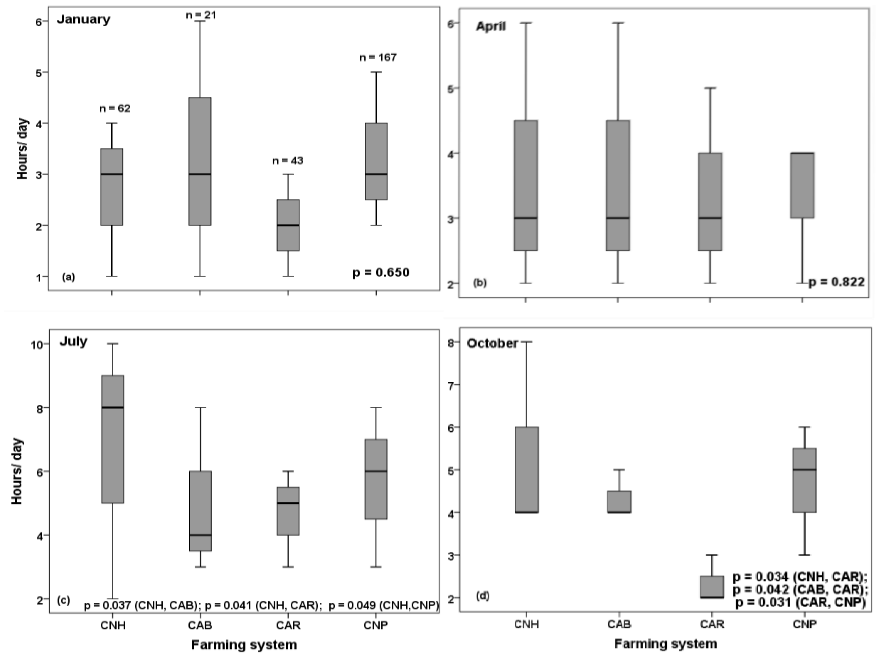
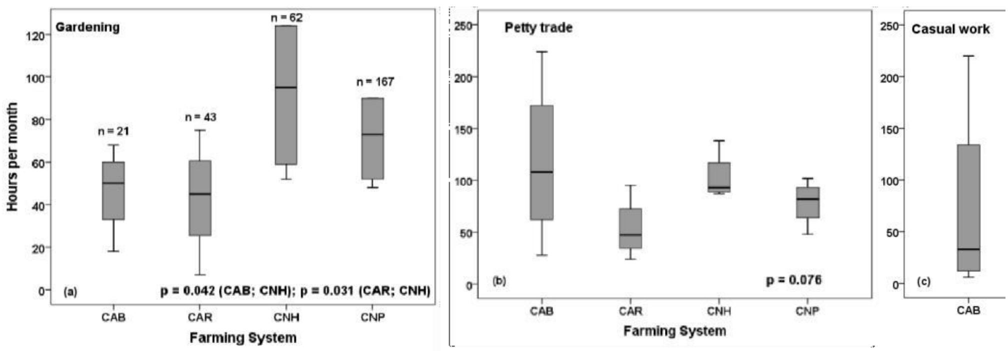
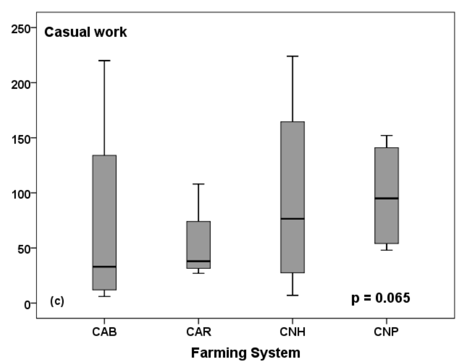


Figure 7. Amount of time (Hours/day) spent by CNH, CAB, CAR and CNP farmers on off-farm livelihood activities in (a) January (b) April (c) July and (d) October during the 2014/2015 agriculture season. The extreme ends of the boxes are the upper and lower quartiles, box heights are interquartile ranges, the top and bottom whiskers represent the time range spent by particular farmers on off-farm livelihood activities in a particular month. The horizontal lines in each box are the median number of hours per day spent by farmers on off-farm livelihood activities each month.

The intensity of off-farm activities among farmers practicing CNH, CAB, CAR and CNP did not differ significantly in January ($F = 3.152$; $p = 0.650$) and April ($F = 2.475$; $p = 0.822$) (Figure 7a-d), when farmers were concentrating on weeding their fields (January) and harvesting their crop (April). In July, however, there were less on-farm activities among CNH and CNP farmers who shifted to off-farm livelihood activities as evidenced by the increase in their intensity of involvement in off-farm activities (Figure 7). For CAB and CAR farmers, this was time for land preparation and the intensity of their involvement in off-farm activities was still limited. CNH farmers spent significantly more time on off-farm activities than did CAB ($F = 5.571$; $p = 0.037$), CAR ($F = 5.152$; $p = 0.041$) and CNP farmers ($F = 4.683$; 0.049) in July. They also spent more time in off-farm activities in October than did CAR farmers ($F = 5.521$; $p = 0.034$). CAR farmers also spent significantly less time in off-farm activities in October than did CAB ($F = 5.137$; $p = 0.042$) and CNP farmers ($F = 5.499$; $p = 0.031$).



(a) (b)



(c)

Figure 8. Amount of time (Hours/month) spent on (a) gardening (b) petty trade and (c) casual work off-farm livelihood activities by CAB, CAR, CNH and CNP farmers in Choma during the 2014/2015 agriculture season. The extreme ends of the boxes are the upper and lower quartiles, box heights are interquartile ranges, the top and bottom whiskers represent the time range spent on each off-farm livelihood by particular farmers while the horizontal line in each box is the median time spent by farmers in each farming system for a particular off-farm livelihood activity.

CNH farmers spent significantly more time on gardening than did CAB farmers ($F = 4.371$; $p = 0.042$) and CAR farmers ($F = 5.436$; $p = 0.031$) (Figure 8 a-c). While CNH farmers also spent more time gardening than CNP farmers, the difference was not significant. The low maize production among CNH farmers during the rainy season could have contributed to the high engagement in gardening during the off-season as it was a coping strategy after their maize depleted. Generally, farmers resorted to off-farm livelihood activities as coping strategies to ensure survival. CNH farmers were also highly involved in casual work and petty trade. However, their involvement in these off-farm livelihood activities did not significantly differ from other farmers practicing the other farming systems (Petty trade: $F = 1.456$; $p = 0.076$. Casual work: $p = F = 0.813$; 0.065). Many CAB farmers were also highly involved in petty trade (Figure 8b), likely as a way of compensating for the reduced maize production during the 2014/2015 agriculture season.

Reasons for Farmers' Preference of Particular Farming Systems

Many of the farmers who adopted conservation farming systems were hoping to increase their crop yields (CAB = 59%; CAR = 63%), improve fertility of their soils (CAB = 44%; CAR = 36%), reduce on their use of chemical fertiliser (CAB = 27%; CAR = 24%) or get free inputs (CAB = 13%; CAR = 16%) from the Conservation Farming Unit (CFU) who were promoting CA in Choma (Table 2). The less intensive nature of CAR farming system made it preferable to 14% of the respondents. Some farmers were engaged in CNH and CNP farming systems as these were the only farming systems they knew (CNH = 7%; CNP = 43%). CNH and CNP farming systems were the traditional methods of farming in the area and farmers have been using them long before organizations started promoting CA farming systems.

Table 2. Reasons for farmers' preference and lack of preference for particular farming systems

Reason for preference/lack of preference for a farming system	% respondents*			
	CAB	CNH	CAR	CNP
To increased crop yields	59		63	
Improve fertility of the soils	44		36	
Reduce on use of chemical fertilizer	27		24	
To get free inputs from CFU	13		16	
It‘s less labour intensive			14	
Only farming system they know		7		43
No interest in CA				7
No difference in yields between CA and CN systems				22
No animals and no ripper to engage in CAR and CNP	10	42		
CAB is too labour intensive		66	41	23
High input costs in CAR	52	37		27

* Numbers are percentages of respondents who prefer or do not prefer a particular farming system. The respondents were allowed to give more than one reason hence the percentage of responses from each farming system were more than 100.

Some CN farmers were just not convinced with the CA farming system as they did not see any difference in the yields between CA and CN farming systems which made them to continue practicing CNP (22%). Farmers who had no oxen or could not hire oxen for CNP or rippers for CAR, preferred either CAB (10%) or CNH (42%). However, there were some 66% of the CNH farmers, 41% of CAR farmers and 23% of the CNP farmers who felt CAB was too labour intensive. On the other hand, 52% of the CAB farmers, 37% of the CNH farmers and 27% of the CNP farmers felt the CAR farming system was too expensive due to its encouraging the use of herbicides for weeding in preference to manual weeding.

DISCUSSION

Diversification of rural livelihoods contribute to stable food systems and enhance food sufficiency among farmers while providing for resilient farming systems. Based on the results, three major issues with the potential to contribute to food sufficiency and sustainable farming systems were identified.

Farmers Should Intensify Their Engagement in Sustainable Livelihood Diversification Rather Than Reactive Livelihood Diversification

Household maize sufficiency for most smallholder farmers in Choma was determined by the difference between the quantity of maize produced and the quantity they sold, which was the maize retained for household consumption. While most of the farmers produced enough maize to sustain the household maize requirements, they ended up selling more of their maize and retained less than their annual requirements. These households ran out of their maize stocks before the next harvest season and had to depend on off-farm livelihoods for survival. The off-farm livelihoods provided coping strategies for these farmers by contributing to household income. Even though all farmers engaged in some off-farm livelihood activity, the intensity of diversity was more among CNH and CAB farmers who spent more time engaging in gardening, petty trade and casual work. Considering these farmers were in a state of maize deficit, their diversification of livelihoods was a coping mechanism to a stressor, food insufficiency. On the other hand, the intensity of engagement in off-farm activities was low among CAR farmers most of whom had enough maize retained for their households for the whole season. This highlights a weakness in the farmers' attitude towards sustainable off-farm livelihoods. Their engagement in off-farm livelihoods was reactive and intensified only when they experienced a failure of their main source of livelihood, which was maize farming. However, to improve on the farmers' adaptive capacities, they needed to engage in meaningful sustainable livelihood diversification which was not perfunctory or dictated by an experienced stress or extreme event. Stable income from such off-farm livelihood activities would provide a buffer to smallholder agriculture in times of crop failure.

Diversified Livelihoods Could Lessen Pressure on Maize as a Cash Crop

Maize is Zambia's most important food and cash crop (Chapoto et al., 2012). The failure to balance the two roles among farming households results in food insufficiency as farmers tend to sale more than they should so as to ensure annual household food sustenance. The money from maize sales was used to settle other domestic financial pressures such as children school fees, repair works, clothing, and recreation. Considering many of the farmers cultivated between 1 and 5 ha of land, even the money from maize harvested from such relatively small pieces of land would not be enough to sustain all their household financial requirements till the following year. As such, engaging in meaningful sustainable livelihood diversification would provide additional income to households but at the same time ensure that farmers are not under pressure to sell beyond their per capita maize requirements. This could help farmers achieve maize sufficiency but at the same time generate income for domestic financial requirements.

Sustainable Farming Systems Should Encourage Diversified Livelihoods

Farmers' engagement in particular farming systems affected the intensity of their engagement in off-farm livelihood activities. Farmers who practiced CNH and CAB farming systems intensified their livelihoods as these labour intensive and non-mechanised farming systems did not allow farmers to cultivate larger plots which would ensure they attained household food sufficiency. The perceived drudgery in CAB and the perceived high financial capital CAR resulted in few farmers engaging in these farming systems. This agrees with findings of Arslan et al. (2014) who reported of low CA adoption and high dis-adoption rates in Zambia of 13% to 5% between 2004 and 2008. The high labour demand in CAB was due to the use of a specialised *Chaka hoe* for making basins. This hoe was relatively heavier than the regular hoe used in CNH. Because of this drudgery in CAB, farmers could not expand their farming system to plots bigger than 0.5 ha without hiring labour. Even with hired labour, the largest CAB plot cultivated in the area was about 3.2 ha. The inability to extend CAB to larger plots makes this farming system unlikely to provide household food sufficiency even though it had a higher production per area for maize compared to the other farming systems. Further, the high labour requirements prevented farmers from meaningfully diversifying their livelihoods.

The time of land preparation in CAR and CAB farming systems affected farmers‘ engagement in off-farm livelihood activities. In order to reduce on labour constraints, promoters of these farming systems encouraged dry season land preparation (CFU, 2007a), which gave farmers more time to prepare their land. However, for most farmers, the dry season was the time to concentrate on off-farm income generating activities, and engaging in farming activities during the dry season affected their livelihood diversification. Sustainable farming systems would allow for income diversification through farmer‘s diversifying their off-farm livelihood activities.

CONCLUSION

The choice of farming systems engaged in by farmers was important to smallholder farmers as it contributed to the household maize sufficiency among farmers. The produce among CNH and CAB farmers were generally low as their farming systems did not allow for expansion to larger plots due to the drudgery in these farming systems. Many of the farmers were in a state of maize deficit as they sold over 50% of their maize produced making their maize retained for household consumption significantly less than the household maize requirements (CNH: T = 6.431; p = 0.001, CAB: T = 6.315; p = 0.001, CAR: T = 2.172; p = 0.002, CNP: T = 4.642; p = 0.001). While these farmers produced enough for household consumption, their indiscriminate selling of the maize resulted in food insufficiency. Diversification of smallholder farmers' livelihoods to include off-farm income generating activities provided a coping strategy for these farmers when their maize retained for household consumption depleted. These off-farm activities were intended to supplement household incomes and help farmers cope when their stored food reserves diminish. Considering 98.4% of CNH farmers, 95.2% of CAB farmers, 60.4% of CNP farmers and 30% of CAR farmers recorded maize deficits over the study period, engaging in sustainable off-farm livelihood activities among smallholder farmers would enhance their food sufficiency. Sustainable livelihood diversification should not be a reactive coping strategy when the main livelihood fails, but should be a sustained routine that regularly contribute to household incomes.

The choice of a farming system has implications on farmers' intensity of involvement in off-farm livelihood activities. CNH farmers spent significantly more time on off-farm activities than did CAB (F = 5.571; p = 0.037), CAR (F = 5.152; p = 0.041) and CNP farmers (F = 4.683; 0.049) especially during the off-farming season. CAB farmers also spent more time in off-farm livelihood activities compared to CAB farmers (F = 5.137; p = 0.042). This was because the low maize produce among CNH and CAB farmers, meant that off-farm activities where more important to them as survival strategies. Diversification of livelihoods among these farmers was more perfunctory than sustainable as most households who had attained maize sufficiency had minimal involvement in off-farm livelihood activities. However, to improve smallholder farmers' food resilience, policy should encourage meaningful involvement in sustainable livelihood diversification. Such sustainable livelihoods provide for stable rural food systems as diversified livelihoods are less vulnerable to impacts of climatic or financial stressor than undiversified livelihoods (Shiferaw et al., 2014).

Current agriculture policies in Zambia have concentrated on encouraging on-farm livelihoods such as maize production and crop diversification (GRZ, 2004) which are seen as not only a means of achieving rural food security but also ensuring resilience in smallholder food systems. While this is commendable, an integration of on-farm livelihoods and sustainable off-farm ones would provide a more stable food system for farmers as these livelihoods are not always affected by the same stressors. For example, while droughts can affect a range of crops on the farm, they would have reduced direct impact on petty trade or casual work. Policy should ensure provision of options for managing risks and shocks as well as protect sustainable diversity of livelihoods in order to reduce vulnerability among farmers. Hence, policy strategies that can build capability to manage shocks and reduce vulnerability through sustainable livelihood diversification would be more useful to rural communities.

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Chapter 6

CONTRACT FARMING AND VEGETABLE VALUE CHAIN EFFICIENCY: ASTUDY FROM QUANG NAM PROVINCE, VIETNAM

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ABSTRACT

Contract farming can create new market opportunities and enhance income for smallholder farmers. This study identifies opportunity for contract farming for vegetable growers in relation to cucumber production in Quang Nam province, Vietnam. The study uses data collected from secondary sources and a survey conducted among selected contract and non-contract farmers in Binh Trieu commune in Thang Binh district, Quang Nam province, Vietnam. Benefit-cost analysis was employed to measure the profitability of cucumber production under contract and non-contract farming at farm level. Socioeconomic

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characters of the contract- and non-contracts farmers were then compared for their economic performance and to identify the constraints surrounding the promotion of contract farming. The results show that there are several benefits in contract farming. In terms of socio-economic characteristics, there are no differences between the contract and the non-contract farmers except their participation in farmers‘ organizations.

Large holding farmers and grower-based cooperatives are much more likely to be selected for contractual arrangement than other farmers. This implies that entrepreneurs tend to be interested in contracts with groups of farmers rather than with individual farmers. Acting collectively is likely to increase bargaining power of the contract farmers and reduce transaction costs. Vegetables can be purchased with higher prices which provides higher net return and profit cost ratio for the contract farmers than those of non-contract growers. Although there is a range of benefits in contract farming, an increase in input prices is one of the obstacles of contract farming and not all farmers can fulfil the requirements for production processes and output quality standards. Delays in payment and limited access to market information are also likely to reduce the participation in contractual agreements. It is recommended that farmers‘ organizations should be formed to enable a group of farmers to enter the value chain and deal effectively with contract farming situations. Market information should be delivered to farmers through local media and the contracts should be made in the form that farmers can easily understand and comply with them. This study also considers a dual supply chain structure in which farmers either operate independently or in partnership with others. Other actors in the value chain, such as middlemen, entrepreneurs as well as end consumers also have important roles to play.

Keywords: value chain, contract farming, smallholders, vegetables, Vietnam

1. Introduction

Quang Nam province is located in the south-central coastal region of Vietnam where natural conditions (e.g., sandy land, lack of water, frequent storms, etc.) are not favourable for vegetable production. For example, in 2009, the total area cultivated in vegetables in Quang Nam was 18,800 ha, concentrated in a few districts (Duy Xuyen, Thang Binh, Dai Loc, and Hoi An). Land devoted to vegetables is fragmented, the area of the average plot ranges from 0.2 to 0.4 ha. The vegetable sector makes only a modest contribution to the provincial GDP, but it remains a significant source of income for a large number of farm households, especially the poor. Gross output of vegetables reached 202.9 billion VND in 2008, accounting for 7.8% of the total agricultural output in the province and 1.2% of the provincial GDP (GSO, 2008).

According to a report by PI (2010), the vegetable value chain in the province was inefficient because (i) farmers were exposed to exploitation of middlemen, (ii) market price was not assure, (iii) a lack of advanced production and postharvest technologies, (vi) inputs not available when needed, and (v) inadequate marketing information. Aside from the producers, the processors in the supply chain had difficulty in ensuring continuous supply of product given variation in quality and quantity from their suppliers. This has also resulted in serious losses for the vegetable producers when they could not sell their products. Furthermore, the consumers in the traditional channels were also affected by increased retail prices of vegetables. Therefore, contract farming emerges as one of the most promising mechanisms to address the constraints discussed above. However, in Quang Nam province, the concept of contract farming is still new.

Contract farming is an agreement between a farmer and a purchaser established in advance of the growing season for a specific quantity, quality, and date of delivery of an agricultural output at a price or price formula fixed in advance (Binswanger et al., 1993). The contract provides the farmer with the assured sale of the crop and at times provides technical assistance, credit, services, or inputs from the purchaser. In the context of agriculture, Eaton and Shepherd (2001) define contract farming as ‒an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices‖, while Roberts and Khiem (2005) further explain that the key feature of contract farming is that it provides a framework for establishing a relationship between farmers and processors. Contracts provide the basis for sharing value, risk, and decision making power between farmers and processors in a way that is mutually beneficial.

Contract farming is emerging as an important form of vertical coordination in improving the efficiency of the agrifood supply chain. Firstly, contracts are an important mechanism in which to coordinate production, distribution, and retail arrangements between different actors in the value chain. Parties to a contract agree on the terms and arrangements specified; both parties share the benefits, costs and risks of coordination. Simmons et al., (2005) mentioned that this type of arrangement will help to ensure a reliable supply for buyers. Morrison et al., (2006) observed that within the last 30 years, contract farming has become an increasingly important form of self-organization in global agrifood sector, facilitating linkages between the various actors along value chain. Such systems are becoming organized into tightly aligned chains and networks, where the coordination of production, processing and distribution activities is closely managed (Silva Dias, 2010).

Further, contract farming helps to bring small-scale farmer to market. The establishment of modern supply chain management requires high quality produce from producers, but many small farmers are not able to meet this strict quality standards required, and are excluded from these arrangements. Evidence shows that in Thailand the number of farmers selling their vegetables to top super markets has fallen from 250 in 2001 to 60 in 2003 (Reardon et al., 2003). In this situation, the contract farming system emerges as a possible mechanism for a supply chain governance strategy to link the smallholders to high value markets. As a result, as Birthal et al., (2008) have noted, vertical coordination of the food supply chain through contractual arrangement is one of the few alternatives that can facilitate small farms' diversification by improving their access to markets and reducing price risks and transaction costs.

In addition to this, contracts in vertical linkage create income for farmers, contributing to poverty reduction. Wang et al., (2010) state that contractual arrangements between farmers or farmer groups and buyers, and more generally vertical integration in the chain, have proved to be an efficient ways to bring additional incomes to farmers. It is more and more widely acknowledged that access to high value chains through contracts have a positive impact on farmers' incomes and poverty alleviation (World

Bank, 2008). Moreover, linkages models through contractual arrangements will help the parties to reduce production cost, overcome the limitations of operating individually, create more added value and generate more employment which can contribute to increase in product competitiveness, profit for companies, and an improved livelihood for farmers.

Contract farming can be a tool for creating new market opportunities to increase incomes for smallholder farmers. However, the critics argue that it is likely to pass the risks to small scale farmers, thus favouring large scale farmers at the expense of those smallholder farmers (World Bank, 2008). A study by Mwambi et al., (2016) found, using a case study of smallholder avocado farmers in Kandara district in Kenya, that participation in contract farming is not sufficient to improve household, farm and avocado income. Further, contract farming also emerges as one of the potential mechanisms to reduce constraints in the traditional supply chain. For example, a study conducted by Ravikumar et al., (2013) in Tamil Nadu state in India reports the obstacles that non-contract farmers faced in the Marigold (flower) value chain such as exploitation of middlemen, lack of assured market price, lack of advanced production and postharvest technologies, and timely availability of raw materials for processors, etc.

The purpose of this study is to identify the opportunities of contract farming for cucumber growers and the constraints surrounding the promotion of cucumber contract farming practices from farmers‘ perspectives using a case study example in Quang Nam province in Vietnam. The study uses data collected from secondary sources and a household survey of contract and non-contract farmers in Binh Trieu commune in Thang Binh district, Quang Nam province, Vietnam. Benefit-cost analysis was employed to measure the profitability of cucumber production under contract and non-contract farming at farm level. Socioeconomic characters of the contract and non-contracts farmers were also compared for their economic performance to identify the constraints surrounding the promotion of contract farming.

The rest of the chapter is structured as follows. Section 2 provides an overview of contract farming system in Vietnam. Section 3 details the data and methodology. Results and discussion are presented in Section 4.

Section 5 details the recommendations to improve the contract farming model (or system) in Vietnam, followed by a conclusion in Section 6.

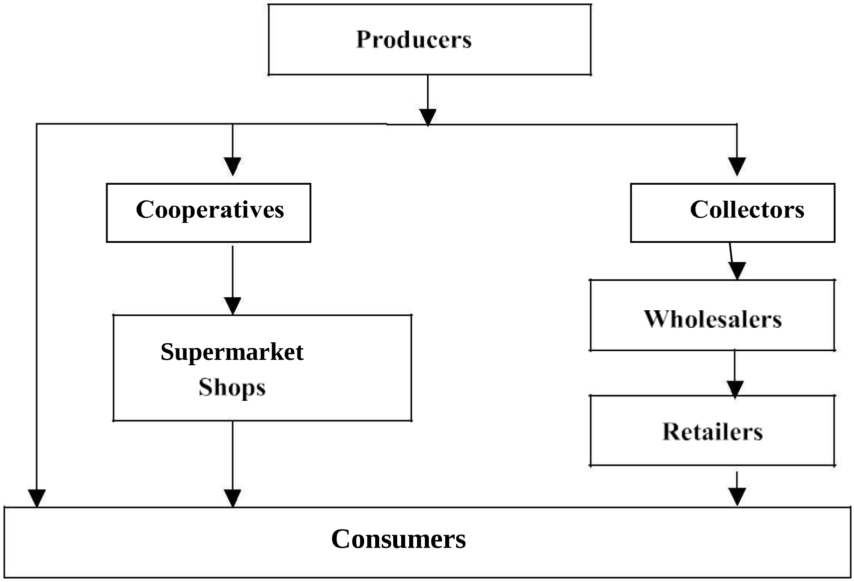
2. Contract Farming System in Vietnam

As the case in other developing countries, the Vietnamese Government strongly supports the concept of contract farming. This support includes Decision 80/2002/Ttg, which regulates the mechanisms and policies for promoting the consumption of agricultural products through signed contracts between enterprises and farmers, and which promotes cooperation between the ‗four houses' of state, farmers, research and enterprises (Roberts and Khiem, 2005). Accordingly, enterprises involved in all sectors are encouraged to sign contracts with producers on sales of farm produce in order to link production with processing and consumption. Tuan (2012) points out that contract farming seems to have gained more attention from researchers and practitioners since around 2002, after the issuance of Decision 80. Examples of contract farming across a wide range of agricultural products in Vietnam have been well documented, particularly for staple foods (rice), industrial crops (e.g., cassava, sugarcane, fruit), forestry products (e.g., timbers, herbs), livestock (poultry, milk), and fishery products (shrimp, shell, fish). According to UNCTAD (2004), in Vietnam, over 90% of cotton and fresh milk, more than 40% of rice and tea and 70% of sugarcane comes from contract farming. Wandschneider (2007) indicates that as the agriculture sector in Vietnam modernizes and commercializes, value chains for agricultural products will become increasingly important, and as a part of this process, contracts will also become a more important and common feature of the agriculture sector.

However, contract farming in the vegetable sector in Vietnam is still limited. According to a survey of vegetable farmers by IFRI (2001), there were about 16% of vegetable and fruit growers distributing vegetables via contracts. Most of them sell their products by themselves. There are several reasons why contract farming in the vegetable sector has not been promoted. Firstly, most of the linkages are conducted through verbal contracts; written contracts are also used but are not popular. In general, the linkages are often small, simple, quite loose, unstable and scattered. Breaching of contracts is still quite common, especially when the market experiences price fluctuation, or changes in input materials. This may result in serious loss of income for vegetable producers when they were unable to sell their products. Furthermore, a study conducted in association with FAO (2010) showed that strict standards expected of contractors prevent vegetable growers from entering contractual arrangements. For example, supermarket vegetables may be required to be sourced from certified safe agricultural zones or else meet VietGAP standards. In addition, supermarkets have their own specific requirements for each vegetable product.

The value chain in Quang Nam province is quite simple compared to that of Vietnam nationally. A survey conducted by PI (2010) as shown in Figure 1 indicated that there were seven actors involving directly in the value chain - growers, cooperatives, supermarkets, collectors, wholesalers, retailers and consumers. In Quang Nam province, vegetable holdings are smaller than the national average, ranging from 0.1 to 0.2 ha per household. The proportion of farmers experienced in growing vegetables is between 10 and 15 years of experience in the field. Like other vegetables producers in Vietnam, farmers in the province have established a long standing and traditional relationship with collectors and wholesalers PI (2010).

The collectors are villagers and even vegetable producers. At harvest time, producers may sell their own products or engage in marketing activities to increase their family incomes. They can collect vegetables from producers who often live in the same village or commune to sell in the local market or directly to the final consumers. The research revealed that about 70% of farmers sell vegetables to collectors who operate on a small scale. These collectors handle between 0.4 and 1 million VND/day, which is equivalent to 600 - 800kg/day (during the main season) and 300 - 600kg/day (during the off season). The remaining 30% sell directly to wholesalers (PI, 2010).



(Source: Prosperity Initiative's (PI) study in Quang Nam, 2010)

Figure 1. Structure of vegetable marketing system in Quang Nam province.

On average wholesaler buys between 1,000 and 2,000 kg per day during the summer-autumn crop (off-season), and between 3,000 and 5,000 kg per day during the winter-spring crop (main season). The working capital required for the wholesale business ranges between 3 and 6 million VND a day. PI (2010) found that 75% of products from wholesalers and 25% from farmers and traders are sold to retailers in Quang Nam and Da Nang (neighbouring city), who then carry vegetables to market by motorcycle or bicycle, depending on the volume of produce and distance to the retail markets.

3. Material and Methods

Thang Binh is an Eastern district of Quang Nam province that has 21 communes and a town with an area of 38,475 hectares (see Figure 2). The district is divided into two sub-regions, including the West with hills and mountains and the East with coastal sand dunes of 10-12m. The total agricultural area is 16.202 hectares, accounting for 42.11% of the natural area. The population of Thang Binh district is nearly 200,000 people of whom 86.5% live in rural areas and of whom 86.3% are employed in agricultural industries. The area is annually affected by rainy weather causing erosion runoff and landslides due to poor soils. Annual rainfall is unevenly distributed. The district is known as one of the largest vegetable production areas in Quang Nam province (QSO, 2010). The total vegetable cultivation area in Thang Binh district is 482.4 ha, in which Binh Trieu commune accounts for nearly 30% with 140 ha.

According to the report by Agriculture Division of the district (PI, 2010), cucumber was found to be dominant crop in the district occupying 65% of the productive area. The cucumber crop was followed by celery (23%) and lettuce (12%). Thus, cucumber was selected for this study. The survey was conducted over a half month period (from 14 June, 2014 to end of June, 2014) in two hamlets (Hung My and Phuoc Am) of Binh Trieu commune, Thang Binh district, Quang Nam province, Vietnam. 20 cucumber growers were selected for the survey (10 famers per hamlet). Two groups of households were purposively chosen to ensure participation of cucumber farmers involved in contracts and of others not using contract. The survey employed a structured questionnaire of 20 questions administered through face to face interview.

The information collected include household demographics, farm size, costs of fertilizer, chemical and seed; labour costs as well as cucumber yield, farm gate prices and constraints on contract farming practice. Ten cucumber growers with contracts were randomly selected from the list provided by My Hung cooperative. 10 cucumber growers without contracts, living in the same locality as the chosen non-contracted farmers, were also randomly selected from the list prepared by hamlet leaders. The sequence of activities for data collection at household level is presented graphically in Figure 3:

Figure 2. Study area.

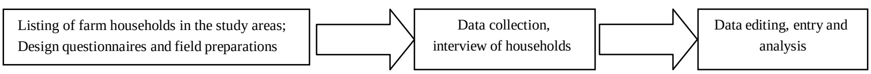


Figure 3. Sequence of activities in the household survey.

Benefit-cost analysis was employed in order to measure the profitability of cucumber production under contract and non-contract farming at farm level. The costs and returns obtained were calculated for individual growers in order to arrive at the benefit-cost ratio for one cucumber crop season per Sao (1 sao = 360m2). Benefit-cost ratio is displayed by the following formula:

BCR = AGR/ATC

Where,
BCR = Benefit-cost ratio
AGR = Average gross return
ATC = Average total cost

The income of a cucumber farmer household is recognized as gross return or net return from cucumber production. The economic returns of cucumber cultivation are measured by profit or profit cost ratio as shown in the following formulas:

ANR = AGR – ATC

PCR = ANR/ATC

Where,
ANR = Average net return
PCR = Profit cost ratio

PCR expresses economic performance on cucumber production of a farmer household. When PCR > 0, the production of a farmer household is economically efficient; when PCR < 0, the production of a farmer household is economically inefficient and when PCR = 0, the production of a farmer household is at the breakeven point. Descriptive statistics measures, including mean and percentage was calculated using Microsoft Excel to help interpret the collected data on household characteristics, profitability of cucumber production and farmers' statements on constraints of contract farming.

4. Results and Discussions

Table 1 shows the socio-economic characteristics of contract and non-contract cucumber households, collated from responses to the survey conducted in this study. The results indicated that the household head's average age is relatively high (over 50 years old) and there was no remarkable difference in age between the two groups. The household head's education level was low in both groups – 6.10 years of schooling for contract farmers and 5.80 years of schooling for non-contract group. Therefore, it is likely that the cucumber growers have a low level of education and have reached middle age, characteristics that could make them less likely to adopt advanced technologies in their farming. However, both groups have rich experiences in cucumber farming spanning 12+ years. Household size of contract and non-contract farmers is medium-sized, standing at 4.80 members and 4.70 members, respectively, of whom nearly two members per household were involved in cucumber farming.

Table 1. Socio-economic characteristics of cucumber growing households

Variables	Contract farmer (n = 10)	Non-contract farmer (n = 10)
Age of household head	50.80	50.60
Education of household head in years of schooling	6.10	5.80
Household head‘s experience in cucumber farming (year)	12.20	12.50
Household size (person)	4.80	4.70
Number of family labor (person)	1.90	1.80
Total land area (sao = 360m2)	5.6	4.9
Cucumber land area (sao = 360m2)	1.5	1.2
Households participating in farmer organizations (%)	31.8	20
Distance to the commune people‘s committee (km)	2.88	3.70

Source: Survey

Regarding production scale, the land holdings of contract and independent farmers is 5.6 sao and 4.9 sao, respectively (Table 1) which is smaller than the average land size of the North and South Vietnam‘s rural households with 6.9 sao and 13 sao, respectively. Land area used for cucumber cultivation for contract and independent farmers is 1.5 sao and 1.2 sao, respectively. The result reveals that contract farmers own more land than the others.

As can be seen from Table 1, contract farmers are more likely to join organizations such as farmers clubs, groups, farmers‘ associations and cooperatives. The result indicates that the percentage of contract and non-contract farmers entering farmers‘ organization is 38.1% and 20%, respectively. The notable association between membership of farmers‘ organizations and contract growing is not surprising: growers who join farmers‘ organizations are more likely to become aware of big orders available from firms, and to meet entrepreneurs who prefer to organize farmers into groups to reduce transaction costs (Key and Runsten, 1999). Acting collectively, smallholders may be in a better position to reduce transaction costs of accessing inputs and outputs, obtain necessary market information, secure access to new technologies, and tap into high value markets, allowing them to compete with larger farmers and agribusinesses (Stockbridge et al., 2003). The findings also show that contract farmers lived in more favourable location characterized by closer distance to the commune people‘s committee, which suggests that contract firms tend to select farmers living in areas with good infrastructure to reduce the transportation costs.

Table 2 shows comparative profitability of cucumber production per sao under contract and independent farming structures. It was found that the total production costs for contract farmers were 11.5% higher than non-contract farmers. The increase in the total production cost under the contract scheme is the consequence of the remarkable increase in cost for labour (21.5%), seed (16.7%), pesticides (7.1%), frames (6.6%) and fertilizers (4.5%). It seems that while non-contract farmers simply follow their traditional practice, contract farmers have to follow more sophisticated approaches such as the Vietnamese GAP guidelines, covering choice of seeds and fertilizer and cultivating and harvesting processes.

Adopting new production technologies on the advice of entrepreneurs can increase risks because the growers don‘t have breadth of understanding of what they are being asked to do (Rehber, 1998). In fact, contract growers must apply certain fertilizers and pesticides with low level of toxic residue; or organic fertilizers and bio-pesticides under the direction and guidance of the entrepreneurs‘ staff to meet high quality standards of cucumber products or the entrepreneurs may take their monopoly to advance much more inputs, which may result in higher costs. Labour costs under contractual agreements are 21.5% higher than for independent growers because contract growers are likely to regularly need more labourers for various tasks like preparing compost. They must also maintain records of pesticide and soil treatments, water sources, harvest dates, processing and transport. Conventional cucumber farming practice is simpler and therefore cheaper.

Table 2. Profitability of cucumber crop cultivation per sao for contract and non-contract growers

Variables	Contract farmer (n = 10)	Non-contract farmer (n = 10)	% increase (+) or % decrease (-)
Total cost of production (1.000 VND/sao)	2829.6	2538.2	11.5
Seed cost	140.6	120.5	16.7
Fertilizer cost	587.8	562.5	4.5
Frames cost	960.6	900.8	6.6
Pesticides cost	140.2	130.9	7.1
Labor cost	1000.4	823.5	21.5
Average yield (kg per sao)	700	650	7.7
Average price at farm gate (VND/kg)	8	7.4	8.1
Gross return (VND/sao)	5600	4810	16.4
Net return (VND/sao)	2770.4	2271.8	21.9
Benefit cost ratio (gross return/total cost)	1.98	1.90	4.4

Note: Unit: 1 Sao = 360 m2. Source: Survey.

Survey analysis shows that although contract growers incurred much higher production costs, they also obtained much higher economic returns than the non-contract growers (Table 2). In fact, the contract farmers sold their cucumber products at 8.1% higher prices than independent farmers, which brought about added returns for contract farmers in terms of gross return (16.4%) and net return (21.9%). Furthermore, cucumber profitability for dependent growers was also increased by 4.4% compared with that for non-contract ones. Farmers participating in contract farming schemes are more likely to get higher revenue than non-contract farmers with the same cultivated area and the same kind of plant (Miyata et al., 2009), thus, they often get higher net revenue than non-contract farmers (Senthinathan et al., 2010).

Table 3 reports this study‘s findings that contract farmers‘ production efficiency is much higher than the others in terms of net return and profit cost ratio. Profit cost ratio of the contract growers was 9.4% higher than that of non-contract growers, which represents superior economic performance under contract arrangements. Farmers reaping improved returns have the capacity to expand their cultivation areas and further increase production and profitability. Consequently, food and nutritional security will be enhanced in Vietnam.

Although there is a range of benefits in contract farming, it is likely that the following several concerns surrounding the promotion of contract farming need to be taken in account. In the study, respondent households were also asked to indicate major problems in engaging in contract farming. From the responses as shown in Table 4, 70% indicated that high technique requirements is the most significant concern, while 60% indicated increasing input costs. Delay in payment, understanding and complying with the contract and lack of market information were less frequently raised concerns (40%, 30% and 20%, respectively).

Firstly, the entrepreneurs often require high technique and strict quality standards for inputs and outputs which farmers hardly meet due to their low level of education and farming skills. For this reason, not all contracted farmers can successfully meet the conditions of their contracts. Farmers may not fully adopt the measures introduced by the entrepreneur involved in their scheme; or they might adopt a new technique but not implement it according to recommendation because their old ways can be hard to give up. In these situations productivity and quality of products are lower than planned (Minot, 1986).

Secondly, some contract growers stated that prices of inputs supplied by entrepreneurs are relatively high, which could be due to purchase of higher quality inputs to meet output quality standards, or because entrepreneurs sometimes may take advantage of their monopoly to raise prices on the inputs they supply to their farmers.

Thirdly, the entrepreneurs regularly gave payment later one week after cucumber delivery compared to cash payment at product delivery by middlemen. This finding is consistent with Tru et al., (2012) who pointed out that more than 60% of vegetable producers in Luc Nam district, Bac Giang province, Vietnam faced delays in payment. It could be concluded that contract arrangement mechanism by the entrepreneurs has not created much more convenience for the farmers than by middlemen‘s such as cash payment mechanism and cucumber collection at farm gate. In fact, farm gate sales tend to result in lower revenue for farmers since the prices are relatively low and variable. However, smallholder farmers tend to prefer farm gate sales because they receive immediate payments and do not incur transaction costs such as transportation costs and tax payments (Shiferaw et al., 2006). Thus, resolving such mentioned constraints like these seems to be a promising way forward towards a more effective cucumber supply chain in future.

Table 3. Economic performance of cucumber growers per single crop

Variables	**Contract farmer (n = 10)**	**Non-contract farmer (n = 10)**	**% increase (+) or % decrease (-)**
Total cucumber land area (sao)	1.5	1.2	
Total cost of production (1.000 VND/sao)	5376.24	3045.84	
Average yield (kg)	1330	780	
Average price at farm gate (VND/kg)	8	7.4	
Gross return (VND/sao)	10640	5772	
Net return (VND/sao)	5263.76	2726.16	
Profit cost ratio (net return/total cost)	0.98	0.90	9.4

Source: Survey

Table 4. Responses of sampled households on major problems (%)

Main problems	**(1)**	**(2)**	**(3)**
High technique requirements	70	20	10
Price increase of inputs	60	30	10
Delay in payment	40	50	10
Understanding and complying with contract	30	50	20
Lack of market information	20	60	20

Note: (1): very difficult; (2): difficult; (3): not difficult. Source: Survey.

Fourthly, surveyed contract farmers displayed a limited understanding of their contracts and low level compliance. The main reason for this concern is probably that most of the farmers, with their low level of education, had difficulty understanding the contents of their contract and how to follow modern production techniques and meet the strict quality standards of inputs and outputs set by their entrepreneurs. Such outcomes can place farmers in breach of their contracts.

Finally, the lack of market information is also one of the difficult problems for farmers when they participate in such linkages, because often they just know how to supply their produce to processing companies, but not the price of that produce after being processed, or where it is delivered, etc. Sometimes this affects the trust of member farmers towards the processing companies.

5. RECOMMENDATIONS TO IMPROVE THE CONTRACT FARMING MODEL

In order to address the above mentioned issues of contract farming, it is recommended that farmers ‗groups should be formed. This enables a group of farmers to enter the value chain and deal effectively with contract farming situations. In fact, it is quite impossible for a company to sign contracts with thousands of farmers. Therefore, signing the contract through a cooperative or association shall be a better choice for the farmers. Roberts and Khiem (2005) point out that a farmers‘ group can represent the interests of its members, coordinate logistics, and often enter into contracts on behalf of group members. There are several formal and informal groups in existence in the agricultural sector in Vietnam, including farmer groups, farmer ―clubs‖, and community groups based around a representative farmer.

However, the organization which has the highest legal entity and the power to sign contracts is a social enterprise known as a co-operative. Nhân et al., (2013) explain that farmers in the same group can share the same goal of establishing a common technical procedure to produce similar quality products. Acting collectively, smallholders may be in a better position to reduce transaction costs of accessing inputs and outputs, obtain the necessary market information, secure access to new technologies, and tap into high value markets, allowing them to compete with larger farmers and agribusinesses (Stockbridge et al., 2003).

Sivramkrishna and Jyotishi (2008) state that farmer organizations strengthen farmers‘ bargaining power, raise the price of produce, control monophony exploitation and increase social welfare. Finally, the cooperatives or associations may have some kinds of risk prevention funds to secure the income of the farmers in a case of market fluctuation or when the farmers have a bad harvest. In order to improve the operational efficiency of farmers groups, it is necessary to empower these groups and improve their skills (Tuan, 2012). He argues that agricultural technical knowledge provides short term gains for farmers, but in the long run, activities such as technical support in setting up farmer groups, building up skills in negotiation, helping farmers to understand the impact of contract farming, analysis of the market and financial management are crucial to empower farmers.

Another recommendation is that payment delays should be avoided. These need to be addressed by the companies in the interest of sustaining long-term synergistic relationships between the firm and farmers. The government should provide the framework for companies to enter into contracts with smallholders as well as enforce it. For instance, in Zimbabwe, companies wishing to contract farmers to produce certain crops were required to sign a Memorandum of Understanding (MOU) with various departments within the Ministry of Agriculture. The MOU usually specified that contracting agribusinesses would provide farmers with extension services, farming inputs including seed, chemicals, tillage, harvesting, curing and marketing resources to a specified value. The model agreement also addressed pricing, grower selection, contract documents and security of land tenure for the duration of the scheme.

Further, contracts should be made in appropriate forms. Nhân et al., (2013) state that the form of contracts should be suited to the needs of both parties. In the case of a contract between a cooperative and a farm household, it is in the interests of both parties to ensure that the contract is as simple as possible. A number of cases in Vietnam have shown that a farming contract becomes very effective if it has a set of clearly defined points for renegotiation of conditions. This allows flexibility in the contracting relationship, and can reduce incentives for breaking contracts. Contracts should include favourable conditions to attract both sides to participate in the contract, particularly conditions regarding price and payment terms. In Vietnam, farmers generally prefer to be paid in cash so cash payments will encourage them to participate in contract farming. In many cases, a contract specifying the contract price at the prevailing market price plus a percentage markup is sufficient to provide incentives for suppliers. Above all, contracts should be fair and spread the risk and benefits between both parties.

Finally, farmers can grow vegetables, but they may not have direct access to the markets. Hence, information related to markets, prices, volume of products and categories of products should be supplied by the Department of Agriculture and Rural Development (DARD) and broadcast monthly by Quang Nam Television and local media in Thang Binh district. Timely information can assist farmers in making decisions on producing and distributing vegetables and ensure a mutual benefit in linkages. Furthermore, it is recommended that linkages events should be organized at the district level to create the bridge between vegetables farmers and buyers to exchange market information and negotiate contracts.

CONCLUSION

Contract farming delivers several advantages to cucumber farmers in comparison with non-contract cucumber growers in Quang Nam province, Vietnam. In terms of socio-economic characteristics of contract and non-contract households, these were not significantly different except the variable of participation in farmers‘ organizations. In fact, growers joining in cooperatives and large farmers‘ group are much more likely to be selected for contractual schemes than other farmers. This implies that entrepreneurs prefer entering contracts with groups of farmers rather than individual farmers; and that small farmers will be marginalized in the contract scheme. Furthermore, group schemes may be able to sell at more attractive prices, sell more, and achieve higher net return and profit cost ratio than those of independent growers. However, the findings show that there are still a number of concerns that contract farmers are facing. An increase in input prices is one of the obstacles of contract farming schemes. In addition to this, not all farmers can meet the strict production process and output quality standards requirements, given their limited education and exposure to advanced ways of thinking. Finally, delays in payment and limited access to market information are likely to reduce the participation of famers in contractual agreements.

Therefore, such constraints experienced by cucumber farmers operating in partnership with entrepreneurs need to be resolved if the potential benefits of entering dependent relationships with others are to be fully realised in the Vietnamese cucumber industry. Other actors in the value chain, such as middlemen, entrepreneurs as well as end consumers also perform important roles, but a detailed consideration of their roles fell outside the scope of this research. Thus, further research should be conducted to cover all relevant actors among the vegetables value chain to measure the benefits and costs from their own perspective as well as to explore the constraints of participating in contractual arrangements. Such research can also highlights the characteristics of different vegetable varieties and different farming methods in terms of their productivity potential in the context of independent and dependent modes of farmer organisation.

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Chapter 7

SUSTAINABILITY STATUS AND COLLECTIVE CAGES BASED SMALLHOLDER FARMING BEEF CATTLE DEVELOPMENT STRATEGY IN LOMBOK ISLAND, INDONESIA

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ABSTRACT

Animal husbandry in Indonesia is still dominated by smallholder farms. Almost all of the cattle population are smallholder livestock businesses with relatively low levels of production and productivity. Beef cattle smallholder farming on the Island of Lombok, West Nusa Tenggara Province, is carried out using a group of collective cages, making it easier to manage and develop them. The development of beef cattle smallholder farming based on collective cages is a model of intensive beef cattle maintenance. This model is built by implementing integrated farmer group management by integrating various aspects (technical, social,

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economic and cultural) in the fields of management of maintenance, feed, breeding, animal health services, marketing, livestock manure management and livestock security systems. This study aims to analyze the sustainability status and development strategy of collective cage-based beef cattle for smallholder farming on the Island of Lombok, Indonesia. The method used to determine the sustainability status is *Multidimensional Scaling (MDS)* with the *Rapid Appraisal Beef Cattle Smallholder (RAPBCS)* approach. Sensitive attributes that affect the sustainability index and the effect of errors are determined based on Leverage analysis and *Monte Carlo Test*. The results of the sustainability analysis show that the dimensions of technical requirements collective cage 56.84; dimensions of collective cage management 58.04 and dimensions of animal health 56. The multidimensional analysis of the sustainability of the development of beef cattle smallholder farming is based on collective cages on the island of Lombok, obtained a combined dimension value of 57.0 with a fairly sustainable category. Determination of the 6 key factors of sustainability is obtained by prospective analysis to determine the future strategy for the development of collective cage-based beef cattle smallholder farming. The conclusion is that the sustainability status of the development of collective cage-based beef cattle smallholder farming on the island of Lombok Indonesia is in the fairly sustainable category with two recommended development strategies, namely: strategies to improve beef cattle health management and strengthening farmer institutions, farmer economic institutions, extension institutions and the role of community leaders.

Keywords: beef cattle, collective cages, development strategy, smallholder farming, sustainability status

INTRODUCTION

Until now, the national beef cattle business is still dominated by smallholder farms. Smallholder livestock is livestock carried out by the people, among others, by farmers or ranchers in addition to their agricultural businesses. The number of people‘s farms is more than 95 percent of the total number of breeders in Indonesia [1]. The real condition of beef cattle farms in West Nusa Tenggara is people‘s farms managed by small breeders with a maintenance scale of 1-3 heads and narrow agricultural land ownership of fewer than 0.25 hectares per household head [2].

West Nusa Tenggara Province consists of two islands, namely Lombok Island with an area of 4,725 km2 and Sumbawa Island with an area of 15,214 km2. The population on the island of Lombok is 3.167 million people and on the island of Sumbawa 1.606 million. The population of cattle in West Nusa Tenggara Province in 2018 was 1,183,570 heads with details of the population on Lombok Island 514,936 heads and 668,634 heads on Sumbawa Island [3]. This means that the area of Lombok Island is 1/3 the area of Sumbawa Island and the total population of Lombok Island is three times the population of Sumbawa Island and the cattle population on Lombok Island is 0.8 times the cattle population on the island of Sumbawa. Based on this data, Lombok Island is a densely populated and cattle-dense area, so that the beef cattle breeding system developed on smallholder farms is carried out with an intensive system based on collective cages.

The cattle-raising system in Indonesia is carried out extensively and intensively. Extensive maintenance is carried out either off the pasture or on slings. Intensive maintenance is carried out using cages either individually or in groups (collectively). The development of beef cattle farming based on collective cages is a model for intensive beef cattle raising developed in Lombok Island, West Nusa Tenggara Province, Indonesia. This model is built by implementing integrated farmer group management by integrating various aspects (technical, social, economic, and cultural) in the animal husbandry business including maintenance management, feed, breeding, animal health services, marketing, livestock manure processing and livestock safety systems [4]. According to [2] the problem of livestock housing is one of the 28 problems of smallholder livestock in West Nusa Tenggara in facing the ASEAN Economic Community in 2015. Since 1990 until now the productivity of Bali cattle in West Nusa Tenggara has continued to decline from year to year. In addition to decreasing livestock productivity, there is also a decrease in livestock resources (land, animal feed resources) [5].

In connection with this, research has been carried out to determine the status of sustainability and the strategy for developing smallholder beef cattle based on collective cages on Lombok Island.

METHODS

The data needed to analyze the sustainability status and development strategy of collective cage-based beef cattle farming on the island of Lombok is primary data in the form of attributes related to three dimensions, namely the technical requirements of collective pens, collective cage management methods, and livestock health. Primary data comes from interviews with respondents, selected experts, and stakeholders as well as direct observations in the field. Determination of respondents using purposive random sampling technique, namely breeders who have at least five years of farming experience and are involved in collective cage management. The number of respondents (n) is determined by the formula: $n = N/1 + Ne^2$ [6]. Information n = number of respondents; N = total population (head of household breeders); and e = acceptable error (10%). As many as 185 respondents were drawn from five districts/cities on the island of Lombok. There were eight selected expert and stakeholder respondents, who were deliberately selected apart from having competence, experience, credibility, being neutral, and willingness to provide answers.

Determination of the sustainability status and development strategy of collective cage-based beef cattle farming is carried out using the Multi Dimensional Scaling (MDS) method called the RAP-BCS (Rapid Appraisal Beef Cattle Smallholder) approach or the Rapid Assessment of Beef Cattle Farms. This method is a development and modification of the Rapfish approach used to assess the sustainability status of capture fisheries [6]; Rap-Agrosapot which is used to assess the sustainability status of Beef Cattle Farming Areas for the Development of an Agropolitan Area in Bondowoso Regency [7] and *Rapseaweed* used in the analysis of the sustainability of the development of seaweed-based coastal areas in West Sumbawa Regency [8]. The score value of each attribute is analyzed in a multi-dimensional manner to determine one or more points that reflect the sustainable position of the development of beef cattle farming based on collective cattle pens studied relative to two reference points, namely the good point and the bad point. The score, which is the sustainability index value for each dimension, is presented in Table 1. Through the MDS method, the position of the point of sustainability can be visualized through the horizontal and vertical axes. With the rotation process, the point position can be visualized on the horizontal axis with the sustainability index value given a score of 0% (bad) and 100% (good). If the system under study has a sustainability index value of ≥ 50%, the system is said to be sustainable and unsustainable if the index value is <50%). The results of the sustainability analysis are stated in the Beef Cattle Development Sustainability Index based on collective cages (*ikb-BCS*). The sustainability index value of each dimension can be visualized in the form of a kite diagram. The formulation of a strategy for developing beef cattle farming based on sustainable collective cages on the island of Lombok is based on the sensitive attributes of the leverage analysis using Rapbeefcattle smallholder (RAPBCS) on each of the dimensions of sustainability. The most dominant sensitive attribute will be made by various efforts or improvement strategies without reducing other attributes. The results of the sustainability analysis are stated in the Beef Cattle Development Sustainability Index based on collective cages (*ikb*-BCS). The value of the sustainability index for each dimension can be visualized in the form of a kite diagram. The formulation of a strategy for developing beef cattle farming based on sustainable collective cages on the island of Lombok is based on the sensitive attributes of the leverage analysis using Rapbeefcattle smallholder (RAPBCS) on each of the dimensions of sustainability. The most dominant sensitive attribute will be made by various efforts or improvement strategies without reducing other attributes. The results of the sustainability analysis are stated in the Beef Cattle Development Sustainability Index based on collective cages (*ikb-BCS*). The value of the sustainability index for each dimension can be visualized in the form of a kite diagram. The formulation of a strategy for developing beef cattle farming based on sustainable collective cages on the island of Lombok is based on the sensitive attributes of the leverage analysis using Rapbeefcattle smallholder (RAPBCS) on each of the dimensions of sustainability. The most dominant sensitive attribute will be made by various efforts or improvement strategies without reducing other attributes. The value of the sustainability index for each dimension can be visualized in the form of a kite diagram. The formulation of a strategy for developing beef cattle farming based on sustainable collective cages on the island of Lombok is based on the sensitive attributes of the leverage analysis using Rapbeefcattle smallholder (RAPBCS) on each of the dimensions of sustainability. The most dominant sensitive attributes will be carried out by various efforts or improvement strategies without reducing other attributes. The value of the sustainability index for each dimension can be visualized in the form of a kite diagram. The formulation of a strategy for developing beef cattle farming based on sustainable collective cages on the island of Lombok is based on the sensitive attributes of the leverage analysis using Rapbeefcattle smallholder (RAPBCS) on each of the dimensions of sustainability. The most dominant sensitive attribute will be made by various efforts or improvement strategies without reducing other attributes.

The data were analyzed through seven stages, namely: (1) Determining the attributes for the three dimensions of sustainability. The number of attributes to be analyzed were 57 attributes, consisting of 20 attributes of the technical requirements of the collective cage; 17 attributes of collective pen management dimensions and 20 attributes of livestock health dimensions; (2) assessment of each attribute on an ordinal scale based on the sustainability criteria of each dimension; (3) preparation of index and status of development sustainability both in multidimensional and in each dimension; (4) ordination stages; (5) leverage analysis to determine variables sensitive to sustainability; (6) Monte Carlo analysis to take into account the uncertainty aspect and (7) formulating a strategy for developing smallholder cattle breeding based on collective cages.

The stage of the status analysis and sustainability strategy development of beef cattle on smallholders farms based on collective cages on the island of Lombok as follows:

Determination of Sustainability Attributes the Development of Beef Cattle Farming Based on Collective Cages

Determination of sustainability attributes the development of beef cattle on smallholders farms based on collective cages based on three approaches to the sustainability dimension, namely: (1) the technical requirements of the collective cage; (2) dimensions of collective pen management and (3) dimensions of livestock health. Attributes are arranged according to research results [4]; [9], good about the development of beef cattle on people‘s farms and other fields related to sustainability. Expert opinion from practitioners and academics is also considered in the preparation of attributes

Assessment of Attributes in the Scale of the Sustainability of Each Dimension

Attribute assessment and scoring based on research, field observations and available secondary data. Each attribute is given a score that reflects the sustainability of each dimension. The score ranges from 1-5 based on a scale Linkert [10] depending on individual circumstances. Bad scores reflect the conditions most unfavorable to development of beef cattle on community farms based on collective cages sustainability, on the contrary good value reflects the most favorable conditions for development of beef cattle based on people‘s farms health management collective cage. The scoring criteria for each dimension development of beef cattle based on people‘s farms health management collective cage on the island of Lombok based on Mashur‘s research results [4] and [9].

Compilation of the Sustainability Index Development of Beef Cattle Smallholders Based on Collective Cages

The compilation of the index scale for the sustainability of the development of beef cattle farming based on collective cages has a range of 0-100. If the system under study has an index >50 then the system is categorized as sustainable, and vice versa if the value is <50, then the system is categorized as unsustainable. The categories of sustainability status for the development of collective cage-based beef cattle farming are arranged into four categories [11]. In this study, four categories of sustainability status were arranged based on a basic scale (0–100) as shown in Table 1.

Table 1. Status categories of the sustainability of the development of beef cattle farming based on collective cage

Index	Category
<25	Bad
25-50	Less
51-75	Enough
> 75	Good

Source: Soesilo, 2003.

Ordination Stages

The ordination stage was analyzed by MDS to determine the position of good (good) and bad (bad) points. Objects or points in MDS will be mapped into two or three dimensional space and be kept as close as possible. According to [12] this ordination process aims to determine the distance in MDS based on Euclidean Distance. The position of bad and good points is depicted horizontally while vertically shows the difference between the mix of attribute scores being evaluated. Furthermore, [11] stated that the point position would be very difficult to imagine considering the many dimensions, to facilitate the visualization of the point position, MDS analysis was used.

Leverage Analysis

Leverage analysis is carried out to see the most sensitive attribute contributing to the sustainable value of the development of collective cage-based beef cattle farming. The effect of each attribute is seen in the form of a change in Root Mean Square (RMS). If the RMS value is greater, then this attribute will be more sensitive in supporting the sustainability of the development of smallholder beef cattle based on collective cages. According to [12], the analysis of Rapfish also allows to analysis of the Leverage (the sensitivity of the attribute reduction to the sustainability score) leverage is calculated based on the standard error of the difference between the score with the attribute and the score obtained without the attribute.

Monte Carlo Analysis

Monte Carlo analysis is a statistical simulation method to evaluate the effect of errors or the effect of errors on statistical processes. The point evaluated in this study is the point of ordination. The Monte Carlo results in this study were presented in a scatter plot with 25 replications. According to [13] Monte Carlo analysis is useful in studying: (1) the effect of attribute scoring errors caused by the lack of information, misunderstanding of the attributes, or the way of scoring the attributes; (2) the effect of the variation in scoring due to differences in opinion or judgment by different researchers; (3) stability of the iterative MDS analysis process (the risk position is unstable); (4) data entry errors or missing data and (5) high ―stress‖ value from the analysis results.

Formulation of a Strategy for Developing Beef Cattle Based on Sustainable Collective Cages

The formulation of a strategy for developing beef cattle farming based on sustainable collective cages in Lombok Island is based on the sensitive attributes of the leverage analysis using the Rapid Appraisal Beef Cattle Smallholder (RAPBCS) on each of the sustainability dimensions. The most dominant sensitive attributes will be made by various efforts or improvement strategies without neglecting other attributes. The strategy prepared contains the steps and efforts that must be made in supporting the development of sustainable beef cattle farming based on collective cages. The stages of strategy formulation are as follows: (1) sorting the attributes of the leverage analysis from the three dimensions of sustainability; (2) priority sequence starting from the dominant attribute affecting the sustainability value of each dimension based on the root mean square (RMS) value;

Results and Discussion

The Status of the Sustainability of the Development of Collective Cage-Based Beef Cattle Farming

Sustainability Status Dimensions of Collective Cage Technical Requirements

Based on Figure 1, the sustainability index value of the technical requirements for collective cages is 56.84. Because the sustainability index value of the technical requirements for the collective cage dimensions> 50, the sustainability status is in the sufficient category. This is in accordance with the opinion of [11]. For this reason, efforts are needed to increase the index value of sensitive attributes which have a low root mean square (RMS) values in order to obtain better sustainability values.

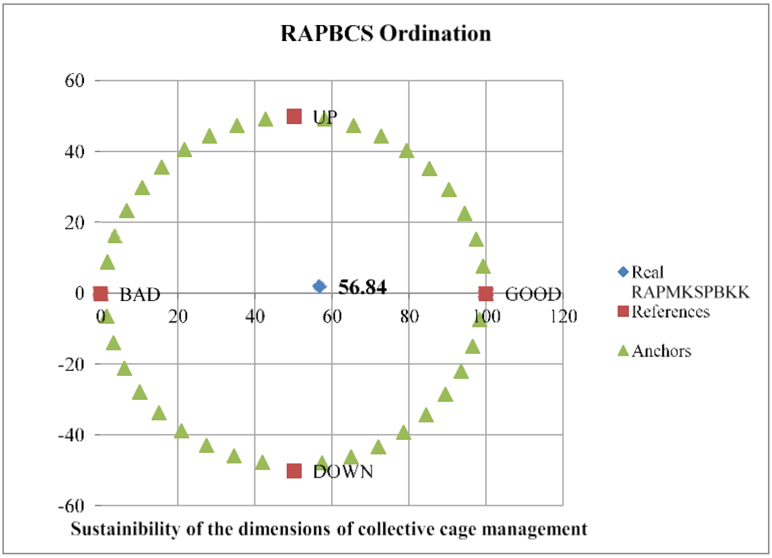

Figure 1. The value of the sustainability index of the technical requirements of the collective cage dimensions.

Figure 2. Beef cattle collective cages on smallholders farming on Lombok Island, Indonesia.

Based on Figure 2, there are four sensitive attributes that need to be improved because of the effect of increasing the value of the sustainability index, namely: (1) The management of cattle waste is not optimal, thus disturbing public health. This sensitive attribute is expressed in the form of a root mean square (RMS) value of 0.66; (2) Cage floor material so that it is strong and easy to clean. This sensitive attribute is expressed in the form of a root mean square (RMS) value of 0.59; (3) The size of the main pen must match the needs of the livestock. This sensitive attribute is expressed in the form of a root mean square (RMS) value of 0.59 and (4) It is necessary to provide a special pen for calving so that it does not mix with other livestock. This sensitive attribute is expressed in the form of a root mean square (RMS) value of 0.57. The greater the RMS value,

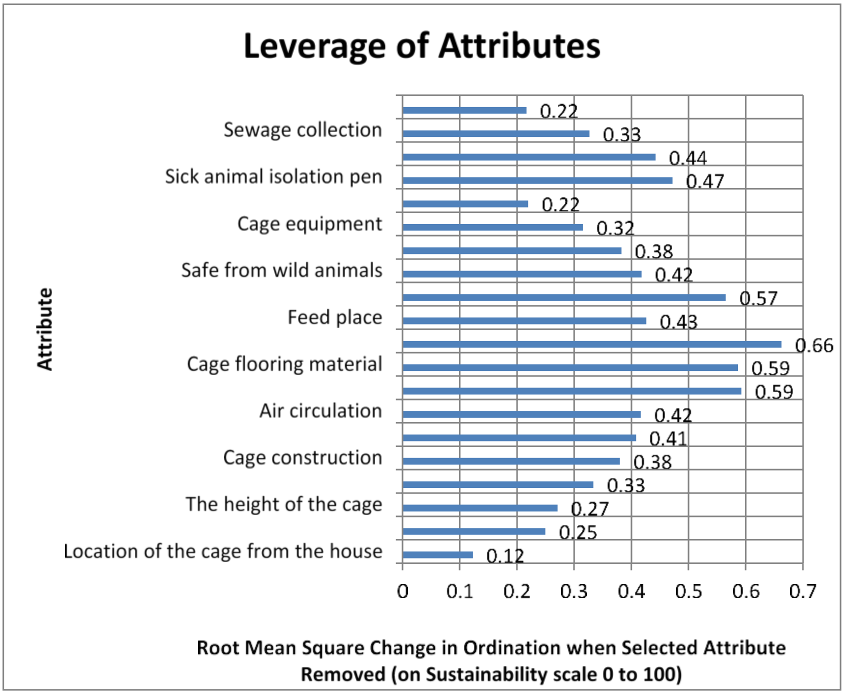

Figure 3. The dimensional attribute values for the technical requirements of collective cages are expressed in terms of the root mean square (RMS) value.

The results of this study are in accordance with the results of the study [4] that although most beef cattle breeders on people‘s farms in Lombok Island have used collective cages, the level of implementation of beef cattle cage health management has not been optimal, both in terms of technical and health requirements as well as collective cage management (Figure 2).

This can be proven by the increasing number of manure that has accumulated around the pen or dumped into rivers or waterways. In the rainy season, manure from the pen, if not managed properly, will be washed away, and flow into rivers, ditches and even into residential areas. In the dry season, piles of manure that are not properly managed are allowed to dry out and be burned or blown by the wind in the form of dust which can harm the health of livestock, breeders, and environmental health.

The Sustainability Status of the Dimensions of How to Manage the Collective Cage

Based on Figure 4, the value of the dimension of the collective cage management method is 58.04. Because the sustainability index value of the dimensions of the technical requirements for the collective cage> 50, the sustainability status is in the sufficient category. This is in accordance with the opinion of [11]. For this reason, efforts are needed to increase the index value of sensitive attributes which have low root mean square (RMS) values in order to obtain better sustainability values.

Based on Figure 5, there are three sensitive attributes that need to be improved because of the effect of increasing the value of the sustainability index, namely: (1) The cage floor should always be cleaned every day so that it is not slippery. This sensitive attribute is expressed in the form of a root mean square (RMS) value of 0.94; (2) The floor of the cage must not have any holes so that it is not flooded. This sensitive attribute is expressed in the form of a root mean square (RMS) value of 0.92 and (3) the cage aisle should be made wide enough to make it easier to clean the pen, carry feed and make it easier for livestock to enter the pen. This sensitive attribute is expressed in the form of a root mean square (RMS) value of

0.86. The greater the RMS value, the more sensitive this attribute is in supporting the sustainability of the development of smallholder beef cattle based on collective cages.

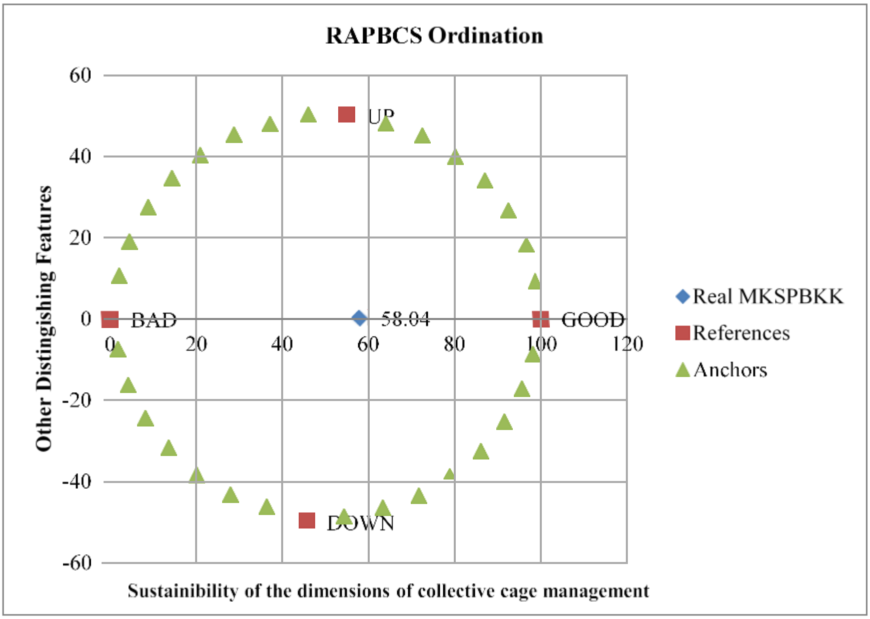

Figure 4. Dimensional sustainability index value for how to manage the cage.

Besides functioning to protect livestock from outside disturbances such as hot weather, rain, and livestock safety, it also functions to protect livestock to avoid disease attacks. Maintaining livestock health is carried out by maintaining the cleanliness of the enclosure environment, providing feed and drinking water according to the nutritional needs of the livestock, and carrying out quarantine as soon as possible for sick cattle. The feasibility of a pen is important considering that the disease has the potential to become an epidemic if the place to live for livestock is neglected. [14] said that the cage should be easy to clean regularly. If the cage is too damp, the ammonia substance contained in animal manure can be inhaled so that the animal is susceptible to disease.

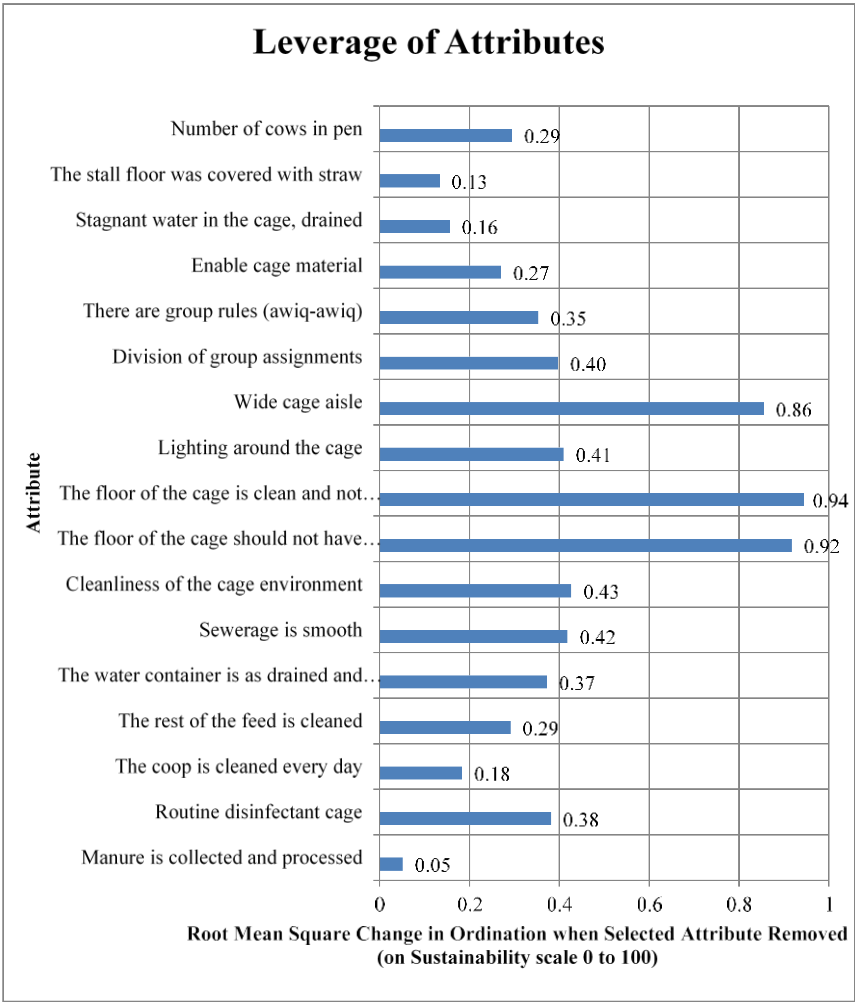

Figure 5. Dimensional attribute values for how to manage the cage are expressed in the form of the root mean square (RMS) value.

Sustainability Status of Livestock Health Dimensions in Collective Pens

Based on Figure 6, the value of the sustainability index for the dimensions of livestock health, how to manage collective pens, is 56.38. Because the sustainability index value of the technical requirements for the collective cage dimensions> 50, the sustainability status is in the fairly sustainable category. This is in accordance with the opinion of [11]. For this reason, efforts are needed to increase the index value of sensitive attributes that have a low root mean square (RMS) values in order to obtain a better sustainability value.

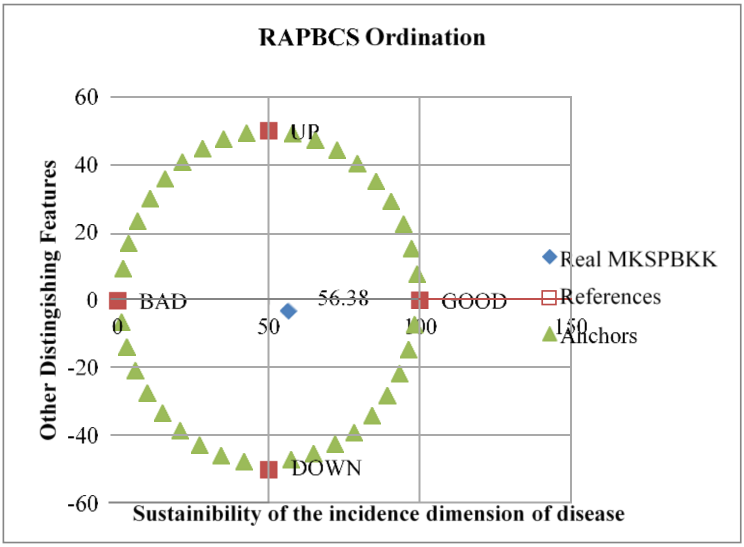

Figure 6. The index value for the sustainability of the dimensions of livestock health.

Based on Figure 8, nine sensitive attributes need to be improved because of the effect of increasing the value of the sustainability index, namely: (1) Deare is expressed in the form of a root mean square (RMS) value of 0.73: (2) Scabies disease is expressed in the form of the root mean value square (RMS) of 0.58; (3) flatulence expressed in the form of a root mean square (RMS) value of 0.58; (4) Itching disease is expressed in the form of a root mean square (RMS) value of 0.57; (5) Demodex disease is expressed in the form of a root mean square (RMS) value of 0.56; (6) Pink eye is expressed in the form of a root mean square (RMS) value of 0.55; (7) Anthrax disease is expressed in the form of a root mean square (RMS) value of 0.55; (8) Disorders of reproductive disorders are expressed in the form of a root mean square (RMS) value of 0, The implementation of collective cage-based beef cattle health management in Lombok Island, both from the dimensions of technical and sometimes collective health requirements as well as from the dimensions of collective cage management, is at sufficient value intervals. In the implementation of health management for individual beef cattle breeders, there are still 10.81% of beef cattle breeders on smallholders farms on the island of Lombok who have bad scores so that the application of technical requirements and the health of collective cages needs to be improved, as shown in Figure 7.

Figure 7. The implementation of health management for individual beef cattle smallholders.

As many as 17.84% of beef cattle breeders have a bad score in the management of collective pens so it is necessary to improve the application of collective cage management [4].

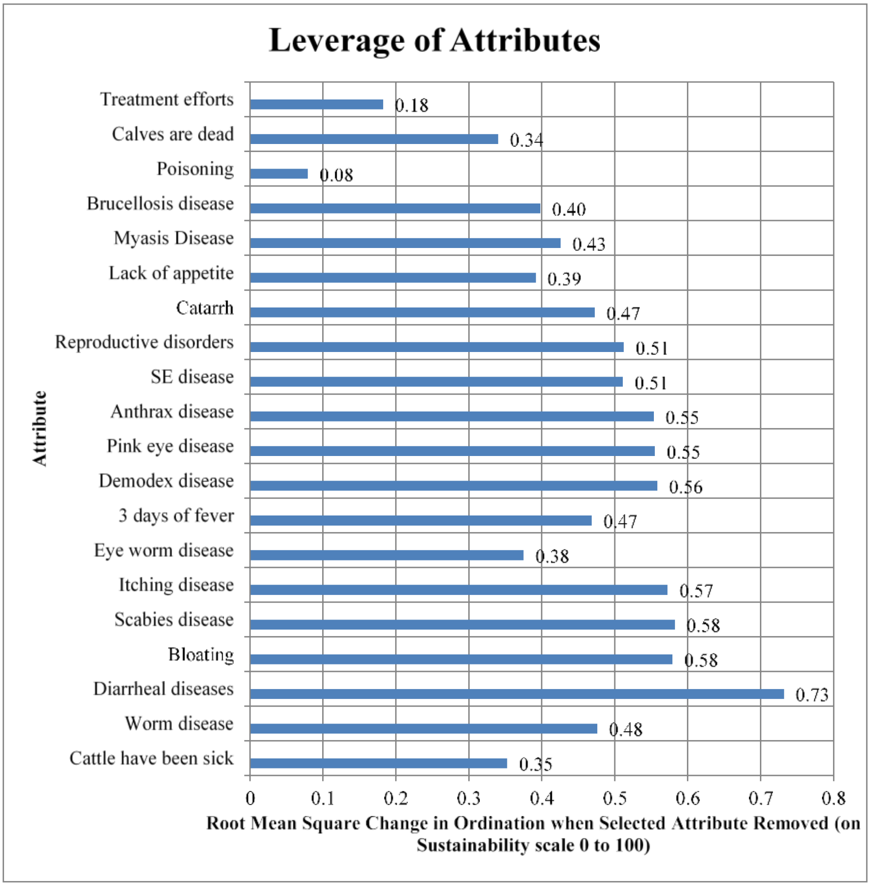

Figure 8. The value of the dimension attribute of disease incidence is expressed in the form of the root mean square (RMS) value.

The results of this study indicate that as many as 78% of respondents stated that their livestock had been sick. 17 types of diseases have attacked beef cattle on people‘s farms on the island of Lombok, both infectious and non-communicable diseases. The most dominant disease is worm disease. As many as 75% of respondents stated that their livestock had experienced worms. This is following the research results of [15] stated that nematodiasis was found in all sub-districts on Lombok Island. The highest prevalence of nematodiasis was found in two districts in East Lombok (94.4%). Tricostrongylidae was recorded as the Nematode worm family with the highest prevalence rate (51.4%). To support animal health services, the NTB Provincial Livestock and Animal Health Service in 2018 has purchased ingredients for veterinary medicines for handling worm disease in calves, namely 3,500 boluses of 300 mg Albendazole and 300 bottles of 50 ml of vitamin B12 injection. Apart from worms, diarrheal disease is the second dominant disease suffered by beef cattle on community farms on Lombok Island based on collective cages. The third dominant disease incidence is beef cattle experiencing a lack of appetite, so that the livestock becomes thin, which causes the selling price to decrease. Among the zoonotic diseases that need to be watched out for are Anthrax and Epizootic Septimea [16]. Even though various types of diseases have attacked beef cattle on the people‘s farm-based on collective cages on the island of Lombok, 75% of farmers stated that they had taken preventive measures. The results of this study are following the 2019 West Nusa Tenggara Province Animal Husbandry and Animal Health Service Report [9].

Multidimensional Sustainability Status

The determination of the value of the sustainability index in a multidimensional manner is an illustration of the sustainability of the development of community livestock based on collective cages on Lombok Island. Multidimensional values are obtained by multiplying the index value between dimensions by the weight between dimensions based on expert opinion. According to [17] in seeing the multidimensional value between the six dimensions, it cannot be done with an average, but it must be done by using a pairwise comparison test obtained from expert assessments in the field of smallholder livestock (technical requirements for collective pens, ways of managing collective cages and livestock health), to obtain the weight of each dimension, as shown in Table 2 below.

Table 2. Multidimensional index value of sustainability status and strategy for developing beef cattle farming based on collective cages on Lombok Island

Dimensions	Weighted value (%)	Sustainability Index Value	Weighted Result Index Value
Collective cage technical requirements	36.59	56.84	20.80
How to manage a collective cage	26.82	58.04	15.57
Livestock health	36.59	56.38	20.63
Total	100	58.80	**57.0**

Based on the results of the multidimensional analysis of the sustainability of the development of beef cattle farming based on collective cages on the island of Lombok in Table 2, the combined dimension value of 57.0 is obtained, which is in the sufficiently sustainable category following [11]. The value of the combined sustainability index to these three dimensions depicted in the kite diagram (kite diagram) in Figure 9.

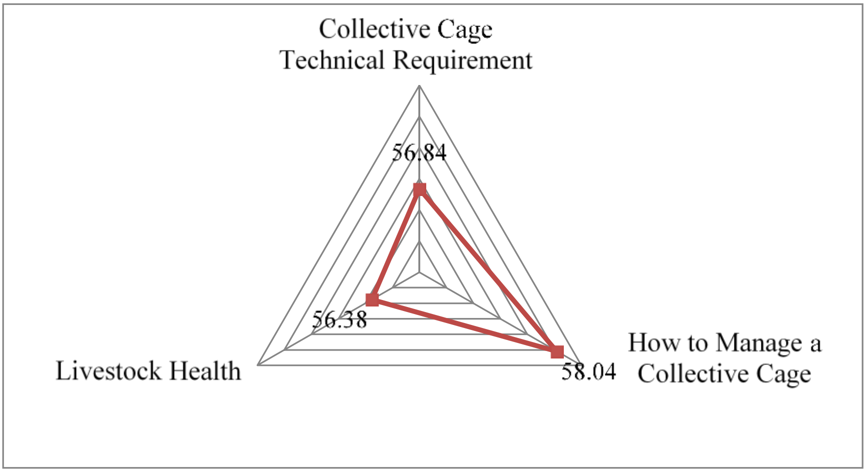

Figure 9. The kite diagram (kite diagram) of the sustainability index value of the three dimensions of the development of smallholder beef cattle farming based on collective cages on Lombok Island.

Value of Stress and Coefficient of Determination (R^2)

The stress value and the coefficient of determination are used to see the accuracy of the results of the sustainability index value or in other terms whether or not it is necessary to add attributes to reflect the level of accuracy of the three dimensions studied so that it can be scientifically accounted for. The stress value is defined as a measure to see the accuracy of the results obtained whether it is close to the original data (goodness of fit), if the stress value is getting closer to zero it indicates that the resulting data can be trusted. The value of stress and the coefficient of determination of each dimension of the sustainability status and the strategy for developing smallholder livestock based on collective cages in Lombok Island are shown in Table 3.

Table 3. The value of stress and the coefficient of determination (R^2) for the three dimensions of the development of smallholder beef cattle based on collective cages on Lombok Island

Dimensions	Stress value	Percen-tage	The coefficient of determination (R^2)	Percentage
Collective cage technical requirements	0.1386808	13.87	0.9525459	95.25
How to manage a collective cage	0.1404049	14.04	0.9516730	95.17
Livestock health	0.1380562	13.81	0.9530509	95.31

The stress value of the three dimensions of sustainability in the development of collective cage-based beef cattle farming on Lombok Island ranges from 0.13-0.14 (13-14%) and the coefficient of determination (R^2) ranges from 0.94-0.95 (94-95%). This means that all the attributes studied from the three dimensions of the sustainability of beef cattle farming based on collective cages are accurate enough to provide good analysis results and can be scientifically accounted for. This is following the research results [12] in the Rapfish model a good stress value is shown <0.25 (25%). While the coefficient of determination (R^2) is closer to greater than 80% or closer to 100% [6]. To see the effect of errors or disturbances from the results of ordination on the sustainability of the development of collective-based beef cattle farms on the island of Lombok, a Monte Carlo analysis is performed, which is a statistical simulation method to evaluate the effect of errors or the effect of errors on the statistical process.

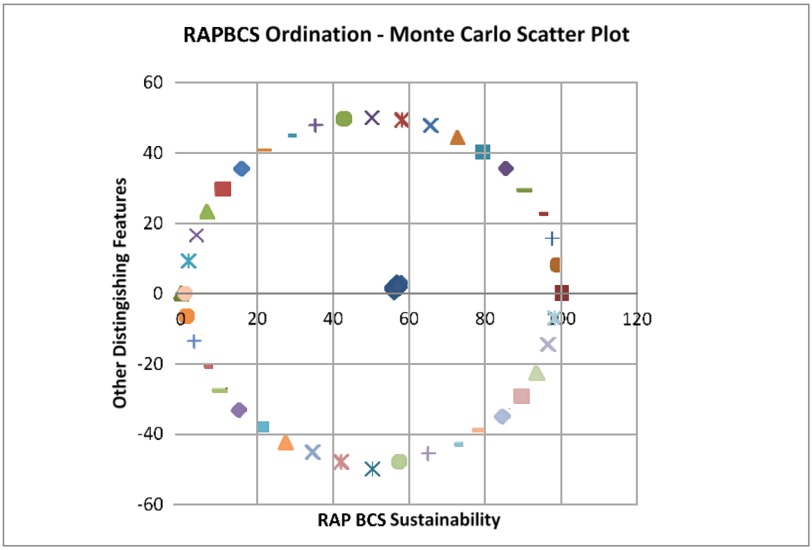

Figure 10. Scatter plot dimensions of collective cage technical requirements.

The results of the Monte Carlo analysis show that the points in the scatter plot are in a collecting position, this means that the results of the ordination points used in determining the sustainable status of the development of collective cage-based beef cattle farming on the island of Lombok are quite stable so that errors or disturbances can be resolved. According to [13] errors or disturbances in ordination results are indicated by points that are spread out or separated from other groups of points in the scatter plot caused by: (1) the effect of the attribute scoring error caused by the lack of information, misunderstanding of the attributes or the way of scoring the attributes; (2) the effect of the variation in scoring due to differences in opinion or judgment by different researchers; (3) stability of the iterative MDS analysis process (the risk position is unstable); (4) data entry errors or missing data; and (5) the high ―stress‖ value from the analysis. In detail, the results of the Monte Carlo ordination of the three dimensions of the sustainability of the development of collective cattle pens based on collective cages on the island of Lombok are shown in the form of a scatter plot as shown in Figure 10.

The Strategy for the Development of Beef Cattle Smallholders Based on Collective Cages in Lombok Island

Development strategy beef cattle farming based on collective cages on the island of Lombok, done by looking at the sensitive attributes of the three dimensions that need to be top priority. These sensitive attributes are the main factors in supporting sustainability development of beef cattle farming based on collective cages on the island of Lombok. For this reason, various efforts are needed both beef cattle breeders, government and multi-stakeholders related to improving the attributesthese sensitive attributes, and maintain or re-enhance well-identified attributes to achieve sustainability. Table 4 shows the sensitive attributes of the three dimensions of the development of smallholder beef cattle based on collective cages on Lombok Island.

Furthermore, from the 16 sensitive attributes, a prospective assessment was carried out by experts and 6 key success factors were determined, namely controlling anthrax disease and Epizootic Septimea disease, avoiding reproductive disorders, paying attention to the capacity/density of the main cage, improving livestock manure management, cleaning the cage floor every day so that not slippery. Based on the priority order of the dominant/sensitive attributes of the results of the leverage analysis that affect sustainability and the key success factors, a development strategy has been prepared for beef cattle farming based on collective cages on the island of Lombok, as follows:

Table 4. Sensitive attributes for each dimension of the sustainability of the development of beef cattle farming based on collective cages on the island of Lombok

Dimensions		**Sensitive attribute (Leverage factor)**	**RMS**
Collective cage health requirements	1	The management of cattle waste is not optimal	0.66
	2	The floor material for the cage is made of strong and non-slip material	0.59
	3	The size of the main pen must match the needs of the livestock	0.59
	4	It is necessary to provide a cage for children	0.57
How to manage a collective cage	1	The floor of the cage is cleaned and not slippery.	0.94
	2	The floor of the cage should not be hollow	0.92
	3	Wide cage aisle	0.86
Disease incidence	1	The incidence of diarrhea	0.73
	2	Scabies disease	0.58
	3	Flatulence	0.58
	4	Gata-hives	0.57
	5	Demodex disease	0.56
	6	Pink Eye Disease	0.55
	7	Anthrax disease	0.55
	8	Reproductive disorders	0.51
	9	Epizootic Septimea Disease	0.51

Strategy 1. Improvement of Collective Cage Health Management, Through

1. Improve the livestock health service system (especially periodic Anthrax and SE vaccinations) and avoid reproductive disorders in livestock.
2. Improve the management of livestock manure so that it does not harm on environmental hygiene and health
3. The cage should be cleaned every day to prevent the floor of the cage from becoming slippery which will endanger livestock
4. Pay attention to the size of the cage, especially the parent cage so as not to exceed capacity.

Strategy 2. Strengthening Farmer Institutions, Extension Institutions, and the Role of Community Leaders, Through

1. Initiation of the establishment of farmer economic institutions (farmer cooperatives)
2. Increasing the role of religious and community leaders in accelerating the development of beef cattle farming based on collective cages
3. Initiating collective farmer group cooperation with the business world in developing beef cattle agribusiness.

CONCLUSION

Based on the results of this study, it can be concluded that the status of the sustainability of the development of collective cage-based beef cattle farming on the island of Lombok uses three dimensions with 57 attributes being in the sufficient category to continue with a score of 57.0. 16 sensitive attributes need to be intervened and with prospective assessments from relevant experts and stakeholders. 6 key success factors need to be considered so that the development of beef cattle farming based on collective cages in Lombok Island in the future is more effective and efficient. For this reason, two strategies for developing beef cattle based on collective cages in Lombok Island have been recommended.

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Chapter 8

IMPROVING SMALLHOLDER ORGANIC COFFEE PRODUCTION IN NEPAL: A CASE STUDYFROM LALITPUR DISTRICT

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ABSTRACT

Coffee is one of the important cash generative crops in the mid hills of Nepal. Coffee, being an important high value crops, is mostly grown in marginal areas with minimum use of improved technologies. In line with the focus of agricultural policies, the concerned have not taken adequate initiatives for the promotion of coffee cultivation. In Nepal majority of coffee is wet processed, which is considered best method for good quality coffee. However, there is lack of updated manpower and improved technologies to work in this regard. As a result of which, quality of

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Nepalese coffee is below international standard. Around 65 percent of Nepalese coffee is exported, and the rest amount is processed and supplied in the domestic market. Majority of coffee is exported through personal contact of traders rather than institutionalized marketing channel. Therefore, there is gap between what policies have stated and what implemented in the real fields for the promotion of coffee.

A study was conducted among smallholder organic coffee producing farmers at Chandanpur and Thuladurlung villages in Lalitpur district of Nepal which is very famous for producing coffee. The data collected from a total of 70 respondents during the period 2019-2020 was assessed for the purpose of improving processing, marketing and export potentiality of organic coffee. These results reveal that though coffee was produced in upland with less care, it had contributed some portion of household income. Farmers should follow better management practices to ensure higher return from coffee cultivation since it is their main source of income. Further, the wet processing method was followed by coffee growers due to its quality and time involved. Though in small quantity of coffee was processed by dry method for home consumption. The cost of processing in wet method is however very high due to expensive machines used. The export of Nepalese coffee indicated that there was impressive growth in the export of Nepalese coffee due to its high value in international market. However there found to be several constraints in processing, pulping, marketing and export of coffee and they should be addressed for the commercialization of coffee sector in future.

Keywords: agricultural policies, coffee production, smallholders, export potential, Nepal

1. INTRODUCTION

Nepal is a landlocked country which is in South Asia. It is in the Himalayan and bordered to the north by the People‘s Republic of China, and to the south, east and west by the Republic of India. With an area of 147181 sq. kilometres and a population of approximately 30 million (CBS, 2011). Agriculture is the major sector of Nepalese economy. It provides employment opportunities to 66 percent of the total population and contributes about 34.7 percent in the GDP (MOF, 2017) Therefore, the development of agriculture sector is key for the development of national economy. Keeping in view of the contribution, the agriculture sector was given priority for its development from the onset of the periodic plans till now plan period.

The Agricultural Policy Plan (APP) 1994/95-2014/15 is long term strategic policy for accelerating agricultural growth by increasing the factor productivity, transforming the subsistence-based agriculture into commercial one by strengthening the production pockets, reducing poverty by providing the employment opportunities and promoting the involvement of private sectors in the development of agriculture. One of the prioritized outputs of APP is to promote high value crops. For this it has prioritized different crops for different ecological zones of the country i.e., Terai, mid hill and high hills. For instance, high hill for apple, mid hills for citrus, nevertheless, coffee has not recognized as a high value crop for the mid hill region of Nepal by APP.

A monk named Hira Giri in Aanpchaur, Gulmi district introduced coffee for the first time in Nepal, from Burma (Myanmar) in 1938 (Dhakal, 2005; Dharkal, 2008). In 1976, Agriculture Development Bank brought seeds from India and distributed to the farmers of Gulmi, thereafter, it has spread to other districts (Bhandari, 2012; Bhandari, 2006). From the mid-seventies, coffee was grown as a commercial crop and commercial nurseries were also established. During mid- eighties, coffee production in some districts was quite high. However, during late eighties poor return from coffee and marketing problems forced many farmers to cut down their mature trees (Shrestha et al., 2008; Shrestha and Poudel, 2004). Coffee Cooperative Union Lalitpur was established on 2008 (12th August) to encourage coffee cultivation and to solve the problems faced by coffee growers.

The competitiveness of coffee has quickly increased in recent years contributing to the improvement of rural livelihoods. According to official records, coffee production area has expanded from around 424 ha in fiscal year 2000/01 to 1760 ha in 2011/12. The production has increased from 89 tons of dry cherry to 418 tons of green beans during the same period. However, its overall production for fiscal year 2012/13 has been found decreasing to 366 tons of green beans, a sign that does not bode well to the coffee sector of Nepal. Coffee cultivation has expanded particularly in the last decade. According to the National Tea and Coffee Development Board (NTCDB, 2009; 2013; 2014), the production of coffee parchment swelled to 536 tons in 2013/14 from 144 tons in 2003/04.

Presently, coffee is cultivated in around 40 districts, but it has been producing commercially in about 20-22 hill districts. In Nepal, coffee is predominately grown by resource poor and small-scale farmers under marginal upland condition (Shrestha et al., 2008) and mostly they don't use chemical fertilizers and pesticides in the production process. In most of cases, coffee cultivation is using unproductive, fallow and the lands prone to degradation and thus it helps to conserve soil erosion, degradation of land and provides 20-25 percent extra income than traditional cereal crop. Coffee is relatively a new cash crop started to be grown in Nepal almost with no use of inorganic fertilizer and pesticides. It could be an important occupation in the rural economics with massive participation of marginal, poor and downtrodden class of rural communities. In addition, it could be an important means for soil conservation, biodiversity maintenance and watershed balance in different locality of Nepal (AEC/FNCCI, 2006). Coffee is emerging as a likely agro-enterprise with great potential to provide farm employment and income generation opportunities in the mid hills of Nepal (CoPP, 2012).

Most of the coffee grown in Nepal is considered organic as coffee is grown in the natural condition and most of the farmers do not use chemical fertilizers and pesticides during cultivation and processing. There has been growing interests from both government and non-government sectors for promoting organic coffee and farmers are also motivated to produce coffee owing to higher demand in the international market. Considering the importance of high value crops including coffee and with the view of expanding the production and productivity, government has promulgated several agricultural policies, strategies and guidelines for the promotion of production, processing and marketing of high value crops. For instance, the Coffee Policy 2004 was promulgated with an aim of fostering production and marketing of coffee. In this context of emerging coffee as a valuable commodity, it is worthwhile to evaluate the focus and implication status of agricultural policies for promoting the production, processing and marketing of coffee in the country.

The rest of the chapter is structured as follows. Section 2 describes the problem and objectives of the study. Study area and sample survey conducted are detailed in Section 3. Methods of data analysis is given in Section 4. Results and discussion are presented in Section 5, followed by summary and conclusion of the study in Section 6.

2. STATEMENT OF PROBLEM AND OBJECTIVES

Coffee is emerging commercial crop but Nepalese farmers are cultivating it in marginal lands, inadequate plant nutrients, water stress condition, pest problems particularly white stem borer, poor yielding varieties, disease infestation and lack of appropriate post-harvest technologies particularly processing are the main reasons of small scale of production and poor quality of coffee in Nepal. Similarly, there is lack of specific institutions in dealing with market related issues of coffee sector in Nepal. There is absence of quality control measures and several problems in terms of production, processing, marketing and export due to lack of clear policy guidelines from the commercialization point of view. Also, there is inadequate research work about the processing and marketing of coffee, the farmers are still unknown about actual profit from the coffee business.

Coffee is an economically profitable crop than cereals by more than three times. It can be successfully integrated into existing cropping system to generate additional income without replacing these crops. Coffee demands large numbers of labour for production, processing and marketing. Therefore, massive employment opportunities can be generated in the area of production of coffee. Many men and women may engage in such business and helps Nepal to be away from unemployment. It may decrease the unemployment rate of Nepal that is really a positive point. In terms of processing, marketing and export, there are many problems faced by Nepalese farmers. Not much work was carried out regarding cost analysis in processing, situation of market and demand in international markets. Those who are interested in coffee business may not know about the investment that requires in processing, marketing and the international demand of the organic coffee. So, this study can be benefit for coffee growers.

The objectives of this study are to analyse the processing, marketing and export potentiality of organic coffee from Lalitpur district, Nepal. A few research reports on coffee production and marketing aspects are available. But the systematic study on the overall processing, marketing and export of Nepalese organic coffee are still lacking. There is difficult to get actual information or data regarding export of organic coffee from Nepal. A few researches were conducted about processing cost analysis. So, the outcome of this research will be useful for the coffee producers, pulper operators, processors, traders, future researcher, entrepreneurs, policy makers, and development workers.

The findings of this study will help to develop a strategy towards the commercialization of coffee sectors including production, processing, marketing and export as well as to recognize Nepalese organic specialty coffee in the international market. Due to various constraints the study was limited to only two Village Development Committees (VDCs) i.e., Chandrapur and Thuladurlung of Lalitpur district of Nepal. The study was mainly based on data taken on recall basis and might have included some research errors. Besides, since some of the required information was not obtained from the respondents, the data was taken from references for finding results.

3. Study Area and Sample Survey

The study was conducted in the Lalitpur district of Nepal. Chandanpur and Thuladurlung VDCs were selected for the study. These settlements are occupied by Brahmin, Chettri, Dalit and Janajaati. The study was done with the consultation of Co-operatives, located at the district. Lalitpur district of Nepal is the pocket area and famous for producing organic coffee, that is why those places were suitable for this research. Lalitpur district is also one of the most potential areas for the coffee production as farmers grow in large amount and those two VDCs were purposively selected for the study due to:

- Potentiality of producing coffee.
- Easily accessible.
- Very famous for organic coffee.
- The mean yield of fresh cherry was 1849.36 kg/ha in Lalitpur (Karki et al., 2018).

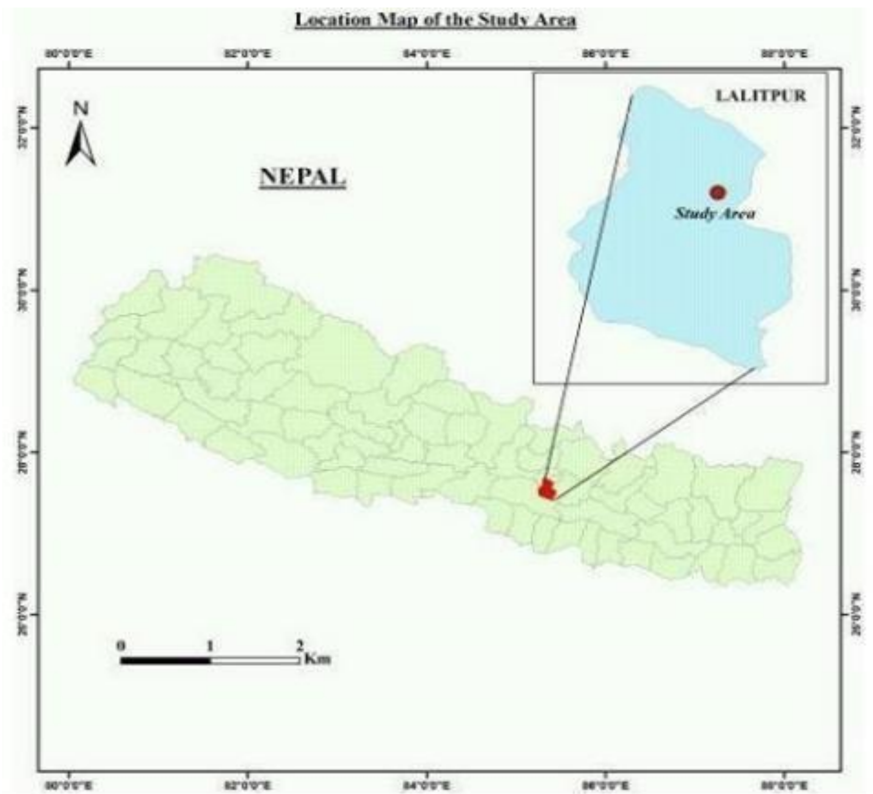

Figure 1. Map of Nepal showing Lalitpur District of Nepal.

The major focus of the study was the commercial organic coffee growers of the selected areas. The list of coffee growers was prepared with the help of Districts Coffee Cooperatives Union and key informants. The coffee growers were targeted population for the study. A total of 70 households were selected to meet our goal of the survey. Coffee growers who were linked with the co-operatives were the main target respondent for the study, so that we could get the information regarding the commercial processing and marketing of organic coffee in Lalitpur district of Nepal. Coffee growers were surveyed, and sample was selected based on purposive random sampling method.

Table 1. Sampling frame and number of respondents of the study

VDCs	**Cooperatives**	**Sampling frame**	**No. of respondents**
Chandanpur	1. Sagarmatha Coffee Producers Cooperative	67 growers	10(14.92)
Thuladurlung	2. Ratogurans Organic Coffee Producers Cooperative	58	20(34.48)
Thuladurlung	3. Durlung Jaibik Coffee Producers Cooperative	43	15 (34.88)
Thuladurlung	4. Lekali Organic Coffee Producers Cooperative	37	25(67.56)
Total	4	205	70 (34.14)

(Note: Figures in parentheses indicate percentage)

Pre- survey field visit was conducted to gather the preliminary information regarding socio- cultural, topographical and institutional features of the study. To collect the primary information of the farmers, interview schedule design was prepared. A co-ordination scheme was prepared in harmony with the objectives of the study to identify the variables and to facilitate the interview schedule preparation. The interview schedule design consists of the different variables like household socio-economic characteristics, farm characteristics, livelihood options, farmer‘s perception, their adaptation strategies and crop production trends.

Pre-testing of the interview schedule was done before the field survey by administering the designed interview schedule to the 10 respondents near the study area with the help of the members of Co-operatives. The final interview schedule was prepared by taking due consideration and suggestion obtained during the pre-testing. After the finalization of the interview schedule, the schedule was prepared to collect the information. Field survey was conducted during Oct- Dec 2019. Respondents from two VDCs were interviewed by visiting their home. Validation of the information was done immediately after filling the interview schedule. Focus group discussion and informational discussion were also done during field survey.

Both the primary source of data and secondary source of data were collected and analyzed for the study. The primary data were collected from the field survey. Face to face interaction with the Coffee growers was done. Secondary source of data was collected from various published journal articles, publications from library and organisations such as NTCDB, Coffee Promotion Project (CoPP) Helvetas, Coffee Cooperative Union (CCU) Lalitpur etc., and from websites. The questionnaire was prepared, and the Coffee growers were interviewed face to face, to collect the primary data for the study. Information was collected from the farmer‘s perceptions.

4. METHODS OF DATA ANALYSIS

Information collected from the field survey was coded first and entered into the computer. Data entry and analysis were done by using computer software package, Statistical Package for the Social Science (SPSS 23 version) and Microsoft Excel. The local units of measurements were corrected into scientific one. All the calculations related to the analysis have been performed with the help of programs like MS Excel and various business plan spreadsheets. The processing, marketing and export of the Coffee will be analysed.

The data and information collected from both the primary and secondary sources for the reliable result. Qualitative information from the survey questionnaire was quantified with the appropriate scaling method. Yes or no, increase or decrease or not noticed were changed to dummy for the further analysis. Weather growers followed wet or dry method? Personal interview was done with processor for finding why they followed wet and dry method. For marketing traders were interviewed and marketing system and marketing channel were analysed, followed by those coffee exporters. For export analysis past data were collected from CCU (Coffee Cooperative Union) and NTCDB (National Tea and Coffee Development Board) Nepal. The qualitative information like pesticides use of past and present data, cropping pattern and Coffee processing were qualitatively analysed and expressed.

The socio demographic and farm characteristics were used for descriptive analysis of the study area and study population. Variables like family size, sex, age description, education level, size of the land holding, ethnicity were included and described by using simple descriptive statistics like percentage, mean, frequency, and charts, tables and diagrams. Climatic data obtained from both the primary and secondary source of data were analyzed by using Microsoft Excel. For marketing traders were interviewed and marketing system and marketing channel were analyzed followed by those coffee exporters. Past data were analyzed by using the Microsoft Excel. Marketing and export rate analysis was done.

Personal interviewing was done with coffee growers and processors for finding why they are motivated to cultivate coffee and why they adopt wet processing method. Most of the growers were indicating that it is a cash crop and they can easily earn money by selling the fresh cheery and other reasons behind it was there is no any problem in marketing, coffee gives three times more income than other cereals. So, they cultivate coffee for their livelihood improvement. And regarding processing method, most of them were indicating that it gives good quality coffee and other reasons behind it was easy method, high market rate and less time consuming in processing.

5. Results and Discussion

Lalitpur District a part of Bagmati Zone, is one of the seventy-five districts of Nepal, a landlocked country of south Asia. The district, with Patan as its district headquarters, covers an area of 385 km square and has a population (2001) of 3,37,785. It is one of the three districts in the Kathmandu and Bhaktapur. Its population was 4,66,784 in the initial 2011 census tabulation.

The total population of the 70-sample household was 307. Out of 307, the family size of sample household of Chandanpur and Thuladurlung was 54(23-Female and 31-Male) and 253 (120-female and 133-male) respectively. The average family size of respondent household was highest in Chandanpur VDC (5.4) and lowest in Thuladurlung VDC (4.21). In total average family size was 4.8, which was higher than the national average (4.70) (CBS, 2011).

Table 2. Family size and the gender of the respondents in the Study Area, 2019

Place	Family size	Average family size	Male	Female
Chandanpur	54	5.4	31	23
Thuladurlung	253	4.21	133	120
Total	307	4.8	164	143

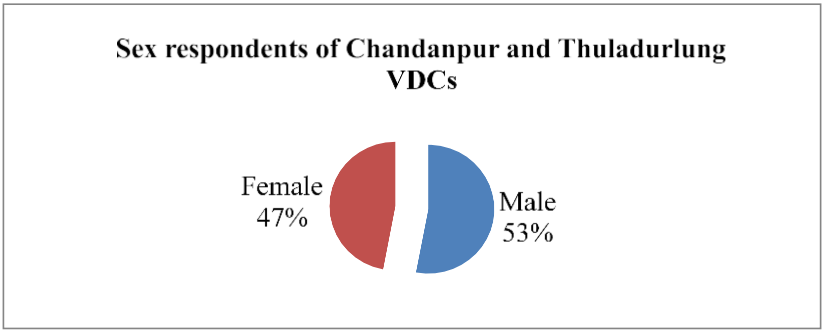

Figure 2. Sex respondents of Chandanpur and Thuladurlung VDCs.

Out of the total respondents of the sampled household from both the places, it was found that 53 percentages of the respondents were male, and 47 percentages of the respondents were female. The detail of the family size, average family size, gender is given in Table 1 and Figure 2.

The respondents were categorised into 3 groups based on their caste, namely Brahmins and chhetries (242), Janajaati (57) and Dalits (8). The Janajaati groups includes Gurung, Sherpa, Magar, Tamang, Newar. Dalits includes Damai, Kami and sarki. Brahmins and chhetries were highest in both VDC (Chandanpur and Thuladurlung).

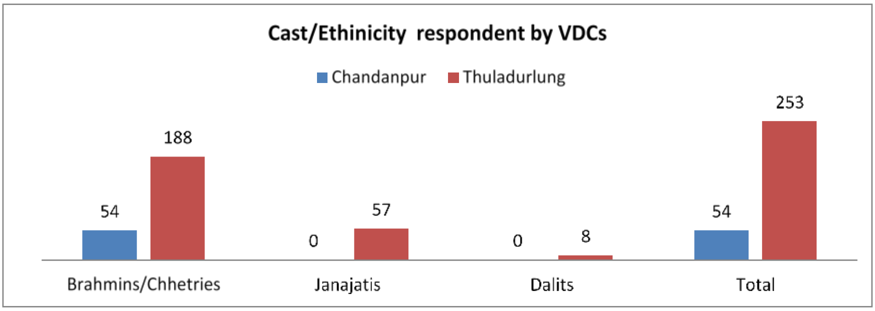

Figure 3. Ethnic Composition of the respondents of Chandanpur and Thuladurlung VDCs.

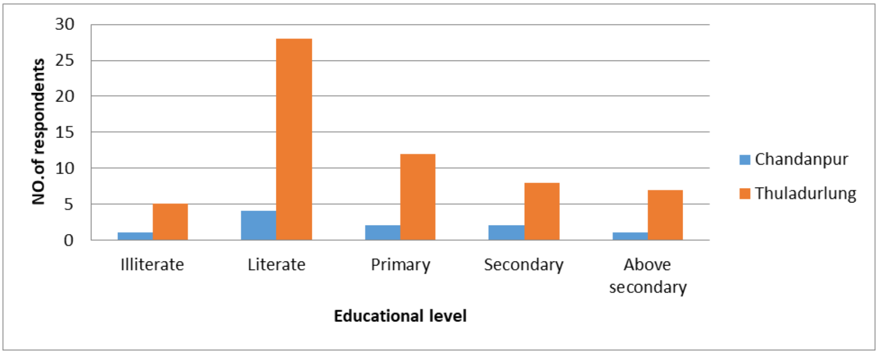

Figure 4. Educational status of family members of the respondents of Chandanpur and Thuladurlung VDC.

The educational level of the population of the surveyed households were categorised into five groups illiterate, literate, primary, secondary and above secondary. The term illiterate refers to those who could not read and write. Literate means those who can only read and write but did not have their formal education. Primary means that who read up to class 5, secondary means class 5- SLC and above secondary means above SLC.

From the study of the research, it was found that the major occupation of most of the respondents was agriculture. The occupations were categorized into 5 different criteria. Out of 70 respondent it was found that 59, 4, 3 and 4 were engaged in Agriculture, Service, Abroad and Business respectively. The further information related to the occupational status is presented in the Table 3 below.

Table 3. Main occupation of the respondent

Main occupation	**No. of people in Chandanpur**	**No. of peoples in Thuladurlung**
Agriculture	9	50
Service	0	4
Abroad	0	3
Business	1	3
Total	10	60

In both VDCs there are two types of land khet and Bari. Farmers planted coffee almost on the all field but some where they planted others crops like maize, mustard, wheat, Buckwheat etc. Due to the problem of irrigation and reasonable price of cheery, all farmers grow coffee in their entire field. Table 4 shows the cropping patterns of khet and Bari.

Table 4.Cropping pattern by the coffee growers

VDCs	**Khet (Irrigated land)**	**Bari (Non- Irrigated Land)**
Chandanpur	Rice-Wheat-Maize Rice-Wheat-Vegetables Rice-Vegetables-fallow	Maize-mustard-fallow Vegetable-wheat -fallow Coffee
Thuladurlung	Rice-wheat-maize Rice-potato-maize Rice-fallow-vegetables	Maize-millet- ginger Maize-mustard-fallow Coffee-Banana

In Table 5, land holding on Chandanpur and Thuladurlung was shown. The average land holding on Thuladurlung was highest than Chandanpur. In both VDCs of respondents the area of Bari (Non- Irrigated land) was highest than Khet (Irrigated Land). From the survey it was concluded that maximum area of Bari of single respondent was 35 ropanies and lowest was 3 ropanies. And while considering about khet, many of them were with very less amount, some of them were with no khet. Land is the most important asset for the rural community, which not only determines the types of crops grown but also shows the socio-economic status of the household in the society. The size of the respondents was categorized into 7 groups. It is evident from the Table 7, 28.57 percent of the respondents had below 10 ropani of land.

Table 5. Size of land holding of the respondents

Size of land (Non-Irrigated Land)	Percent
No land	1.42
below 10 ropani	28.57
10.1 to 15	24.29
15.1 to 20	17.14
20.1 to 25	14.29
25.1 to 30	7.14
above 50	7.14

Irrigation is one of the most important factors for increasing cropping intensity. The irrigation facility determines the production of vegetable and therefore household‘s income. The irrigation facility helps to improve the soil structure and fertility. In both VDCs there was scarcity of water, people faced many problems of irrigation. They wait monsoon for proper irrigation. And for daily use they had tap, which was distributed to various houses through pipes lines, this was also not a permanent source of irrigation.

The Food and Agriculture Organization (FAO) defines pesticides ―as any substance or mixture of substance intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substance which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies‖. This study revealed that both VDCs are totally organic area. So, all of the peoples were aware regarding pesticides. They did not use any chemical pesticides, that‘s why this area was certified as organic area. Instead of pesticides they use herbal extracts such as Tite Pati, Asuro, Khirro, Sisno, Neem, Cow and buffalo urine etc.

Table 6. Motivation factors for Coffee Cultivation

Motivating factors	Chandanpur	Thuladurlung
High price value and easy market	I	I
Longer shelf life	III	IV
Resistance to disease and pest	IV	III
Can be cultivated in marginalized land	II	II

Reasons for starting coffee cultivation were found by preference ranking. Table 6 showed that the respondents of Chandanpur and Thuladurlung VDCs expressed that they took this enterprise because it has high price value and easy to market followed by can be cultivated in marginal land. In total resistant to disease and pest was the third and fourth reason.

Table 7. Total production of Lalitpur districts over years

S. N	Year	Dry parchment (Kg)	Dry cherry (Kg)
1	2016	29845	600
2	2017	28131	575
3	2018	25775	675

(Source: CCU, 2019)

Most of them followed the wet processing method because for good quality of coffee.

Table 8. Motivating factors for wet processing method

Motivating factors	**Chandanpur**	**Thuladurlung**
Easy method than dry	II	III
Good quality of coffee	I	I
High market rate	IV	II
Less time consuming in pulping	III	IV

As we know that without problems there is no any work, we should tackle with any kinds of problems. In coffee sector there are lots if problem in production, pulping, processing, marketing and export. According to pulper operator's perceptions on pulping problems, problems ranking was done. Table 9 shows that the most important problem faced by pulper operators was size of pulping machine followed by proper equipment‘s for drying, lack of proper weighing equipment, no electric machine, lack of transportation and lack of skilled labour.

Table 9. Problems in pulping

S.N.	**Problems**	**Rank**
1.	Size of pulping machine	I
2.	Lack of proper equipment for drying of parchments	II
3.	Lack of proper weighing balance	III
4.	Lack of electric machine	IV
5.	Lack of proper transport facilities	V
6.	Lack of skilled labour	VI

Marketing is the major work for producers and others (middleman) to get the profits from their business. There are various problems in marketing of Nepali products. But according to the coffee farmers of Lalitpur districts, they had not any problems regarding coffee marketing because they sold their products to cooperatives and all further works had carried out by District Coffee Cooperative Union (DCCU).

The major problems faced by DCCU, Lalitpur were listed below:

- There is absent of organically certified body in Nepal.
- Documentation is very difficult for export coffee.
- The print on packaging materials is expected to be organically printed.
- There is unfair competition with private trade.

Some major factors which plays vital role in reduced production were listed below:

- White stem borer
- Climate misfortunes
- Migration
- Lack of manpower
- Lack of irrigation.

Marketing of coffee involves all the activities in moving different forms of coffee from producers to ultimate consumers. The main stakeholders of coffee marketing in Lalitpur district are producers, pulper operators, District Coffee Producers Association (DCPA), processors and traders. In both VDCs there were similar types of marketing channel. The producers were selling fresh cherries to the pulping centres. The fresh cherries were depulped, fermented, washed and dried to form dry parchment (moisture 12%) in the pulping centres. The DCCU of related districts collected the dry parchment and sold it to the processors. After processing, roasted beans and ground coffee were sold in the domestic markets and green bean was exported in the international market. The marketing channel was shown in following diagram (Figure 5):

The type of coffee exported and imported by Nepal is categorized in to six categories. They are:

- Neither roasted nor decaffeinated (green bean)
- Coffee
- Not roasted, decaffeinated

- Roasted and decaffeinated
- Roasted, not decaffeinated
- Instant coffee

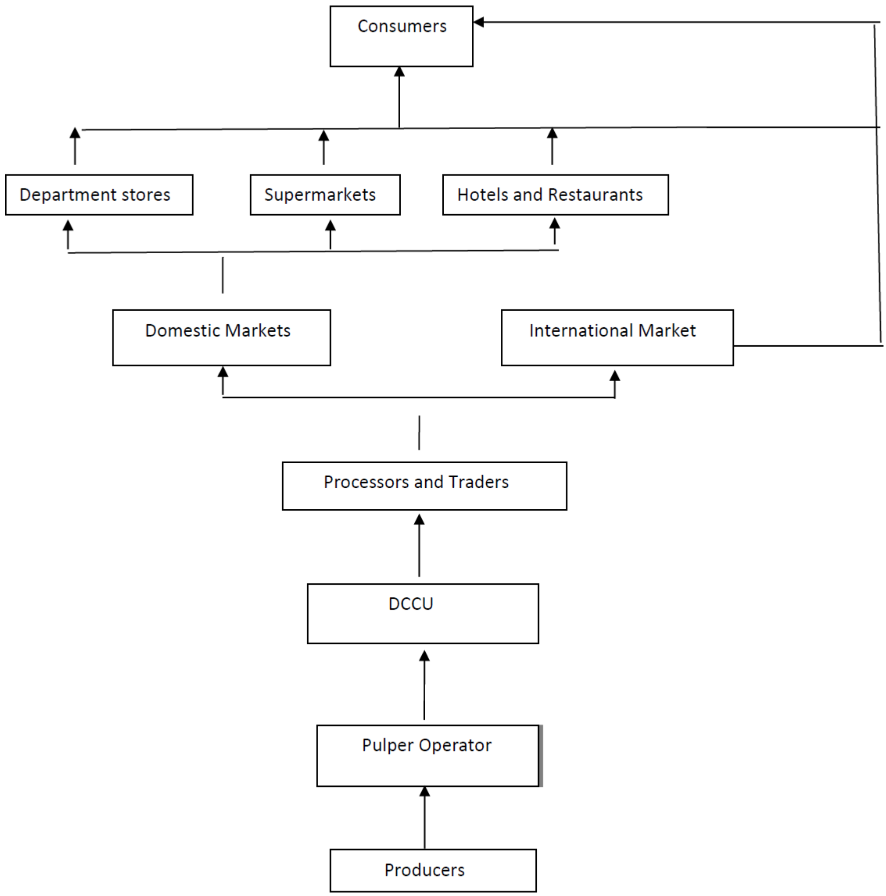

Figure 5. Marketing channel of coffee in Chandanpur and Thuladurlung VDCs.

Apart from instant coffee, Nepal imports as well as exports all other categories of coffee. However, if we look at the data over last 8 years (2009-2017), quantity of green bean import is increasing whereas quantity of green bean export is in decreasing trend. It is observed that in 2016 Nepal imported 9.42 MT coffee and 41.8 MT instant coffee. Although there has been an increase in domestic production of green beans, import of green beans is increasing rapidly. This could be since while prices of green bean for Nepali coffee stood at Rs. 1235.34 per Kg on exports, prices were significantly low at Rs. 289.52 for imported green beans (2017).

Table 10. Export of Organic Coffee to different countries with amount

S. N	Year	Amount (Tons)	Country	Domestic consumption (KG)
1	2016	16	Germany	3700
2	2017	12+3	Germany+ Korea	1300
3	2018	12	Germany	1385

(Source: CCU, 2019)

Almost 95.36 percent of green beans imported in Nepal in last 8 years (2009-2017) were from India (MOICS, 2018). Nepali green beans are costly because of small-scale farming, organic practice, lower productions, and lack of agricultural infrastructures, labour costs and other factors. Mainly Germany and Korea were the countries where CCU, Lalitpur exported coffee from 2010. Other countries like Japan and United states also import coffee from Nepal but it was like a gift to taste them.

CONCLUSION

The study was conducted in two VDCs during 0ct- Dec 2019. The general objective of this study was to know about processing, marketing and export potentiality of organic coffee in Lalitpur districts. The total sample size was 70 from two VDCs of Lalitpur i.e., Chandanpur and Thuladurlung. The study found that most of the household respondents in all location were between 31-40 years age group. Most of the people were highest caste that was Brahmins/chhetries. But all of them spoke Nepali language. Farmers of Chandanpur and Thuladurlung VDCs were started coffee cultivation due to high value and easy market. It can be cultivated in marginal land was another factor that motivate them to go for coffee cultivation. Few of them were interested in coffee, to become a successful and famous grower. The overall land holding of majority farmers was with below 10 ropanies of Bari (Non- Irrigated land). And very few of them were with Khet (Irrigated land). Ipil-Ipil, Banana trees were selected to grow with coffee for providing shade for it, which may reduce the attack of white stem borer. Organic manure, organic solutions were used for coffee production. For organic solution local resources like Tite Pati, Asuro, Sisno, Khirro etc. were used.

Hence, this study aims to highlight the two processing methods of coffee in terms cost and recommends one which is more feasible both economically and technologically. Coffee is processed either by wet method to produce parchment coffee or by dry method to obtain cherry coffee. In Nepal, dry processing was predominantly practiced in the past (10 years ago). But nowadays, this method has gradually been replaced by wet processing method. Wet method has also becoming more popular and been introduced for export of green beans (Deoju and Manandhar, 2004). The major problem currently facing Nepali coffee production is the great variation in the quality of dried coffee beans. The problem comes from the fact that the coffee beans are collected from the many small-scale farmers and, in the absence of quality standards for coffee, this has led to variation in quality. There are several reoccurring processing errors in both dry and wet processing systems. So nowadays, in Lalitpur district all the processing work was totally taken by cooperatives to provide the same quality and international standard coffee to the consumers. Coffee producers, pulper operators, DCPAs, DCCU, processors and exporters were the major actors of coffee marketing in lalitpur district.

The producers sold fresh cherries to pulping centres. After pulping dry parchment (with 12% moisture) was collected by DCPAs. Then dry parchment was sent to processing centres. After processing roasted bean and ground coffee were sold in the domestic market while green bean was sold in the international market. The total price of fresh cherry was highest in Lalitpur district than in all over the Nepal. The actual price of fresh cherry was Rs 96/kg. The actual price of green bean was 750-800/kg and roasted bean was 1000-1100/kg. Coffee in international market was $7-

8/kg. Germany and Korea were the major importer of organic coffee from Lalitpur district. The major problems in pulping of coffee were size of the pulping machine, lack of proper equipment‘s for drying, lack of electric machine, followed by lack of transportation facilities. The major problems in processing centres were the lack of expert processor, followed by heavy load shedding in spring season. The major problems in marketing were its very hard to get the consumer in Nepali market. Only Hotels & Cafe were major importer of coffee in Nepal, there was no more home consumption.

Lalitpur district is very famous for organic coffee and the coffee production in Lalitpur is totally organic (Chaudhary, 2008). Chandanpur and Thuladurlung VDCs are production potential area of coffee due to climatic and edaphic suitability as well as market access. Coffee from Lalitpur district is totally different in quality so that the price for coffee is very high in international market. Coffee produced in all study area was shade grown and organic. While we compare the two VDCs, Thuladurlung VDC had produced more coffee per year than Chandanpur VDC. If there was more production, they got more benefit. Though coffee was produced in upland with less care, it had contributed some portion of household income. Farmers should follow better management practices to ensure higher return from coffee cultivation. In both VDCs the main source of farmers‘ income was from coffee. So, they (farmers) told that, "Coffee was our life."

The wet processing method was followed by coffee growers due to its quality and time. Though in small quantity of coffee was processed by dry method for home consumption. Total cost of processing in wet methods is very high due to expensive cost of different kinds of machines. The export of Nepalese coffee indicated that there was impressive growth in the export of Nepalese coffee. Due to high value in market, we can take foreign currencies through its export in international market. There were several constraints in processing, pulping, marketing and export of coffee. If these constraints are not overcome, commercialization of coffee sector could be affected in near future.

The following are possible suggestions for improvement:

- Intercropping should be done to be away from WSB by planting trees for shade.
- Proper irrigation facilities should be provided, which may reduce the attack of WSB.
- Training provided for quality pulping and processing.
- Proper equipment should be used in pulping and processing centres.
- Coffee promotional activities and advertisement should be planned carefully and done so that common people get idea about the brand in market and sales may increase thus insuring the benefits even more for the enterprise.

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Chapter 9

EFFECT OF INPUTS ON PRODUCTION AND VARIABILITY OF INTRODUCED CHICKEN STRAINS AT FARM LEVEL: A CASE OF SMALL CHICKEN KEEPERS IN SELECTED AREAS OF TANZANIA

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ABSTRACT

This study investigated the effect of inputs on the production and variability of introduced chicken strains. The study applied the developmental research design, which involves provision of 25 six-week old chicks to 20 farmers in 12 on-farm testing sites. The study was carried out in Dodoma, Morogoro and Njombe regions to assess the effects of agro-ecological differences on production and production variability. Data used were gathered by using a structured questionnaire, direct measurement, farmers‘ and extension officers‘ records. A semi log multivariate regression model according to the Just and Pope Framework was applied in this study. Results from the mean function revealed that maize bran, rice bran, sunflower cake, minerals, frequency of medication, vegetables and house condition had significant effects on production in the production of both live chickens and eggs. Also, there is production variability attributable to inputs use and hence exposing farmers to risk. However, there was an inconsistent effect of input on production performance variability since some inputs were both variability increasing and reducing; that is, reducing in production of birds but, increasing in egg production for the same strain and vice versa. Therefore, it is likely that the full potential of the introduced strains requires standardized inputs for reduced variability. It is important to design strategies that will lead to performance stability. Such strategies should include the design of trials at farm level to evaluate the input mix for chicken with minimum effects on output variability.

INTRODUCTION

In agricultural production, risk in terms of variability is an inherent part of the production process and plays an important role in both input use decisions and production of output (Asche and Tveteras, 1999; Kumbhakar, 2002; Nalley and Barkley, 2007). Agricultural production face risk surrounding the production and marketing processes which are related to unpredictable weather variation (drought, frost, flood, and wind storm), input quality, pest and disease attacks, price fluctuations, new technology failure, and changes in government policies. In addition, agricultural risk can be categorized into two main types namely, production risk which is characterized by high variability of production outcomes and price risk (Wanda, 2009; Bizimana and Richardson, 2017). In this regard, variability is among key sources of risk in production process in Tanzania (Moshi et al., 2017). Hence, the performance of the introduced chicken strains is likely to suffer from the same problem, hence exposing farmers to risk. Additionally, agricultural performance variability also creates significant challenge in the design and implementation of technology (De Janvry, 1972; Chavas and Shi, 2015).

Recently, Tanzania established the Tanzania Livestock Master Plan (TLMP) 2017/2018-2021/2022 with the overall target of raising annual chicken meat production almost eightfold; from about 60 800 to 465 600 tonnes and egg production from about 3.0 to 4.2 billion by year 2021/22(URT, 2017). The main pathways include: Improved Traditional Family Chicken (ITFC), Tropical Improved Chicken (TIC) and expanded Specialized/Commercial Chicken (SCC) with layers and broilers sub-systems. In addition, the Master Plan considers interventions in the areas of animal health, genetics, marketing and processing being the cornerstone to increasing the contribution of the poultry sub-sector to the Gross National Product (GNP) by 182 percent in 2017 to nearly USD 324 million in 2022. In supporting the established initiative, the ACGG project introduced two chicken strains for on-farm testing to evaluate their economic potential at farm level in different agro ecological zones. The introduced strains are Kuroiler and Sasso, which have performed better in terms of growth rate and egg production than local strains in other countries including Ethiopia and. The Kuroiler strain, which is developed and marketed by Kegg farms, weighs about 1.8–1.9kg (hen) and 2.3–2.4 kg (cock) at 20 week age (cock) and a hen can produce about 150 eggs per year (World Society for the Protection of Animals, 2011). The Sasso strain, which originally was developed and marketed by Hendrix Genetics weighs 1.5-1.7 kg (hen) and 2.2-2.5kg (cock) at 20 week age and can produce about 150 eggs per hen per year (Rodelio and Silvino, 2013). However, the performance of the introduced strains may be unstable due to variability that emanates from input use, thus exposing farmers to production risk. As noted by scholars (Simon, 1959; Hurd, 1994; Fufa and Hassan, 2003; Khayyat and Heshmati, 2014), variability in agricultural production is one of the major sources of risk. Moreover, some endorsed innovations may be so risky to the extent that added risk offsets the gain in income leading to worse the livelihood outcomes among farmers (Richardson et al., 2008). Facing variability in production, farmers will try to mitigate the risks through input choices (Tveteras et al., 2011), since such input choices play a great role in determining variability in performance (Antle, 1983).

The analysis intended to reveal the effect of controllable inputs on production and variability of the introduced chicken strains in selected areas in Tanzania. This is because ignoring effect of inputs on performance variability in assessing the economic potential of agricultural technologies can lead to wrong inferences and recommendations (Koundouri and Nauges, 2005). The analysis is useful to farmers through increased knowledge on the effect of input choices on performance variability for improves production stability. Furthermore, it follows that the outcome of this study is important when the re-designing and scaling up the introduced chicken strains. The study is guided by the hypothesis that, input factors do not significantly influence the production and variability of introduced chicken strains with respect to controllable inputs.

THEORETICAL FRAMEWORK

The study was based on the Just and Pope (1979) production function expressed as the summation of the mean and variance functions. It is widely recognized that agricultural products are stochastic and levels of inputs used influence variance of the output (De Janvry, 1972; Fufa and Hassan, 2003). To account for variability, the Just-Pope framework is used as a standard framework that can perform joint estimation of both the mean and variance functions (Just and Pope, 1979; Khayyat and Heshmati, 2014). The framework provides a method for estimating the effect of inputs on production and production variability. The production function is capable of evaluating; i) the effect of inputs on the mean level of output and ii) the effects of inputs on variability in yield (Just and Pope, 1979; Fufa and Hassan, 2003; IFPRI, 2006; Guttormsen and Roll, 2013).

The basic concept introduced by Just and Pope was to construct the production function as the sum of two components, one relating to the output level, and one relating to the variability of output to provide a convenient and flexible representation of the effects of inputs on means and variances (IFPRI, 2006). The model is also appropriate for analysing the risk effects of inputs on output distribution in cross sectional, time series and a combination of time series and cross sectional production data (Fufa and Hassan, 2003).

In analysing the effects of inputs on production variability, it is important to start investigating whether there is any significant output variability (Asche and Tveteras, 1999). To test the presence of production variability one can draw from the Just and Pope (1979) theoretical framework whereby variability is determined in terms of heteroskedasticity (Asche and Tveteras, 1999; Fufa and Hassan, 2003; Guttormsen and Roll, 2013). The current study applied the Maximum Likelihood (ML) Breusch-Pagan test to assess the existence of variability in both chicken and eggs production for Kuroiler and Sasso strains among farmers participating in the ACGG study.

METHODOLOGY

Research Design

A developmental research design was applied for establishing on farm testing and then to analyse the technical, allocative and economic efficiency of keeping introduced chicken stains. The design assumes a traditional model of skill in which the unit of analysis is taken to be the individual (AFNETA, 1992; Richey, 1994). According to Barrow and Röling (1989), the development and transfer of appropriate technologies should be a function of the farmers‘ socio-economic and management practices at the field level. The study design is in accordance to Thornton et al. (2017) that testing and dissemination of technology are at the core of development-oriented agricultural research. Selection of location for establishing on-farm testing was based on Tanzania‘s Agro Ecological Zones (AEZs) to present the general farming systems in Tanzania.

The AEZs range from higher rainfall areas on the coast and highlands in the north, far west, south and southwest, to arid and semi-arid areas in the interior of the country (URT, 2015). Accordingly, cropping patterns, climatic differences reflect biophysical characteristics for growth and stability of chickens. On-farm testing for introduced chicken strains across different AEZs was meant facilitating farmers and other actors in poultry value chain evaluate the potential of the strains at farm level.

Three assumptions underlie the design. First, selected farmers had have experience in keeping chickens so that the design does not add any fixed cost such as chicken house, feeding facilities and drinkers. In other words, on-farm testing used already available facilities. Secondly, time and labour spent in keeping introduced chickens and available local chickens were presumed similar and hence zero opportunity cost. Third, small-scale local farmers in Tanzania operate relatively similar in keeping chickens. Thus, any of AEZs fit for on-farm testing. According to ACGG (2015), households recruited to receive the chickens met the following criteria:

i. Chicken keeping households that had kept local chickens for a continuous period of at least two years prior to the baseline survey;
ii. Keeping at least 15 adult chickens but no more than 50;
iii. Willingness to accept 25 birds of randomly selected strain;
iv. Commitment to provide some supplemental feeds and
v. Willingness to participate in the project for a minimum of 72 weeks.

Setting the basic criteria for selecting farmers to participate in on-farm testing, the baseline survey was conducted. Baseline survey was conducted to identify legible population in central semi-arid, eastern sub-humid, southern highlands, lake zone and southern humid to represent different agro-ecologies in the country. Specifically, first step involved selection three regions and the selected ones were Morogoro, Dodoma and Njombe regions to present AEZs.

In each region, one district was selected purposely taking into account the availability of villages which had about 20 and above households that have least 15 adult chickens but no more than 50. Secondly, out of the qualified villages, four of them from each district were selected randomly from the long list of villages. Subsequent stage involved randomly selection of households from the long list of households that met the set criteria. After random selection of qualified farmers, it followed provision of six-week pre-brooded chicks to these households whereby each farmer received 25 chicks. At this stage, each farmer received either Kuroiler or Sasso. Chicks received the recommended vaccination against Mareks, Newcastle Disease, Infectious Bronchitis and fowl pox before being distributed to farmers. Farmers continued keeping these strains based on their practices with some additional supplementation using locally available feeds and providing treatment and shelter under a semi-scavenging system (ACGG, 2016).

Description of Study Area

This study was conducted in three regions where farmers were participating in on farm testing of introduced chicken strains in Tanzania that is Dodoma (central), Morogoro (eastern zone) and Njombe (Southern highland) whereby in each region one district was selected. Dodoma is a semi-arid region, which lies on Latitude 6°48`S and Longitude 39°17`E and an altitude of 1125M above sea level. Annual rainfall is about 500 to 700mm and annual average temperature of about 22.6°C. Between the driest and wettest months, the difference in precipitation is 129 mm and the average temperatures vary by 5.1°C (Climatic Data Org, 2016). The common crops grown include drought tolerant crops like family of sorghum, groundnuts, sunflower, and little maize. In Dodoma region, on farm test sites were located in four villages namely Mayamaya, Bahisokoni, Mudemu and Mpamatwa in Bahi district.

Morogoro region is located between latitude 5°58` 10°0`S and longitude 35°30`E and an altitude of about 525M above sea level. The annual rainfall ranges from 600 to 1200 mm with average annual temperature of about 25°C. The zone is characterized by an average annual rainfall of 1160 mm with average temperature of 16°C. There are typically two distinct long and short rainy seasons of March–May and November–January/February, respectively, but rain sometimes falls uninterrupted from October to March. The Udzungwa and extensive river system have deposited rich alluvial sediments in the valley (Climatic Data Org, 2016). Rice and maize production, horticultural produces and bananas dominate the production system in Ifakara district council. Villages in which farmers participated in ACGG project include Kibaoni, Kikwelila, Lipangalala and Lumemo.

Njombe region is located between Latitude 8°51`0`S and Longitude 34°50′0`E and an altitude of about 2000M above sea level. Its climate is classified as warm and temperate. In winter, there is much less rainfall than in summer. The average annual rainfall is 1160 mm with average temperature of 18.6°C (Climatic Data Org, 2016). Maize, sunflower, pulses and horticultural production dominate farming system of the site. Wanging`ombe district was purposively selected among district forming Njombe region hereby farmers from Ujindele, Uhambule, Msimbazi and Ufwala villages were involved to provide data used in this study.

Data Collection

Data used in analyses for this study were collected from local chicken farmers participating in the ACGG project at the chosen sites. A total of 202 participant households from 12 villages were involved in the study. Out of the total famers, 111 farmers were Sasso strain keepers whereas 91 farmers were Kuroiler chicken keeping households. Data were collected through weekly recordings, survey and observation. Direct observation was applied to access the quality of the chicken house and accessories. The survey covered broad issues related to the chicken enterprise: viz. the number of chickens, number of eggs sold, ready for selling, number of chicks/chicken sold and ready for sale, amounts and prices of feeders, brooder, chicks, eggs, feeds, medication and labour), number of chicken/chicks which died and the cost of constructing the chicken house.

The following elements of improved poultry housing were used to assess housing structure of participating households: (i) ventilation status and orientation; (ii) spacing requirement of chicken; (iii) floor status; (vi) roof status (spillage); (v) presence of feeder and drinkers; (vi) presence of litter/bedding material; (vii) general hygiene status. The housing structure in this context was not necessarily built using expensive materials to be ranked high but rather to meets the basic requirements regardless of construction materials used (Pius and Mbaga, 2018). Thus, from the developed scale, poultry houses were ranked with three levels; a house scored between 1 and 3 as rated poor, between 4 and 5 and between 6 and 7 was rated normal/moderate and good house respectively.

Data Analysis

A Multivariate multiple regression model in the Just and Pope framework was applied to determine the effect of inputs on production and variability using Stata version 13 software. Multivariate multiple regression model is an extension of the standard multiple linear regression model. The model is used when a problem consists of two or more predictor variables and two or more response variables (Cassandra, 2013 and Dattalo, 2013). The multivariate regression model for each response on the ith observation is presented in equation 5.1, where i=1, 2,… n, represent the number of farmers or respondents.

$$\left\{ \begin{array}{l} Y_{i1} = \beta_{01} + \beta_{11}X_{i1} + \beta_{21}X_{i2} + \ldots + \beta_{r1}X_{ir}) + u_{i1} \\ Y_{i2} = \beta_{02} + \beta_{12}X_{i1} + \beta_{22}X_{i2} + \ldots + \beta_{r2}X_{ir}) + u_{i2} \end{array} \right\} \quad (1)$$

Where Y_1 is the sum of chickens sold, consumed, available, Y_2 is total number of eggs produced, X_i is the inputs used in production process such as maize bran, rice bran, cakes, vegetable and fishmeal and u_{i1} and u_{i2} are random errors for chicken and eggs respectively.

Multivariate multiple regression in the Just and Pope stochastic production function can be represent as follows:

$$y = g(x, v) \tag{2}$$

where y is output, x is a vector of controllable inputs such as feeds, and medicines, v is a vector of non-controllable inputs such as weather conditions, and g(x, v) denotes the largest feasible output given x and v. The Just and Pope (1979) production framework can be expressed as follows:

$$g(x, v) = f(X, \beta) + [h(x, \theta)]^{2} e(v) \tag{3}$$

Where, f(.) is mean production function, h(.) is variance (or risk) function, x = vectors of inputs, β and θ are parameters for the mean function and the risk function respectively; and e is the exogenous stochastic disturbance or production shock (error term). This specification allows differentiating the impact of inputs on output and risk, and has sufficient flexibility to accommodate both positive and negative marginal risks with respect to inputs. Further, the model allows first test for the presence of production risk and if production variability is found to be present, the mean and risk (variance) functions are estimated separately (Asche and Tveteras, 1999). Specifically, multivariate multiple regression can be specified as in equation 4:

$$\left\{ \begin{array}{l} g_1(x, v) = f_1(X, \beta) + h_1(x, \theta)e(v) \\ g_2(x, v) = f_2(X, \beta) + h_2(x, \theta)e(v) \end{array} \right\} \tag{4}$$

Whereby 1 is Just and Pope Function for chicken and 2 is Just and Pope egg production function.

It follows that, the decision as to which type of production function to be applied is made at two levels: first, at the review of production functions and second at the empirical level. At the review level, the Just and Pope

Framework requires that, heteroskedasticity (variability indicator) is non-linear, so its estimation must use a nonlinear function (Just and Pope, 1979). The later was done using a likelihood test of different models such as the Quadratic function, Square root functions, the Translog and both Log and Semi log functions. In likelihood procedure, the semi log production function was found to be superior. The Semi log production functions for both mean and variance production functions are presented as follows:

$$\ln Y_{i1} = \beta_{01} + \beta_{11}X_{i1} + \beta_{12}X_{i2} + \beta_{13}X_{i3} + \beta_{14}X_{i4} + \beta_{15}X_{i5} + \beta_{16}X_{i6} + \beta_{17}X_{i7} + \beta_{18}X_{i8} + \beta_{19}X_{i9} + \beta_{110}X_{i10} + \beta_{111}X_{i11} + e_{i1}$$

$$\ln Y_{i2} = \beta_{02} + \beta_{21}X_{i2} + \beta_{22}X_{i2} + \beta_{23}X_{i3} + \beta_{24}X_{i4} + \beta_{25}X_{i5} + \{\beta_{26}X_{i6} + \beta_{27}X_{i7} + \beta_{28}X_{i8} + \beta_{29}X_{i9} + \beta_{210}X_{i10} + \beta_{211}X_{i21} + e_{i2}\} \tag{5}$$

and the risk function is given as follows:

$$\ln \hat{u}_{i1}^2 = \theta_{01} + \theta_{11}X_{i1} + \theta_{12}X_{i2} + \theta_{13}X_{i3} + \theta_{14}X_{i4} + \theta_{15}X_{i5} + \theta_{16}X_{i6} + \theta_{17}X_{i7} + \beta_{18}X_{i8} + \beta_{19}X_{i9} + \beta_{110}X_{i10} + \beta_{111}X_{i11} + v_{i1}$$

$$\ln \hat{u}_{i2}^2 = \theta_{02} + \theta_{21}X_{i1} + \theta_{22}X_{i2} + \theta_{23}X_{i3} + \theta_{24}X_{i4} + \theta_{25}X_{i5} + \{\theta_{26}X_{i6} + \theta_{27}X_{i7} + \beta_{28}X_{i8} + \beta_{29}X_{i9} + \beta_{210}X_{i10} + \beta_{211}X_{i11} + v_{i2}\}$$

Where Y_1=number of chickens (available, sold and consumed) for the ith farmer, Y_2=number of eggs, β_0 and γ_0=Constants, β and θ =unknown estimates for production and variability respectively, e_(i1) ande_(i2)=random errors, X1=amount of maize bran (kg)/annum, X2= amount of rice bran(kg)/annum,X3=amount of sunflower cake(kg)/annum, X4=amount of fishmeal (kg)/annum, X5=Minerals (kg), X6=Number of bundles of vegetables, X7=Frequency of providing medication, X9=House condition (defined as poor, normal, good), X10=Labour (number of hours spent, X11=Location, u ̂_i2^2 and u ̂_i2^2are variance (risk) for chicken and eggs respectively. Yield (Yi) and the yield variance ($\hat{U}^2$) are estimated using equation 6 and 7 respectively. The decision as to which type of production function to apply was made at two levels: at review of production functions and at the empirical level. At the review level the Just and Pope Framework recommends that heteroskedasticity (variability indicator) is non-linear, so its estimation must use a nonlinear regression (Just and Pope, 1979). The later was done by a likelihood test of different models like Quadratic function, Square root functions, Translog and both Log and Semi log functions. The dependent logged semi log function was found to be superior to the rest. The Semi log production functions for both mean and variance production functions are presented as follows:

$$\left\{\begin{array}{l} \ln Y_{i1} = \beta_{01} + (\sum X_{1-13})\beta'_1 + u_1 \\ \ln Y_{i2} = \beta_{02} + (\sum X_{1-13})\beta'_2 + u_2 \end{array}\right\} \quad (6)$$

and the yield variance function is given as follows:

$$\left\{\begin{array}{l} \ln u^2_{i1} = \gamma_{01} + (\sum X_{1-13})\gamma'_1 + v_1 \\ \ln u^2_{i2} = \gamma_{02} + (\sum X_{1-13})\gamma'_2 + v_2 \end{array}\right\} \quad (7)$$

where Y_i = the number of chickens/eggs sold and available for sale for i farmer, β_0 and γ_0 = Constants, β and =Unknown estimates, e_i = random errors, X_1 = Maize bran (kg), X_2= Rice bran (kg), X_3=Sunflower cake(kg), X_4 = Fishmeal (kg), X_5 = Minerals (kg), X_6 = Number of bundles of vegetables, X_7 = Frequency of vaccinations, X_8 = Frequency of treatment, X_9 = House condition, X_{10} = Labour, X_{11} = Ifakara, X_{12} = Wangingòmbe, X_{13}= Bahi, and u^2_{ij}= variance (a measure of variability).

RESULTS AND DISCUSSIONS

Growth of Chickens across Agro-Ecological Zones

The average weight gains of the strains (Table 1) indicates that, an average weight of Sasso cockerels in 22 weeks was about 2216 ± 41, 2102 ± 70 and 2090 ± 14g in Wanging‘ombe, Ifakara and Bahi respectively. Similarly, the body weight of Kuroiler strains recorded were 2197 ± 51, 2070 ± 53 and 2121 ± 50 in Wanging‘ombe, Ifakara and Bahi respectively. Table 1 details the weight gain of introduced chicken strains across the agro ecological zones and sex.

Table 1. Growth of introduced chicken males across agro-ecological zones (g) (Mean ± SD)

Age/Zone	Wangingòmbe	Ifakara	Bahi
Weight (Kg)	Male	Male	Male
Sasso strain			
Week 6	1137 ± 11	1102 ± 39	1283 ± 10
Week 10	1257 ± 18	1385 ± 74	1328 ± 12
Week 14	1763 ± 29	1401 ± 44	1762 ± 20
Week 18	1911 ± 27	1927 ± 41	1978 ± 147
Week 22	2166 ± 41	2102 ± 70	2090 ± 14
Kuroiler strain			
Week 6	1127 ± 43	939 ± 58	1028 ± 41
Week 10	1373 ± 35	1385 ± 74	1373 ± 35
Week 14	1710 ± 36	1680 ± 38	1710 ± 36
Week 18	1920 ± 34	1913 ± 26	2097 ± 51
Week 22	2197 ± 51	2070 ± 53	2121 ± 50

Egg Production

The results (Table 2) indicate that for Sasso strain, on average total eggs produced per birds during the production cycle ranged from 20 to 109 eggs with a mean of 48, 45 and 59 eggs in Bahi, Ifakara and Wanging‘ombe respectively. On the other hand, the egg production for Kuroiler strain indicates that eggs per hen ranged between 16 and 95 per production cycle. Like Sasso strain, Wanging‘ombe sites showed the highest production performance with average of 53 eggs per chicken while Ifakara sites were the least with an average of 41 eggs per annual. The egg production differences were found to be statistically different across the selected sites (P Value = 0.000).

Table 2. Egg Production across agro-ecological zones per hen per 12 months

Sites	**Egg production**		
	Minimum	Average	Maximum
Sasso strain			
Ifakara	21	45	78
Wangingombe	23	59	95
Bahi	20	48	109
P Value			0.000
Kuroiler strain			
Ifakara	16	41	78
Wangingòmbe	21	53	95
Bahi	18	49	86
P Value			0.000

Survival Rate

Table 3 illustrates the mortality of introduced chicken strains at farm level in the selected areas. The average cumulative mortality recorded at farmer level, after 6 weeks old until the age of 68 weeks was 27.0 and 27.1% on Sasso and Kuroiler respectively. The mortality of Sasso strain is somehow higher than the mortality recorded Ethiopia whereby mortality at farmer level condition after 45-day old till the age of production was 25% (Getiso et al., 2017). The highest mortality was observed at the age between 26 and 42 weeks. Kuroiler and Sasso strain showed the highest mortality rate of 5% and 3.5% between 26 and 42-week age. Farmers and extension officers reported the signs of egg peritonitis and related infections as the plausible causes of mortality between that age intervals. Egg yolk peritonitis is the inflammatory reaction of peritoneum caused by the presence of yolk material in the coelomic cavity (Srinivasan et al., 2013). Accordingly, (Srinivasan et al., 2013) report that egg peritonitis was responsible for 15.39% of the reproductive tract abnormalities in commercial layers between 21 and 80 week of age. Other recorded causes of mortality include diarrhoea, Cannibalism, Coryza, fowl cholera, typhoid, toxic, accident and respiratory infections. Generally, the total mortality was found to be 27 and 27.1% for Sasso and Kuroiler respectively.

Table 3. Mortality of introduced chicken strains for 66 weeks

Age (Week)	**10**	**14**	**18**	**22**	**26**	**30**	**34**	**38**
Kuroiler	0.002	0.013	0.017	0.022	0.016	0.023	0.035	0.049
Sasso	0.024	0.025	0.027	0.013	0.007	0.030	0.011	0.033
Age (Week)	42	46	50	54	58	62	66	P Value
Kuroiler	0.036	0.008	0.017	0.006	0.015	0.011	0.27	0.52
Sasso	0.011	0.019	0.019	0.014	0.016	0.022	0.271	

Mean Yield Function Results

The estimated results for the mean response function for chicken production (live bird and egg) in study sites are given in Table 4. The factors affecting yield were quantity of maize bran, quantity of rice bran, quantity of sunflower cake, minerals, frequency of medication, vegetables and house condition. The results show that, for maize bran, the coefficient is positive for chicken production as well as in egg production. The elasticity of mean production for Sasso chicken and Kuroiler with respect to maize bran was 0.0007 and 0.0073respectively ($p<0.05$). This implied that maize bran has a positive effect on increasing production in both chicken strains. In addition, 1% increase in the use of maize bran by significantly ($p<0.05$) increased egg production by 0.0016% and 0.0009% for Sasso and Kuroiler respectively. Accordingly, maize bran is the main feed supplement in rural chickens keeping and greatly impacts production since it is a key in determining the nutrient intake levels (Mbajiorgu et al., 2011).

Table 4 shows that, the elasticity of chicken production with respect to rice bran was positive (0.0009) and (0.0120) implying that a 1 percent increase in feeding rice bran supplement increase chicken production by 0.0009 and 0.0012% in Sasso strain and Kuroiler strain respectively.

However, there was no significant difference ($P<0.05$) between Sasso and Kuroiler for the effect of rice bran on production. The results are consistent with the result by Samli et al. (2006). In their experimental research, they revealed that rice bran was very important for chicken growth and egg production.

Sunflower cake supplement was found to influence chicken production ($P<0.005$) for Sasso strain. The results indicate that increase in provision of sunflower cake increased Sasso production by 0.0008%. However, in Kuroiler chicken and in both eggs production, the effect was not significant. Also minerals significantly influenced egg production in both introduced strains. As indicated in Table 4, 1% increases in sunflower provision significantly increased eggs production in Sasso strain by 0.01% ($P<0.005$) while in Kuroiler strain increased by 0.1089% ($P<0.1$).

The regression coefficients of medication in both chicken strains are positive implying that the increasing treating and vaccinating the introduced chicken strains contributed much on the rising production performance. The coefficients of medication for chicken production have positive sign, although not significant, which implies that there was likelihood of impacting on production. Further, the coefficients of medication on egg production had significant impact on egg production ($P<0.05$). As indicated in Table 4, 1% increases in frequent provision of medication increased egg production by 0.022% and 0.0315 in Sasso and Kuroiler respectively. The results are consistent with Verbeke et al. (2015). In their analysis, they concluded that the health of livestock is the critical determinant of the success of a livestock business. The addition of the cost of medication/vaccines makes the chickens in a healthy condition and be able to utilize feed consumed to support production optimally. Additionally, Thomsen (2005) indicated that farmers recognize vaccination as the most effective means of combating disease for improving egg production.

Fishmeal is a high quality animal feed used to provide a good balance of essential amino acids, energy, vitamins, minerals and trace elements for poultry (Frempong et al., 2019). On the contrary, fishmeal was found to have insignificant effects on both live chicken and egg production.

According to Cho and Kim (2011), researchers have demonstrated that including fish meal in chicken feeds result in better growth performance. However, limited availability, low rate use and timing are very crucial to realise its impact (Babu et al., 2005). Consistently, results in Table 5 indicate that very few farmers fed their chicken with fishmeal.

Table 4. Mean production function for chicken and eggs

Variable	Chicken Production		Egg production	
	Sasso	Kuroiler	Sasso	Kuroiler
Maize bran (kg)	0.0007***	0.0073***	0.0016**	0.0009**
Rice bran (kg)	0.0009**	0.0120**	0.0020**	0.0016*
Sunflower cake (kg)	0.0008**	0.0007*	0.0001	0.0001
Fishmeal	0.0020	0.0018	0.0030	0.0041
Minerals	0.0029	0.0029	0.0100**	0.1089*
Vegetables	0.0007	0.0008	0.0010*	0.00130
Frequency of medication	0.0057	0.0045	0.022***	0.0315***
Sites				
Ifakara	-0.0273	-0.0424	-0.574	-0.6341
Wanging'ombe	-0.0740	-0.0140	-0.159	-0.1875
House condition				
Good	0.099**	0.9332*	0.022**	0.6963*
Normal	0.0423	0.0413	0.045	0.1336
Labour	0.6120	-0.3216	0.1623	0.0916
Constant	1.2588***	1.6600***	2.411***	3.1638***
R^2	0.26	0.23	0.33	0.31

Significance levels are denoted by one asterisk (*) at the 10 percent level, two asterisks (**) at the 5 percent level, three asterisks (***) at the 1 percent level.

The coefficient for the chicken house condition (Table 4) is positive and statistically significant from zero in both Sasso and Kuroiler chicken production and in Sasso only in egg production. Chicken kept in a house rated good, performed better relative to poor house. Sasso strain kept in the good house performed better than the same strain kept in poor house with elasticity of 0.0990 while Kuroiler stain kept in good house performed better with elasticity of 0.0220 relative to the strain kept under poor condition house. The results are consistent with Oloyo and Ojerinde (2019) who asserted that, poultry housing condition is very crucial to protect the birds from the harsh environmental climatic conditions, which may have adverse effect on the chickens‘ performance and productivity. However, the results are inconsistent with that of Montero et al. (2011) who reported that there was no significant influence of house condition on chicken and egg differences.

Table 5. Summary statistics for feeds supplement for 12 months

Statistics	**Maize bran (kg)**	**Rice bran (kg)**	**sunflower cake (kg)**	**Fishmeal (kg)**	**Minerals (kg)**	**Vegetables (bundle)**
Kuroiler strain						
Mean±SD	7.5±4.6	6.6±3.6	1.8±1.8	0.6±0.6	0.5±0.6	2.3±0.9
% of farmers	100	63	64	37	52	19
Sasso strain						
Mean±SD	9.5±5.0	5.2±2.1	3.1±2.2	0.9±0.7	0.6±0.6	3.2±3.0
% of farmers	100	16	51	15	30	24

Testing for Performance Variability

First, a hypothesis was carried out to test for the absence of input oriented performance variability (homoskedasticity) in chickens and eggs production in the two strains. As indicated in Table 6, the χ^2 values in all four cases are statistically greater than the corresponding χ^2 Critical values, resulting in P values are less than 0.05 (critical value). Thus the hypotheses of homoskedasticity in chicken performances variability are rejected and hence confirming that there is existence of inputs caused variability in performance. The finding on presence of performance variability conforms to that of Vaidyanathan (1992) who noted that agricultural technologies, even as they help to raise yield, also lead to great instability in output in terms of variability and hence creating risks to farmers. Further, Yang et al., (2016) who explained that yield variability in production is influenced by choice of input combinations as detailed in the subsequent discussion.

Table 6. Testing for evidence of performance variability

Chicken	Hypothesis	Critical Value	Statistics	P-Value
Kuroiler- Birds	$e^2_{ikb} = \sigma^2_{kb}$	4.485	39.21	0.000***
Kuroiler-Eggs	$e^2_{ike} = \sigma^2_{ke}$	2.697	28.47	0.003***
Sasso –Birds	$e^2_{isb} = \sigma^2_{isb}$	8.08	55.21	0.000***
Sasso –Eggs	$e^2_{ise} = \sigma^2_{ise}$	2.25	23.98	0.014**

Notes: e^2-variance, kb-Kuroiler Bird, ke-Kuroiler eggs, sb-Sasso Birds, se-Sasso eggs.

Effect of Inputs on Performance Variability

Results of the specification of the J-P variance function shows both decreasing and increasing effects of inputs on chickens and eggs performance variability in the two strains (Table 7). Variability in performance of introduced chicken strains was not well explained by the controllable input factors under consideration as indicated by the low R^2 value (Table 7). The reason for this is that some of factors were beyond the researchers` control. These factors include scavenging for household scraps, rainfall, temperature and diseases incidences, which have strong influences on performance variability (Zaghari et al., 2011; Rust and Rust, 2013; Rekwot et al., 2016).

Provision of maize bran was found to significantly ($p<0.05$) increase the variability of chicken and egg production in both chicken strains. A one percent increase in maize bran consumption increased chicken performance variability by 0.016 and 0.009 percent in Sasso and Kuroiler strains respectively. The results imply that increase in quantity of maize bran was more likely to increase production risk. This might be because these farmers depended heavily on the feed and hence over utilizing it relative to other feed ingredients.

However, egg production variability showed contradicting results; where maize bran feed ingredient increased variability with increasing input use in Sasso strains while variability decreased with increase in maize bran feeding in Kuroiler strains. Further, the results on egg production variability were insignificant, providing weak evidence that provision of maize bran leads to significantly influencing egg performance variability. Meanwhile, the use of rice bran did not significantly decreased performance variability for Sasso strains performance in both birds and eggs, but rice bran appears to have a significant ($p<0.05$) effect on the level of variability, with an elasticity of 0.009 percent for Kuroiler birds.

Sunflower cake was found to be a variability increasing input as the results show that a one percent increase in sunflower cake feeding, increases performance variability of Sasso birds by 0.0254 percent ($p<0.001$). However, sunflower cake did not affect performance variability of Sasso eggs, and Kuroiler eggs and birds. Though not significant, Fishmeal was found to be the only input factor with a sign of the variability decreasing effect in both live birds and egg production performances in both strains.

Vegetable supplementation indicates results (Table 7) whereby one percent changes in vegetable supplementation increased significantly performance variability by 0.035 percent in Kuroiler egg production while in rest cases the effect on production variability was not significant.

The results (Table 7) further showed that medication had a negative and significant effect on the production variability of egg production for both chicken strains. This implies that, farmers who treated their chickens timely increased egg production stability and hence reducing the risk that farmers in that area face. The coefficients for medication with respect to egg production were -0.1020 and -0.336 ($p<0.1$) and significantly different from zero, which means they had a risk reducing effect for Sasso and Kuroiler chicken strain respectively. This is consistent with Sodjinou (2011) and Thomsen (2005), who argued that good timing for vaccination and treatment reduced death rate amongst several birds and hence high contribution to variability decreasing. Nevertheless, frequency of medication showed the signs of variability increasing in Sasso and Kuroiler bird production.

House condition was found being variability decreasing significantly for Kuroiler chicken production but with a sign of variability decreasing in egg production in both strains while it showed the sign of variability increasing in Sasso bird production. The decreasing sign implies that house condition was important in reducing variability such that farmers with poorhouse conditions were more likely to have poorer production compared to those with good house.

Table 7. Effect of inputs on production variability of introduced chicken strains

	Chicken production		**Egg production**	
	Sasso	**Kuroiler**	**Sasso**	**Kuroiler**
Maize bran	0.0167***	0.009***	-0.0031	-0.007
Rice bran	-0.0069	0.009**	-0.0069	0.009
Sunflower cake	0.0254***	0.007	0.0031	0.021
Fishmeal	-0.0745*	-0.033	-0.0249	-0.038
Minerals	-0.0079	0.01***	0.0369*	-0.001
Vegetables	0.0004	-0.002	-0.0004	-0.035***
Frequency of medication	0.0494	0.015	-0.1020*	-0.336**
House condition				
Good **Normal**	0.0496 -0.0413	-0.16*** 0.054	-0.0037 0.0589	-0.106** -0.170
Labour	0.832	-0.246	0.1237	-0.077
Agro-ecological zone (sites)				
Ifakara	0.7200	0.0933	-0.746	0.124
Wangingòmbe	0.5347	-0.1636	-0.0300	1.073
Constant	1.5821***	1.8710***	2.6120***	3.4713***
R^2	0.49	0.21	0.43	0.31

Notes: statistical significance levels: ***1%; **5%; *10%. Corresponding P value standard errors are shown in parentheses.

while in Sasso, it showed variability increasing. For variability decreasing, this study results are consistent with results by Fufa and Hassan (2003) who reported that the coefficient for labour was insignificant with positive and negative effect to production and variability respectively. Contrary, Wanda (2009) reported that labour was negatively related to yield variability of a crop production in Uganda.

Lastly, the location had no effect on the production variability for both birds and eggs and in either strain. This implies that location specificity does not influence performance variability in both strains. On the contrary, study by Meon and Weill, (2005) found that geographical location contributed much on the performance and performance variability.

CONCLUSION AND RECOMMENDATIONS

The results indicate that controllable inputs had effects on both performance and variability. Controllable factors having the effect included were quantity of maize bran, quantity of rice bran, quantity of sunflower cake, minerals, and frequency of medication, vegetables and house condition. Some inputs were both variability increasing and reducing; reducing in production of birds but increasing in egg production for the same strain and vice versa, although many inputs were not significant. Overall, the study rejected the null hypothesis that input factors do not influence variability in production of the strains implying that they do have such influence. Nevertheless, it is likely that the full potential of the introduced strains requires inputs in the form of husbandry. It is important to design strategies that will lead to yield stability. Such strategies should include the design of trials at farm level to evaluate the input mix with minimum effect on output variability.

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Opportunities and Challenges of Smallholders and Smallholding

Donát Horváth
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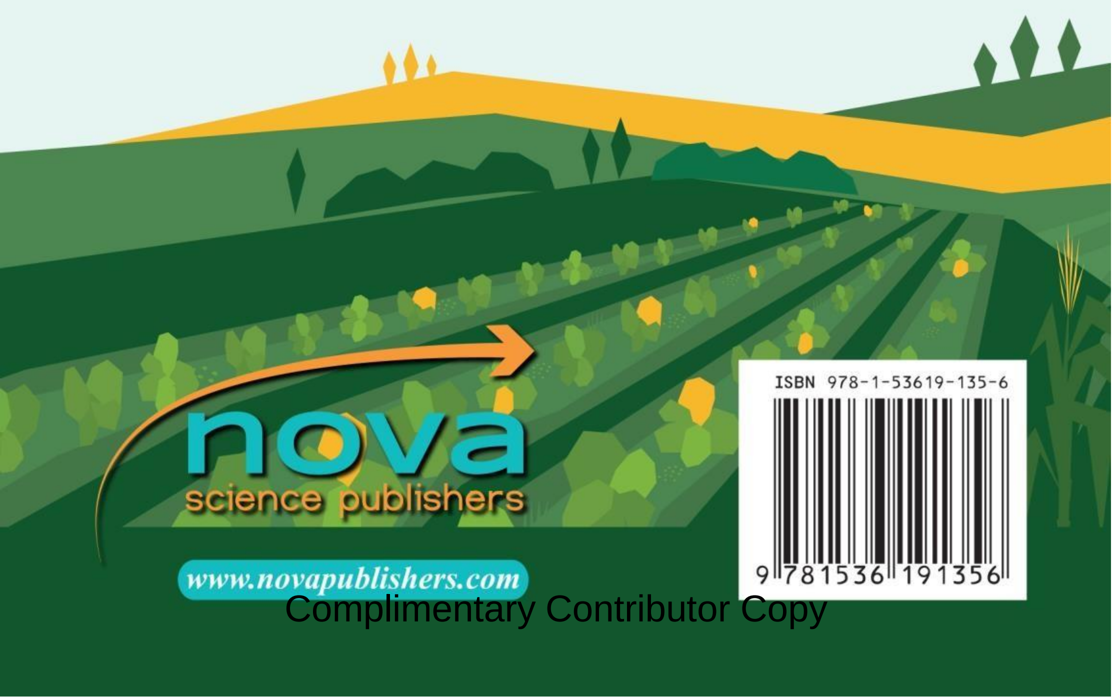

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