The Sustainable Financing of the Agricultural Sector in Rwanda

Mikhail Miklyaev

Submitted to the
Institute of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Finance

Eastern Mediterranean University
May 2021
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

Prof. Dr. Ali Hakan Ulusoy
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy in Finance.

Prof. Dr. Nesrin Özataç
Chair, Department of Banking and Finance

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Doctor of Philosophy in Finance.

Prof. Dr. Glenn Paul Jenkins
Supervisor

Examining Committee

1. Prof. Dr. Fernando Fernholz
2. Prof. Dr. Hasan Güngör
3. Prof. Dr. Glenn Paul Jenkins
4. Prof. Dr. Chun-Yan Kuo
5. Assoc. Prof. Dr. Hasan Ulaş Altıok

ABSTRACT

Rwanda has aimed to achieve food self-sufficiency but faces binding land and budgetary constraints. A set of government policies have been in force for 20 years that have controlled the major cropping decisions of farmers. A cost–benefit analysis methodology is employed to evaluate the financial and resource flow statements of the key stakeholders. The object of the analysis is to determine the sustainability of the prevailing agricultural policies and donor financed interventions in the agricultural value chains from the perspectives of the farmers, the economy, and the government budget. A total of nine value chains were evaluated including seven crops, dairy and poultry. The study has revealed that, in crops value chains, only a third of the (7 scenarios have positive returns and 15 have negative returns) scenarios of crops cultivated in various regions generate positive economic returns. In all provinces, one or more of the crops were either not sustainable from the financial perspective of the farmers or are economically inefficient in the use of Rwanda's scarce resources. The annual fiscal cost to the government of supporting the sector is substantial but overall viewed to be sustainable. A major refocusing is needed of agricultural policies, away from a mono-cropping strategy to one that allows the farmers to adapt to local circumstances. A more market-oriented approach is needed if the government wishes to achieve its economic development goal of having a sustainable agricultural sector that supports the policy goal of achieving food self-sufficiency.

The situation is different in the dairy value chain. USAID interventions designed to increase farm level productivity and create/expand market access for small scale dairy farmers resulted in increase of the dairy farmer's income, as well as stimulated value-

added activities in the value chain and reduced price of milk for low-income consumers.

The Government of Rwanda policies to reduce cost of production for poultry farmers increase financial returns and stimulate farmers to invest more resources into the poultry farming. However, main constraint to further growth of the Rwanda poultry sector is its dependence on imports, including ingredients for the local production of poultry feeds, as well as pharmaceutical products. To further increase competitiveness of the dairy value chain the Government of Rwanda should address the limited domestic supply of day-old chicks and availability of poultry vaccine.

Keywords: agricultural policy sustainability, dairy value chain, food self-sufficiency, integrated investment appraisal, Rwanda.

ÖZ

Ruanda, gıdanın kendi kendine yeterliliğini sağlamayı amaçlamıştır, ancak bağlayıcı arazi ve bütçe kısıtlamalarıyla karşı karşıyadır. Çiftçilerin önemli ekim kararlarını kontrol eden bir dizi hükümet politikası 20 yıldır yürürlüktedir. Kilit paydaşların mali ve kaynak akış tablolarını değerlendirmek için bir maliyet-fayda analizi metodolojisi kullanılmaktadır. Analizin amacı, tarımsal değer zincirlerinde hâkim olan tarım politikalarının ve bağışçıların finanse ettiği müdahalelerin çiftçilerin, ekonominin ve devlet bütçesinin bakış açılarından sürdürülebilirliğini belirlemektir. Yedi mahsul, süt ürünleri ve kümes hayvanları dahil olmak üzere toplam dokuz değer zinciri değerlendirildi. Çalışma, mahsul değer zincirlerinde, çeşitli bölgelerde yetiştirilen mahsullerin senaryolarının (7 senaryo olumlu, 15'inin olumsuz getirisi) yalnızca üçte birinin olumlu ekonomik getiri sağladığını ortaya koymuştur. Tüm illerde, bir veya daha fazla mahsul, çiftçilerin mali perspektifinden sürdürülebilir değildi veya Ruanda'nın kıt kaynaklarının kullanımında ekonomik olarak verimsizdi. Sektörü desteklemenin hükümete yıllık mali maliyeti önemli olmakla birlikte genel olarak sürdürülebilir olarak görülüyor. Tekli ürün stratejisinden çiftçilerin yerel koşullara uyum sağlamasına olanak tanıyan bir stratejiye doğru, tarım politikalarında büyük bir yeniden odaklanmaya ihtiyaç vardır. Hükümet, gıdanın kendi kendine yeterliliğini sağlama politika hedefini destekleyen sürdürülebilir bir tarım sektörüne sahip olma ekonomik kalkınma hedefine ulaşmak istiyorsa, daha pazar odaklı bir yaklaşım gereklidir.

Süt ürünleri değer zincirinde durum farklıdır. Çiftlik düzeyinde üretkenliği artırmak ve küçük ölçekli süt hayvancılığı çiftçileri için pazar erişimini oluşturmak /

genişletmek için tasarlanan USAID müdahaleleri, süt çiftçisinin gelirinin artmasına ve değer zincirinde katma değerli faaliyetlerin teşvik edilmesine ve düşük gelirli tüketiciler için düşük sütün fiyatına neden oldu.

Ruanda Hükümeti'nin kümes hayvanı çiftçileri için üretim maliyetini düşürme politikaları mali getirileri artırıyor ve çiftçileri kümes hayvancılığı çiftçiliğine daha fazla kaynak yatırmaya teşvik ediyor. Bununla birlikte, Ruanda kümes hayvanı sektörünün daha fazla büyümesinin önündeki ana kısıtlama, kümes hayvanı yemlerinin yerel üretimi için bileşenler ve farmasötik ürünler de dahil olmak üzere ithalata olan bağımlılığıdır. Süt ürünleri değer zincirinin rekabet edebilirliğini daha da artırmak için Ruanda Hükümeti, günlük civcivlerin sınırlı yurt içi arzını ve kanatlı aşısı bulunabilirliğini ele almalıdır.

Anahtar Kelimeler: tarım politikası sürdürülebilirliği, süt ürünleri değer zinciri, gıda kendi kendine yeterliliği, entegre yatırım değerlendirmesi, Ruanda.

DEDICATION

I dedicate my dissertation work to my family. A special feeling of gratitude to my wife, Marzhan Miklyaeva, who always freed up time for me to focus on my work. She always encourages me to push the limits and believe in myself. Without her on my side the journey would be impossible. I also dedicate this work to my lovely parents, Zarrina and Sergey Miklyaev, who always stayed by my side.

ACKNOWLEDGEMENTS

I wish to thank my "angel investor", thesis supervisor and professional mentor, Glenn Jenkins, who opened the world of applied welfare economics to me. A special thanks for his countless hours of reflecting, reading, encouraging, and most of all patience throughout the entire process. I wish to thank my committee members Assoc. Prof. Dr. Hasan Ulaş Altiok and Prof Dr. Hasan Güngör for being willing to serve on my thesis committee. I would like to acknowledge and thank Rwandan agronomists and animal husbandry experts involved in original studies and my colleagues, Noel Ujeneza, Primrose Basikiti, Brian Matanhire, Shahryar Afra and David Shobowale who made enormous contributions to this work. I also wish to thank Veronica Maigida who provided valuable assistance in the final preparation and processing of this thesis document.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AI	Artificial Insemination
AKEFEMA	Association of Kenya Feed Manufacturers
APEL	Appui aux Petit Elevage Support to Small Livestock
ASIP	Agriculture Sector Investment Plan
BIF	Burundian Franc
CAADP	Comprehensive Africa Agriculture Development Program
CBA	Cost Benefit Analysis
CDF	Congolese Franc
CEPGL	Economic Community of Great Lakes Countries
CIP	Crop Intensification Program
COMESA	Common Market for Eastern and Southern Africa
DCP	Bicarbonate of Phosphores
DOSE	Document d'Orientation du Secteur d'Élevage
DRC	Democratic Republic of Congo
EAC	East African Community
EAV	Ecole Agri-Vétérinaire
ECC	Egg Collection Centers
EDPRS	Economic Development and Poverty Reduction Strategy
EGAE	Etats généraux de l'agriculture et de l'élevage (Burundi)
EU	European Union
FAO	United Nations Food and Agriculture Organization
FEP	Foreign Exchange Premium
FNPV	Financial Net Present Value

FRw	Rwandan Franc
GoR	Government of Rwanda
Ha	Hectare
HACCP	Hazard Analysis Control of Critical Points
IIA	Integrated Investment Appraisal
IMF	International Monetary Fund
IRR	Internal Rate of Return
ISAE	Higher Institute of Agriculture and Animal Husbandry
KARI	Kenya Agricultural Research Institute
KES	Kenya Shilling
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries (Uganda)
MDG	Millennium Development Goals
MERR	Modified Economic Rate of Return
MCCs	Milk Collection Centers
MINAGRI	Ministry of Agriculture and Animal Resources (Rwanda)
MINOLAC	Minoterie du Lac
ND	Newcastle Disease
NEPAD	New Partnership for African Development
NGO	Non-Governmental Organization
NISR	National Institute of Statistic of Rwanda
NPV	Net Present Value
PPP	Public-Private Partnership
PRSP	Poverty Reduction Strategic Plan
PSTA	Plan Stratégique pour la Transformation de l'Agriculture Strategic Plan for Agricultural Transformation in Rwanda

RAB	Rwanda Agriculture Board
RBS	Rwanda Bureau of Standards
RDB	Rwanda Development Board
RDCP	Rwanda Dairy Competitiveness Program
RPIA	Rwanda Poultry Industry Association
RSB	Rwanda Standards Bureau
SDG	Sustainable Development Goals
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TZS	Tanzanian Shilling
UBOS	Uganda Bureau of Statistics
UGX	Ugandan Shilling
UN	United Nations
USA	United States of America
USD	United States Dollar

Chapter 1

INTRODUCTION

1.1 Rwanda and Vision 2020

The Republic of Rwanda is located where the African Great Lakes region and East Africa converge. Albeit small geographically, given a population of 12 million people, Rwanda is the most densely populated country in mainland Africa, with 498.66 people/km2 (World Bank Development Indicators, 2019b). The country is very popularly known for the horrific genocide in 1994, which, apart from the direct human casualties, caused staggering social and economic harm. During the post-genocide transition period, the Rwandan Patriotic Front (RPF) was unofficially the central decision-making authority in the government. They had little access to bilateral funding, which was very much needed to alleviate the devastated economy. The government was forced to look externally to multilateral organizations like the World Bank for loans. Accompanying these loans were economic liberalization policies which helped increase transparency, decrease labor market regulations, and provide a more private-sector-friendly legal and regulatory framework. These reforms and the monetary inflow that accompanied them, in addition to the social reforms of the government of national unity, led to an immediate boost in the economy in the aftermath of the genocide.

The Rwandan Patriotic Front (RPF), which was the unofficial central decision-making authority of the government of national unity during the 9-year transition period, has

officially ruled since the end of the political transition period in 2003. Over the last two decades, the Government of Rwanda has embarked upon radically restructuring the agricultural sector. At the beginning of the century, the government's goal, coined 'Vision 2020', had six key objectives: the 'Pillars of Vision 2020'. These pillars are:

Good governance and a capable state;

Human resource development and knowledge-based economy;

A private-sector-led economy;

Infrastructure development;

Productive and market-oriented agriculture;

Regional and international economic integration.

Each of these pillars is broken down into series of sectorized and measurable objectives. The objective of the Rwandan Government’s development framework, Vision 2020, has been to convert the economy from an agrarian one into a private-sector-led, knowledge-based economy and to transform the agricultural sector from subsistence-based to one that is market-oriented (Kaberuka, 2000). From 2004 to 2018, Rwanda was one of the fastest-growing economies in Africa, with an average growth rate of 7.7% per annum. With 66% of the labor force employed in agriculture, the positive return from the investment in this sector has been a driving force of the economic growth observed in the country.

As part of the government agenda, the agricultural transformation plan focused on three key agricultural subsectors, including the food crop subsector, the dairy subsector, and the poultry subsector. The stakeholders of these subsectors consist of the producers and the government, and foreign investors like multilateral agencies who

provided funding and other foreign private investors who provided technical aid. Given that a critical problem faced by many of the producers in the agricultural sector is the poor access to finance and improved resources, the government, with the help of foreign donors, combat this by artificially reducing the cost of vital raw materials to the producers through subsidies. As a result, vital producers' inputs are at financial prices that do not reflect their economic costs. Interventions like these, when done correctly, can be used to strengthen sectors to a point where they will no longer need to rely on external aid and will be sustainable enough to contribute to the economy. On the other hand, if they are not well managed, they can waste valuable resources.

Now, the government has moved on from Vision 2020 to the new Vision 2050. The Vision 2050 borrows a lot from its predecessor but comes with an additional focus on climate resilience. As the development framework, Vision 2020, ends and the nation moves on to Vision 2050, it is vital to understand the impact of the current policies on the cultivation of key crops, poultry, and dairy value chains. This thesis aims to examine the financing of each of the critical agricultural value chains viz.: the food crop value chain, the dairy value chain, and the poultry value chain; to determine the parts that can contribute without further government assistance and the parts that might be sustainable in the future. It is also essential to identify the unsustainable value chains that should be modified or terminated to make the best use of the available scarce resources. It will value the impacts of each of these value chains from the perspectives of each of the stakeholders. It will also discuss the policies affecting each value chain to understand what adjustments the government might need to consider as the country moves to achieve its Vision 2050.

1.2 Area of Study

The goals of food security and poverty alleviation have been the focus of Rwanda's economic development since the devastating genocide some 25 years ago. The state of the country now is vastly different than it was in 1994. From 2004 to 2018, it was one of the fastest-growing economies in Africa, with an average growth rate of 7.7% per annum (World Bank Development Indicators, 2019a). With 66% of the labor force employed in agriculture, this sector has been at the forefront of economic policies to achieve the goals of reaching "Upper Middle-Income" country status by 2035 and "High-Income Country" status by 2050 (Gatete, 2016). During the five years 2008–2012, the agricultural sector contributed to more than 50% of the decrease in total poverty (Aertssen et al., 2014). This was achieved by obtaining substantial yield increases across a range of crops, accompanied by improved efficiency in the marketing of agricultural produce. The path which Rwanda has set out for itself as its principal policy aim is to increase the productivity of the agricultural sector. In this way, it will reduce the volume of labor tied up in this sector. The labor resources freed for the agricultural households are expected to move over into the service and manufacturing sectors.

Chapter 2

RWANDAN CROP POLICIES

The experiences of Rwanda regarding ecological sustainability and social differentiation have been compared to that of the former Green Revolutions (Cioffo et al., 2016). Due to highly fragmented agro-ecological zones throughout the country, the historical policies used elsewhere may face challenges if applied in Rwanda. In many of the developed and developing world, the policies have promoted land consolidation with improved agricultural intensification practices that focused on a small number of crops per region. The intensive use of chemical fertilizers was usually an important input to the programs. For example, Malaysia has worked aggressively to consolidate fragmented land holdings to concentrate on rubber and oil palm production (Kwan, 1980). Consequently, in 2016, Malaysia ranked fifth highest in the world in its use of chemical fertilizers per unit of arable land, while Rwanda ranked 140 out of 159 countries in this regard. By comparison, China ranks thirteenth, while the UK, USA, and Kenya rank 32nd, 64th, and 115th, respectively (Knoema, 2019).

Rwanda relies more on organic fertilizers, which is advantageous when considering the long-term sustainability of the soils under intense cropping patterns (Fanelli, 2019). The promotion of the dairy industry with its heavy fodder requirements also introduces an additional strain on the land use and challenges to cropping policies in Rwanda, but it also provides a valuable supply of organic fertilizer.

To reach its target goals, the Rwandan Government sets targets to which it binds subnational governments via a particular performance contract mechanism called Umihigo contracts (Ansoms et al., 2018). This is one of the various home-grown systems introduced by the government. It is a top-down process whereby a regional agronomist selects crops each season following the targets set by the government (Bugingo et al., 2011). This Umihigo contractual mechanism has been described as a results-based approach to public sector performance (Klingebiel et al., 2016). It employs competition between villages, rewarding the best on the publicly available ranking systems. Consistently underperforming mayors can also be removed.

Under this policy, before each season, households submit contracts to local authorities indicating that they will grow the selected crops and value chains. This system leads to a high level of results-based competition among local representatives of the government. Due to the high level of competition, agronomists, in conjunction with local authorities, try to ensure that government-subsidized resources are used only on government-approved projects while enforcing land use consolidation (Huggins, 2017a).

2.1 Crop Intensification Program

A key instrument for the implementation of policies by the Ministry of Agriculture and Animal Resources (MINAGRI) has been the Crop Intensification Program (CIP). To gain efficiencies of scale in production and to lower the logistics costs for inputs and outputs, it has been the government's view that an increased concentration of crops grown in each region was necessary. Also, to achieve economies of scale, the consolidation of landholdings has been thought to be necessary.

Initiated in 2007, the objective of the CIP has been to boost the yield of high-potential food crops, namely beans, cassava, wheat, rice, maize, and potato. Subsequently, soybean was added to the list. These were designated as "priority crops" (Kathiresan, 2012). Being a landlocked country with a high population density, Rwanda faces a binding constraint of farmland availability. The average size of farmland is 0.72 ha, which on average is split into four parcels (National Institute of Statistics of Rwanda (NISR), 2015). The government has encouraged smallholder farmers to consolidate their landholdings (Kathiresan, 2012; Nishimwe et al., 2020). Land is recognized as such a critical constraint that the Government of Rwanda has instituted a natural capital account of land in Rwanda (Nishimwe et al., 2020). The land accounts will also improve access to credits, which will improve the productivity of smallholder farmers significantly (Ali et al., 2014; Deininger & Goyal, 2012). The effects of land use consolidation have been shown to differ based on the size of the consolidated land (Ansoms et al., 2008; Chigbu et al., 2019; Muyombano & Espling, 2020; Nilsson, 2019).

Although to date, Rwanda is overall a low user of chemical fertilizers, an integral part of this program has been to increase the availability of fertilizers and improved seeds to the farmers via subsidies (Monitor Group, 2012). Elsewhere input-led agricultural intensification strategies have often led to land degradation, which significantly reduces over time the productivity of the soils (Fanelli, 2020). As a result of setting mineral fertilizer use targets in some regions with the subsidies that come along with it has been an increase in the use of chemicals in farming practices (Ansoms et al., 2018; Huggins, 2017c). The government was previously in charge of the importation and distribution of fertilizer through bulk procurement, but from 2012 to 2016, it

proceeded gradually to privatize both activities (IFDC, 2010).

Furthermore, to meet the goal of achieving "productive high value and market-oriented agriculture," the government aimed to reform the organization of the agricultural research and extension services (Kaberuka, 2000). To this end, farmers were organized into cooperatives to improve their technical know-how with support from both the government and aid agencies (Huggins, 2017b; Moon & Lee, 2020). Since 2014, the farmer-to-farmer agro-extension model, known as Twigire-Muhinzi, has been predominant in the country (MacNairn & Davis, 2018). This Twigire-Muhinzi system has been instrumental in the organization of the extensive training of the farmers to improve their technical know-how. Based on a farmer-to-farmer transfer of knowledge, this system has created an effective institution for the rapid dissemination of improved farming methods.

In Rwanda, the policies of the government have concentrated on promoting one or two solutions to improving soil management, informed by more generic tests, rather than tailoring technologies to micro soil quality indicators (Kuria et al., 2019). This contrasts starkly to the heterogeneous and diverse traditional approaches to improving soil management by the local smallholder farmers. The lack of integration of the local farmers into the decision making has been shown not to be optimal for soil management practices as the agro-ecological knowledge of the farmers helps to identify fine-scale contextual differences that help to improve the decision-making of soil management options (Kuria et al., 2019). It has led to the formulation and promotion of policies that are not always suited for the variety of agro-ecological zones in the country (Isaacs et al., 2016; Kuria et al., 2019).

The combination of farmers' agro-ecological knowledge with scientific research in agricultural policy formulations will lead to the development of policies that are more likely to be adopted by farmers. If this is done alongside the breakdown of the forceful mechanisms of policy implementation, it will allow farmers to decide which government-promoted policies to follow and which ones to discard without the fear of societal repercussions. This would enable the agro-ecological practices that are better suited to sustainable development to improve the level of income of the farmers that adopts them. The farmer-to-farmer extension model of the "Twigire-Muhinzi" will further aid knowledge-sharing among farmers.

It is noteworthy to clarify that the goal of sustainable agricultural intensification is not a mere government target as a derivative of the sustainable development goals of their international donors. It is also in the best interest of the farmers to improve the productivity of their farming practices in a sustainable manner. The integration of more sustainable agro-ecological practices will preserve the agricultural value of the land. The preservation of the productivity of the farmer-owned land is an especially critical factor to farmers in a region as Rwanda, where farmer-owned land is such high social and cultural status and land constraints are stringent. Regarding the ability of smallholder farmers to cope with the impacts of climate change, the forceful nature of the implementation of the crop intensification program has significantly hampered their abilities to resist the impacts of climatic shocks (Clay & King, 2019; Clay & Zimmerer, 2020). The integration of smallholder farmers into the decision making of the agricultural policies without infringing on their decision-making autonomy will allow the formulation of policies that are not just less degrading on the land but also more climate-resilient, thus ensuring more environmentally smart policies.

The analysis carried out in this paper will identify the crops where Pareto improvements in social welfare are likely to be possible by switching the policy emphasis away from promoting the growth of particular crops in a region to allowing other more economically productive crops to be grown. Excessive subsidization of the inputs of particular crops can result in a waste of resources that would have a greater social benefit if used elsewhere. Encouraging farmers to grow crops that would not be grown without subsidy is likely to cause farmers to believe that these policies are not sustainable over time. Hence, they will likely not be willing to make the investments in terms of their time and effort to engage in environmentally sustainable land husbandry practices that would have a financial and economic payoff if they were allowed to grow other more profitable crops.

2.2 Land Usage

Land usage is an integral resource component in dictating the impact of each value chain. Like other primary data used, land usage was derived by undertaking field studies. The preview of each province is shown in Figure 1 below.

Figure 1: Map of the Provinces of Rwanda

Table 1: Use of Land Resource Across Rwanda (000s ha)

Crop	Eastern (1)	Southern (2)	Northern (3)	Western (4)	Total Rwanda
Bush bean	95	68	-	-	163
Climbing bean	-	-	41	43	84
Cassava	31	112	-	29	172
Maize	39	17	31	31	118
Potato	-	4	35	-	39
Rice	6	4	-	2	12
Soybean	9	10	-	4	23
Wheat	-	5	10	3	17
Total Rwanda	179	220	116	111	627

Source: MINAGRI, author estimates.

Beans, both climbing and bush beans, are the most cultivated crop, with about 247,000 ha dedicated to their cultivation across the country. The total use of land for bean production is split between the two varieties. The land resource that is dedicated to the cultivation of bush beans is almost double that dedicated to the climbing bean variety. Following beans, cassava is the second most cultivated crop across the entire country. Maize, the third most popular crop, is grown in all the provinces but is not the dominant crop in any of the provinces. Given the specific marshland requirement of rice cultivation, it is no surprise that it has the least amount of land dedicated to its cultivation, with about 12,000 ha. With the further development of marshland, this number is expected to continue to rise.

Considering the cropping pattern by province, we find that the Eastern Province is dominated by the cultivation of bush beans, cassava, and maize. It is also one of the three provinces that produce rice and soybean. Cassava is by far the dominant crop planted in the Southern Province, followed by bush beans; it is also the province where

the largest amount of rice is cultivated. Relatively small acreages of maize, potato, soybean, and wheat are also grown. In the Northern Province, climbing beans, cassava and maize are the dominant crops while also being the main area in the country for growing wheat. In the Western Province, the main crops are climbing beans, cassava, and maize, with relatively small amounts of land used for growing rice, soybean, and wheat.

2.3 Methodology and Data

The analysis is carried out by developing an annual cash flow statement that accrues to the farmers from each crop studies in each region. The analysis estimates the rates of return and the net present value of the financial gain that a single farmer is expected to earn over 12 years, over and above all their opportunity costs, including that of their labor. This cash flow is then adjusted to reflect their economic values over time to allow the creation of annual resource flows, reflecting the economic costs and benefits that accrue to Rwanda over the period of the analysis.

Components of these annual statements are reporting as fiscal expenditures and revenues accruing to the government. The stakeholder analysis is essentially examining the impact on the farmers and then identifying the causes of the differences between the financial and economic values of each variable. In the case of Rwanda agriculture, these differences are primarily caused by the government subsidies of agricultural inputs, the tariff protection of some crops. Finally, the taxes that are generated indirectly because of the foreign exchange saved because the amount of foreign exchange required to be spent abroad to supply food to the population is reduced.

The data used in the analysis was gathered primarily via field studies by local agronomists in 2016 and updated in 2020. The analysis is carried out initially considering hypothetical farms of 1 hectare in size. The financial present values and the economic net benefits of cultivating each crop are initially analyzed based on the prevailing farming practices, market prices, and yield levels in that region. With information on the extent to which each crop is grown in a region, the results from the hypothetical farms are then aggregated to the regional level (G. P. Jenkins et al., 2017). The detailed financial and economic models, along with the data sets used, are reported and available to the readers (G. P. Jenkins et al., 2017).

The appraisal of each crop is carried out for the period 2016 till 2027[2], and all crops are assumed to be mono cropped. Although, in practice, more than one crop will often be cultivated by a farmer at a given point in time, the assumption of monocropping is made to focus the analysis on the financial and economic profitability of each crop that is the target of the agricultural policies. It is also the case that monocropping is the practice that has been encouraged by the government's policies (Isaacs et al., 2016).

The results of our analysis are likely to be slightly more pessimistic from the perspective of the farmer than is actually realized. The farmers often disregard the government's instructions to monocrop to improve their incomes. This is particularly the case with intercropping of maize and climbing beans where the nitrogen-fixing effects of the beans increase the yield of the corn, and the corn stalks provide support for the climbing beans at no cost. The assumption that the size of the farm is 1 hectare should not create a bias because all the inputs and outputs are scaled accordingly.

2.3.1 Farmers' Perspective: Financial Profitability

The evaluation criteria applied to the stream of annual cash flows to determine the financial profitability from the perspective of the farmer are the farmers' modified internal rate of return (MIRR) and their financial net present value (FNPV). The MIRR is the rate at which the present value of cash inflows during operation equals the initial cash outlay. For the evaluation of the economic resource flows, it is the economic net present value (ENPV) that is employed. It is described by equation 1.

$$MIRR = \sqrt[k]{\frac{Future\ value\ (Positive\ cash\ flows * cost\ of\ capital)}{Present\ value\ (Negative\ cash\ flows * Financing\ cost)}} - 1, \quad (1)$$

where *k* refers to the total number of years over which the analysis is conducted. The FNPV is described by Equation 2.

$$FNPV = \sum_{t=0}^{k} \frac{R_t - C_t}{\pi_t(1+d_t)} \quad (2)$$

where *d* refers to the discount rate, *t* to the year, R_t to the annual revenue derived from crop sales in year *t* (in cases where a significant proportion of farmers are directly involved in a post-harvest value chain instead of selling the crop directly, the chain value is also proportionately accounted for, considering both its benefits and costs), and C_t to the total annual cost of the resources used in the production in year t.

The annual revenue is derived by Equation 3.

$$R_t = \sum_{i}^{m} (Y_i * F * S) * (1 - PHL) * P_{i,}^{mkt} \quad (3)$$

where *m* is the number of different products that can be produced from the cultivation of the crop, Y_i is the quantity of produce *i* produced in a farming season, *F* the number of farming seasons per year, *S* the average farm size, *PHL* the proportion of post-harvested losses, and P_i^{mkt} the market price of produce *i*. The annual cost incurred is shown in Equation 4.

$$C_t = (\sum L_{jn} * W_{Lj} * F * S) + (\sum K_{qn} * P_{Kq}^{mkt} * F * S), \quad (4)$$

where L_{jn} denotes the number of days required for labor activity *j* per seasonal cultivation and W_{Lj} refers to the prevailing daily wage rate for labor activity j for the region (although the use of family labor is common, the valuation of labor here accounts for the opportunity cost of family labor). The amount of an input K_q required per seasonal cultivation is denoted by *n*, while P_{Kq}^{mkt} denotes the market price of input q (rental cost of land for each region is included as part of the input cost).

2.3.2 Country's Perspective: Economic Valuation

The net economic contribution that each crop value chain is producing in each region is measured by the economic net present value (ENPV) for each crop for 12 years. It is shown in equation 5.

$$ENPV = \sum_{t=o}^{k} \frac{R_t^{eco} - C_t^{eco}}{\pi_t(1+d_t)}, \quad (5)$$

where shows the annual revenue received for the cultivation of the crop at economic prices in time t, whilst denotes the total economic cost of resources used by the value chain for the year t. The discount rate used for the society is the economic opportunity cost of capital (EOCK) as specified by the government (Republic of Rwanda, Ministry of Finance and Economic Planning, 2014). The annual value of the economic output at economic prices is shown in Equation (6).

$$R_t^{eco} = \sum_i^m (Y_i * F * S) * (1 - PHL) * (P_{i,}^{mkt} * CF_i), \quad (6)$$

The economic cost is shown in equation 7.

$$C_t^{eco} = (\sum L_{jn} * W_{Lj} * F * S * CF_{ij}) + (\sum K_{qn} * P_{Kq}^{mkt} * F * S * CF_{kq}), \quad (7)$$

where CF_i, CF_{ij} and CF_{kq} denote the corresponding conversion factor for outputs, labor and inputs, which converts the financial price of an item to its economic value.

2.3.3 Stakeholder Analysis: Distributive Impacts

The stakeholder analysis evaluates the distributional impacts of all externalities. The externality, which is the difference between the financial and economic analyses, is allocated to the stakeholder that is being affected. The externalities accounted for include taxes – both direct and indirect – and subsidies; as such, the main stakeholder, apart from the farmers, is the government. The stakeholder evaluation quantifies the impact of each value chain on the government budget.

To examine the results of the stakeholder analysis, the NPVs of the various components of the analyses are estimated to be consistent with the general relationship shown by equation 8.

$$NPV_{@EOCK}^{ECON} = NPV_{@EOCK}^{FIN} + \sum NPV_{@EOCK}^{EXT}, \quad (8)$$

where $NPV_{@EOCK}^{ECON}$ denotes the economic net present value, $NPV_{@EOCK}^{FIN}$ denotes the financial net present value and $NPV_{@EOCK}^{EXT}$ shows the present value of all relevant externalities that accrue to society's stakeholders excluding farmers. For this relationship to hold precisely, a common discount rate needs to be used to calculate the NPV of each stakeholder (G. Jenkins et al., 2019b). For convenience, the government-measured EOCK is used.

The economic discount rate, or EOCK for Rwanda, has been estimated to be 13% (Republic of Rwanda, Ministry of Finance and Economic Planning, 2014). Given that farmers usually face rather severe financing constraints, their discount rate is not expected to be less than 13%, so it is assumed here that this rate is also their discount rate. This assumption simplifies the reconciliation of the various aspects of the integrated analyses, as shown in equation 8 (G. Jenkins et al., 2019b).

2.4 Empirical Results and Discussions

2.4.1 Beans

Due to the constraint of land availability and the ability of the climbing beans to grow vertically around stakes, the government has been encouraging farmers to move towards the cultivation of the climbing bean (Musoni, 2016). However, due to its ease of cultivation and earlier maturity, the bush bean variety is more attractive to many farmers. The climbing bean variety is usually cultivated at high altitudes, frequently intercropped with maize, which is used to provide staking (Isaacs et al., 2016). Bush bean is exclusive to lower altitudes and is often intercropped. As such, the climbing bean is cultivated mostly in the Northern and Western Provinces, on 41,073 ha and 42,716 ha of land, respectively.

The bush bean variety is cultivated mostly in the Southern and Eastern Provinces, on 68,000 ha and 95,500 ha of land, respectively. Beans have two annual cropping seasons. With the high rate of anaemia, particularly in women and children (Donahue Angel et al., 2017), beans are essential for the Rwandan diet. Domestic consumption has been unable to keep up with the population growth, resulting in an upward trend in the importation of beans from neighbouring Uganda and Tanzania (U.N.).

Equations 1, 2, 3, and 4 are used to estimate the financial returns for these two crops in their respective regions, as reported in Table 2.

Table 2: Present Values of The Beans Value Chain (2016 values)

Province (crop)	MIRR -1	FNPV per ha – $ -2	ENPV per ha – $ -3	Agg. FNPV – 000s $ -4	Agg. ENPV – 000s $ -5	Externalities – 000s $	
						Tax revenue -6	Subsidy -7
Northern (climbing bean)	31.01%	1,568	1,926	64,409	79,122	14,713	-
Eastern (bush bean)	8.62%	−170	60	−16,199	5,716	21,915	-
Southern (bush bean)	−11.28%	−924	−744	−62,839	−50,599	12,240	-
Western (climbing bean)	−13.64%	−1,402	−1,242	−59,883	−53,036	6,847	-
Total/average Rwanda (climbing bean)	8.25%	54	311	4,526	26,086	21,560	-
Total/average Rwanda (bush bean)	0.34%	−483	−275	−79,038	−44,883	34,155	-
Total/average Rwanda	3.02%	−301	−76	−74,512	−18,797	55,715	-

From the perspective of the farmer, the results of the estimated MIRR and the Financial NPVs (Table 2 columns 1 and 2) indicate that the returns to the farmers from cultivating climbing and bush beans are very mixed. Only in the Northern Province is climbing beans financially highly attractive to be grown as a monocrop. In the Eastern Province, does bush bean cultivation generates a modest MIRR of 8.62% (Table 2, column 1, row 2). This return is significantly less than the prevailing discount rate of 13%.

The financial results in the Southern and Western Provinces are surprising. The notion that farmers will engage in activities that are unprofitable to them seems unlikely without a precise understanding of the government policies affecting the decision-making of many Rwandan farmers. While the top-down policy directives of the government, combined with a strict enforcement policy, have focused on monocropping, farmers often cultivate beans as a component of intercropping. The nitrogen fixation property of the bean crops provides an incentive for farmers to cultivate beans with other crops. Farmers have observed that intercropping beans with maize offers greater benefits than monocropping (Isaacs et al., 2016).

The significant benefits of intercropping have caused the Rwandan Government to relax its monocropping regulations to some extent (Huggins, 2017a). This has allowed farmers to cultivate crops even when they are marginally or not profitable due to their intercropping benefits. With beans being one of the most prominent CIP crops since 2011 and representing 55% of all consolidated lands in 2016 (Del Prete et al., 2019), it is less surprising to see such results emerging. On average, climbing beans is a financially more profitable crop than bush beans for farmers to cultivate. This is similar to the conclusion made by other researchers investigating the disparities in the

profitability of both crops (Catherine et al., 2016; Katungi et al., 2019).

When appraised from an economic perspective, the subsequent results differ subtly from the financial perspective discussed above. As farmers across the country use subsidized fertilizers in negligible amounts for the cultivation of bean crops, the main externality effect of this activity for the government occurs in the form of increased tax revenues associated with the savings in foreign exchange that arise from domestic production of beans rather than importing this or another food item.

The cultivation of climbing beans in the Northern Province yields an economic NPV return of $1,926 per hectare, in contrast to the economic NPV loss of $1,242 in the Western Province by the same crop under similar conditions (Table 2, column 3, rows 1 and 4). Cumulated across each province, this shows that the farming of climbing bean in the Northern Province results in an economic NPV benefit of $79 million to the economy while soaking up economic resources worth $53 million in the Western Province (Table 2, column 5, rows 1 and 4). Combined, this results in a net economic resource gain of $26 million in NPV terms to the Rwandan economy from climbing bean cultivation (Table 2, column 5, row 5).

The economic impact analysis of the bush bean crop reveals results similar to those for climbing bean in the sense that its production is beneficial to the economy in one province and detrimental to the economy in another. Although the cultivation of bush beans in the Eastern Province is not proven to be financially prudent from the farmers' perspective, from the economic perspective, it returns a positive economic NPV of $60 per hectare planted in the province (Table 2, column 3, row 2). In contrast, the cultivation of bush beans in the Southern Province yields a negative economic NPV of

$744 per hectare (Table 2, column 3, row 3). Cumulatively, bush bean cultivation across the Eastern Province generates a net economic benefit (ENPV) worth $5.7 million while there is an economic NPV loss of $63 million in the Southern Province (Table 2, column 5, rows 2 and 3).

The discrepancy between the financial and economic returns of the crops in each province is identical to the tax revenue generated to the government. Typically, this shows that the cultivation of bush beans creates a negative economic NPV of $275 per hectare across the country (Table 2, column 3, row 6). Aggregated across the country, the net negative economic NPV reflects a loss of $45 million from bush bean cultivation (Table 2, column 5, row 6). Therefore, when the performances of both bean crops are aggregated, bean cultivation produces an average economic NPV loss of $76 per hectare, or $19 million countrywide (Table 2, columns 3 and 6, row 7).

2.4.2 Cassava

Cassava is a staple food crop in Rwanda, produced mainly to satisfy domestic consumption. In the period 2009–2017, only about 1.4% of total production was involved in cross-border trade (FAO, n.d.-a). Its cultivation is concentrated in 112,213 ha in the Southern Province, 30,695 ha in the Eastern Province, and 28,804 ha in the Western Province. About 80% of cassava farmers are involved in the production of cassava chips for immediate sale to consumers. The remaining farmers either sell to the Kinazi Cassava Plant (KCP) for processing into flour (Kinazi Cassava Plant Ltd., n.d.) or sell the tubers directly to consumers in the open market.

Severe outbreaks of cassava brown skin disease (CBSD) and cassava mosaic disease (CMD) in 2009 caused production to plummet. The industry has been trying to recover since 2015 with the development of the Namulonge selection (NASE14) variety,

which is resistant to CBSD. Cuttings of this new variety have been distributed by MINAGRI to large-scale farmers and cooperatives (Ntirenganya, 2016). In 2017, a CBSD control project was developed in the region to aid the combat of both CBSD and CMD (International Institute of Tropical Agriculture (IITA), 2018). The analysis of the cassava value chain carried out here assumes that the severe CBSD and CMD disease outbreaks would be contained with the development and dissemination to farmers of the disease-resistant varieties.

Cassava tubers, once harvested, tend to spoil rather quickly. To minimize post-harvest losses, they need to be dried, processed and sold into the market within a week. This is a crucial reason for the low inter-country cassava trade. Hence, cassava is a less tradable crop than many others that are analysed in this paper. However, in the border areas, it is still regionally traded. Production is used mainly for domestic consumption. Thus, it serves as a substitute for potato, maize, or rice.

Table 3: Present Values of The Cassava Value Chain (2016 values)

Province	MIRR -1	FNPV per ha – $ -2	ENPV per ha – $ -3	Agg. FNPV – 000s $ -4	Agg. ENPV – 000s $ -5	Externalities – 000s $	
						Tax revenue -6	Subsidy -7
Eastern	13.09%	6	272	173	8,352	8,179	-
Southern	12.07%	−63	231	−7,118	25,929	33,047	-
Western	0.27%	−453	−250	−13,055	−7,211	5,844	-
Total/average	10.27%	−116	158	−20,000	27,070	47,070	-

Cassava has just one farming season per annum. The MIRR results in Table 3 show the estimated average rate of return of cultivating cassava in each province. In Table 3 column 2, the FNPVs are estimated for the farmer. In the Eastern Province, cassava

farming generates an average MIRR of 13.09% for farmers (Table 3, column 1, row 1) and a positive FNPV. The slight difference between the latter return and the 13% discount rate shows that cassava cultivation will be only marginally more profitable than the average return that could be generated elsewhere. In the Southern Province, the farmers cultivating cassava are estimated to generate a MIRR of 12.07% on average (Table 3, column 1, row 2). The MIRR in the Western Province is significantly less than that in the Eastern and Southern Provinces.

In the Western Province, farmers generate a financial rate of return of 0.27% from cultivating cassava given the current conditions (Table 3, column 1, row 3). This shows that the farmers in the Western Province make enough revenue to recover the funds they have invested but not enough to cover their opportunity cost. Across the country, cassava cultivation provides an average MIRR of 10.27% to farmers. Averaged across the country, this ranks cassava as less financially profitable to the farmers cultivating it than climbing bean and more profitable than the bush bean.

If the conversion of the cultivation to the disease-resistant varieties is effective, the results of the estimation of the FNPVs and ENPVs according to equations 1 and 4, respectively, will be as reported in Table 3. Similar to the bean crops, with the insignificant use of subsidized inputs by the cassava production chain, the main externality occurs in relation to the tax revenue that flows indirectly to the government (G. P. Jenkins et al., 2015).

From the standpoint of the economy, the cultivation of cassava not only generates revenue for farmers but, as it substitutes for food that would otherwise be imported, also indirectly generates taxes for the government (G. P. Jenkins et al., 2015).

Consequently, the impact of cassava cultivation on the economy generally is better than its financial impact on farmers. Per hectare cultivated, farming cassava in the Eastern Province adds economic resources worth $272 to the economy in NPV terms (Table 3, column 2, row 1). When aggregated across the province, this results in an economic resource gain of $8.4 million in NPV terms from cassava cultivation in the province (Table 3, column 5, row 1). Similarly, in the Southern Province, it generates a positive economic NPV profit of $231 to the economy per hectare cultivated, which aggregates across the province as an economic NPV profit of $25.9 million to the economy (Table 3, columns 3 and 5, row 2). In contrast to what is observed in the Eastern and Southern Provinces, the cultivation of cassava in the Western Province results in economic loss.

As measured by the economic NPV, this economic loss is $250 per hectare cultivated (Table 3, column 3, row 3). When aggregated over the whole province, it is found that cassava cultivation in the Western Province generates an economic NPV loss of $7 million (Table 3, column 5, row 3). The aggregation of all the provincial results demonstrates that cassava cultivation yields a positive economic NPV profit of $27 million to the Rwandan economy (Table 3, column 5, row 4). This averages out at yielding an economic NPV of $158 per hectare of cassava cultivated across the country (Table 3, column 3, row 4).

The cultivation of cassava is found to be profitable for the economy, though not always profitable financially for the farmers if it is grown for commercial sale.

2.4.3 Maize

Maize is the crop that is most promoted by the Rwandan Government, alongside wheat. A primary motivation behind this policy has been the desire for food self-

sufficiency (Republic of Rwanda, Ministry of Trade and Industry (MINICOM), 2015a). Intensive efforts by the Rwanda Agriculture Board (RAB) have led to an increase in the quantity of high-quality, locally produced seeds which are distributed to farmers (Nkurunziza, 2018). About 30% of total Rwandan maize production is bought by the Rwanda Grains and Cereals Corporation (RGCC); it is subsequently supplied to millers both domestically and in neighbouring countries. It is cultivated on 38,840 ha in the Eastern Province, 29,602 ha in the Western Province, 30,769 ha in the Northern Province, and 17,364 ha in the Southern Province. Maize has two harvesting seasons per annum in most regions of Rwanda. The array of subsidies to promote the cultivation of maize includes a subsidy of FRw 1,500 per kilogram of seed, 35% of the price of DAP fertilizer, 30% of the price of urea fertilizer, 15% of the price of NPK17.17.17, and 50% of the cost of micro-nutrients. Slightly offsetting these expenditures is the foreign exchange premium (FEP) of 5.3% of net foreign exchange earnings.

Table 4: Present Values of The Maize Value Chain (2016 values)

Province	MIRR -1	FNPV per ha – $ -2	ENPV per ha – $ -3	Agg. FNPV – 000s $ -4	Agg. ENPV – 000s $ -5	Externalities – 000s	
						Tax revenue -6	$ Subsidy -7
Southern	31.99%	1,349	361	23,417	6,261	5,720	−22,876
Northern	16.60%	143	−707	4,410	−21,760	10,293	−36,463
Eastern	6.60%	−251	−1,234	−9,741	−47,945	12,967	−51,171
Western	−2.27%	−505	−1,567	−14,944	−46,387	9,400	−40,843
Total/average Rwanda	10.77%	27	−942	3,142	−109,831	38,380	−151,353

The MIRR, FNPVs, and ENPVs estimated are reported in Table 4. These results are shown in columns 4 to 7 reconciled as expressed by the relationship denoted by equation 8. The financial return of maize cultivation varies along provincial lines. In the Southern Province, maize cultivation is estimated to return 32% on the investment cost over the 12 years of analysis (Table 4, column 1, row 1). In the Northern Province, farmers are estimated to make an average return of 16.6% (Table 4, column 1, row 2). This rate of return experienced by the farmers cultivating maize in the Northern Province is about half that seen in the Southern Province. Given that the return experienced in the Eastern Province is higher than the 13% discount rate, the farmers will be interested in cultivating this crop in the current conditions. Meanwhile, maize cultivation in the Eastern Province is estimated to generate a return of 6.6% to farmers (Table 4, column 1, row 3), less than the discount rate. In contrast, cultivating maize in the Western Province does not generate enough revenue, in real terms, to cover its investment requirement. It returns a negative 2.27% on average to farmers (Table 4, column 1, row 4).

At the prevailing market rate, small farmers who own land might prefer to lease out their land to generate rent if they cannot escape maize cultivation due to pressure from local authorities (Huggins, 2017c). On average, any alternative investment that will generate a 13% return rate will be preferable to cultivating maize in this province, but given the enforcement of government policies, some farmers might continue to cultivate less profitable crops for as long as they can cover their average variable costs.

Aside from the financial impact on farmers, maize farming depends on some subsidized inputs and generates taxes for the government. In the Southern Province, maize cultivation is shown to produce a mean economic NPV value worth $361 per

hectare to the economy (Table 4, column 3, row 1). This translates into an economic NPV benefit of $6.3 million to the economy via maize cultivation across the entire Southern Province (Table 4, column 5, row 1). In contrast to what is observed in the Southern Province, maize cultivation in all the other regions does not appear to be beneficial to the economy.

On average, maize farming results in economic NPV losses worth $707, $1,234, and $1,567 per hectare cultivated in the Northern, Eastern, and Southern Provinces, respectively (Table 4, column 3, rows 2, 3, and 4). These translate into economic NPV losses of $21.8 million in the Northern Province, $48 million in the Eastern Province, and $46 million in the Western Province (Table 4, column 5, rows 2, 3, and 4). This means that cumulated across the country, maize cultivation results in economic NPV losses worth $110 million to the Rwandan economy (Table 4, column 5, row 5). This translates into an average economic NPV loss of $942 per hectare of maize cultivated (Table 4, column 3, row 5).

For the cultivation of maize to be economically viable in the Northern, Eastern, and Western Provinces, the yield would have to increase by 8.6%, 14.13%, and 17.99%, respectively, in these provinces. Unfortunately, Rwanda experienced an average decrease in maize yield of 5.86% annually from 2012 to 2016 (FAO, n.d.-b). Moreover, maize yield is shown to be highly susceptible to climate variability (Austin et al., 2020). Maize yield in Rwanda is shown to be inversely related to heat and causally related to rainfall (Murenzi, 2018).

As maize is a rainfed crop, the unpredictable nature of rain across the country has been shown to result in erratic maize yields in district-based observations (Huggins, 2017c).

Due to climate change, the variability in rainfall is expected to increase, and the rainy season is expected to become shorter and more intense, with longer and dryer dry seasons leading to increased proneness to floods and droughts (Reliefweb, 2018). The average temperature in the country, which has increased by 1.4°C more than the global average since 1970, is expected to continue rising (Reliefweb, 2018).

Keeping other factors constant, in order to increase yields, some of the prevailing practices will have to change to include the increased use of urea per hectare, the use of $NPK_{17.17.17}$ instead of DAP fertilizer, the use of hermetic bags to combat post-harvest losses, and the employment of micro-nutrients including borax pentahydrate, ammonium sulfate, and zinc sulfate monohydrate.

2.4.4 Potatoes

Potato cultivation has two farming seasons each year. The price floor is determined regionally by the Ministry of Trade and Industry (MINICOM) based on production cost and distance to market, which is Kigali. A wholesale company, Regional Potatoes Trading Ltd., was created in Kigali to cut out intermediaries by managing 126 collection centers in 4 districts (Republic of Rwanda, Ministry of Trade and Industry (MINICOM), 2015b).

Potatoes are cultivated only marginally in the Western and Eastern Provinces, as most of the production comes from the volcanic region and Gicumbi district of the Northern Province, with 35,082 ha in cultivation, and the Southern Province, with 4,122 ha in cultivation. Potato has been rising in importance as a staple food in Rwanda since the mid-1960s, with per-capita consumption growing from 6 kg in 1964 to 99.86 kg in 2011 per year (PotatoPro, n.d.). Potato demand is higher in urban than in rural regions. The fertilizer used in its cultivation by the farmers is $NPK_{17.17.17}$, which attracts a 35%

subsidy from the government. Rwanda is still a small net importer of potatoes; hence, potato cultivation is an import substitution activity. Most imports come into the country via informal cross-border exchange with the North Kivu Province of the Democratic Republic of Congo and the Kisoro district of Uganda (Okoboi, 2001).

Table 5: Present Values of The Potato Value Chain (2016 values)

Province	MIRR -1	FNPV per ha – $ -2	ENPV per ha – $ -3	Agg. FNPV – 000s $ -4	Agg. ENPV – 000s $ -5	Externalities – 000s	
						Tax revenue -6	$ Subsidy -7
Southern	50.79%	18,333	19,384	75,561	79,891	6,333	−2,003
Northern	37.59%	12,849	13,789	450,763	483,755	50,045	−17,053
Total/average Rwanda	38.97%	13,425	14,377	526,324	563,646	56,378	−19,056

Potato cultivation is shown to be a highly profitable crop for farmers. On average, potato cultivation generates a MIRR of 50.79% to farmers in the Southern Province and 37.59% to those in the Northern Province (Table 5, column 1, rows 1 and 2). It should be noted that these high financial rates of returns are not adjusted to reflect high opportunity cost of land, as potatoes are grown on volcanic soil allowing farmers to minimize use of fertilizers. The adjustment was the opportunity cost of land was not made to demonstrate regional competitiveness of Rwanda potatoes production. Taking the entire country as a whole, potato cultivation generates a financial return rate of 38.97% (Table 5, column 1, row 3). The high average financial rate of return reveals how highly profitable potato cultivation is. The FNPVs for the farmers are all positive.

Moreover, the analysis reveals that farming potatoes in the Southern Province generate about $80 million of economic NPV benefit to the economy. On a per-hectare basis, about $19,000 of economic NPV benefit is generated in the Southern Province through potato cultivation (Table 5, column 3, row 1). Similarly, in the Northern Province, cultivating potato allows farmers to generate about $14,000 in economic NPV benefit to the economy per hectare of potato cultivated (Table 5, column 3, row 2). This yields about $451 million of economic benefit to the economy of Rwanda from potato cultivation in the Northern Province (Table 5, column 5, row 2). All in all, Rwanda is estimated to generate a resource benefit worth $564 million to its economy in NPV terms by cultivating potatoes (Table 5, column 5, row 3). This is in line with an average, per hectare, of the economic benefit of about $14,000 in NPV terms (Table 5, column 3, row 3).

This is the most economically competitive of all the crops examined so far by a large margin. It is demonstrated that potatoes will be a highly sustainable food crop for the foreseeable future; even without the fertilizer subsidy, farmers should be very willing to cultivate and expand the production of potatoes. However, its high vulnerability to the effects of climate change is a significant cause for concern (Austin et al., 2020).

2.4.5 Rice

Rwanda's rice value chain is heavily protected by the government, with an import duty of 45% (East African Community, 2019). The tariff is essentially a tax on consumers to the benefit of domestic producers. Rice cultivation is concentrated in the Gatsibo and Nyagatare districts of the Eastern Province, the Rusizi district of the Western Province, and the Gisagara district of the Southern Province, with 5,770 ha, 1,772 ha, and 4,126 ha of land cultivated in each province, respectively. The farmers enjoy a 15% subsidy on $NPK_{17.17.17}$ fertilizer, a 30% subsidy on urea fertilizer, a 35% subsidy

on DAP fertilizer, and a 25% subsidy on KCl fertilizer, but no subsidy on urea briquettes. Even with these subsidies, the use of KCl fertilizer and DAP fertilizer is observed to be negligible.

Rice is cultivated on marshland covering about 12,000 ha, although about 48,000 ha of potential marshland has been identified. Through the Rural Sector Support Project (RSSP), the government, co-financed by the World Bank, has effectively invested significantly in marshlands and hillsides of sub-watersheds to ramp up domestic rice cultivation (The World Bank, 2008). Rice has two farming seasons per annum, and women account for 45% of rice farmers (Republic of Rwanda, Ministry of Finance and Economic Planning, 2013). The local production lags consumption, with imports accounting for 36% of consumption from 2010 and 2017 (FAO, n.d.-b). The short-grain rice variety makes up about 60% of domestically produced rice and is consumed by rural households, bulk buyers, and low-income urban households. In contrast, most of the imported rice consists of the fragrant, long-grain variety that goes to high-income urban households, hotels, and restaurants. Rwanda faces a dual challenge of raising both the quality and the quantity of rice production. The present values of the rice value chain are shown in Table 6.

Table 6: Present Values of The Rice Value Chain (2016 values)

Province	MIRR -1	FNPV per ha – $ -2	ENPV per ha – $ -3	Agg. FNPV – 000s $-4	Agg. ENPV – 000s $ -5	Externalities – 000s $		
						Tax Revenue -6	Subsidy -7	Tariff -8
Eastern	31.11%	2,783	−2,528	18,466	−14,587	4,512	−3,462	−34,103
Western	31.58%	2,691	−2,617	5,551	−4,637	1,348	−1,063	−10,473
Southern	30.56%	2,620	−2,699	12,536	−11,135	3,191	−2,476	−24,386

Total/average Rwanda	30.98%	2,712	−2,602	36,553	−30,359	9,051	−7,001	−68,962

The analysis reveals that the cultivation of rice is profitable on average for farmers across all regions. The MIRR is approximately 31% on average to the farmers irrespective of the province in which it is cultivated (Table 6, column 1, row 1).

On average, farmers in the Eastern Province make a profit of $2,783 in NPV terms per hectare of rice cultivated (Table 6, column 2, row 1). In the other provinces where rice is also cultivated, farmers average similar returns on a per-hectare basis, generating average financial NPV returns of $2,691 and $2,620 per hectare in the Western and Eastern Provinces, respectively (Table 6, column 2, rows 2 and 3). The aggregate analyses for each region show that rice farming generates about $18.5 million, $5.6 million, and $12.5 million in NPV terms for farmers in the Eastern, Western, and Southern Provinces, respectively (Table 6, column 4, rows 1, 2, and 3). Therefore, rice cultivation generates $36.6 million for all the farmers in Rwanda in NPV terms (Table 6, column 4, row 4). These results reveal rice to be a profitable crop for farmers to cultivate.

The economic analysis presents a different story. Although rice cultivation is shown to have similar impacts on a per-hectare basis across provinces, it takes more resources from the economy than the benefit it creates. It generates negative economic NPV impacts, ranging from a mean value of $2,528 in the Eastern Province to a mean value of $2,699 in the Southern Province (Table 6, column 3, rows 1, 2, and 3). Across Rwanda, the economy loses $2,602 for an average hectare of rice cultivated (Table 6,

column 3, row 4). This is similar, in absolute terms, to the average financial revenue generated by farmers per hectare of rice cultivated, which is $2,712 in NPV terms (Table 6, column 2, row 4). From an economic perspective, this shows that without distortions, the cultivation of rice is closer to exhibiting a rate of return that is similar to the average opportunity cost of capital.

What the externalities do, essentially, is to transfer resources from the economy to the farmers, which makes rice cultivation appear more attractive than it is. The cultivation of rice across Rwanda costs the economy about $30 million in NPV terms (Table 6, column 5, row 4). Disaggregated by provinces, rice cultivation costs about $14.6 million, $4.6 million, and $11 million in the Eastern, Western, and Southern Provinces, respectively (Table 6, column 5, rows 1, 2, and 3).

Unlike the other crops that have been analysed, which yield a negative impact on the economy, rice cultivation generates more direct tax revenue than the subsidy costs to the government. For instance, in the Eastern Province, where rice cultivation yields a negative $14.6 million economic NPV while farmers gain financially about $18.5 million NPV, the government gains about $4.5 million in taxes from rice cultivation in this province, spends about $3.5 million subsidizing the farmers, and loses about $34 million in tariff revenues if rather than being domestically cultivated, rice had been imported instead (Table 6, row 1, columns 4, 5, 6, 7, and 8). Rwanda imports rice mainly from Tanzania and Pakistan (Fintrac Inc., 2013). These foregone tax revenues are not directly observable by the Treasury. This creates an illusion that rice cultivation is not only makes farmers financially better off, but also have a positive net fiscal impact. As domestic cultivation will displace imports, it is then essential to consider the import tariff lost as an opportunity cost. Since the tariff raises the domestic price

of rice, the financial price of rice will overstate its economic value by the rate of the tariff, with further adjustments for the FEP and production subsidies; thus, the loss in tariff revenue due to the domestic production of rice has a negative impact on the government's tax revenue (G. Jenkins et al., 2019a).

The analyses reveal that the Rwandan economy loses resources worth about $30.4 million in NPV terms from domestic rice cultivation, mainly as a result of overstating the financial price due to an import tariff that transfers the surplus enjoyed by consumers to domestic producers. The results of the analysis conclude that the rice value chain is neither economically nor fiscally sustainable, albeit that it is financially profitable for farmers.

For rice farming to become economically sustainable under prevailing conditions, a break-even analysis shows that yield would have to increase by 21.96% across the country. Rwanda experienced yield increases of 8.18% from 2012 to 2016 (Factfish, 2020). Given this experience, it could achieve sustainability in the near future if such growth rates are maintained. Ways in which the current production practices can be improved include harnessing deep fertilizer placement technology and using soil-specific fertilizers, including 75 kg of DAP, 60 kg of KCl, and 112.5 kg of urea.

2.4.6 Soybean

Soybean was included in the CIP in 2012. Since then, the government has been providing support via seeds and fertilizer subsidies. Based on their current practices, farmers enjoy an 85% subsidy on imported seeds and a 66% subsidy on local seeds. Soybean is mainly cultivated in the Southern, Eastern, and Western Provinces on 10,047 ha, 8,707 ha, and 4,019 ha of land, respectively. While soybean is not a staple part of the Rwandan diet, demand has been increasing, primarily in the production of

high-nutrient foods and animal feed. The government has also invested in processing plants to boost the demand for soybean. A key characteristic of soybean cultivation is that it has a more significant potential for nitrogen fixation in the soil than the next best alternative, common beans (One Acre Fund, 2016).

The soybean seed production in Rwanda is still being developed. There is usually a substantial shortage in the supply of seeds in the domestic market, and this is being bridged via imports by the government, non-governmental organizations, agro-dealers, and independent seed multipliers (Tukamuhabwa et al., 2016). For this analysis, the proportions of domestic and foreign seeds are taken to be equal; that is, half the seeds are assumed to be sourced domestically while the remaining half is imported. Soybean can produce two crops per annum; hence, the annual results reported here are the aggregations of both crops. Table 7 shows the impacts of soybean cultivation, financially to the farmers and government budget, and economically to society as a whole.

Table 7: Present Values of The Soybean Value Chain (2016 values)

Province	MIRR -1	FNPV – $ -2	ENPV – $ -3	Agg. FNPV – 000s $ -4	Agg. ENPV – 000s $ -5	Externalities – 000s $	
						Tax revenue -6	Subsidy -7
Southern	1.53%	−355	−1,494	−3,369	−15,008	2,269	−13,908
Western	−15.66%	−1,145	−2,366	−4,601	−9,509	655	−5,563
Eastern	−19.29%	−1,498	−2,726	−13,044	−23,736	1,361	−12,053
Total/average Rwanda	−9.46%	923	2,119	−21,014	−48,253	4,285	−31,524

The analysis of soybean cultivation shows that its profitability varies along provincial

lines. It is revealed to be a slightly positive activity in the Southern Province, generating a return rate of 1.53% (Table 7, column 1, row 1). In contrast, the negative 15.66% and negative 19.29% rates of return of soybean cultivation in the Western and Eastern Provinces, respectively, suggest that the soybean farmers in these two provinces do not even cover their accounting costs, let alone the opportunity cost of their capital (Table 7, column 1, rows 2 and 3). If the country is examined as a whole, it is estimated that soybean cultivation results in a loss for the farmers on average, generating an average MIRR of negative 9.46% (Table 7, column 1, row 4).

From the evaluation criteria, on average, farmers will not be interested in cultivating this crop without external motivations to do so. Like beans, soybean has proved beneficial when intercropped with maize and sorghum due to its nitrogen fixation property. This factor allows farmers to continue cultivating it even though it is not profitable when monocropping.

The result of the impact of soybean cultivation on the economy is even worse than its financial outcomes. While the cultivation in the Southern Province results in the least negative impacts, it is still not an economically profitable activity in any of the provinces. In NPV terms, its cultivation averages net economic NPV losses of resource to the economy worth $1,494, $2,366, and $2,726 per hectare cultivated in the Southern, Western, and Eastern Provinces, respectively (Table 7, column 3, rows 1, 2, and 3). The aggregate economic NPV losses from farming this crop in the Eastern Province are equivalent to the combined losses from its cultivation in the Southern and Western Provinces. Overall, the cultivation of soybean costs the Rwandan economy approximately $48 million in NPV terms (Table 7, column 5, row 4). These results demonstrate the critical need for the revision of this value chain to make the best use

of the country's scarce land resources.

To achieve economic viability, the yield of soybean will have to increase by about 32%, 69%, and 82% in the Southern, Western, and Eastern Provinces, respectively. Unfortunately, data shows that from 2012 to 2016, the yield declined at an annual average of 7.96% (FAO, n.d.-b).

2.4.7 Wheat

Wheat, together with maize, is one of the most promoted crops in Rwanda and is harvested bi-annually. While it does not have any tariff protection (East African Community, 2019), a 75% subsidy is given to purchase wheat seed alongside 35% and 30% subsidies on DAP and urea fertilizers, respectively. Wheat cultivation is concentrated in the Northern, Southern, and Western Provinces, on 9,525 ha, 4,539 ha, and 3,030 ha. The wheat market is rapidly expanding, with domestic consumption increasing by 155% during the last decade (IndexMundi, n.d.); with most of the demand from urban consumers, it is projected to increase further. Straw, a by-product of wheat, also provides a valuable source of revenue for wheat farmers. It is an essential input for the button mushroom growing industry, expanding in the country(Feed the Future (FtF) Program, 2016).

Table 8: Present Values of The Wheat Value Chain (2016 values).

Province	MIRR -1	FNPV per ha – $ -2	ENPV per ha – $ -3	Agg. FNPV – 000s $ -4	Agg. ENPV – 000s $ -5	Externalities – 000s Tax revenue -6	$ Subsidy -7
Northern	15.04 %	133	−1,317	1,268	−12,545	4,243	−18,056
Western	−2.45 %	−606	−2,144	−1,837	−6,495	1,086	−5,744
Southern	−4.38 %	−774	−2,311	−3,514	−10,491	1,627	−8,604
Total/Average	6.79%	−239	−1,728	−4,083	−29,531	6,956	−32,404

Wheat cultivation exhibits varying degrees of financial profitability across the country. It generates a return rate of 15.04% on average to farmers cultivating it in the Northern Province (Table 8, column 1, row 1), but less than the average return from maize in the same province (16.6%). In contrast, wheat cultivation is not capable of generating enough revenue to cover its costs in the Western and Southern Provinces. This is reflected in the negative 2.45% and negative 4.38% average rates of return from farming wheat in these provinces, respectively (Table 8, column 1, rows 2 and 3). Although it generates losses on average for the farmers in the latter provinces, when the country is examined as a whole, wheat cultivation is estimated to generate an average MIRR to farmers of 6.79% financially (Table 8, column 1, row 4).

While wheat cultivation is revealed to be profitable financially in a province, from an economic perspective, cultivating wheat is not favorable at all. From the societal perspective, wheat cultivation in the Northern, Western, and Southern Provinces on a per-hectare basis results in an economic NPV loss worth $1,317, $2,144, and $2,311, respectively (Table 8, column 3, rows 1, 2, and 3). This results in an average loss of resources worth $1,728 in NPV terms per hectare of wheat cultivated across the country (Table 8, column 3, row 4). Aggregately, the wheat value chain costs the economy an economic NPV of $12.5 million in the Northern Province, $6.5 million in the Western Province, and $10.5 million in the Southern Province (Table 8, column 5, rows 1, 2, and 3). This adds up to a cost of about $29.5 million worth of resources in NPV terms to the economy of Rwanda (Table 8, column 5, row 4).

From the results, wheat cultivation is proven not to be a profitable activity for the

economy. Although the government and international donors have been massively subsidizing this activity, it is still not profitable for farmers to cultivate, except for the Northern Province. The financial cost of subsidizing wheat cultivation is greater than the tax revenue that is generated indirectly by the output production. This shows that the cultivation of wheat is not a profitable crop for the Rwandan economy under prevailing conditions. For the economy to break even on wheat production, with the current policies and valuations in place, the per-hectare yield will have to increase by 10.22% in the Northern Province, 17.79% in the Western Province, and 18.92% in the Southern Province. In reality, productivity has only increased across the country by an average of 1.24% from 2012 to 2016 (FAO, n.d.-b).11 At this rate, it will take about eight years to achieve sustainability in the Northern Province and about 15 years in the Southern and Western Provinces. A key recommendation for improving yields is to increase mechanization of post-harvest processes such as threshing, winnowing, and warehousing to reduce the post-harvest losses faced by many smallholder farmers. This is still a work-in-progress by the RAB.

2.5 Conclusion

The financial and economic returns of seven of the most cultivated crops in Rwanda, namely beans, cassava, maize, potato, rice, soybean, and wheat, have been analyzed to determine their sustainability if the current agriculture policies are continued in Rwanda.

This integrated cost-benefit analysis shows beans, cassava, and potato cultivation to be financially, economically, and fiscally sustainable, but rice, wheat, and soybean cultivation to be financially unsustainable without continued subsidization. Maize production is found to be economically sustainable in the Southern Province but not

in any of the other provinces where it is cultivated. The land and climatic zones in Rwanda are highly segmented. It is critical to select the crops to be grown in each zone so that farmers have a financial incentive to grow the crop and so that it is economically feasible in order to be sustainable.

Table 9: Annualized Fiscal Impacts of The Agricultural Policies Of Rwanda (000s $ - 2016 Values)

Crops	Western	Eastern	Southern	Northern	Total
Bush beans		3,703	2,068		5771
Climbing beans	1,157			2,486	3643
Cassava	988	1,382	5,584		7954
Maize	-5,313	-6,456	-2,899	-4,422	-19090
Potato			732	5,575	6307
Rice	-1,722	-5,586	-4,000		-11308
Soybean	-830	-1,807	-1,967		-4604
Wheat	-787		-1,179	-2,334	-4300
Total	**-6507**	**-8764**	**-1661**	**1305**	**-15627**

In Table 9, the fiscal impacts of the agricultural policies are annualized. The values represent the average annual overall fiscal burden of the government that combines the cost of the direct subsidies, the indirect taxes gained and the tariff revenues lost from the domestic production of rice. The net impact is approximately 15,627 million annually. This is equal to approximately 1 percent of the annual government budget. While this is a substantial fiscal drain of the government, it is not likely to be an unsustainable fiscal burden. A disproportionate amount of the net costs is created by the government's promotion of rice, soybean, and wheat cultivation. While they account for only 8 percent of the total land cultivated in crops, the combined losses account for more than 100 percent of the net annualized fiscal losses of the government. Of these three crops, only rice has some potential to become a sustainable crop without direct subsidization but in the presence of protection from international

competition. While maize is imposing a significant fiscal burden at present, this loss is coming about principally because of the low productivity of maize in the Western Province. For all the crops, the Western Province has the lowest level of return to the farmers except for rice and wheat, which are being heavily subsidized. In particular, wheat has little possibility of ever being economically sustainable.

Chapter 3

COST-BENEFIT ANALYSIS OF RWANDAN DAIRY VALUE CHAINS

3.1 Rwanda Dairy Competitiveness Program II

One of the key policy objectives of the government of Rwanda is to increase the competitiveness of Rwandan dairy products in regional markets and to improve rural households' incomes by leveraging private and public investment to increase the quality and efficiency of the dairy value chain (VC).

These include its Vision 2020, Economic Development and Poverty Reduction Strategy (EDPRS), Strategic Plan for the Transformation of Agriculture in Rwanda (PSTA II), and Agriculture Sector Investment Plan (ASIP), each of which includes the objectives of enhancing the dairy VC and increasing the consumption of milk-based products.

This chapter is an integrated investment appraisal of the RDCP II project which has entailed a wide range of interventions to improve the productivity of the dairy VC and enhance the quality of outputs. This project collaborates with the –Girinka/One Cow Per Family program.

The project approach was designed to address strategic drivers of the dairy VC, such as production volumes, seasonal variations in production, milk quality, and the

reduction of cost inefficiencies. The RDCP II interventions across the VC are illustrated in Figure 2:

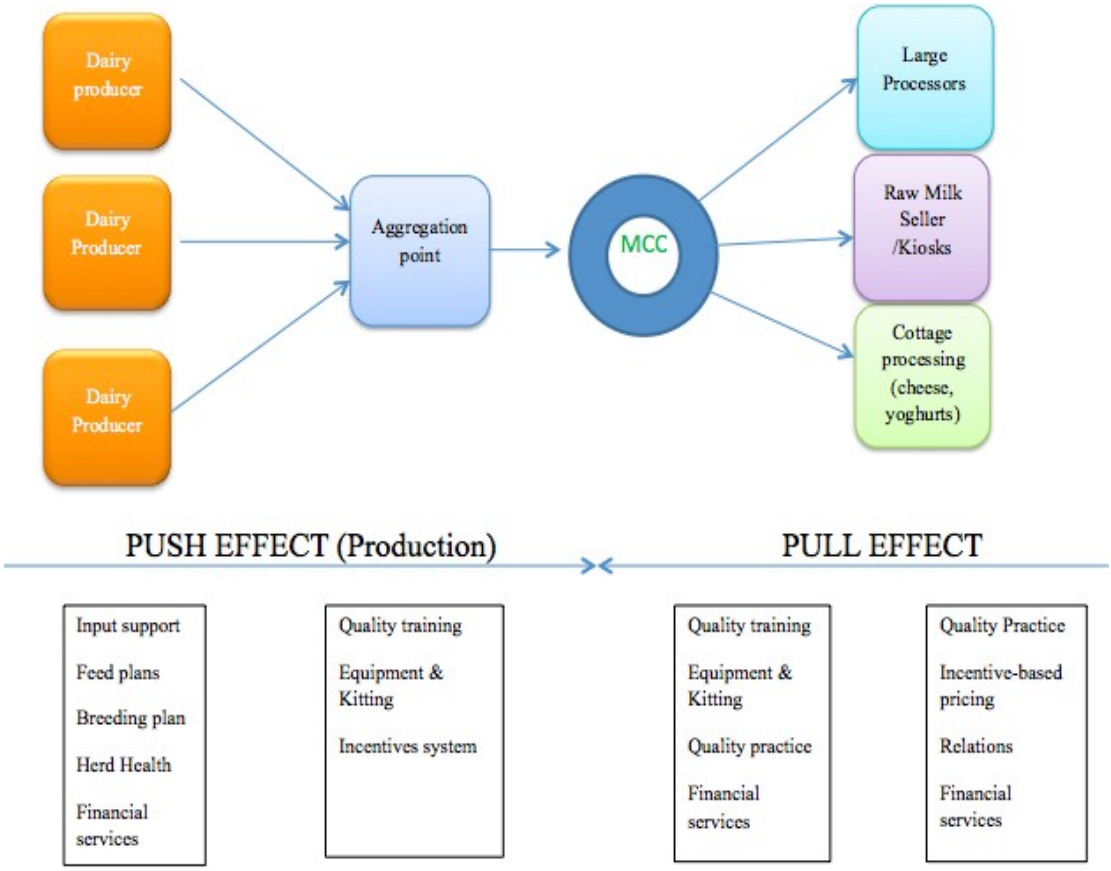


Figure 2: RDCP II Interventions across Dairy Value Chain (Land O'Lakes Inc., 2015)

The push-and-pull strategy selected by the RDCP II project resulted in positive financial and economic gains throughout the VC. Significant improvement in raw milk quality and market linkages translated into an increase in the farm-gate price for raw milk, which further fueled an increase in production at the farm level. Training programs and follow-up sessions enabled farmers to improve their skills and achieve higher productivity.

The CBA grouped RDCP II project interventions according to three functional areas of activity:

Productivity improvement interventions – Interventions that result in higher annual milk yield. These interventions affect major production parameters such as lactation, milk yield, and calving interval. The interventions include:

a. Training of service providers
b. Training of farmers
c. AI provision and support
d. Facilitation of access to veterinary services.

Quality enhancement and market access improvement interventions – Interventions that directly improve the quality of raw milk to satisfy the quality requirements of milk processing companies. These interventions helped to improve market access and achieve a one-third price increase for raw milk. The interventions include:

a. Creation/enhancement of market linkages
b. Expansion grants to Milk Collection Centers (MCCs) and producers of dairy products
c. Input support (equipment and testing kits)
d. Training of MCC staff and processors on quality improvement and new product development.

Increased milk consumption interventions – Interventions that contributed to the successful roll-out of milk zones resulting in a significant reduction in the price of pasteurized milk. The interventions include:

a. National milk consumption campaign ―Shisha-Wumva‖
b. Support in the development and roll-out of milk zones.

The complexity of the dairy VC means that an increase in productivity is unlikely to result from a single intervention. For example, while training can help farmers boost milk yields, they may remain reluctant to increase investment in feed in the absence of market linkages to facilitate the sale of increased output. However, by grouping interventions according to functional activity, a VC-based analysis of the RDCP II project can demonstrate the direct benefits attributable to each group of activities—an approach greatly facilitated by the clear and efficient design of the RDCP II project itself.

3.2 Methodology and Data

3.2.1 Methodology

The Integrated Investment Appraisal (IIA) model offers a means of evaluating both the financial and the socio-economic effects of an investment project, estimating its impact from various perspectives. IIA is the only single-model approach to quantify the impact of every project-related transaction, from the private investor to tax revenues, fiscal expenditure, consumers, and the environment. The methodology is used in project evaluations by major development banks, donor agencies, and public investment units.

Alternative forms of impact analysis entail discrete financial analyses and assessments of economic impact, which independent analysts often carry out at different stages of project development, therefore, rarely provide an opportunity for experts to adjust and improve project design.

This analysis is conducted on an incremental basis to determine the net incremental impact of the project on various stakeholders, including project beneficiaries, and to

test the project's financial sustainability. The socio-economic assessment (Economic module) builds on the Financial, greatly reducing the time and resources normally required for such studies. The Economic module is based on the principles of applied welfare economics, according to which socio-economic benefits are assigned monetary values and assessed using typical investment project efficiency indicators, such as economic net present value (ENPV), analogous to financial net present value (FNPV), and economic rate of return (ERR), analogous to the internal rate of return (IRR).

3.2.2 Model Description

The analysis is applied to a 20-year evaluation period, 2012-32, and compares –with-project and–without-project scenarios on an incremental basis, with real financial and economic discount rates set at 12 percent. The model is constructed on an annual basis with the base year of 2012 and results expressed in 2012 prices. The model first derives nominal cash flows, which are then discounted using corresponding price indexes to derive real cash-flow statements. The analysis uses World Bank inflation and exchange rate data. The model is based on the herd projection table, which uses technical parameters of the reproductive performance of dairy cows to estimate numbers of live animals and milk production[1].

Statistical analysis and field visits[2] revealed a mean herd size per household of two dairy cows. Limited landholdings do not allow significant expansion of per-household herds. However, field visits also revealed that improved productivity resulted in farmers shifting cattle from free-grazing to zero-grazing, enabling them to feed up to three cows. This finding was also confirmed by Land O'Lakes staff. Therefore, the

[1] The sources of all inputs used in the analysis can be found in annex H.
[2] The stakeholders interviewed can be found in annex A.

without-project scenario assumes that per-household herd size will be limited to two dairy cows, while the with-project scenario envisages farmers expanding to the optimal three-cows per household.

Dairy farmer cash-flow profiles provide the basis for subsequent economic, stakeholder, and risk analysis of dairy farming activities. The number of beneficiaries who received RDCP II support is used to derive an aggregate economic resource flow statement.

3.3 Empirical Results and Discussions

3.3.1 Incremental Financial Analysis

Primary data for the financial analysis was collected during a data collection trip in November 2015. Consultations with agricultural experts and implementers of the RDCP II project and a literature review were used to analyze and adjust the data. A set of farm budgets for the without-project and with-project scenarios was prepared[3], adjusted for an increase in farm-level production costs. The farm budgets were prepared based on mean values, excluding statistical outliers from the analysis.

A summary of the incremental financial analysis of the RDCP II project is presented in Table 10 below.

Table 10: Incremental Financial Analysis (US$)

RDCP II Beneficiaries	IRR	FNPV
Household	20.90%	1,663
Total	20.90%	39.6 mill

[3] See Annex B – Indicative Annual Dairy Farm Budget ("Without Project") and Annex C – Indicative Annual Dairy Farm Budget ("With Project") below

The adoption of farming practices promoted by the RDCP II project has resulted in positive financial returns for dairy farmers. For the first three years of the project, 2012 to 2015, the dairy farmers will experience temporary reduction in their annual cash flow. This period is a transition period when farmers are expanding their stocks from 2 to 3 cows. It is not that the wealth of farmers is going down; rather, farmers are investing to realize higher future returns. In 2015, the annual dairy farmer household income would reach US$155.5 with-project, compared to US$111.4 in the without-project scenario. The incremental income is US$44.1 per household, which represents an increase of 39.6 percent. The incremental cash flow approaches its maximum in 2016 and stabilizes in 2017. Starting 2017, the net incremental income of farmers reached US$ 416, which is almost four times of US$111.4 in the without-project scenario. The expected incremental FNPV from the farmers' perspective is US$39.6 million, assuming that 23,817 individual farmers will benefit from the project. The incremental IRR is 20.9 percent.

The analysis assumes that farmers have two dairy cows in both the with and the without-project scenarios. In the with-project scenario, farmers rear a heifer to expand their herd to three dairy cows. The opportunity cost of the cows is not included as a financial outflow at the farm level. The FNPV of the without-project scenario is US$507/household. The FNPV of the with-project scenario is US$2,170/household. If the opportunity cost of two-cows/household is included as an investment cost, the FNPVs of the without-project and –with-project scenarios are negative US-$808 and positive US$854, respectively. That is to say, investments by farmers and entrepreneurs in dairy farming became financially feasible. Field visits revealed the establishment of a few small-scale private dairy farms, which confirms this important conclusion.

3.3.2 Benefits of RDCP II Interventions

3.3.2.1 Benefits of Productivity Improvement Interventions

Training programs on improved dairy-farming practices, including animal feeding and care, heat detection, milking practices, and shelter parameters, coupled with improved access to AI and veterinary services, have resulted in better animal reproductive performance and higher milk yields. RDCP II extended grants to veterinary and AI service providers to purchase much-needed motorcycles, train farmers, and inseminate dairy cows of vulnerable households. This allowed private veterinary companies to expand their network of clients while also contributing to the sustainability of the RDCP II approach.

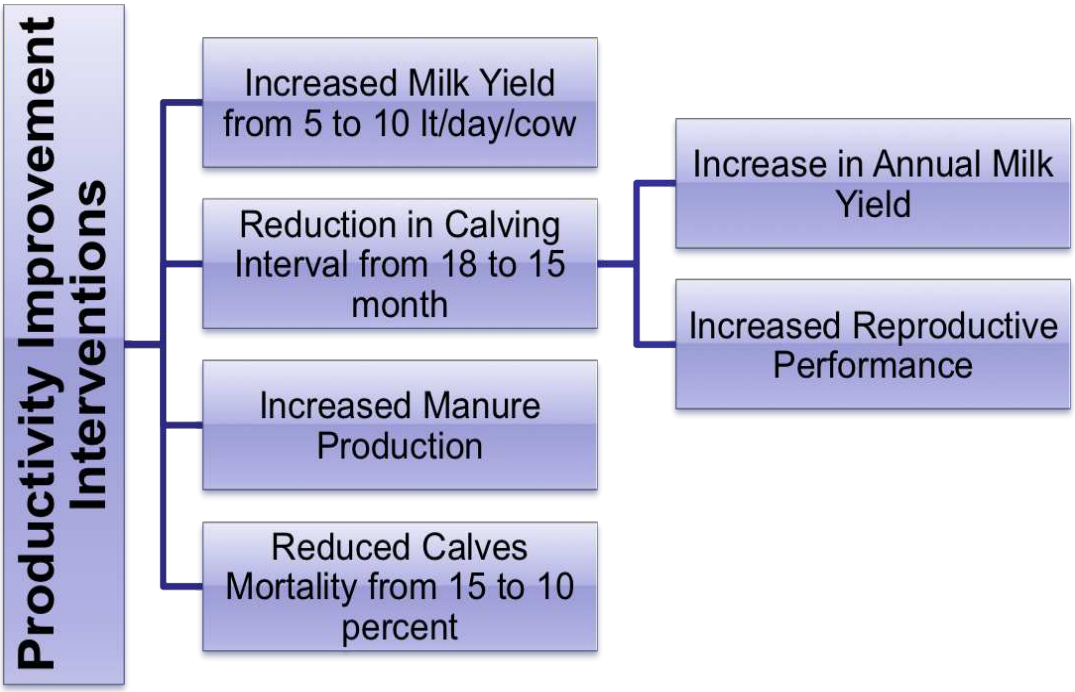


Figure 3: Benefits of Productivity Improvement Interventions

The daily milk yield increased from an average of 5 lt/cow to 10 lt/cow, while the calving interval reduced from 18 to 15 months. The annual milk yield per cow

therefore increased from 608 liters to 1,949 liters[4]. In addition to increasing milk yields, a reduction in the calving interval has the additional benefit of improving animal reproductive performance. At the same time, improved nutrition and the more frequent use of anti-tick spray, de-worming drugs, and vitamins reduced the calf mortality rate from 15 to 10 percent. Furthermore, increased feed intake doubled farm-level production of manure.

3.3.3 Benefits of Quality Enhancement and Market Access Improvement Interventions

The RDCP II project has linked individual dairy producers to dairy cooperatives and MCCs[5]. The MCCs in turn were linked to milk processors, including Inyange Industries and in some instances other private milk processing companies. The financial and business management coaching has allowed MCCs to operate more efficiently and effectively. Throughout the VC, significant investments were also made to improve milk quality, including grants to cooperatives to buy motor vehicles to to transport milk from milk aggregation points, expand the capacity of MCCs, and purchase milk quality testing kits.

[4] $\text{Annual Milk Yield} = \frac{\text{Lactation Milk Yield}}{\text{Calving Interval}} \times 365$

[5] The MCCs were built by the GoR, which retains ownership, but are operated by individual dairy cooperatives.

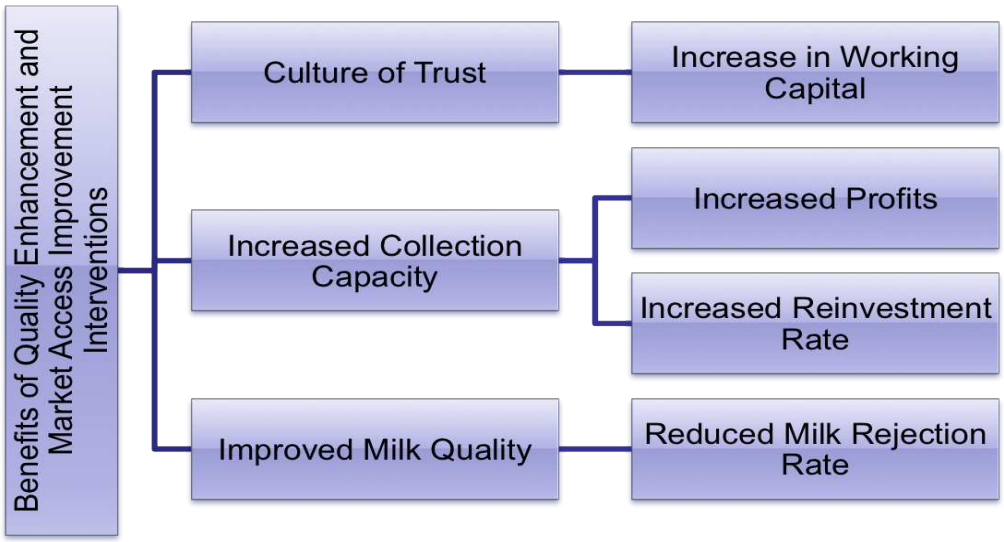


Figure 4: Benefits of Quality Enhancement and Market Access Improvement Interventions

Improved MCC management practices and strong linkages with farmers created a culture of trust between the MCCs and dairy farmers.

Farmers are now paid monthly for milk delivered to the MCCs, minus the cost of maize bran and feed concentrates purchased from the MCCs[6]. MCC members can also borrow money from the cooperatives. By paying farmers monthly, MCCs can maintain sufficient working capital to operate while farmers can save and plan their investments. Better linkages with farmers also allow the MCCs to increase capacity utilization and, in many instances, even expand the initial installed capacity of milk cooling units. This, in turn, positively affected the profitability of MCC operations.

Rates of raw milk rejection at the MCC level were dramatically reduced by training farmers in techniques for the prevention of mastitis and by distributing milk quality testing kits to MCCs and individual milk collectors (see Box 1).

[6] Previously, farmers were paid on a daily basis.

Box 1: Benefits of Milk-Testing Kits

Milk collectors collect around 2-5 liters of milk from an individual farmer, which is then transported in 20-liter jerry cans. In the absence of testing kits, poor quality milk from a single farm can therefore result in the spoilage of an entire jerry can, yet it is not possible to identify which farm supplied the tainted milk.

Not only are milk losses high, but trust between milk collectors and farmers is also jeopardized.

Collectors travel by bicycle for significant distances along mountain roads; once milk is rejected at the MCC, collectors have little incentive to return milk to farmers. Testing kits enable the identification of poor-quality milk at the farm gate. The farmer is then able to find an alternative use for the rejected milk.

Moreover, milk collectors have been trained by the MCCs to identify potential reasons for poor quality milk and to advise farmers accordingly.

Interviews with MCC staff revealed that the gains associated with testing kits had led to investments in the purchase of additional kits for distribution to every collector working with the MCC.

The analysis indicates that improved milk quality and market linkages resulted in a one-third increase in the farm-gate milk price, from RWF 120 per liter to RWF 160 per liter. This price increase stems from two sources:

a. Prior to the linkage between MCCs and milk processors, the farm-gate price of milk was RWF 120/lt. Once the linkage was created, the MCCs immediately increased the price to RWF 160/lt—an increase made possible by the higher price milk processors paid to the MCCs because of increased quality. Milk processors require the MCCs to deliver milk of a certain level of quality.

b. Field visit investigations revealed that in areas where farmers have limited

market access, the farm-gate price of milk remained at RWF 120/lt.

The dairy cooperatives distribute profits to members in the form of dividends. The distribution of profits combined with the significant increase in the farm-gate price leads to the conclusion that financial gains at the MCC level are pushed down to individual dairy farmers.

3.3.3.1 Benefits of Increased Milk Consumption Interventions

The enhanced productivity of Rwanda's dairy VC has resulted in significant gains for consumers. The project sponsored a national milk consumption campaign, ―Shisha Wumva‖[7], which has reached more than 650,000 households. Although the analysis does not attempt to estimate the increase in milk consumption that is due to Shisha Wumva, it is reasonable to expect that such a campaign had a positive effect on milk consumption.

Prior to donor/GoR interventions to improve the productivity of the dairy VC, Inyange Industries' daily sales of packaged pasteurized milk were just 10,000 liters—a figure limited by the prohibitively high price of US$ 1.05/lt. However, improved market linkages resulting from the RDCP II project produced such a sharp increase in the supply of raw milk to processing plants that Inyange Industries was unable to sell all the milk provided by the MCCs an expensive packaged product. The result was an innovative development known as milk zones.

Inyange Industries launched the first milk zone in Kigali in 2014, selling pasteurized milk - on tap at half the price of its packaged milk (US$ 0.53/lt vs. US$ 1.05/lt). Within

[7] Which roughly means if you drink milk, you will grow strong

18 months of its launch, Inyange Industries had established 70 milk zones, with daily sales of pasteurized milk reaching 28,000 liters—an increase of 17,000 lt/day. The RDCP II project played an active part in operationalizing Inyange Industries' milk zone idea.

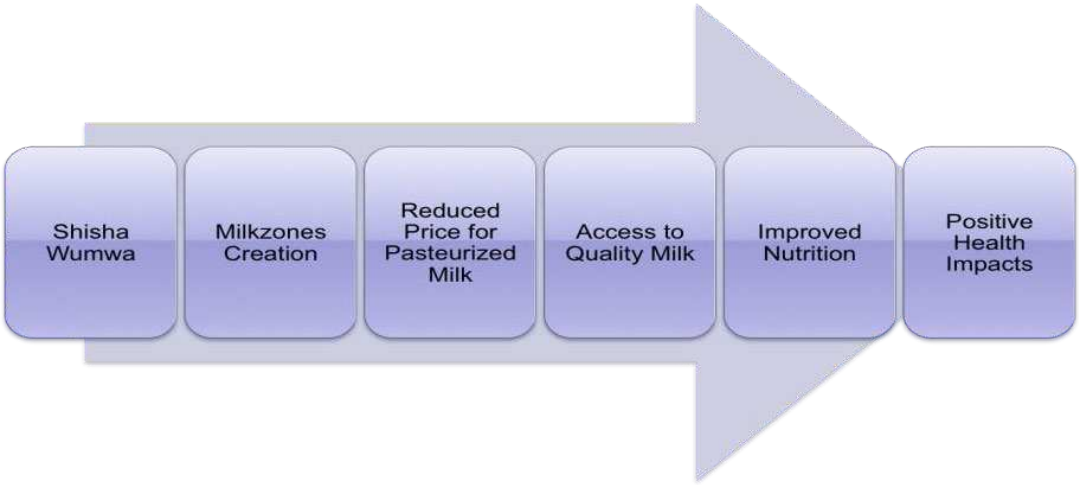


Figure 5: Milk-Consumer Benefits

A 50 percent reduction in the price of pasteurized milk amounts to a significant gain for milk consumers. According to the FAO, the own-price elasticity of demand for pasteurized milk for high-income and low-income groups is 0.21 and 0.70, respectively (Muriuki, 2011). For US$ 1.05/lt, it is reasonable to assume that only relatively high-income households will exhibit a demand for pasteurized milk. Assuming an own-price elasticity of 0.21, the increase in pasteurized milk consumption among high-income households will amount to 1,050 lt/day. Total milk consumption of high-income households will therefore reach 11,050 lt/day. The annual gain in consumer surplus amounts to US$ 2.02 million to this household group. Assuming no growth in demand for milk, the PV_{2012} at 12%[8] of these annual gains

[8] An economic discount rate of 12% is used in the study as this rate of economic discount is a

over the 20 years of analysis is US$14.89 million.

$$CS^{\text{High Income}} = (P^0 - P^1) * Q^1 + \frac{1}{2}(P^0 - P^1) * (Q^1 - Q^0)$$

$$CS^{\text{High Income}}_{\text{Annual}} = \text{US\$ } 2.02 \text{ mill}$$

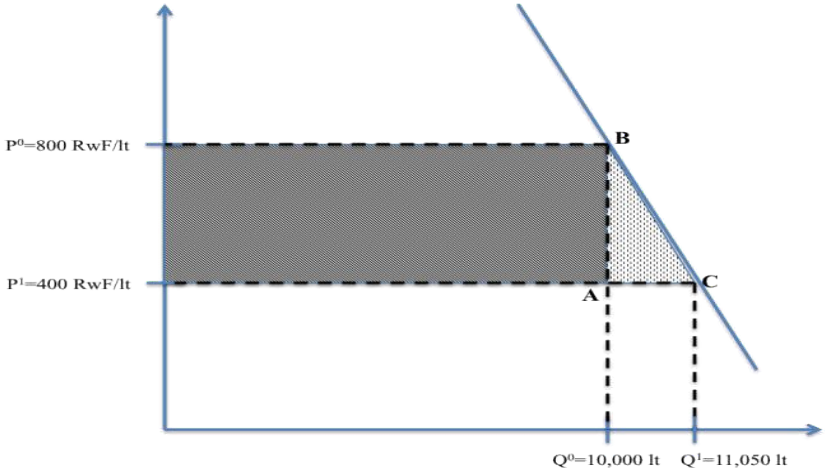


Figure 6: Gain in Consumer Surplus of High-Income Households

Low-level income households who previously used to boil raw milk consume the remaining 16,950 lt per day. The average Rwandan urban household purchases one to three liters of raw milk per day. In Kigali, raw milk currently trades at US$ 0.46/lt (RWF 350/lt). An important additional cost, however, is the cost of boiling.

The cost to a household of a liter of boiled milk, according to the amount prepared, has been calculated as US$0.77 (RWF584)/lt for one liter, US$ 0.61 (Rwf 467)/lt for two liters, and US$ 0.56 (Rwf 428)/lt for three liters (see Annex D; the cost of boiling is constant irrespective of amount prepared).

requirement in evaluating USAID financed project.

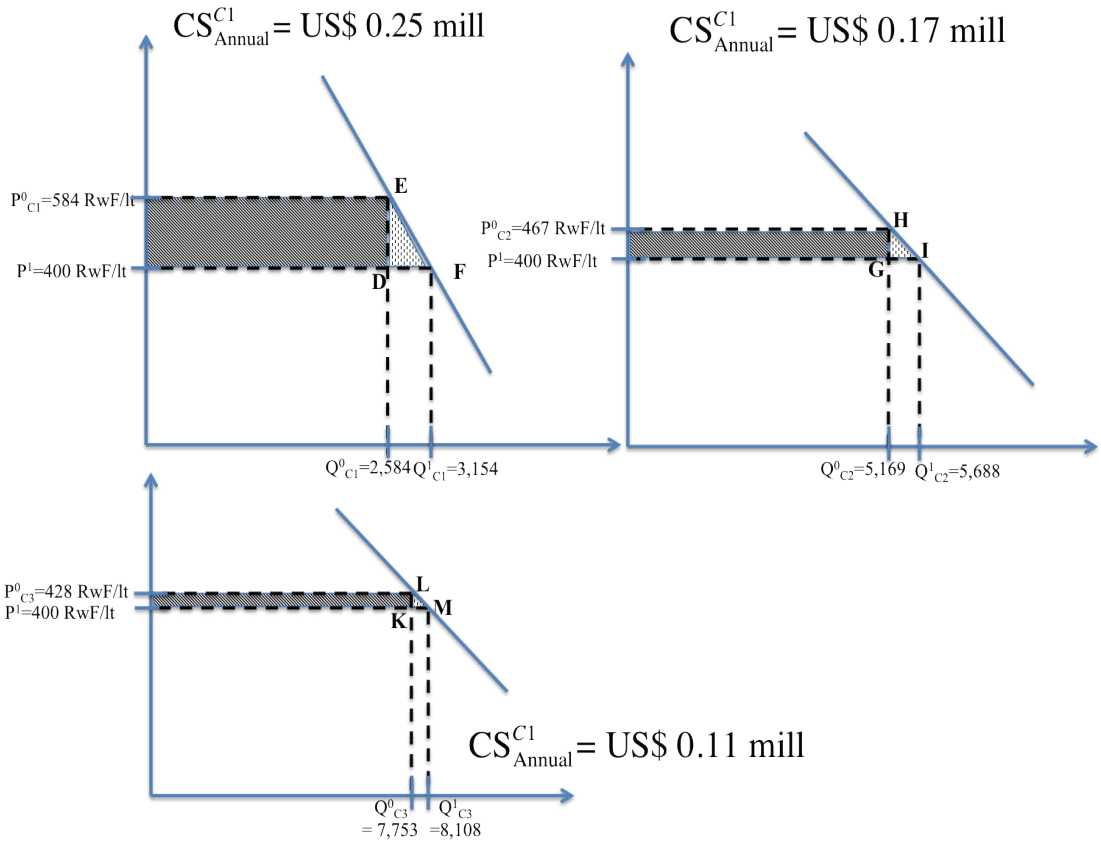


Figure 7: Gain in Consumer Surplus of Low-Income Households

Annual gains in consumer surplus for the three types of low-income households, categorized by milk consumption, range from US$0.11 million to US$0.25 million. The total annual gain in consumer surplus is US$0.53 million, which has a PV_{2012} at of US$3.94 million.

The total PV of gains in consumer surplus due to the creation of milk zones is estimated at US$18.83 million. However, these gains cannot be exclusively attributed to the RDCP II or to any other specific stakeholder in the dairy VC. Therefore, while the finding is important, the analysis does not include the gains as a benefit in its estimate of economic returns of the RDCP II project.

3.3.4 Incremental Costs of Dairy Farming

Given the limited land availability in Rwanda, zero-grazing cattle or intensive farming represents the only sustainable option for profitable dairy farming. However, the shift from free- (extensive) to zero-grazing (intensive) implies a significant increase in the incremental cost of dairy farming, including:

a. **Construction of cattle shelters:** The RDCP II project trained farmers in animal husbandry and hygiene, including minimum requirements for shelters. The average cost for the construction of a shelter for three dairy cows is US$ 329 (RwF 250,000).

b. **Increase in the incremental cost of feed and water:** The without-project scenario assumes that dairy farmers allocate an average of 0.75 ha of marginal land to feed a head of cattle, plus a bundle of Napier grass as an evening supplement to free grazing - a poor feed ration that contributes to low dairy-cow productivity. In the with-project scenario, cattle are moved to zero-grazing, thereby gaining the opportunity cost of land previously allocated to free grazing (or the collection of grass if the cow was zero-grazed). However, cattle then require three bundles of Napier grass, three kg of feed concentrate, and three jerry cans of water per day, per cow - increasing the incremental cost of feed and water by almost four times, from US$ 112 per cow/year to US$ 441 per cow/year.

c. **Increase in veterinary costs:** Average annual veterinary costs increase from US$ 61 per cow/year to US$ 70 per cow/year.

d. **Increase in labor:** Improved animal care requires more labor, the cost of

which increases from US$ 47 cow/year to US$ 79 per cow/year.

3.3.5 Economic Analysis

The financial analysis outlined above forms the basis for an economic assessment of RDCP II investments, examining the incremental costs and benefits of project activities in terms of their broader impact on society. However, market prices frequently do not correspond to the actual value of resources produced and consumed during a given activity due to distortions such as taxes and subsidies. The GoR exempts all agricultural and livestock products from value-added tax (VAT), and there are no import duties. The main source of distortion, therefore, is a foreign exchange premium.

The analysis presented here uses commodity-specific conversion factors to adjust cash flows to derive net resource flows from dairy farming (Republic of Rwanda, Ministry of Finance and Economic Planning, 2014). The net resource flows are then scaled up according to the number of RDCP II beneficiaries to capture total net economic benefit[9].

Table 11: Incremental Economic Analysis of RDCP II Project (US$)

RDCP II Beneficiaries	ERR	ENPV
Household	23.00%	2,038
Total	23.00%	48.5 mill
Present Value of Investment		12.2 mill
Economic Net Present Value:		36.3 mill
ERR International Donor Agency Perspective:		18.70%

[9] See Annex F for a complete set of conversion factors employed in the analysis.

The analysis treats milk as an importable project output. Although no statistics on milk imports to Rwanda are available, interviews with the Ministry of Agriculture staff indicate that before 2012 significant quantities of milk were imported from Uganda. However, domestic production now appears sufficient to satisfy domestic demand. Moreover, several sources report increasing exports of Rwandan dairy products (Land O'Lakes, FAO). All non-processed agricultural and livestock products are exempt from GoR VAT, as is locally processed milk. The only distortion on milk is the foreign exchange premium (FEP), which is estimated at 5.3% for Rwanda(G. P. Jenkins et al., 2015).

Maize bran and concentrates used as animal feed are produced locally. However, production inputs are imported from Uganda and Tanzania. There is no import duty or VAT on these inputs; the conversion factor is estimated at 1.053 due to the FEP distortion. The same distortion and conversion factor apply to animal pharmaceuticals and vaccinations.

The conversion factors for artificial insemination (AI) and veterinary services are estimated as a weighted average conversion factor for animal pharmaceuticals, transportation and veterinary service charges equal to 0.984 and 1.037, respectively.

3.3.6 Stakeholder Analysis

The social analysis of the project estimates the distribution of income changes caused by the project. This distributive analysis includes the reconciliation of financial, economic, and distributional appraisals, as well as identifying project impacts on principal objectives of the society concerned. There are four main stakeholders associated with the RDCP II project are the dairy farmers, Rwandan government, milk consumers and the multilateral donor agency.

The financial gains to dairy farmers are reported as the corresponding FNPV in the financial analysis section. Taxes represent a fiscal gain to the GoR with a PV of US$8.9 million over the 20-year period. The bulk of the gains to the GoR is due to FEP savings from reduced milk imports. Sales of culled animals and male calves for beef also result in FEP earnings, since large quantities of meat are exported from Rwanda to the Democratic Republic of the Congo.

The cost of international donor agency investments is nominal at US$15 million over the life of the RDCP II project. This translates into a PV at 12% of US$12.4 million. Table 12 presents the results of distributive analysis.

Table 12: Distributive Analysis (US$ millions)

Stakeholder	PV of Gains/Losses
Dairy Farmers	US$ 39.6 mill
Government of Rwanda	US$ 8.9 mill
International Donor Agency Investment	(US$ 12.2 mill)
Total	US$ 36.3 mill
Milk Consumers	US$ 18.83

It should be noted that the PV of consumer gains (US$ 18.83 million) are not included as a financial or economic benefit of RDCP II investments. The project's contribution in terms of consumer surplus should, however, be acknowledged.

3.3.7 Sensitivity and Risk Analysis

A sensitivity analysis was carried out to analyze the impact of changes to the main assumptions/parameters on deterministic returns of the RDCP II project. The

sensitivity analysis was conducted on six variables:

1. Change in the calving interval
2. Change in the daily milk yield
3. Change in the price of Napier grass
4. Change in calves' mortality rate
5. Change in the farm-gate milk price
6. Change in optimal herd size.

The calving interval is the main parameter affecting the reproductive performance of dairy cows. A change in the calving interval affects the number of births per period and has a significant impact on annual milk yield. Therefore, a change in this parameter has a significant impact on the financial and economic returns of dairy farming. The baseline scenario assumes a fall in the average calving interval, from 548 days to 457 days—a 20 percent reduction that results in an FNPV 14-times higher than the FNPV of RDCP II interventions with no change in the calving interval.

Table 13: Change in the Calving Interval (US$ millions)

		Financial NPV	Economic NPV	Fiscal NPV	Econ. Intl. Donor Agency
-20%	366	95.16	107.41	12.25	95.23
-15%	388	79.39	90.71	11.32	78.53
-10%	411	64.67	75.12	10.45	62.95
-5%	434	51.46	61.12	9.66	48.95
-	**457**	**39.60**	**48.54**	**8.94**	**36.37**
5%	480	28.89	37.19	8.30	25.02
10%	503	19.18	26.89	7.71	14.72
15%	526	10.34	17.52	7.18	5.34
20%	548	2.59	9.30	6.71	(2.88)

The annual milk yield of a dairy cow is a function of the calving interval and average daily milk yield during the lactation period. The baseline analysis assumes an increase in milk yield from 5 liters to 10 liters per day per cow. This parameter varies significantly according to several factors, including cattle breed, age, feed ration, point of lactation cycle, and the expertise of the individual farmer. An increase in average daily milk yield of just one liter, from 10 lt/day to 11 lt/day, results in a 63.6 percent increase in the ENPV from the international donor agency perspective. A drop from 10 lt/day to 8 lt/day results in a negative FNPV and ENPV from the international donor agency perspective. However, dairy farmers will always seek to ensure financial profitability by adjusting feed rations according to milking performance.

Table 14: Change in the Daily Milk Yield (US$ mill)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. Intl. Donor Agency
5	(69.58)	(66.43)	3.16	(78.60)
6	(47.75)	(43.43)	4.31	(55.61)
8	(4.07)	2.55	6.63	(9.62)
10	**39.60**	**48.54**	**8.94**	**36.37**
11	61.43	71.53	10.10	59.36
12	83.27	94.53	11.26	82.35
13	105.11	117.52	12.41	105.35
14	126.94	140.51	13.57	128.34

The baseline scenario assumes a price of RWF 100 per bundle of Napier grass. However, Napier grass is rarely traded as it is the main component of feed, and farmers prefer to grow it themselves. The cost of production of Napier grass can be as low as RWF 50 per bundle, while the dry-season price may rise as high as RWF 500 per bundle. A 10 percent increase in the baseline price of Napier grass results in a 27.5 percent decrease in ENPV from the international donor agency perspective.

Table 15: Change in the Price of Napier Grass (US$ millions)

		Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. Intl. Donor Agency
-30%	70	69.47	78.41	8.94	66.24
-20%	80	59.51	68.45	8.94	56.28
-10%	90	49.55	58.50	8.94	46.32
-	**100**	**39.60**	**48.54**	**8.94**	**36.37**
10%	110	29.64	38.58	8.94	26.41
20%	120	19.68	28.63	8.94	16.45
30%	130	9.73	18.67	8.94	6.50

The team could not obtain solid evidence of the positive impact of the RDCP II interventions on calf mortality rates, which vary from farm to farm. In the absence of statistical analysis, it is nonetheless possible to state that improved feeding and animal care would result in a reduction in mortality rates. The analysis therefore assumes a conservative 5-percent decrease in the calf mortality rate, compared to the baseline estimate of 15 percent. If the RDCP II interventions had no impact on the calf mortality rate, ENPV from the international donor agency perspective falls 14.1 percent, from US$ 36.37 million to US$ 31.24 million.

Table 16: Change in the Calves' Mortality Rate (US$ mill)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. Intl. Donor Agency
5%	44.42	53.70	9.28	41.53
6%	43.46	52.66	9.21	40.49
8%	41.52	50.60	9.08	38.43
10%	**39.60**	**48.54**	**8.94**	**36.37**
12%	37.68	46.48	8.81	34.31
14%	35.76	44.44	8.68	32.26
15%	34.81	43.41	8.61	31.24

One of the main benefits of project interventions to improve milk quality and market linkages was an increase in the farm-gate price of milk, from RWF 120 to RWF 160. A 12.5 percent reduction in the baseline price of RWF 160 reduces ENPV from the international donor agency perspective by approximately 80 percent to US$ 7.63 million, while the FNPV falls by 70 percent to US$ 12.3 million. The floor price of milk (adjusted for increased feed costs) is approximately RWF 130.

Table 17: Change in the Farm Gate Milk Price (US$ millions)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. Intl. Donor Agency
120	(14.99)	(8.94)	6.05	(21.12)
130	(1.35)	5.43	6.77	(6.75)
140	12.30	19.80	7.49	7.63
150	25.95	34.17	8.22	22.00
160	39.60	48.54	8.94	36.37
170	53.25	62.91	9.66	50.74
180	66.89	77.28	10.39	65.11
190	80.54	91.65	11.11	79.48
200	94.19	106.02	11.83	93.85

The field visits found that farmers tend to increase herd size from two to three dairy cows to increase profitability. However, the sensitivity analysis of herd expansion does not appear to confirm this finding. If the herd size remains at two dairy cows, the FNPV and ENPV from the international donor agency perspective increase by 14 percent and 8 percent, respectively. An increase in herd size results in lower cash flows in the initial years due to the increased cost of animal rearing. However, the optimal herd size of three dairy cows results in annual incremental cash flow, rising from US$244 to US$416 per farmer. By investing in an appreciating asset (a heifer), farmers accumulate savings that can either be turned into cash, therefore mitigating risk, or increasing future net cash flows. The real IRR of herd expansion is 10.7 percent. Therefore, a farmer for whom the next best investment alternative will generate a return of less than 10.7 percent is likely to invest in herd expansion. Given that nominal interest rates on deposit accounts in Rwanda range from 6 to 9 percent, it is not unreasonable to expect many farmers to expand their herds.

Table 18: Change in Optimal Herd Size (US$ millions)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. Intl. Donor Agency
2	45.23	51.45	6.22	39.27
3	39.60	48.54	8.94	36.37
4	33.96	45.09	11.13	32.91
6	22.65	37.20	14.55	25.03

3.4 Conclusion

The RDCP II project has produced positive financial and economic returns, with an ERR of 18.7 percent and an ENPV of US$36.37 million. An additional US$18.8

million in consumer gains are attributed to the creation of milk zones.

Following the successful piloting of activities aimed at boosting domestic production of butter, cheese, and yogurt under the RDCP II project, it is recommended that future international donor agency interventions focus on increasing the market for raw milk. Such interventions may include the promotion of local, small-scale production of pasteurized milk and other dairy products. International donor agency/Rwanda and the RDCP II project may also consider providing several MCCs with grants to purchase milk pasteurizing equipment as part of a pilot intervention to expand the market for raw milk.

The analysis revealed that the main gains from market creation are passed on to dairy households through an increase in the farm-gate price of milk. Furthermore, the distribution of dairy cooperatives' profits in the form of dividends paid to members means that financial gains at the MCC level extend to individual dairy farmers.

Chapter 4

COST-BENEFIT ANALYSIS OF RWANDAN POULTRY VALUE CHAINS

4.1 Policy Review[10]

This chapter undertakes and integrated analysis of the laws, regulations, and strategic plans drawn up by the Ministry of Agriculture and Animal Resources (MINAGRI) under its 2012 poultry strategy and implementation plan and the Ministry of Trade and Industry (MINICOM). Five policy areas are considered:

1. Increasing domestic production of day-old chicks;
2 Building a competitive animal-feed industry;
3. Controlling veterinary product quality and improving access to veterinary services;
4. Developing the meat industry; and
5. Regulating the marketing of poultry products on domestic and regional markets.

4.1.1 Poultry Subsector Strategy

The development of Rwanda's poultry industry is guided by a five-year strategy initiated by MINAGRI in 2012 to establish the poultry industry as the flagship of Rwanda's livestock industry by end-2017 (Republic of Rwanda, Ministry of Agriculture and Animal Resources, 2012).

[10] More information about the policies and goals of the Government concerning the poultry subsector can be found in annex I.

MINAGRI's strategy aims to attract private investment to help meet growing domestic and regional demand in a two-pronged approach focusing on improving the (1) production and (2) marketing of Rwandan poultry products.

4.1.1.1 Production

MINAGRI's strategy to improve the production of poultry meat and eggs entails five components, each addressing a key challenge faced by Rwanda's poultry industry;

1. **Poultry nutrition:** The strategy promotes a range of actions, including technical assistance on feed formulation, assessment of locally available poultry-feed resources, and the development of a Public-Private Partnership (PPP) in feed manufacturing. The goal of these actions is to develop a competitive domestic animal-feed industry, while improving stakeholders' knowledge and capacity in animal nutrition.

2. **Supply of day-old chicks:** The strategy aims to develop expertise in the rearing of parent stock and privatize National Hatchery at Rubirizi, as well as to encourage development of new, decentralized mini-hatcheries. The goal of these actions is to boost domestic supply of day-old chicks.

3. **Improve poultry health and biosecurity:** The strategy aims to develop a Rwandan Poultry Biosecurity Program which will include protocols designed to reduce and manage the incidence of disease outbreaks in poultry flocks.

4. **Develop village-level poultry farms:** The strategy aims to improve livestock living conditions, breeding, animal health and disease control. These actions aim to stimulate increase in smallholder farms poultry production.

5. **Strengthen institutional frameworks:** The strategy suggests forms of institutional

support to boost poultry-industry competitiveness, including fiscal incentives, training and the development of industry-specific insurance products.

4.1.1.2 Marketing

MINAGRI's strategy to improve the marketing of poultry products entails two components, each addressing a key marketing challenge faced by Rwanda's poultry industry;

1. Training in standards of sanitation: The strategy aims to raise awareness of and skills in controlling sanitary standards in poultry meat processing and marketing.

2. Branding of Rwandan poultry products: The strategy aims to establish poultry product standards and inspection regimes, with a view to improving competitiveness through the promotion of a high-quality 'made in Rwanda' brand.

The following section provides an overview of policies affecting poultry-industry inputs (feed, seeds, veterinary products, and services) and outputs (meat processing, handling, marketing and regional trade).

4.1.1.3 Policies Affecting Demand for High-quality Poultry Feed

MINAGRI has developed two strategy documents to promote development of a professional feed industry, with a view to increase the domestic supply of high-quality, competitively priced compound feeds. The first, a strategic plan for improving animal nutrition, was launched in 2009(Republic of Rwanda, Ministry of Agriculture and Animal Resources, 2014). This was supplemented in 2012 by a poultry strategy and investment plan, which provides technical guidelines to improve quality of the animal

feed[11].

In addition, the GoR introduced VAT exemption on ready-made feed, and on inputs used for the feed production. VAT exemption is currently applied to the major feed ingredients such as industrial food waste, crops' by-products, salt, minerals and vitamin premixes (Republic of Rwanda, Ministry of Finance and Economic Planning, 2015).

As a result of these policies three medium-sized animal-feed manufacturers, Zamura Feeds, PAFI and Gorilla Feed, launched their facilities in 2014 and 2015. However, these commercial feed producers operate below their potential capacity, frequently below 50% of their installed capacity, due to limited demand. The three feed factories produced just 7,700 tons of poultry feed in 2015, which is equivalent to only 20 percent of annual domestic demand for poultry feed. Limited demand for commercially produced feed can largely be explained by two factors:

a. High price when compared to imported or mixed by farmers feed, FRw 310 per kg compared to FRw 280 per kg.

b. Limited trust/awareness of the quality of commercially produced feed. Majority of farmers prefer to mix feed themselves, because this allows to easily observe the quality of feed ingredients.

[11] A list of the major feed producers as well as the constraints they face can be found in annex P.

4.1.1.4 Policies to Improve Poultry Nutrition

MINAGRI strategies recognize the importance of developing farmers' knowledge and awareness of poultry nutrition. However, the cost of feed concentrates results in a farm-gate price for broilers (average unit cost of kg of broilers is FRw 1,699.5) is above the minimum market price of FRw 1,600 per kg of imported meat. The high cost of feed concentrates is in turn largely dictated by the high cost of the major feed ingredients.

Land constraint prevents Rwanda from efficient large-scale cultivation of maize and oilseed. For instance, it costs an average of FRw 110 per kg to produce maize in Rwanda, compared to FRw 68 per kg in Uganda (prices as of 2016). As a consequence, while the feed itself can be produced in Rwanda, almost all ingredients are still imported from neighboring countries. The imported ingredients are also subject to a withholding tax. Rwandan feed producers also face high utility costs, purchasing electricity at FRw 126 per Kwh compared to FRw 69 per Kwh in Uganda.

In addition, the Rwanda Standards Board (RSB) has yet to introduce regulations on the quality and nutritional value of poultry feed and supplements. The only controls in place concern mycotoxins in maize, which are harmful to animals and traceable through the food chain.

4.1.1.5 Policies Affecting the Poultry-seed Market

Poultry seeds include fertilized eggs, day-old chicks and pullets. The domestic supply of day-old chicks is already increasing fast, supported by the GoR's strategy of providing technical guidelines to local producers, including training in the rearing of parent stock. The strategy also proposes privatization of the National Hatchery at Rubirizi, and encouragement of investors to establish decentralized mini-hatcheries.

Four hatcheries—Rwanda-chick, Rwanda Best, the National Hatchery and Soeurs Visitantines—supplied 51 percent or 912,000 of the day-old chicks sold in Rwanda in 2015, with a further 870,000 (49 percent) imported, mostly from Uganda and Belgium. A day-old chick produced by the National Hatchery (Rubirizi) sells for FRw 700 and FRw 500 for layers and broilers respectively[12], compared to an imported price of FRw 1,025 and FRw 800 from Belgium. A layers day-old chick is also being imported at the price of FRw 790 from Uganda.

According to poultry farmers, however, the quality of a Rwandan day-old chick is similar to the Belgium, pointing to the potential to expand domestic production of good quality day-old chicks, recovering the cost of investment through an increase in the sale price. Indeed, recent evidence suggests that Rwanda-chick has adopted such a policy, raising the price of a day-old layer chick from FRw 800 to FRw950.

Table 19: Break-even price of Broilers Production Assuming a Change in the Feed Price (FRw/kg)

Price of feed	Small Broiler (A)	Medium Broiler, Hatchery included (B)	Medium Broiler, Hatchery excluded (C)	Average (A&B)	Average (A&C)
FRw 275	1,775	1,469	1,703	1,622	1,739
FRw 271	1,767	1,459	1,695	1,613	1,631

The price of feed produced by the commercial plants can be dropped to FRw 275 and FRw 271 and still allow 20% and 15% real rate of return on investment, respectively.

[12] However, there may be hidden subsidies (the price at Rwanda-chick for layers and broilers are FRw 950 and FRw 550 respectively).

However, as it can be seen from the Table 19, the price reduction alone will not allow to reduce the cost of production below the price of imported chicken meat of FRw 1,600. The only scenario when price of chicken meat produced in Rwanda drops below the imported level is in the case of medium scale broiler production with hatchery. This observation allows to conclude that high market price of DOC jeopardizes regional competitiveness of chicken meat production.

4.1.1.6 Policies Related to Veterinary Products and Services

Rwanda's poultry farmers enjoy relatively easy access to veterinary pharmaceutical products, through a large agro-dealers network with more than 1,200 outlets. Veterinary pharmacies are regulated by the GoR (Determining the Organization of Veterinary Pharmacy Practice, 2010), managed by a similarly large network of veterinary doctors and supported by a statutory council, also regulated by law (Determining the Organization of Veterinary Pharmacy Practice, 2010). The two policies regulating veterinary pharmacies and the provision of veterinary services include the requirement that a pharmacy manager hold a bachelor's degree in veterinary medicine and be registered with the Rwanda Veterinary Council, and that an application to open a pharmacy be approved by MINAGRI, which also inspects the premises.

The GoR also exempts veterinary products from VAT to increase affordability of these products at farm level. Despite good access to pharmacies and veterinary doctors, the poultry industry faces a number of key challenges;

- Vaccines are only available in Kigali. High transport costs prevent farmers accessing timely poultry vaccinations, resulting in high mortality rates due mainly to Gumboro and Newcastle diseases.

- Farmers lack sufficient knowledge to avoid the poor quality, cheaper veterinary products from China and India that dominate the market. Better use should be made of the mass media to effectively disseminate information about veterinary products.

- Farmers lack clear guidelines on best practice in poultry farming, including hatchery management, comparative density of different chicken breeds, animal safety and living conditions, including standards of hen housing. The large-scale dissemination of best- practice guidelines to farming should be a priority.

- An increase in the currently limited number of technicians in some districts would encourage potential small-scale investments in poultry farming. Only Gakenke, Rulindo, Bugesera and Kamonyi are well covered by poultry specialists. There is evidence that the presence of technicians in these areas has resulted in increased investment in small-scale poultry farming. There is therefore a need to train and allocate more technicians in rural areas.

4.1.1.7 Policies Related to Meat Processing, Handling, and Marketing

The meat industry is a development priority for the ministries of agriculture and trade, as reflected by the five-year strategy adopted and supportive policies and regulations implemented.

4.1.1.8 Strategy and Investment Plan to Strengthen the Meat Industry (2012-17)

The five-year strategy to strengthen Rwanda's meat industry aims to increase the domestic consumption of quality meat, while increasing the competitiveness of Rwandan meat in East and Central African markets. The objective is to ramp up the current basic structure of Rwandan production to establish a meat industry of sufficient organization and scale as to have a significant impact on the country's social and

economic development.

To that end, the strategy identifies three strategic priorities: to increase meat supply; develop industrial infrastructure; and improve access to domestic and regional markets. Since the launch of the strategy in 2012, MINAGRI has implemented a number of laws regulating the meat industry.

Animal transportation: The transport of live animals is regulated with a view to protecting animal welfare (Public Notice Regarding Livestock Identification, 2002). The law underlines the cultural importance of maintaining the health and welfare of animals, specifying, for example, that chickens are to be transported only in appropriate baskets in the presence of the day light, between the hours of 6 am and 6 pm.

Processing: The slaughter of animals and inspection of meat are regulated by MINAGRI (Ministerial Order on Animal Slaughtering, Meat Inspection, 2010), which oversees guidelines and the issuing of permits required to establish a slaughterhouse. The law also specifies guidelines for the inspection of all meat, whether slaughtered locally or imported, fresh or preserved.

Meat trade: The transport and trade of meat are also regulated by MINAGRI (Ministerial Order on Transport and Trade of Meat, 2010) according to an order detailing requirements for those engaged in the transport of meat and the operation of butchers. The order also specifies the technical requirements of vehicles and employees' clothing, as well butchery design and equipment.

Despite the wide-ranging specifications detailed in the law, however, the issue of compliance remains a challenge. According to a recent survey of 161 butchers conducted by MINAGRI in Kigali, only 8 per cent met basic regulations, including official permits to operate (The New Times, 2015). However, these entrepreneurs do regularly attend training on regulations regarding the handling and storage of meat, and authorities carry out regular inspection exercises to ensure compliance with provisions of the ministerial order.

With regard to other regulations, butchery owners expressed reluctance to invest to meet required standards. One important reason for their unwillingness may be the low purchasing power of meat consumers, such that investments to meet regulations may, at least in the short term, increase the price of meat and so significantly decrease demand.

4.1.1.9 Poultry Sector Subsidies and Fiscal Incentives

A number of donor- and government-funded development projects (e.g. the One-Egg-per-Child program) offer subsidies, physical facilities or stimulate demand to encourage agricultural activities in Rwanda, including poultry farming.

The GoR has also implemented fiscal incentives to encourage farming enterprises. Agricultural inputs and unprocessed outputs are VAT-exempt, including day-old chicks, ready-made animal feed and ingredients used in the manufacture of feed (cereal brans, oilseed cakes, and salt, mineral and vitamin premixes). Veterinary pharmaceutical products and laboratory equipment are also exempt of VAT, as well as equipment used to prepare and process meat and poultry industry equipment (farm inputs, hatching machines, incubators, cold-room equipment and refrigerator systems, and chicken-feed equipment and feed-processing lines)(Republic of Rwanda, Ministry

of Finance and Economic Planning, 2015).

In addition, agri-businesses with an annual turnover of less than FRw 12 million are exempt from income tax (Modifying and Complementing Law No 06/2001 of 20/01/2001 on VAT Code, 2010). As a result of these incentives, most smallholder poultry farmers are exempt of all major taxes.

4.1.1.10 Impact of VAT Exemption

Prior to the February 2015 a standard value added tax (VAT) was levied on the sales of processed animal feeds. Majority of the farmers preferred either to prepare the required feeds at their own farms or to buy informally-prepared feeds from other farmers. In the presence of VAT, the relative competitive position of informal feed producers was strengthened because they could offer lower prices compared to the commercial producers. The existing registered feed producers were incurring losses due to their inability to sell their products and there were also no incentives for new ones to enter the market. As a result, the registered producers started lobbying intensively for almost three years with the Ministries of Trade, Agriculture and Finance in order to drop the VAT on their sales. They had mentioned in their proposal that if the VAT drops, it not only levels the competition in the market, but it also makes their products more affordable for farmers.

In February 2015, the Rwandan Ministry of Finance and Economic Planning accepted the inclusion of processed animal feeds to the list of agricultural products exempted from the VAT liability. No evaluation, however, has been made yet that analyzes the impacts of this policy on the animal feed processing industry. Thus, the current study aims to assess the impact of VAT exemption using an example of poultry feed processing unit with 2 MT/hour capacity.

Prior to VAT exemption for feed concentrates an investment in the feed producing factory would yield a negative financial rate of return of -11% (shown in Table 19) preventing the private investment in this important segment of the poultry value chain. The price of feed required for the private companies to break-even on their investment is estimated at 327 FRw/kg. This price, nevertheless, is 9% more than the existing feed market price which has been already perceived expensive by farmers. The negative financial returns explain the frequent complaint of unprofitability of the feed production raised by the private investors.

The recent VAT exemption allows feed producers to realize a financial rate of return of 53%. Such a high rate of return would in medium term increase competition and drive the price for feed concentrates down, therefore, stimulating further growth of the poultry industry.

Assuming that 20 percent real rate of return on investment is sufficient to attract private capital to feed producing industry, the analysis concludes that the price of feed in a short to medium term will drop to approximately FRw 271/kg (a 10% reduction in the current price). The time lag required for the investors to identify profitable opportunities in the market, allows existing feed producers to benefit from the price of FRw 300/kg. However, increased competition will soon stimulate the price reduction. In addition, the major competitors for the feed producing plants are the farmers themselves. Farmers on average are able to produce good quality feed at FRw 280/kg. Therefore, any price below FRw 280/kg would provide a financial incentive to the farmers to substitute in-house feed production with the commercial feed concentrates. The analysis therefore concludes that the recent VAT exemption on ready feed provided significant incentive for the development of commercial feed industry in

Rwanda.

Table 20: Financial NPV and IRR without and with VAT Exemption (2MT Feed Processing Plant)

Scenario	FNPV (Million FRW)	FNPV (000's USD)	FIRR
Without VAT Exemption	-350	-455	-11%
With VAT Exemption	440	572	53%

Since broilers are either sold domestically and are subject to VAT (without receiving a credit for VAT paid on the feed) or exported without a VAT input refund, the VAT levy on commercially produced feed results an over taxation of the poultry sector as compared to the correct VAT treatment. In addition, because no VAT is levied on feed mixed by the farmers, it puts feed mills at a competitive disadvantage. Furthermore, if the VAT treatment gives the farmers an incentive to mix their own feed while the feed mills can do it a lower economic cost, then an unnecessary inefficiency and waste of resources is created. In such a circumstance the right policy is to not levy VAT on mixed feed.

It is important to note that the GoR also benefits from this policy from different perspectives. Firstly, although it may seem that VAT exemption would reduce fiscal inflows to the GoR, the estimated negative financial returns of the commercial feed production implies that the private investment will not take place, and therefore the potential foregone VAT revenues are rather hypothetical. The GoR will collect the present value of FRw 326 million from each feed producing plant in form of direct and indirect taxes. In addition, the quality of commercially- produced feeds is inspected on

a regular basis, and increased availability of such feed should enhance overall productivity of the livestock sector. Lastly, increase in domestic supply of the feed will benefit the economy through foreign exchange savings since the imports from the neighboring countries would fall.

4.1.1.11 Policies Related to Poultry Import/Export Markets

East African markets are relatively well-integrated and Rwandan importers and exporters are therefore subject to very low regional trade distortions. However, the GoR is continuing to work to decrease non-tariff barriers to trade.

Rwanda is a member of the Economic Community of Great Lakes Countries (Communauté Économique des Pays des Grands Lacs—CEPGL), which includes Burundi and the DRC, and the East African Community (EAC) comprising Burundi, Kenya, Tanzania and Uganda[13]. In 2010, Rwanda signed up to the EAC Customs Union and Common Market Protocol, ensuring the free movement of people, services, labor and capital.

In addition to supporting regional integration, the GoR has initiated a number of policies aimed at boosting national competitiveness in export markets. Guided by the national cross-border trade strategy (2012–17), the Ministry of Trade and Industry (MINICOM) implemented two policies in 2010—the first related to trade and the second to competition and consumer protection. For its part, the Ministry of Agriculture (MINAGRI) is currently reviewing the Rwanda National Export

[13] A review of the poultry sector of Uganda, Tanzania, Kenya, DRC, and Burundi can be found in annexes J, K, L, M, and N, respectively. Rwanda's comparative advantage, if any, is also discussed.

Strategy(2011), drawn up by the National Agriculture Export Development Board.

The GoR also offers local and foreign investors technical assistance in marketing for export, with a focus on logistics, standards (e.g. packaging), exploring market opportunities and improving competitiveness.

With the exception of coffee, tea and minerals, the bulk of Rwanda's exports are to neighboring countries. Almost three-quarters of this cross-border exchange is conducted by informal women traders, dealing in agricultural produce, manufactured goods and re-exports.

Around 80 percent of Rwanda's cross-border trade is in supplies of goods to the DRC's North and South Kivu provinces, which have an estimated annual food demand of over US$2 billion. Persistent instability in the DRC has forced many farmers to flee the land for the comparative safety of towns and cities. Domestic food production is therefore insufficient to meet the needs of the local population, boosting demand for exports/re-exports of poultry products (broilers and eggs) from Rwanda to the DRC's Bukavu and Goma regions.

This growing market has helped push regional market integration to the top of Rwanda's development agenda. As well as taking an active part in regional economic communities, the GoR has pursued policies conducive to regional trade, offering incentives and technical support to private sector interests with a view to increasing national competitiveness.

4.1.2 Poultry Value Chain Analysis

The section analyses Rwanda's poultry industry value chain and its regional competitiveness. The analysis draws on publicly available statistics, as well as on interviews with the key stakeholders.

4.1.2.1 Rwanda's Poultry Value Chain

The growing domestic and regional markets for poultry has spurred investment in the subsector, attracting both local and international funds. (See Figure 1 for key characteristics of the egg and broiler production business environment, including main actors and enabling factors.) The rapid increase in investment in the subsector (mainly for the last three years), is shown by the growing number of agribusinesses in:

Poultry farming (small, medium, large): New large poultry producers like Mugisha farms, Abusol Business Ltd and etc. (See the summary in the annex O enclosed).

Investments in feeds manufacturing by foreign (Zamura feeds, Gorilla feed and PEAL) and domestic (PAFI) investors have been made in 2014/15. In addition, other feed producers such as Rwamagana and Huye animal feed factories are expanding their operations.

Rwanda Chick is the largest day-old Chick producer recently established in Rwanda. Biyinzika, a Ugandan company, opened a day-old outlet in Kigali.

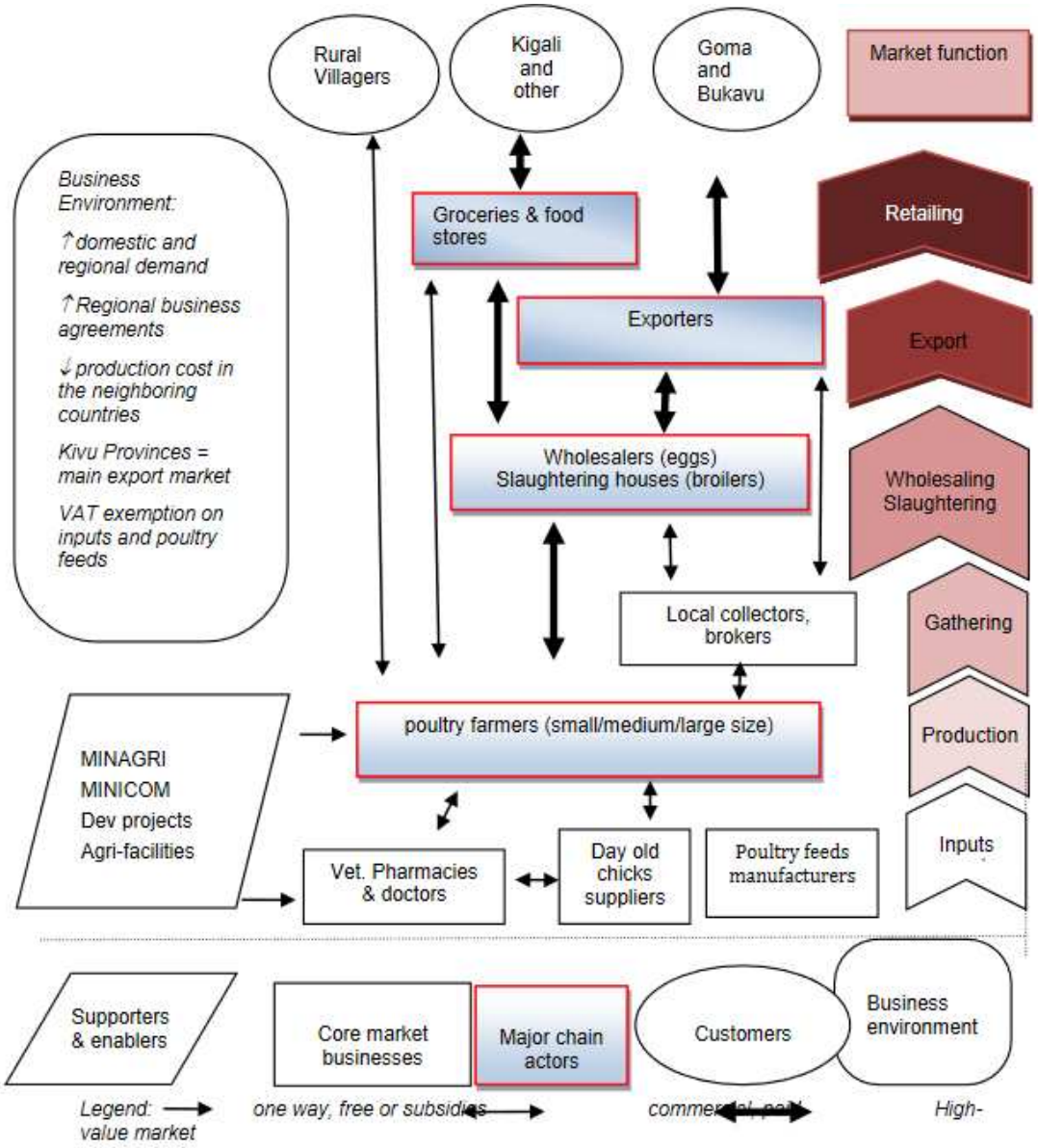


Figure 8: Rwanda Poultry Value Chain (Eggs and Broilers)

Eggs and broilers are produced by small, medium and large poultry farmers, with the majority of output purchased by small traders for delivery to city outlets (wholesalers, exporters and retailers). In addition to domestically produced poultry products, wholesalers also supply retailers with imported eggs and/or broilers. Retailers supply eggs and broilers to hotels, bakeries, street vendors, fast food chains, restaurants and households throughout the country. The end consumer price of an exotic-breed egg is FRw 80-100 in Kigali and FRw 60-70 in other urban and in rural areas.

Some poultry farmers deliver eggs directly to retail outlets. Most large-scale farmers operate slaughtering houses, delivering broilers directly to retail outlets. Spent layers, the meat of which is of poorer quality, are distributed through the same market channels.

The Rwandan market for poultry products is dominated by exotic-breed eggs and broilers. A small quantity of indigenous eggs and hens are sold directly to consumers at rural weekly markets, or through middlemen known as collectors. Collectors sell to travelers along the highway to Kigali, DRC and Burundi, or to food outlets and residents in neighboring urban areas. The end-price of an indigenous-breed egg is FRw 120-150 in Kigali and FRw 80-100 in rural areas. The retail price of a live indigenous bird ranges from FRw 3,500 in rural areas to FRw 5,000 in Kigali.

According to GoR research, egg consumers prefer large, yellow yolks, with some requesting details of origin. The majority of eggs and broilers are sold on domestic markets, in rural villages, cities and Kigali. The bulk of poultry-product exports are marketed in the Kivu provinces of the DRC, accessed via Western province border crossings in Rwanda's Rubavu and Rusizi districts. A small proportion of exports are sold in Burundi. The main competition to Rwandan eggs' export comes from Uganda.

Both the domestic and regional markets for poultry show signs of steady expansion, spurred by population growth, increasing urbanization and associated changes in diet. Medium- to high- income urban residents of Kigali and the wider region are increasingly adopting a diet rich in animal protein. Rwanda's average annual per capita consumption of meat, especially chicken, has risen from 6.4 kg in 2010 to an estimated 8.3 kg in 2015—a trend expected to continue as the price of chicken meat falls (see

Table 21).

Table 21: Meat Consumption (Kg Per Year per Capita, 2010-15)(National Institute Of Statistics Of Rwanda (NISR), 2015)

Year	2010	2011	2012	2013	2014	2015*
Meat consumption per capita	6.44	6.69	6.77	7.5	7.9	8.32

The average price per live spent layer varies by area, ranging from FRw 2,500-3,500. The farm- gate price of broiler meat is FRw 1,800-2,200 per kg, rising to FRw3,000-3,500 per kg in butchers/supermarkets and up to FRw 6,800 per kg for chicken breast. An indigenous cock costs FRw 5,000 per bird in Kigali, compared to FRw 3,500 in rural areas.

4.2 Methodology and Model Description

4.2.1 Introduction

The Financial and Economic Analysis was conducted on the basis of data and information collected through interviews with various stakeholders that are currently active in the poultry value chain as well as a literature review.

The analysis covered small and medium size broilers and layers private farms as well as a medium size feed production plant. Five excel models were prepared (the models are provided together with this report) to assess financial and economic profitability of the farming and feed production activities;

a. Small scale broilers production with the farm size of 1,000 birds.
b. Medium scale broilers production with the farm size of 6,000 birds. The production is partly mechanized and includes small hatchery and

slaughterhouse.

c. Small scale eggs production with laying population of 1,000 birds.

d. Medium scale eggs production with laying population of 8,000 birds.

e. Commercial feed producing plant with the capacity of 2 MT/hour.

4.2.2 Methodology

The Integrated Investment Appraisal (IIA) methodology is used to evaluate both the financial and the socio-economic effectiveness of the private production activities, estimating its impact from various perspectives. IIA is the only single-model approach to quantify the impact of every project-related transaction, from the private investor to tax revenues, fiscal expenditure and consumers. The methodology is used in project evaluations by major development banks, donor agencies, and public investment units.

The investment appraisal begins with an evaluation of the profitability of the investment (Financial module). This analysis is conducted assuming that the project is a green field investment. The socio-economic assessment (Economic module) builds on the Financial, greatly reducing the time and resources normally required for such studies. The Economic module is based on the principles of applied welfare economics (Harberger, 1971), according to which socio-economic benefits are assigned monetary values and assessed using typical investment project efficiency indicators, such as economic net present value (ENPV), analogous to financial net present value (FNPV), and economic rate of return (ERR), analogous to internal rate of return (IRR)[14].

[14] Internal Rate of Return (IRR) is the (break-even) interest rate at which investors can expect to receive positive returns. The Economic Rate of Return (ERR) differs from the Financial Rate of Return (FRR) in that it takes into account the effects of factors such as price controls, subsidies, and tax breaks to compute the actual cost of the project to the economy.

4.2.3 Model Description

The analysis is applied to a 20-year evaluation period, 2016-36, with real financial and economic discount rates set at 13 percent. The model is constructed on an annual basis with a base year of 2016 and results expressed in 2016 prices. The model first derives nominal cash flows, which are then discounted using corresponding price indexes to derive real cash-flow statements. The analysis uses World Bank inflation and exchange rate data. Financial cash-flow profiles provide the basis for subsequent economic, stakeholder, and risk analysis of poultry farming activities.

4.3 Financial Analysis

Primary data for the financial analysis was collected during a data collection trip in February 2016. Consultations with agricultural experts, farmers, importers of feed ingredients, feed producers and other stakeholders as well as a literature review, were used to analyze and adjust the data. A set of farm budgets and budget for feed producing plants was prepared. The farm budgets were prepared based on mean values, excluding statistical outliers from the analysis. A summary of the financial analysis is presented in Table 22 (below).

Table 22: Financial Analysis (FRw)

	Farm	Production	IRR	FNPV (FRw
	Population	Capacity		million)
Small scale broilers production	1,500 birds	12,000 birds/year	50%	18.75
Medium scale broilers production	6,000 birds	48,000 birds/year	43%	86.26
Small scale hatchery[15]	375 parents	108,500 fertilized eggs/year	38%	70.12
Medium scale broilers production with Hatchery	6,000 birds	48,000 birds/year	43%	157.66
Small scale eggs production	1,500 birds	355,000 eggs/year	19%	4.33
Medium scale eggs production	8,000 birds	2,840,320 eggs/year	34%	102.76
Commercial feed producing plant	N/A	2 MT/ha	53%	440.32

The financial analysis has revealed that the small and medium level chicken meat and eggs production is profitable. However, there are a number of risks factors that currently significantly affect the industry. These risk factors also explain the behavior of farmers that can be observed empirically:

[15] Given that majority of farmers' purchase imported from Belgium DOC, the price for DOC at hatchery assumed to be FRw800. It should, however, be noted that the price of DOC produced in Rwanda is approximately FRw700

1. Transition from chicken meat to eggs production: Many farmers start broilers production as a temporarily activity to finance eggs production. It takes approximately 6 months before a chicken will start laying eggs, and therefore, requires significant cash outlays to rear the chicken before the first revenue occurs. The broilers production cycle is in turn only 45 days (plus additional 15 days for cleaning of hen houses). The profits from chicken meat production are used to finance feed and other expenses of eggs production. Although chicken meat production potentially exhibits higher financial returns than eggs production, internal rate of return of 50% vs. 19% for small scale and 43% vs. 34% for medium scale, the market for eggs has two important advantages that explain farmers' transition:

a. Eggs can be preserved for a period of up to a month with no additional cost, which is advantageous if the output cannot be readily marketed. Broilers producers frequently face additional high cost of storing broilers if the output cannot be immediately marketed (or significant price reduction). This additional cost is likely to reduce financial profitability of broilers production below eggs production.

b. Price of chicken meat is highly volatile depending on the demand and supply forces. The eggs price in Rwanda in turn did not change at all during last five years. This market price stability provides certainty for farmers, hence, significantly reducing market price risk.

2. Volatility of chicken meat prices: The farm gate price for chicken meat can range from FRw 1,800 per kg to FRw 2,400 per kg at any point of time depending on the market situation, as opposed to the farm gate price of eggs,

which remained unchanged at about FRw 70.0 per egg for the last five years.

Table 23: Financial Analysis (FRw)

	Unit Cost per kg	Break-even Price per kg
Small scale broilers production	FRw 1,734	FRw 1,786
Medium scale broilers	FRw 1,665	FRw 1,714
Medium scale broilers production with Hatchery	FRw 1,451	FRw 1,481

The short production cycle of 45 days may result on significant fluctuations of the supply causing frequent decrease of the chicken meat price. Many farmers observing high price of the chicken meat in the market may temporarily enter the market, resulting an oversupply and price decrease. In addition, given a large number of small and medium scale producers it may become easy for large scale producers to periodically overestimate the market demand, and therefore reduce the price of meat until the market prices adjust to the cost of producing the chickens.

Exit of eggs producing farmers from the market*:* Some of the farmers that used to produce eggs have decided to stop the activity despite anticipated positive financial returns. The farm gate price of FRw 65.0 to 70.0 per egg that remained unchanged for the last five years has greatly reduced the profitability of eggs production. Therefore, farmers that are not willing to accept reduced returns decided to shift their activities into other value chains that perceived to be more profitable (such as dairy and pork production). However, as mentioned previously, a number of farmers are still starting eggs production confirming the financial profitability of the activity.

The financial analysis has also revealed that investment into production of feed concentrates is financially feasible. The financial internal rate of return (IRR) on the investment in medium size feed producing factory with an annual capacity of 5,760 MT/ 8-hour shift is estimated at 53%. It should be noted that the prior to the VAT exemption the IRR on the same investment was -11%. Therefore, the recent VAT exemption provided significant financial incentive for the private investors (Please refer to the –Impact of the VAT Exemption‖ section of the report for more details). The FNPV is estimated at FRw 440.32 million.

The financial analysis of investment in mini-hatchery, assuming DOC price of FRw 800, has revealed an internal rate of return of 38%, exhibiting very high market price for the DOC. High initial investment requirement into building, equipment and parent stocks, however, prevents many farmers from construction of mini-hatcheries. Increased domestic production of DOC will drive the price of this critical input down and greatly improve regional competitiveness of the Rwanda poultry value chain. Therefore, any steps to increase/improve domestic supply of DOC, such as privatization of the national hatchery are strongly advised.

4.4 Economic Analysis

The financial analysis outlined above forms the basis for an economic assessment of poultry farming activities as well as private investment into feed production, examining the incremental costs and benefits of project activities in terms of their broader impact on society. However, market prices frequently do not correspond to the actual value of resources produced and consumed in the course of a given activity, due to distortions such as taxes and subsidies. The GoR exempts all agricultural and livestock products from value added tax (VAT), and there are no import duties. The

main source of distortion, therefore, is a foreign exchange premium.

The analysis presented here uses commodity-specific conversion factors to adjust cash flows to derive net economic resource flows[16]. A summary of the economic analysis is presented in Table 24.

Table 24: Economic Analysis (FRw)

	ERR	ENPV (FRw million)
Small scale broilers	73%	44.16
Medium scale broilers production	57%	312.31
Medium scale broilers	62%	195.45
Small scale hatchery	51%	115.87
Small scale eggs production	30%	13.78
Medium scale eggs	43%	188.64
Commercial feed producing	72%	764.55

The economic returns of investments into poultry farming and feed production are positive. Chicken meat, eggs and feed are importable commodities to Rwanda, therefore, significant amount of indirect taxes streaming from increased availability of foreign exchange will be collected by the government if the industry will keep its expansion.

[16] See Annex R for a complete set of conversion factors used in the analysis.

4.5 Stakeholder Analysis

The social analysis of the project estimates the distribution of income changes caused by the project. This distributive analysis includes the reconciliation of financial, economic, and distributional appraisals, as well as identifying project impacts on principal objectives of the society concerned. There are four main stakeholders that are included in this analysis:

1. Small and medium scale broilers producers
2. Small and medium scale eggs producers
3. Commercial feed producers
4. Government of Rwanda.

The financial gains to farmers and feed producers are reported as the corresponding FNPV in the financial analysis section. Taxes represent a fiscal gain to the GoR with a total present value of FRw 598.83 million over the 20-year period. The bulk of the gains to the GoR is due to Foreign Exchange Premium (FEP) savings from reduced imports and increased exports of poultry products and from the corporate income tax collections. Increased domestic production of feed concentrates also results on reduction of feed imports and therefore on foreign currency.

Table 25: Anticipated Tax Revenues (FRw)

Present Value of Tax Collection (million)	
Small scale broilers production	25.26
Medium scale broilers production	153.57
Small scale eggs production	9.3
Medium scale eggs production	84.83
Commercial feed producing plant	325.87
Total	598.83

4.6 Sensitivity Analysis

A sensitivity analysis was carried out to analyze the impact of changes to the main parameters on deterministic returns of the investments in the poultry value chain. The sensitivity analysis was conducted on a number of variables (please refer to the spreadsheets). The major variables affecting financial and economic returns of the investments are:

1. Impact of the change in the price of feed on small and medium scale chicken meat production
2. Impact of the change in the price of feed on feed producing plants
3. Impact of the change in the price of broilers
4. Impact of the change in the price of eggs
5. Impact of the change in the price of DOC
6. Impact of the change in the average laying rate
7. Impact of the change in the price of manure.

Table 26: Impact of the Change in the Price of Feed (Million FRw)

Price	Small Broiler FNPV	Medium Broiler, Hatchery included FNPV	Medium Broiler, Hatchery excluded FNPV	Small Layers FNPV	Medium Layers FNPV
260	22.93	172.3	98.82	12.59	148.68
280	18.75	157.66	86.26	4.33	102.76
300	14.67	143.02	73.67	-2.79	56.55
320	10.73	128.37	61.05	-10.34	9.66

The minimum price of FRw 300/kg for commercially produced feed is not financially feasible for small scale layers' farmers (Table 26). This group of farmers, however,

normally form an important segment of the feed market for the feed producing industry. Farmers from this group are frequently new entrants to the value chain and therefore may not have sufficient knowledge to produce good quality of feed. Table 26 clearly exhibits that if price of feed is reduced to FRw 280 or below (note that break-even price, assuming real rate of return of 20%, for feed producers is FRw 275), the feed producing companies will penetrate the new and important market segment. Moreover, the price of FRw 280 and below will divert many medium level (more experienced) farmers from in-house feed production toward commercial solutions, as FRw 280 is the in-house cost of feed production for the medium level farmers.

Table 27: Impact of the Change in the Price of Feed (Million FRw)

Price	Feed Producing Plants, Exempted VAT, FNPV	Feed Producing Plants, Levied VAT, FNPV
270	5.66	-1,118.66
275	95.45	-969.53
280	178.44	-828.64
285	256.17	-693.92
300	440.32	-350.63

Table 27 exhibits that currently market price for commercially produced feed is very attractive for the private investment. However, in a medium term increased competition is likely to drive the price of feed to a range of FRw 270 – 280/kg and therefore greatly improve competitiveness of the poultry value chain.

Table 28: Impact of the Change in the Price of Broilers (Million FRw)

Price	Small Broiler FNPV	Medium Broiler, Hatchery included FNPV	Medium Broiler, Hatchery excluded FNPV
1,600	-17.71	36.67	-36.07
1,800	1.11	97.35	26.18
1,900	9.48	127.61	56.3
2,000	18.75	157.66	86.26
2,200	36.77	217.75	145.97
2,400	52.65	277.7	205.69

Table 28 exhibits that small scale broilers production is not financially feasible under a market price of FRw 1,800 which explains frequent complaint of many small scale farmers that market price fluctuations result on the unprofitability of broilers production. Medium scale farmers can achieve positive financial returns when the market price is above FRw 1,600/kg. Only medium level farmers with their own hatchery are competitive with the cheap imports of FRw 1,600/kg.

Table 29: Impact of the Change in the Price of Eggs (Million FRw)

Price	Small Layers FNPV	Medium Layers FNPV
60	-5.83	36.84
66	4.33	102.76
68	8.19	124.7
70	11.83	146.44
75	21.71	200.73

Table 30 exhibits that financial returns are sensitive to a change in the price of DOC. The sensitivity of broilers production is even higher than sensitivity of eggs production (Table 31). If continuous and timely supply from National Hatchery will be available at a price of FRw 550 the returns to small scale broilers producers will double from FRW 18.75 million to FRw 37.22 million

Table 30: Impact of the Change in the Price of DOC of Layers (Million FRw)

Price	Small Layers FNPV	Medium Layers FNPV
700	6.71	116.33
790	6.03	112.57
800	5.96	112.16
1,025	4.33	102.76
1,100	3.8	99.63

The farm gate price of eggs ranges from RWs 65 to 70 per egg. The break-even price is estimated at FRw 63.5 per egg. As can be seen from Table 29, financial returns are highly sensitive to a change in the price of eggs, especially for the small-scale farmers. A slight increase in price of eggs from FRw 66 to 70 per egg almost triples the FNPV from FRw 4.33 million to FRw 11.83 million.

Table 31: Impact of the Change in the Price of DOC of Broilers (Million FRw)

Price	Small Broiler FNPV	Medium Broiler, Hatchery included FNPV	Medium Broiler, Hatchery excluded FNPV
550	37.22	161.77	142.24
600	33.58	160.95	131.04
700	26.2	159.3	108.65
800	18.75	157.66	86.26
1,000	5.03	154.37	41.3

Table 32: Break-even Points (FRw)

	Small Broiler FNPV	Medium Broiler, Hatchery included FNPV	Medium Broiler, Hatchery excluded FNPV	Small Layers FNPV	Medium Layers FNPV	Feed Producing Plants, Exempted VAT, FNPV
Price of Mix-Feed	382	493	416	292	324	270
Price of Broilers	1,786	1,481	1,714	N/A	N/A	N/A
Price of Eggs	N/A	N/A	N/A	63.5	56.7	N/A
Price of DOCs	1,085	9,293	1,182	1,687	3,454	N/A
Average Laying Rate	N/A	N/A	N/A	84.60%	75.60%	N/A

Table 33 below presents impact of the simultaneous change in price of feed and DOCs on the cost of production of broilers. Given strong preferences of consumers toward Rwanda produced meat, the reduction of price below the price of cheap imports from Uganda (FRw 1,600 per kg) will greatly increase competitiveness of the Rwanda produced meat in the region and provide strong case for import substitution. As can be seen from Table 33, such scenario is not possible even if the price of feed will fall to

FRw 260 kg. However, even at current average feed price of FRw 310, if price of good quality DOCs will fall to the range of FRw 500-550, the per kg production cost will be FRw 1,552 – 1,578 per kg.

Table 33: Cost of Production per Kilogram of Meat (Medium-Scale Broiler Farm FRw)

Price of DOCs (broilers	Price of mix-feed				
	260	280	300	310	354
475	1,465	1,495	1,524	1,539	1,604
500	1,478	1,508	1,537	1,552	1,617
550	1,505	1,534	1,563	1,578	1,643
600	1,531	1,560	1,590	1,604	1,669
700	1,583	1,613	1,642	1,657	1,722
800	1,636	1,665	1,695	1,709	1,774
1,000	1,741	1,770	1,788	1,796	1,851

Table 34[17] below presents financial returns of the commercial feed production under different VAT levels. If VAT of 18% is levied on the feed, then on average price of all components of feed should fall by 10 percent allowing investors to realize positive financial returns. In turn, the current VAT exemption (VAT of 0%) will still allow investors to realize positive financial returns even if the price of all ingredients on average increase by 10 percent.

[17] Under the assumption of fixed feed price of FRw 300 per kg.

Table 34: Financial NPV of Feed Producer (FRw million)

VAT on poultry mix-feed					
Change in price of inputs (%)	0%	5%	10%	15%	18%
-15.00%	1,038	804	591	397	289
-10.00%	839	605	392	198	90
-5.00%	639	406	193	-1	-111
0.00%	440	207	-6	-206	-351
5.00%	241	7	-211	-481	-636
10.00%	42	-197	-489	-767	-922
15.00%	-161	-471	-775	-1,052	-1,207

4.7 Conclusions

Over the last five years, the government of Rwanda (GoR) has developed a number of successful policies and regulations to address key challenges facing the poultry subsector. As outlined in its poultry subsector strategy for 2012-17, the government aims to establish poultry as the flagship of Rwanda's livestock industry, with a particular focus on improving production and marketing.

The GoR has introduced a number of financial incentives to boost poultry production. Agricultural inputs and unprocessed produce are VAT exempt, while small agribusinesses with an annual turnover of less than FRw 12 million are exempt from income tax. The GoR has exempted feed producers from VAT, therefore, providing an incentive to invest into locally produced feed concentrates.

The financial and economic analysis of poultry farming activities has revealed positive financial and economic returns. The recent VAT exemption on feed concentrates

created an attractive environment for the investors to invest into feed production.

The VAT exemption provided for the main feed ingredients (maize, oil cakes and others) used to significantly reduce competitiveness of the commercially produced feed as opposed to in-farm feed mixes. The commercial feed producers would fail to obtain any VAT credit and therefore VAT would act as 18% tax on gross sales.

Since broilers are either sold domestically and are subject to VAT (without receiving a credit for VAT paid on the feed) or exported without a VAT input refund, the VAT levy on commercially produced feed results in over taxation of the poultry sector as compared to the correct VAT treatment. In addition, because no VAT is levied on feed mixed by the farmers, it puts feed mills at a competitive disadvantage. Furthermore, if the VAT treatment gives the farmers an incentive to mix their own feed while the feed mills can do it at a lower economic cost, then an unnecessary inefficiency and waste of resources is created. In such a circumstance the right policy is to not levy VAT on mixed feed.

Although it may seem that VAT exemption reduced tax collections to the GoR, the estimated negative financial returns of the commercial feed production implies no private investment in commercial feed production, and therefore the potential foregone VAT revenues are rather hypothetical.

It is estimated that, while VAT is exempted, the GoR will collect the present value of FRw 326 million from each new feed producing plant, of 2 MT/hr capacity, in form of direct and indirect taxes (the corporate income tax alone amounts FRw 278.8 million). In addition, the quality of commercially-produced feeds is inspected on a regular basis,

and increased availability of such feed should enhance overall productivity of the livestock sector. Lastly, increase in domestic supply of the feed will benefit the economy through foreign exchange savings since the imports from the neighboring countries would fall, however, the foreign exchange savings are marginal since the inputs for feed production are still imported.

Both domestic and export markets preferences are inclined toward Rwanda poultry products. Domestic demand for poultry eggs and meat far outstrips local production, with imports accounting for 43 percent of total Rwandan consumption of poultry products in 2015. At the same time, Rwandan producers risk losing ground to Ugandan producers in the lucrative export markets of DRC and Burundi.

The main constraint to further growth of the Rwanda poultry sector is its dependence on imports, including ingredients for the local production of poultry feeds, as well as pharmaceutical products. In addition, imports of major inputs are currently dominated by a single firm, Agrotech. The availability of poultry vaccines also remains a challenge in rural areas. The price of a broiler day-old chick (DOC) imported from Belgium (FRw 900) is far above FRw 500, which is the price of DOC supplied by the National Hatchery. However, the domestic supply of (DOC) is very limited. Farmers are particularly concerned with limited ability to insure stable and timely supply of DOC from the local sources and therefore prefer to pay higher price for timely availability of Belgium DOC.

The financial analysis of investment in mini-hatchery has revealed an internal rate of return of 38%, exhibiting current high market price for the DOC (FRw 800). High initial investment requirement into building, equipment and parents' stock, however,

prevents many farmers from construction of mini-hatcheries. In addition, many farmers lack knowledge on the management of parent stock. Increased domestic production of DOC will drive the price of this critical input down and greatly improve regional competitiveness of the Rwanda poultry value chain. Therefore, any steps to increase/improve domestic supply of DOC, such as privatization of the national hatchery are strongly advised.

The price of feed produced by the commercial plants can be dropped to FRw 275 and FRw 271 and still allow 20% and 15% real rate of return on investment, respectively. However, such price reduction alone will not allow reducing the cost of production below the price of imported chicken meat of FRw 1,600 per kg. The only scenario when price of chicken meat produced in Rwanda drops below the imported level is in the case of medium scale broiler production with hatchery. This observation allows to conclude that high market price of DOC jeopardizes regional competitiveness of chicken meat production.

Despite many achievements, the Rwanda poultry subsector can still be characterized by having limited competitiveness at the domestic or regional levels. Animal feed remains expensive due to the high price of imported ingredients. The availability of poultry vaccines also remains a challenge in rural areas.

At the market level, Rwandan producers must compete with poultry products imported from Uganda and Kenya. The country is also dependent on imports of feed ingredients such as maize and oilcake from Uganda and Tanzania. In addition, significant increase in the regional competition is expected to soon come from Tanzania. The Tanzanian poultry subsector is steadily recovering from an outbreak of avian influenza that almost

halved the flock, falling from 107 million in 2011 to 58 million in 2012. The poultry population has since increased to 69 million in 2015.

Chapter 5

CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Rwandan Crop Policies

The net fiscal impact is about 1% of the annual government budget. While this is a substantial fiscal drain of the government, it is not likely to be an unsustainable fiscal burden. A disproportionate amount of the net costs is created by the government's promotion of the cultivation of rice, soybean, and wheat. While they account for only 8 percent of the total land cultivated in crops, the combined losses account for more than 100 percent of the net annualized fiscal losses of the government.

A major refocusing of agricultural policies to make them much more market-driven rather than command-directed is necessary if the government wishes to achieve its economic development goals. Particular attention should be paid to the potential benefits of intercropping. This is most important when considering the returns to climbing beans and maize if grown together in the Northern and Western provinces. A limitation of this research is that we were not able to study the benefits and costs of more extensive intercropping.

Future research needs to be focused on both yield-enhancing interventions that would be applicable to the climatic and soil conditions of the Western Province. Farmers in this province are benefiting the least from the current agricultural cropping policies. Experimentation needs to be done to determine if there are new crops that could be

introduced that could be profitably cultivated in the Provinces that are faring poorly under the current policies.

In the absence of subsidization, forcing farmers to grow specific crops in regions where they do not cover their opportunity costs will likely lead to failure in the sustainable development of these segments of Rwanda's agriculture sector. In the preparation of Vision 2050 economic policies, including the formulation of the regional agricultural policy directives, it is vital that the government and international donors consider all aspects of sustainability – financial, economic, fiscal, and environmental.

5.2 Rwandan Dairy Value Chains

Limited landholdings constrain the ability of households to expand dairy herds due to insufficient acreage for grazing. Statistical analysis revealed that, although total milk production in Rwanda increased from 142.5 million liters in 2005 to more than 628 million liters in 2013, the total number of cattle herd increased by just 9 percent (See Annex E). The increase in milk production is therefore the result of a shift toward better breeds of dairy cattle and zero grazing methods. The introduction of legumes and grass-conservation policies would allow further expansion in herd size without a concomitant expansion in acreage allocated to cultivation of feed. The cultivation of legumes and grass conservation will also help stabilize seasonal fluctuations in the milk supply.

The CBA revealed that following the GoR, an international donor agency, and other donor interventions in the dairy VC, investment in Rwanda's dairy production is financially feasible, assuming that a farmer has access to the market and follows key recommendations of the RDCP II project with respect to cattle feed, breeding and

quality control of milk. Field visits also revealed the establishment of new, small-scale private dairy farms, which confirms this important conclusion.

5.3 Rwandan Poultry Value Chains

Rwanda is well positioned to increase market share in the eastern DRC. Developing exports and re-exports to the DRC is a strategic objective worth focusing on. However, the export markets of Uganda, Tanzania and Kenya, as well as those deeper within the DRC, should not be a short-term objective.

The following recommendations are expected to support efforts to realize the full potential of Rwanda's poultry subsector:

1. Maintain the current policy of VAT exemption on the production of feed concentrates.
2. Improve the dissemination of subsector policies and strategies to poultry-sector stakeholders, especially smallholder farmers.
3. Support meat traders to bring butchers' facilities in line with recent regulations.
4. Increase the availability of day-old chicks, privatizing the National Hatchery and supporting the establishment of new mini-hatcheries across the country.
5. Disseminate best practice in poultry farming by a range of means, including through veterinary pharmacies and the mass media.
6. Increase the number of technicians specialized in poultry farming.
7. Increase the availability of vaccines beyond Kigali.
8. Provide farmer training in finance and improve access to credit.
9. Fund research into cheap substitutes for protein-bearing feed ingredients such as fish.
10. Enhance vertical linkages (feed producers, farmers, markets).

11. Introduce micro-pack alternatives attractive to low-, medium- and high-income consumers, expanding domestic and export markets.

REFERENCES

Aertssen, G., Mutijima, A., & Mbarubugeye, S. (2014). Rwanda Agricultural Policy Note, Background Study# 1: Prospects for achieving sustainable agricultural growth in Rwanda (No. ACS9719; p. 56) http://documents1.worldbank.org/curated/en/883411468305660877/pdf/ACS97190WP0P1400Box385238B00PUBLIC0.pdf.

Ali, D. A., Deininger, K., & Duponchel, M. (2014). Credit Constraints and Agricultural Productivity: Evidence from rural Rwanda. *The Journal of Development Studies,* 50(5), 649–665. https://doi.org/10.1080/00220388.2014.887687

Ansoms, A., Cioffo, G., Dawson, N., Desiere, S., Huggins, C., Leegwater, M., Murison, J., Bisoka, A. N., Treidl, J., & Damme, J. V. (2018). The Rwandan agrarian and land sector modernisation: Confronting macro performance with lived experiences on the ground. Review of African Political Economy, 45(157), 408–431. https://doi.org/10.1080/03056244.2018.1497590

Ansoms, A., Verdoodt, A., & Van Ranst, E. (2008). The inverse relationship between farm size and productivity in rural Rwanda. Institute of Development Policy and Management - Discussion Paper, 2008–09. http://hdl.handle.net/1854/LU-684186

Austin, K. G., Beach, R. H., Lapidus, D., Salem, M. E., Taylor, N. J., Knudsen, M., & Ujeneza, N. (2020). Impacts of Climate Change on the Potential Productivity

of Eleven Staple Crops in Rwanda. Sustainability, 12(10), 4116. https://doi.org/10.3390/su12104116

Bugingo, I., Interayamahanga, R., & Institute of Research and Dialogue for Peace. (2011). A study on the development and use of governance indicators in Rwanda: Draft report. IRDP. http://www.idasa.org.za/media/uploads/outputs/files/rwanda_report.pdf

Catherine, L., Dorene, A.-M., Ekin, B., & Jeffrey, A. (2016). Assessing the adoption of improved bean varieties in Rwanda and the role of varietal attributes in adoption decisions. Intl Food Policy Res Inst.

Chigbu, U. E., Ntihinyurwa, P. D., de Vries, W. T., & Ngenzi, E. I. (2019). Why Tenure Responsive Land-Use Planning Matters: Insights for Land Use Consolidation for Food Security in Rwanda. *International Journal of Environmental Research and Public Health,* 16(8), 1354. https://doi.org/10.3390/ijerph16081354

Cioffo, G. D., Ansoms, A., & Murison, J. (2016). Modernising agriculture through a 'new' Green Revolution: The limits of the Crop Intensification Programme in Rwanda. Review of African Political Economy, 43(148), 277–293. https://doi.org/10.1080/03056244.2016.1181053

Clay, N., & King, B. (2019). Smallholders' uneven capacities to adapt to climate change amid Africa's 'green revolution': Case study of Rwanda's crop intensification program. World Development, 116, 1–14.

https://doi.org/10.1016/j.worlddev.2018.11.022

Clay, N., & Zimmerer, K. S. (2020). Who is resilient in Africa's Green Revolution? Sustainable intensification and Climate Smart Agriculture in Rwanda. Land Use Policy, 97, 104558. https://doi.org/10.1016/j.landusepol.2020.104558

Deininger, K., & Goyal, A. (2012). Going digital: Credit effects of land registry computerization in India. *Journal of Development Economics*, 99(2), 236–243. https://doi.org/10.1016/j.jdeveco.2012.02.007

Del Prete, D., Ghins, L., Magrini, E., & Pauw, K. (2019). Land consolidation, specialization and household diets: Evidence from Rwanda. Food Policy, 83, 139–149. https://doi.org/10.1016/j.foodpol.2018.12.007

Determining the Organization of Veterinary Pharmacy Practice, Ministerial Order No008/11.30 (2010). http://extwprlegs1.fao.org/docs/pdf/rwa105454.pdf

Donahue Angel, M., Berti, P., Siekmans, K., Tugirimana, P. L., & Boy, E. (2017). Prevalence of Iron Deficiency and Iron Deficiency Anemia in the Northern and Southern Provinces of Rwanda. Food and Nutrition Bulletin, 38(4), 554–563. https://doi.org/10.1177/0379572117723134

East African Community. (2019). Approved measures on import duty rates in the EAC common external tariff. EAC Gazette.

Factfish. (2020). Rice, paddy, production quantity (tons) for Rwanda | Tilasto.

Rwanda: Rice, Paddy, Production Quantity (Tons). https://www.tilasto.com/en/topic/geography-and-agriculture/crop/rice/rice-paddy-production-quantity/rwanda

Fanelli, R. M. (2019). The (un)sustainability of the land use practices and agricultural production in EU countries. *International Journal of Environmental Studies,* 76(2), 273–294. https://doi.org/10.1080/00207233.2018.1560761

Fanelli, R. M. (2020). The Spatial and Temporal Variability of the Effects of Agricultural Practices on the Environment. Environments, 7(4), 33. https://doi.org/10.3390/environments7040033

FAO. (n.d.-a). FAOSTAT. Crops and Livestock Products. Retrieved April 12, 2021, from http://www.fao.org/faostat/en/#data/TP/visualize

FAO. (n.d.-b). FAOSTAT. Crops. Retrieved April 12, 2021, from http://www.fao.org/faostat/en/#data/QC/visualize

Feed the Future (FtF) Program. (2016). Rwandan Farmers turn Straw into Income. U.S. Agency for International Development (USAID).

Fintrac Inc. (2013). Rwanda Cross-border Agricultural Trade Analysis. U.S. Agency for International Development (USAID).

Gatete, C. (2016). The Rwanda We Want: Towards 'Vision 2050.' 22.

Harberger, A. C. (1971). Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay. *Journal of Economic Literature,* 9(3), 785–797.

Huggins, C. (2017a). An overview of the political economy of agricultural reform in Rwanda. In Agricultural Reform in Rwanda: Authoritarianism, Markets, and Zones of Governance (1st ed.). Zed books.

Huggins, C. (2017b). Contemporary agricultural reforms in sub-Saharan Africa. In Agricultural Reform in Rwanda: Authoritarianism, Markets, and Zones of Governance (1st ed.). Zed books.

Huggins, C. (2017c). Maize production and the "fugitive farmers" in Kirehe District. In Agricultural Reform in Rwanda, Authoritarianism, Markets, and Zones of Governance (1st ed.). University of Chicago Press.

IFDC. (2010, December 14). New Project Helps Rwanda to Privatize its Fertilizer Sector. IFDC. https://ifdc.org/2010/12/14/new-project-helps-rwanda-to-privatize-its-fertilizer-sector/

IndexMundi. (n.d.). Rwanda Wheat Domestic Consumption by Year (1000 MT). Retrieved April 12, 2021, from https://www.indexmundi.com/agriculture/?country=rw&commodity=wheat&graph=domestic-consumption

International Institute of Tropical Agriculture (IITA). (2018, May 5). CBSD Control Project in Rwanda and Burundi commended by partners. IITA News.

http://bulletin.iita.org/index.php/2018/05/05/cbsd-control-project-in-rwanda-and-burundi-commended-by-partners/

Isaacs, K. B., Snapp, S. S., Chung, K., & Waldman, K. B. (2016). Assessing the value of diverse cropping systems under a new agricultural policy environment in Rwanda. Food Security, 8(3), 491–506. https://doi.org/10.1007/s12571-016-0582-x

Jenkins, G., Kuo, C.-Y., & Harberger, A. C. (2019a). Economic prices for tradable goods and services. In Cost-Benefit Analysis for Investment Decisions (1st ed., pp. 277–300). Amazon Publishing.

Jenkins, G., Kuo, C.-Y., & Harberger, A. C. (2019b). Evaluation of stakeholder impacts. In Cost-Benefit Analysis for Investment Decisions (1st ed.). Amazon Publishing.

Jenkins, G. P., Kuo, C.-Y., & Salci, S. (2015). Measuring the Foreign Exchange Premium and the Premium for Non-Tradable Outlays for 20 Countries in Africa. *South African Journal of Economics,* 83(2), 269–285. https://doi.org/10.1111/saje.12068

Jenkins, G. P., Miklyaev, M., Ujeneza, N., Afra, S., Matanhire, B., Basikiti, P., & Nsenkyire, A. (2017). Comparative Economic Advantage of Crop Production in Rwanda. In Development Discussion Papers (No. 2017–19; Development Discussion Papers). JDI Executive Programs. https://ideas.repec.org/p/qed/dpaper/3006.html

Kaberuka, D. (2000). Rwanda Vision 2020. Republic of Rwanda, Ministry of Finance and Economic Planning; https://repositories.lib.utexas.edu/bitstream/handle/2152/5071/4164.pdf. https://repositories.lib.utexas.edu/bitstream/handle/2152/5071/4164.pdf

Kathiresan, A. (2012). Strategies for Sustainable Crop Intensification in Rwanda. 59.

Katungi, E., Larochelle, C., Mugabo, J., & Buruchara, R. (2019). Climbing bean as a solution to increase productivity in land-constrained environments: Evidence from Rwanda. Outlook on Agriculture, 48(1), 28–36. https://doi.org/10.1177/0030727018813698

Kinazi Cassava Plant Ltd. (n.d.). Vision, Mission & Objectives – Kinazi Cassava Plant Ltd—The Best Cassava Flour. Retrieved April 12, 2021, from https://kcp.rw/missions/

Klingebiel, S., Gonsior, V., Jakobs, F., & Nikitka, M. (2016). Case Study: Imihigo—A Traditional Rwandan Concept as a RBApp. In S. Klingebiel, V. Gonsior, F. Jakobs, & M. Nikitka (Eds.), Public Sector Performance and Development Cooperation in Rwanda: Results-Based Approaches (pp. 41–73). Springer International Publishing. https://doi.org/10.1007/978-3-319-42144-5_3

Knoema. (2019). Fertilizer consumption by country, 2019—Knoema.com. Knoema. https://knoema.com//atlas/ranks/Fertilizer-consumption

Kuria, A. W., Barrios, E., Pagella, T., Muthuri, C. W., Mukuralinda, A., & Sinclair,

F. L. (2019). Farmers' knowledge of soil quality indicators along a land degradation gradient in Rwanda. Geoderma Regional, 16, e00199. https://doi.org/10.1016/j.geodrs.2018.e00199

Kwan, A. Y.-H. (1980). Rural Development in Malaysia-Issues and Problems Conf ronting MADA, FELDA and RISDA1. Asian Journal of Social Science, 8(1), 64–86. https://doi.org/10.1163/156853180X00067

MacNairn, I., & Davis, K. (2018). Rwanda: Desk study of extension and advisory services. U.S. Agency for International Development (USAID); https://ebrary.ifpri.org/digital/collection/p15738coll5/id/7494/. https://www.digitalgreen.org/wp-content/uploads/2017/09/DLEC-Rwanda_Desk-Study_revised_final.pdf

Ministerial Order on animal slaughtering, meat inspection, Pub. L. No. N°013/11.30 (2010).

Ministerial Order on Transport and Trade of Meat, Pub. L. No. 013/11.30 (2010).

Monitor Group. (2012). The Business Case for Investing in the Import and Distribution of Fertilizer in Rwanda (p. 37). USAID. https://www.usaid.gov/sites/default/files/documents/1860/The%20Business%20Case%20for%20Investing%20in%20the%20Import%20and%20Distribution%20of%20Fertilizer%20in%20Rwanda.pdf

Moon, S., & Lee, S. (2020). A Strategy for Sustainable Development of Cooperatives

in Developing Countries: The Success and Failure Case of Agricultural Cooperatives in Musambira Sector, Rwanda. Sustainability, 12(20), 8632. https://doi.org/10.3390/su12208632

Murenzi, H. (2018). Investigating the Effect of Climate Variability Maize Yield in Rwanda [Thesis, University of Nairobi]. http://erepository.uonbi.ac.ke/handle/11295/106425

Muriuki, H. G. (2011). Dairy Development in Kenya. Food and Agriculture Organization of the United Nations (FAO). http://www.fao.org/3/al745e/al745e.pdf

Musoni, A. (2016). Plant breeding in Revolutionizing Agriculture [Interview]. http://rab.gov.rw/index.php?id=235

Muyombano, E., & Espling, M. (2020). Land use consolidation in Rwanda: The experiences of small-scale farmers in Musanze District, Northern Province. Land Use Policy, 99, 105060. https://doi.org/10.1016/j.landusepol.2020.105060

National Institute of Statistics of Rwanda (NISR). (2015). National Statistical Yearbook. National Institute of Statistics of Rwanda (NISR).

Nilsson, P. (2019). The Role of Land Use Consolidation in Improving Crop Yields among Farm Households in Rwanda. The Journal of Development Studies, 55(8), 1726–1740. https://doi.org/10.1080/00220388.2018.1520217

Nishimwe, G., Rugema, D. M., Uwera, C., Graveland, C., Stage, J., Munyawera, S., & Ngabirame, G. (2020). Natural Capital Accounting for Land in Rwanda. Sustainability, 12(12), 5070. https://doi.org/10.3390/su12125070

Nkurunziza, M. (2018, August 29). Over 2,000 tonnes of maize seeds set for distribution. The New Times | Rwanda. https://www.newtimes.co.rw/business/over-2000-tonnes-maize-seeds-set-distribution

Ntirenganya, E. (2016, July 4). Farmers upbeat about productivity of new cassava variety. The New Times | Rwanda. https://www.newtimes.co.rw/section/read/201411

Okoboi, G. (2001). The marketing potential of potatoes in Uganda and market opportunities for Rwanda. Institutional Institute of Tropical Agriculture.

One Acre Fund. (2016). Soybean and Rhizobium—2015B Season.

PotatoPro. (n.d.). Agricultural Statistics Rwanda. PotatoPro. Retrieved April 12, 2021, from https://www.potatopro.com/rwanda/potato-statistics

Public notice regarding livestock identification, Pub. L. No. law n° 33/2002 (2002).

Reliefweb. (2018). Climate Change Profile: Rwanda. Ministry of Foreign Affairs of the Netherlands. https://reliefweb.int/sites/reliefweb.int/files/resources/Rwanda_3.pdf

Republic of Rwanda, Ministry of Agriculture and Animal Resources. (2012). Strategy and investment plan to strengthen the poultry industry in Rwanda. Republic of Rwanda, Ministry of Agricultural and Animal Resources.

Republic of Rwanda, Ministry of Agriculture and Animal Resources. (2014). Strategic Plan for Animal Nutrition Improvement Programme for Rwanda [Technical Assistance for Institutional Component of Support Project to the Strategic Plan for the Transformation of Agriculture in Rwanda (PAPSTA)]. HTSPE Limited.

Republic of Rwanda, Ministry of Finance and Economic Planning. (2013). National Rice Development Strategy.

Republic of Rwanda, Ministry of Finance and Economic Planning. (2014). Rwanda CSCF. Commodity-Specific Conversion Factors Database for the Republic of Rwanda. http://rwanda-cscf.cri-world.com/

Republic of Rwanda, Ministry of Finance and Economic Planning. (2015). List of Agricultural Inputs and other Agricultural and Livestock Materials and Equipment exempt from the Value Added Tax. Republic of Rwanda.

Modifying and Complementing Law no 06/2001 of 20/01/2001 on VAT code, Pub. L. No. 25/2010 (2010).

Republic of Rwanda, Ministry of Trade and Industry (MINICOM). (2015a, January 26). Minimum price to improve farmers' income.

http://www.minicom.gov.rw/index.php?id=24&tx_ttnews%5Btt_news%5D=917&cHash=802b7d9f959a489345e06198d9e32a82

Republic of Rwanda, Ministry of Trade and Industry (MINICOM). (2015b, January 26). Minister Kanimba launches a wholesale market for irish potatoes in Kigali. http://www.minicom.gov.rw/index.php?id=24&tx_ttnews%5Btt_news%5D=1012&cHash=e0d9f59c59484400f1473abf9e484779

The New Times. (2015, December 17). Kigali meat dealers cautioned on hygiene. The New Times | Rwanda. https://www.newtimes.co.rw/section/read/195390

The World Bank. (2008). Implementation Completion Report for Rural Sector Support Project (No. ICR0000675).

Tukamuhabwa, P., Kwikiriza, N., Agaba, H., & Ariong, R. (2016). Feasibility Study for Implementation of the Project on Increased Soybean Production and Productivity for Sustaing Markets. Rwanda Agricultural Board (RAB).

U.N. (n.d.). International Trade Statistics Database. UN Comtrade. Retrieved April 12, 2021, from https://comtrade.un.org/

World Bank Development Indicators. (2019a). GDP growth (annual %)—Rwanda | Data. GDP Growth (Annual %) - Rwanda. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=RW

World Bank Development Indicators. (2019b). Population density (people per sq. Km of land area)—Rwanda | Data. Population Density (People per Sq. Km of Land Area) - Rwanda. https://data.worldbank.org/indicator/EN.POP.DNST?locations=RW&view=chart

APPENDICES

Appendix A: List of Interviewed Stakeholders

Table 35: List of Interviewed Stakeholders

Date	Location	Stakeholders
City of Kigali (Nov 2 – 5, 2015)		
Monday, November 2, 2015	Gasabo District Nyarutarama (Land O Lakes Office)	Land O'Lakes - Dennis Karamuzi (CoP) and colleagues
Tuesday, November 3, 2015	Gasabo District – Kacyiru Sector	USAID – Daniel Handel (Mission Economist) & colleagues
Wednesday, November 4, 2015	Kicukiro District - Masaka Sector	Group of farmers (RDCP II beneficiaries)
Wednesday, November 4, 2015	Gasabo District Nyarutarama (Land O Lakes Office)	RNDP - Dr John Baptist Musemakweli/Executive Director
Thursday, November 5, 2015	Kicukiro District - Masaka Sector	Inyanges Industries - David Bucakara/Supply Chain Director
Thursday, November 5, 2015	Gasabo District – Remera Sector	Urwego Opportunity Bank (UOB) – Jacques/Agribusiness portfolio Manager
Thursday, November 5, 2015	Gasabo District – Kacyiru Sector	Minagri - Dr Theogene Rutagwenda/Director General Animal Resources
Northern Province (Nov 6 – 9, 2015)		
Friday, November 6, 2015	Gicumbi District Kageyo Sector	Farmer's cooperative (IAKIB Ltd) - Dacien Twine/Managing Director
	Gicumbi District Kageyo Sector	Farmer (RDCP II beneficiary) - Domina
Friday, November 6, 2015	Gicumbi District Manyagiro Sector	Blessed Dairies Ltd - Milton Ngirente/Director

Friday, November 6, 2015	Gicumbi District Rukomo Sector	Individual model farmer - Uwera
Monday, November 9, 2015	Nyabihu District Mukamira Sector	DVO - Eugène Shingiro
Monday, November 9, 2015	Nyabihu District Bigogwe sector	Fromagerie la Reine - Gadi
Monday, November 9, 2015	Nyabihu District Bigogwe sector	Bigogwe MCC (UPROCENYA) & Ingabo Dairy
Monday, November 9, 2015	Nyabihu District Bigogwe sector	Model Farmer (RDCP II beneficiary) -
Monday, November 9, 2015	Musanze District Muhoza Sector	Model Farmer (RDCP II beneficiary)
Monday, November 9, 2015	Musanze District Muhoza Sector	ATIVET Ltd - Jean Bosco Niyonzima/Owner
Monday, November 9, 2015	Musanze District Muhoza Sector	Zamura feeds Ltd
Eastern Province (Nov 10 – 11, 2015)		
Tuesday, November 10, 2015	Rwamagana district Kigabiro Sector	Rwamagana District – John / DVO
Tuesday, November 10, 2015	Rwamagana district Kigabiro Sector	MCC (Dukundamatungo Cooperative)- Patrick Byabagamba/Chairman
Tuesday, November 10, 2015	Rwamagana district Kigabiro Sector	Milk collector (aggregation point) - Jean Baptiste Hakizimana
Tuesday, November 10, 2015	Rwamagana district Kigabiro Sector	Urwego Opportunity Bank (Rwamagana Branch) - Daniel Ndahayo/Credit Officer

Tuesday, November 10, 2015	Rwamagana district Kigabiro Sector	Individual Farmers (Non-Beneficiaries of RDCP II) - Etienne Kaberuka & Ramadhan Habyarimana
Tuesday, November 10, 2015	Rwamagana district Munyiginya Sector	Individual Farmers (Beneficiaries of RDCP II - Loans by UOB) -Fidele Mugabo & Daniel Ntirenganya
Tuesday, November 10, 2015	Rwamagana district Kigabiro Sector	BARICE Ltd - Vincent Barigye/Managing Director
Wednesday, November 11, 2015	Nyagatare district Rwimiyaga Sector	Kirebe MCC - Peter Uwiringiyimana/ Manager
Wednesday, November 11, 2015	Nyagatare district Rwimiyaga Sector	VYEC/Itabaza -Jean Paul Habimana/Chairperson
Wednesday, November 11, 2015	Nyagatare district Rwimiyaga Sector	Individual Farmer (RDCP II beneficiary) - Oswald Nkuranga
Wednesday, November 11, 2015	Nyagatare district Nyagatare Sector	Inyange industries (Savanna Dairy) - Hamad Rukwaya/Plant Manager
Southern Province (Nov 12 – 13, 2015)		
Thursday, November 12, 2015	Nyanza district Nyagisozi Sector	Individual Farmer (RDCP II beneficiary) - Theogene Munyensanga
Thursday, November 12, 2015	Nyanza district Nyagisozi Sector	Milk transporter (small scale) - Nathanael Nzabamwita
Thursday, November 12, 2015	Nyanza district Busasamana Sector	Zirakamwa Dairies ltd - Immaculée Kayitesi/Owner
Thursday, November 12, 2015	Huye District Rusatira Sector	RUDACO Ltd - Viateur Harindintwari/President
Friday, November 13, 2015	Kamonyi District Kayenzi Sector	COOPEKA MCC - Martin Nzabarinda/President -

Friday, November 13, 2015	Kamonyi District Kayenzi Sector	NIR HOPE Ltd - Roland Nzayisenga/Veterinarian
Friday, November 13, 2015	Kamonyi District Kayenzi Sector	Individual Farmer (RDCP II beneficiary) - Emmanuel Habumugisha
Friday, November 13, 2015	Kamonyi District Karama Sector	Small-Scale Milk collector - Jean Dusabimana

Appendix B: Indicative Annual Dairy Farm Budget ("Without Project")

Table 36: Indicative Annual Dairy Farm Budget ("Without Project")

Item	Quantity	Value per Unit (RWF)	RWF/Head
Revenues			
Milk (Liters)	563	120	67,560
Manure (Wheelbarrow)	48	1,000	48,000
Sales of livestock*		136,449.5	136,449.5
Total Revenues			252,009.5
Costs			
Feeding Costs			
Napier grass (Bundle/Head)	365	100	36,500
Maize bran (Kg/Head)	0	110	0
Concentrate (Kg/Head)	0	140	0
Salt (Kg/Head)	24	150	3,668
Water (Jerrycan/Head)	0	70	0
Total cost of Feeding			40,168
Veterinary Service Costs	1	40,000	40,000
Veterinary expense	0.7	3,000	1,995
Bull / AI Services	52	80	4,160
Sprayings (Anti Tick)	0	10,000	0
Vitamins / Deworming			
Total Veterinary Expenses			46,155
	0.75	60,000	
Other Costs	0	0	45,000
Rental cost of land (Ha/Land)	0.2	180,000	0
Shelter			36,000

Labor Total other costs			81,000
Total Costs			167,323
Net Income			84,686.5

* The indicative farm budget is prepared assuming optimal herd size of two dairy cows.

Appendix C: Indicative Annual Dairy Farm Budget ("With Project")[18]

Table 37: Indicative Annual Dairy Farm Budget ("With Project")

Item	Quantity	Value per Unit (RWF)	RWF/Head
Revenues	1920	160	307,200
Milk (Liters)	96	1,000	96,000
Manure (Wheelbarrow)		176,684	176,684
Sales of livestock			
Total Revenues			579,884
Costs			
Feeding Costs			
Napier grass (Bundle/Head)	1,095	100	109,500
Maize bran (Kg/Head)	365	110	40,150
Concentrate (Kg/Head)	730	140	102,200
Salt blocks (Kg/Head)	20	900	18,068
Water (Jerrycan/Head)	1095	60	65,700
Total cost of Feeding			335,618
Veterinary Service Costs	1	30,000	
Veterinary expense	1.60	3,000	30,000
Bull / AI Services	104	80	4,800
Sprayings (Anti Tick)	1	10,000	8,320
Vitamins / Deworming			10,000
Total Veterinary Expense			53,120
Other Costs	0	60,000	
Rental cost of land (Ha/Land)	0.33	39,000	0
Rental value of shelter[19]	0.33	180,000	13,000
Labor			60,000
Total other costs			73,000
Total Costs			455,738
Net Income			118,146

[18] The indicative farm budget is prepared assuming optimal herd size of three dairy cows.

[19] The corresponding shelter rental value is used to calculate the shelter's construction cost.

Appendix D: Cost of Boiling Raw Milk

Table 38. Cost of Boiling Raw Milk

	Fresh milk from the farm Quantity = 2 liters Price = 350 RwF/liter
	Cost 1 – Cleaning the casserole Time[20]: 5 min = RwF 33 Soap: Negligible Water (5 liters) @ RwF 390/m^3) = RwF 2.0
	Cost 2 – Burning the brasero Time: 10 min = RwF 66 Other: Negligible Charcoal = RwF 40
	Cost 3 – Time Monitoring: 12 minutes (boiling time), Cooling: N/A Packing: 2 min. Cost: RwF 93
	Total cost of boiling = 234 RwF/2 liters

Note: Cost for boiling one liter = cost for boiling 5 liters. RwF 234 required to boil volumes of between 1 and 5 liters.

[20] Housekeeper expense:
1. Salary: 50,000 RwF/month
2. Lodging 20,000 RwF/month
3. Meal and other expenses: 30,000 RwF/month

Total cost = 100,000 (working approximately 250 hours per month) = 400 RwF/hour

Appendix E: Dairy VC Description

Rwanda dairy value chain

Introduction

Milk is traditionally a popular product in Rwanda. In addition to its nutritional qualities, rearing one or more cows is yet seen as a sign of prosperity and high social status, even when their productivity remains relatively low.

For more than 15 years, the Rwanda dairy subsector significantly improved. From 2005 to 2014, the national milk production nearly quintupled from 142,000 cubic metrics to 628,000 cubic metrics. In the same time, the number of cows slightly increased, from 1,040,000 to 1,132,000 heads. This means that farmers are getting more milk per cow, which attests that they are progressively replacing their local and traditional cows by adopting cross and pure breeds. The percentage of households rearing cattle (s) increased from 34.4% in 2006, to 47.3% in 2011 and 50.4% in 2014[21]. A typical household rears 1 to 2 cross-breed cows.

[21] Source: Rwanda Integrated Household Living Conditions Survey (EICV) 2013/2014

Table 39: Milk Production and Consumption in Rwanda

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Milk production (,000 lts)	142,511	152,511	189,827	257,480	334,727	372,619	442,337	503,130	628,266	706,030
Cattle (,000 heads)	1,040	1,059	1,147	1,195	1,219	1,335	1,143	1,135	1,132	-
Milk consumption (l/pers/yr.)				25.7	33.5	37.3	44.2	50.1	58.1	-

Source: Rwanda Statistical Year books (2011 – 2014), Minagri (Dec 2015).

Rwanda milk sheds

Active stakeholders in the dairy subsector identified five demarcated milk sheds, based on region's specificities (landscape, population, climate, farmer's capacity and experience …). The five are Kigali, Eastern, Southern, Northern and North-Western milk shades.

Kigali milk shed

The Kigali milk shed is extended to urban districts (Kicukiro, Gasabo and Nyarugenge), together with Bugesera district (South of Kigali – Eastern Province). It's dominated by larger farms with higher proportion of absentee owners, leaving in Kigali and rearing cows as a "*weekend's prestige business*". Farms are established on high value lands and report high operation costs (frw 150 - 180 invested to produce one liter). Farmers rear pure and cross-breeds cows but not yet producing closer to their genetic potential (10 to 20 liters per day per cow). With easy access to Kigali market, these farms seem profitable when directly selling their fresh milk to numerous milk kiosks at RwF 300 per liter.

Eastern milk shed

The eastern milk shed covers the Eastern Province (Bugesera excluded). It's reported that at least 40% of the total cows are in the region. However, the dairy farming is challenged by the poor access to clean water, the low carrying capacity of the land and relatively recurrent long period of dry season (800-900 mm per year). The northernmost zone (Nyagatare) has yet larger farms with the largest number of MCCs.

Southern milk shed

The southern milk shed covers the Southern Province. The region is characterized by medium rainfall (900 – 1,000 mm) with a limited access to land. With a long tradition of rearing cows, farmers adopted zero-grazing. The region has some milk business

centers (Nyanza, Ruhango, Rusatira…), where a large number of small scale processors produce fermented milk, sold to Kigali, Bukavu (DRC) and Bujumbura markets.

Northern milk shed

The Northern milk shed covers the Northern Province (mainly Gicumbi, Rulindo, Musanze and Burera Districts). The region is characterized by medium to high rainfall (1,000 – 1,500 mm). Gicumbi District is definitely more organized to supply raw milk to Kigali market, thanks to IAKIB cooperative and Blessed Dairies Ltd, respectively ensuring the milk collection and transportation.

Northwestern milk shed

This milk shed is extended to Rubavu and Nyabihu District (Gishwati farms). The region is near DRC and Goma, the nearest city in DRC is seen as one of attractive market for dairy products. The climate (high rainfall more than 1,500 mm) and a relatively easy access to land are more favorable for pasture-based systems. The region has also a high proportion of absentee owners (Gishwati farms). However, the region's poor roads impact milk collection, especially in wet season when the farm gate price falls around RwF 120 per liter.

Market systems

Domestic Market

The fermented whole milk is the most consumed product in Rwanda, but the demand of other dairy products (yogurt, cheese, butter, skimmed and flavored milk…) is also rapidly growing, mainly attracted by the urban middle income consumers. From 2008 to 2013, the milk consumption per capita doubled, from 25.7 to 58.1 liters per year. Coming agriculture statistics will likely exhibit higher consumption for 2014 and 2015, thanks to the recent large campaigns like "*Shisha wumva campaign*", "*One Cup of*

Milk per Child program" and the *"school milk program"* implemented by the GoR and its partners.

Import/Export Market

For past years, Rwanda registered a decreasing trend of import of dairy products. From 1999 to 2007, dairy products decreased from 1,280 MT formally imported in 1999 to less than 500 MT imported in 2007. In the meantime, Rwanda progressively increased its importation of pure-breed cows, up to 7,290 cows imported in 2007, just one year after the Girinka program's launch.

Table 40: Milk and Pure-Breed Importation in Rwanda

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
Milk importation (MT)	1280	1378	1687	1378	720	645	500	500	450
Imported heifer (pure breeds)	-	210	85	450	381	243	985	1178	7290

Source: Minagri 2007 statistical report & BNR 2007 report (Cited by Innocent Rutamu (2008).

The 2000-year's importations were dominated by raw fresh milk from Southern Uganda, together with processed dairy products, like powdered milk, cheese and butter. Importing dairy products was discouraged by the GoR, which overtaxed the powdered milk, while creating awareness for the local fresh milk consumption.

The period from 2007 to 2010 is likely a transition where the domestic demand for dairy products was apparently balanced by the local production. Since, Rwanda is gradually exporting dairy products, targeting neighboring countries, mainly Burundi

and the Democratic Republic of Congo. From 2012 to 2015, the milk informal exportation doubled from 6,000 MT to 12,300 MT[22].

Table 41: Informal Milk Exports from Rwanda

Year	2012	2013	2014	2015
Milk informal exports (MT)	6 016	9 815	14 518	12 339

Our estimation based on the Informal Cross Border Trade (ICBT) data (Source: NAEB)

Informal milk exports (cross border trade) are dominated by fermented milk, progressively sold in the neighboring cities, like Goma, Bukavu and Bujumbura. Most milk is supplied in small plastic containers (1, 2 and 5 liters).

Actors in the dairy subsector

Dairy producers

Cows are reared by zero-grazing (*cut and carry*) or closed-pasture-open/free-grazing system, depending on the land availability;

1. Smallholder dairy producers

Milk is dominantly produced by the smallholder farmers remotely established in the country. In addition to their home consumption, they sell the surplus to their neighbors and/or to the numerous local milk collectors. The farm gate price varies between frw

[22] There is a positive trend in milk exportation. However, clear evidences are needed, as different sources are reporting non coherent data. For instance, according to the Rwanda National Dairy Strategy, 2013 and White gold: Opportunities for dairy sector development collaboration in East Africa – WUR, 2014: Rwanda informally exported some 12 million liters to the both countries, while the National Agriculture Export Development Board (NAEB) estimated the formal export at 6,556,474 liters in 2012/2013 and 10,381,738 liters in 2013/2014.

120 and frw 200, depending on the remote area's accessibility and the season.

Zero-grazing is the dominant production system and perfectly integrated into the farming system. It's preferred in the highly populated areas. The system is then practiced everywhere in the country and has been promoted for the last 30 years. Smallholder dairy farmers face many challenges, including unreliable market (especially during rainy season), preservation of the milk quality, together with high production costs.

2. "Large" dairy farmers

The open grazing is practiced in some specific regions (Gishwati, Eastern Province and Kigali's peri-urban zones) and managed by some "large farmers" that rear 10 to 20 dairy cows on 3 to 20 hectares.

Local milk collectors

The small quantity of milk produced by each household attracts a large range of milk collectors, mainly depending on their investment capacities. The simplest are door-to-door collectors who gather around 20 liters of milk from a dozen of families early each morning. Most of the time, they sell the collected milk to other collectors established in the nearest "business center", using bicycle or motorcycle to transport the collected milk to the nearest city. There is an informal agreement that each collector get frw 10 per liter as the gross margin.

These traveling milk collectors mainly deliver the raw milk to the milk kiosks, which sell fresh and fermented milk to the urban low- and medium-income consumers. This informal market is yet dominant.

Milk collection centers (MCC)

Since more recently (later in 2013), more travelling collectors are progressively deliver milk to processing premises, through MCC. This formal market is growing thanks to the GoR and its partners, who provided technical and financial supports to milk collectors, MCCs and processors. The aim is to improve quality and organize the milk supply chain. Rwanda has 96 milk collection centers, financially supported by different Minagri's projects (mainly PADEBL[23] and LISP[24]). The MCC's role is to chill/bulk milk, which delay spoilage and ensure the milk quality, before supplying the milk to retailers and/or processors.

Milk transporter

Most of MCC do not have capacity to supply milk to the processors/retailers. There are two options. Some MCCs sell milk to a transporter, who has already identified a reliable market. Most of the time, MCCs subcontract transporters to deliver milk to the market identified by MCCs. Here, transporters charge fixed rates (RwF 20 – 30 per liter) for milk transport. With appropriate transport logistics and cold storage, they help maintain quality milk from MCCs to processors/retailers.

Milk processors

As a perishable product, milk processing is very important. Processors extend its shelf life and produce new products for different market segments. Processed dairy products are delivered to the end consumers through wholesalers/retailers and/or food shops.

According to RDB (investor's prospectus), only 7% of the national milk production is sold through commercial dairies. Currently, there are 7 well-functioning dairies in

[23] PADEBL: Projet d'Appui au Development de l'Elevage Bovin Laitier (Dairy livestock Development Support Project)

[24] LISP: Livestock Infrastructure Support Program

Rwanda. Inyange industries (with its subsidiary Savannah Dairy), Nyanza Dairy, Zirakamwa Dairy, Masaka Farms, Blessed Dairies, Gishwati Farms, Bugesera Dairy. The all installed capacity of the seven dairies is 350,000 liters per day, but their current performance is around 120,000 liters per day (35% of the installed capacity). Inyange, the largest dairy in the country processes between 80,000 and 100,000 liter per day. These are recent performance thanks to emerging milk zones. In 2014, Inyange industries used to process between 30,000 to 40,000 liter per day.

There is a huge opportunity to invest in the dairy sector. In addition to the 7% of milk sourced by commercial dairies, 30% is daily sold through formal market (farmer – MCC – retailer – consumer) and the remaining 63% reach the final consumer through informal channels (farmer – collector – kiosks – consumer).

Milk kiosks

Milk kiosks are specialist outlets selling milk. These popular premises can daily sell as much as 1,000 liters of milk, creating 10 to 15 decent jobs. They use both family labor and wage employment.

Dairy chain enablers and supporters

Minagri – one cow one poor family program "Girinka"

Since 2006, MINAGRI is implementing the popular "One Cow per Poor Family Program, commonly known as "Girinka" program. The twelve years program (2006 – 2017) intends to reduce child malnutrition while increase household incomes for poor farmers. The program covers all 30 Rwandan districts and targets to reach 350,000 households by the end of 2017.

So far, more than 222,539 cows have been distributed to the poor farmers by the Rwanda government, together with its partners (International Fund for Agriculture

Development, Food and Agriculture Organization, World Food Program, Lutheran World Federation, Netherlands Development Organization (SNV), Heifer International, Send a Cow, World Vision, Global Fund, local and international NGOs, private sectors …)

Minagri - Livestock Infrastructure support Program (LISP) (2012 – 2015)

In addition to Girinka program, MINAGRI has launched the livestock Infrastructure support program (LISP), to reinforce the development of a modern livestock industry in Rwanda through value addition and access to markets. The program built rural infrastructure, especially water supply for livestock farmers, feeder roads and new milk collection centers (MCCs).

Rwanda Dairy Competitiveness Program II (2012 – 2017)

The Feed the Future's initiative is the second phase of a previous project implemented by Land O'Lakes and partners since 2007. The overall objective is to increase competitiveness of Rwandan dairy products in both domestic and regional markets. The program provides technical and financial assistance to dairy chain actors and enablers. At the national level, the program aims to upgrade the dairy industry's value chain by boosting milk quality and making processing more efficient.

Appendix F: List of Commodity Specific Conversion Factors

Table 42: Commodity Specific Conversion Factors (CSCFs) employed in the analysis.

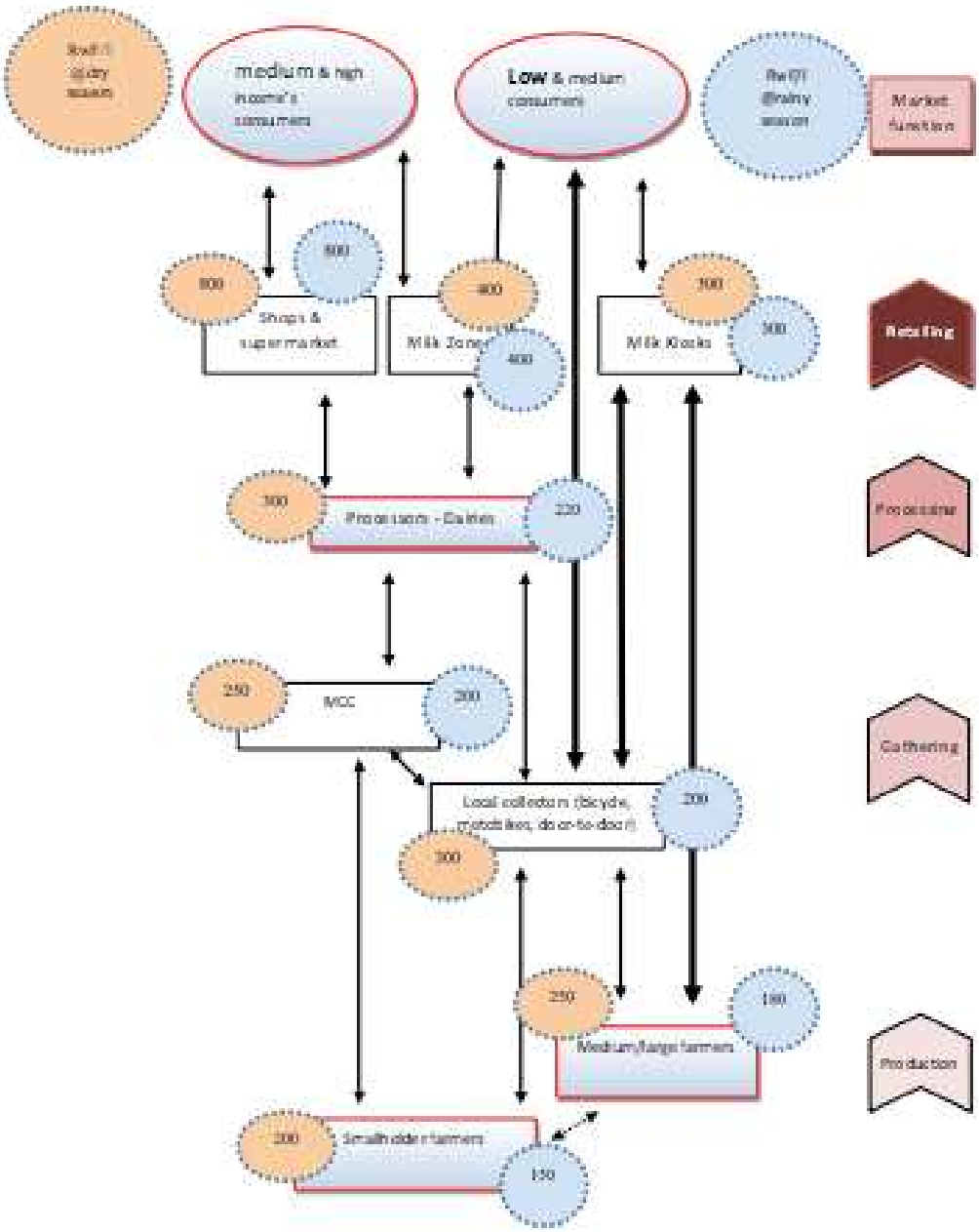
Milk (Exportable output)	1.053
Livestock (Importable input)	1.053
Livestock (Importable output)	1.053
Bovine meat (Exportable output)	1.053
Napier Grass (Non tradable)	1.000
Maize bran (Importable input)	1.053
Concentrate (Importable Input)	1.053
Salt (Importable Input)	1.053
Water (Non tradable)	1.000
Anti-tick spray (Importable input)	1.053
Anti-worm medicine (Importable input)	1.053
Land (Non-tradable)	1.000
Shelter (Construction)	0.884
Labor (Labor)	1.000
Transportation (Transportation)	0.872
Veterinary Medicine (Importable Input)	1.053
Veterinary Services (Non-tradable)	1.037
Bovine Semen (Importable input)	1.053

AI Services (Non-tradable)	0.984
Manure (Non-tradable)	1.000

Source: http://rwanda-cscf.minecofin.gov.rw

Alternatively please use: http://rwanda-cscf.cri-world.com

Appendix G: Milk Prices



Appendix H: Sources of Inputs

Table 43: Sources of Inputs Used in the Analysis of The Dairy Value Chain

Without Project	
Input	Source
Number of beneficiaries (Cell I82 to M82)	Land O'Lakes
Optimal and initial herd size (Cell F83 to F84)	Interviews with farmers Field visits
Lactation period (Cell F87)	Interviews with farmers Interview with local veterans
Calving interval (Cell F88)	Interviews with farmers Interview with local veterans
Artificial Insemination(AI)/ Bull Services (Cell F89)	Interviews with farmers Interview with local veterans
Daily milk yield (Cell F90)	Interviews with farmers Interview with local veterans
Milk loss (Cell F95)	Interviews with farmers Interview with Milk Collection Centers Interview with formal and informal transporters
Feeding prices (Cell F98 to F102)	Interviews with farmers Interview with Cooperatives
Daily feeding ration (Cell F105 to F109)	Interviews with farmers Interview with Cooperatives
Land requirement in open grazing system (Cell F111 to F114)	Field visits Interviews with farmers
Animal shelter (Cell F116 to F119)	Assumption Field visits Interviews with farmers
Labor requirement (Cell F121 to F122)	Interviews with farmers

Veterinary services (Cell F 124 to F 128)	Interviews with farmers Interview with local veterans Interview with Cooperatives
Mortality rate (Cell F131 to F132)	Interviews with farmers Interview with local veterans Interview with Cooperatives
Calving rate (Cell F135 to F136)	Assumption
Culling rate (Cell F138)	Assumption Interviews with farmers Interview with local veterans
Animal feeding units (Cell F140 to F143)	Assumption Interviews with farmers Interview with local veterans
Selling prices (Cell F145 to F150)	Interviews with farmers
Manure (Cell F152 to F 153)	Interviews with farmers
With Project	
Input	Source
Optimal and initial herd size (Cell F161 to F162)	Interviews with farmers Field visits
Lactation period (Cell F165)	Interviews with farmers Interview with local veterans
Calving interval (Cell F166)	Interviews with farmers Interview with local veterans
Artificial Insemination(AI)/ Bull Services (Cell F167)	Interviews with farmers Interview with local veterans
Daily milk yield (Cell F168)	Interviews with farmers Interview with local veterans
Milk loss (Cell F171)	Interviews with farmers Interview with Milk Collection Centers Interview with formal and informal transporters

Feeding prices (Cell F174 to F178)	Interviews with farmers Interview with Cooperatives
Daily feeding ration (Cell F181 to F186)	Interviews with farmers Interview with Cooperatives
Animal shelter (Cell F193 to F196)	Assumption Field visits Interviews with farmers
Labor requirement (Cell F198 to F199)	Interviews with farmers
Veterinary services (Cell F201 to F205)	Interviews with farmers Interview with local veterans Interview with Cooperatives
Mortality rate (Cell F208 to F209)	Interviews with farmers Interview with local veterans Interview with Cooperatives
Calving rate (Cell F212 to F213)	Assumption
Culling rate (Cell F215)	Assumption Interviews with farmers Interview with local veterans
Animal feeding units (Cell F217 to F219)	Assumption Interviews with farmers Interview with local veterans
Selling prices (Cell F221 to F226)	Interviews with farmers
Manure (Cell F228 to F229)	Interviews with farmers
Investment Costs by USAID	
Input	Source
USAID investments, Nominal USD (Cell I231 to M231)	Land O'Lakes
Macro Information	
Input	Source

Discount rate (Cell F234)	USAID guidelines
EOCK (Cell F235)	USAID guidelines
Real exchange rate (Cell F237)	2015 is the base year and therefore the nominal exchange rate is equal to real exchange rate.
Macroeconomic Indicators	
Input	Source
US inflation rate (Row 239)	IMF[25]
Price index – US (Row 240)	Function of US inflation
Rwanda inflation rate (Row 241)	IMF
Price index – Rwanda (Row 242)	Function of Rwanda inflation

[25]http://www.imf.org/external/pubs/ft/weo/2015/02/weodata/weorept.aspx?pr.x=36&pr.y=7&sy=2013&ey=2020&scsm=1&ssd=1&sort=country&ds=.&br=1&c=722&s=PCPIPCH&grp=0&a=

Appendix I: The Poultry Subsector, Development Goals and Agricultural Policy in Rwanda

The development of Rwanda's agricultural sector is guided by international and regional agreements, conventions and protocols focused on global socio-economic goals. These include global Millennium Development Goals (MDGs) and forthcoming Strategic Development Goals (SDGs), as well as African agricultural development policies (NEPAD/CAADP) and regional initiatives (COMESA, EAC and CEPGL).

At the national level, Rwanda's agricultural development is embedded in the framework of Vision 2020 and successive Strategic Plans for the Transformation of Agriculture (PSTAs), through which MINAGRI implements the government's Economic Development and Poverty Reduction Strategy (EDPRS). The current (third) PSTA runs to 2018, working towards the goal of transforming Rwanda's agricultural sector from subsistence to market-based.

Policies, laws and regulations affecting Rwanda's poultry subsector

The following provides an overview of Rwanda's poultry subsector in the context of global and national development goals, assessing the effect of successive implementation strategies (PRSP, EDPRS, nutrition, and investment promotion strategies) on the production and marketing of poultry products on domestic and regional markets.

Recent policy changes, including laws, regulations and the implementation of PSTAs, have had a significant impact on the poultry subsector. This section assesses the alignment of poultry subsector strategies and policies with specific needs of the poultry

subsector: that is, the supply of day-old chicks and animal feed, and access to veterinary products and services. Broader policies related to the overall development of the meat industry are also examined.

The Rwandan poultry subsector in the context of global development goals

GoR policies for the poultry subsector are in line with current MDGs (2000-15) and forthcoming SDGs (2016-30).[26]

The production of affordable and nutritious products (chicken meat and eggs) contributes to the reduction of poverty, hunger and child mortality (MDG 1 and 4; SDG 1, 2 and 3). Relatively small investments in the poultry subsector provide vulnerable groups such as women and youths with reliable employment, contributing to national economic growth (MDG 3; SDG 5 and 8). In addition to nutritious food, poultry farming produces high-quality organic manure, suitable to the development of sustainable farming ecosystems (MDG 7; SDG 6, 13 and 15).

Rwanda Vision 2020, PRSP and EDPRS

At the national level, Rwanda's development path is guided by Vision 2020—a 20-year program launched in 2000 and revised in 2012, which aims to transform the country into a knowledge-based middle-income country by 2020. Vision 2020 is implemented through a series of strategic plans: the Poverty Reduction Strategic Plan (PRSP, 2002-06) and two phases of the Economic Development and Poverty Reduction Strategy (EDPRS, 2008-12 and EDPRS II, 2013-18).

Over the ten years from 2000-10, the GoR concentrated on establishing a

[26] For more details, refer to *http://www.un.org/millenniumgoals/* and *https://sustainabledevelopment.un.org/*

comprehensive national framework for social development, supported by strong institutions. The policies and institutions developed during this post-conflict period aimed to reduce poverty and re-launch a pro-poor strategy for growth. Although the focus was on overall national development rather than specific industries, the poultry subsector was recognized as having a role in national policy.

The subsector is directly relevant to three of the six pillars central to Vision 2020, contributing to the emergence of a private sector-led economy (pillar three); the development of a productive and market-oriented agricultural industry (pillar five); and Rwanda's integration in the regional and global economy (pillar six).

In terms of implementation level, the poultry subsector can be considered a key component of PRSP priority areas of rural development, agricultural transformation and private-sector development. Similarly, the poultry subsector has been central to both phases of the EDPRS, playing its part in accelerating growth, creating employment and generating competitive products for export. More importantly, the subsector is critically important in fulfilling national nutrition goals, which aim to tackle protein and micronutrient deficiencies, particularly in children under 5.

Overview of Agricultural Policies in Rwanda

PSTA I, II and III: Reflecting the evolution of agricultural policy

Beginning in 2004, the development of Rwanda's agricultural sector has been guided by a National Agriculture Policy implemented through three successive Strategic Plans for Agricultural Transformation (PSTA I, II and III). These strategic plans have been developed in line with the PRSP and EDPRS, which establish the agricultural sector with a leading role in economic development and poverty reduction.

PSTAs I (2004-08) and II (2009-12) comprised four programs: extension of sustainable production systems; professionalization of farmers; development of commodity chains and agribusinesses; and institutional development. The programs included the launch of successful agricultural schemes such as Girinka (2006) and CIP (2007), resulting in a significant increase in agricultural production by the end of 2012, along with policies, laws and regulations specific to agricultural subsectors.

The PSTA III (2013-18) introduced a new strategic focus on increasing private-sector investment in agriculture, to increase exports, processing and value addition. While PSTA-III activities continue to boost the production of staple crops and livestock products, the focus of agricultural policy has now shifted from ensuring national food security to providing jobs and supporting Rwanda's broader economic transformation.

Agricultural subsector policies

The introduction of sectoral policies aimed at developing Rwanda's poultry industry began after 2010, in support of the objective of building a modern poultry industry by 2018. A brief overview of policies affecting the poultry subsector follows;

- **Master plan for fisheries and fish farming in Rwanda (2011-20):** Fish and fish byproducts are key components of chicken feed. The MINAGRI master plan is aimed at the cost-effective use of existing resources (lakes, rivers, fish ponds) to increase national fish production. The poultry industry would benefit from a larger supply of fish byproducts, resulting also in a drop in imports of Lake Tanganyika sardines (*Limnothrissa miodon*) from Burundi and Tanzania, used to feed poultry.

Strategic plan for animal nutrition improvement (since 2009): The strategic plan has

raised awareness of the need to develop a national feed industry for non-ruminants (pigs and chickens), while focusing on the conservation of high quality forage for dairy cows. The overall goal is to shift from imports of ready-to-use feed towards a domestic animal-feed industry using locally grown ingredients.

- **Strategic and investment plan to strengthen meat industry (2012):** The poultry industry is expected to play a leading role in efforts to develop Rwanda's meat industry, with a focus on increasing domestic average annual per capita consumption of quality meat (currently 7.5 kg) and competing on the flourishing regional meat market.

- **Strategy and investment plan for small-animal farming (2012-17):** The strategy focuses on pig, goat, rabbit and sheep farming, as well promoting the village or smallholder poultry-production model, with a view to improving performance of rural farmers. The smallholder-farmer model is based on the introduction of exotic breeds, crossbred with local breeds better adapted to tropical conditions.

- **Strategic and investment plan to strengthen animal genetics (2012):** Improving the performance of rural poultry farmers depends on developing better breed stock. Four steps are suggested: identify superior birds in the local flock; train smallholder farmers to identify such birds; establish parent-stock farms; and control the quality of imported birds.

- **Irrigation, land husbandry and mechanization strategies (2009-18):** These strategies aim to improve rural infrastructure and facilitate on- and off-farm

tasks. Hand-hoes should be replaced by tractors, power tillers and/or animal power, and transport, irrigation and agro-processing equipment should be upgraded. Improvements in the operational efficiency and productivity of the land, as well as an increase in areas under cultivation, are expected to dramatically reduce farm-level production costs. This should result in more affordable and competitive raw materials (such as maize) for the animal-feed industry.

Laws and regulations

In addition to strategies and investment plans, MINAGRI has initiated a large number of laws and regulations over the last five years, providing a framework for the development of the livestock value chain, including the poultry subsector.

Regulation of poultry farming (production): All domesticated animals, including poultry, must be contained in a designated kraal. Free-roaming animals are strictly prohibited (Ministerial Order Nº010/11.30 of 18/11/2010). The prevention and control of contagious disease in domesticated animals is also regulated (Law N° 58/2008 of 10/09/2008).

Regulation of poultry marketing (live-animal transport, meat processing and retailing): The transport and slaughter of chickens and the inspection and trade of meat are regulated (Ministerial Order N° 013/11.30 of 18/11/2010). Specific guidelines regarding the transport of chickens in appropriate containers are covered by Ministerial Order N° 33/2002 of 06/10/2002.

Regulation of veterinary services: Veterinary-pharmacy practices are regulated by ministerial Order N° 009/11.30 of 18/11/2010. Such pharmacies are managed by

veterinary doctors, regulated by a council established by Law N° 56/2013 of 09/08/2013.

In addition to these regulations, other policies regarding the production and marketing of agrochemicals and seeds, as well as the fishing subsector, have an indirect impact on the poultry industry.

Appendix J: Uganda's Poultry Industry

Poultry population and production systems

Uganda's poultry population increased by an average of 4.7 percent per year over the 2010-15 period, from 39.7 million to 50.9 million. Traditional (indigenous) breeds account for the vast majority of the poultry flock (88 percent), with the remainder comprising exotic layers (6.6 percent) and exotic broilers (5.4 percent—see Table 44).

Table 44: Evolution of Uganda's Poultry Population (million heads, 2010-15)

Year	2010	2011	2012	2013	2014	2015*
Indigenous breeds	34.8	35.9	37.0	38.1	39.2	-
Exotic breeds	4.9	5.0	5.2	5.3	5.5	-
Total poultry population	39.7	40.9	42.2	43.4	44.7	50.9

Source: Uganda Statistical Abstract (UBOS, 2015) - *estimate

Egg production in Uganda has witnessed similar steady growth, averaging 3 percent per year to reach 850 million eggs in 2014 from 760 million 2010 (see Table 45).

Table 45: Evolution of Egg Production (million, 2010-14)

Year	2010	2011	2012	2013	2014
Total Egg production	761,3	784,1	807,6	831,9	856,8

Source: Uganda Statistical Abstract (UBOS, 2015)

Poultry have long been integrated in Uganda's subsistence farming systems. Free-range indigenous birds are ubiquitous in rural areas, where 85 percent of Ugandans live. Small-scale backyard poultry operations are also common in urban areas, mainly catering to household needs. These low-input, low-output production methods account for almost 90 percent of Uganda's poultry population.

In addition to the indigenous, traditionally maintained bird population, 5.5 million exotic poultry are reared in intensive poultry farms. Over 80 percent of these farms are in the central region of Kampala and surrounding districts, with easy access to markets and essential inputs (including water, electricity, feed, pharmaceutical products, vaccines and day-old chicks). However, limited access to inputs (and markets, especially for exotic-breed meat) is a major impediment to poultry farmers in up-country districts.

There are three types of intensive poultry-production systems in Uganda, classified by size:

Small-scale poultry farms (less than 1,000 birds): Account for 50 percent of exotic layers and broilers. Two main advantages are modest investment and mitigated market risk. Preferred by development organizations targeting groups such as women, widows and youth.

Medium-size poultry farms (1,001 to 5,000 birds): Account for 30 percent of exotic layers and broilers.

Large-scale poultry farms (over 5,000 birds): Account for less than 20 percent of the intensively-farmed poultry population.

Animal Feed

Ugandan production of animal feed outstrips domestic demand, with the surplus exported to Rwanda, the DRC, Kenya, and South Soudan. The main poultry feed manufacturers are Ugachick Poultry Breeders, Chudapet, Nyala Poultry, Bulemezi Farm Enterprises, Hill Top Farm, Poultry Association of Uganda, Jays Links

International, and Unga Millers (U).

Ugandan poultry feed is the cheapest in the region, with 2015 prices averaging UgX 1,100 (USD 0.33 or FRw 242) per kg—at least 25 percent cheaper than in Rwanda where average prices (imported and locally produced) were FRw 300 (layer feeds) and FRw 315 per kg (broiler feeds).

Uganda benefits from three factors conducive to the manufacture of feed: locally available, reasonably priced ingredients (maize, soybeans, fish products and byproducts, cottonseed meal); relatively high demand from poultry producers; and reasonably priced power (UgX 315—USD 0.1 or FRw 69 per Kwh, compared to FRw 126 per kilowatt in Rwanda). These factors also account for the comparatively low price of poultry feed in Uganda.

By contrast, Rwanda's feed-manufacturing industry imports key ingredients, from Uganda and Tanzania. In addition, a large number of feed shops in Kigali and other urban areas deal exclusively in Ugandan-produced feed. However, recently introduced fiscal incentives have resulted in the establishment of three specialized poultry-feed factories in Rwanda (Zamura, PAFI, and Gorilla Feeds), with target annual production of 7,884 tons—equivalent to some 60 percent of annual national demand for poultry feed.

Poultry-Seed Market

Uganda produces a significant number of day-old chicks. The two largest producers are Biyinzika Enterprises and Ugachick, operating alongside a number of small-scale hatcheries, mainly in Kampala.

Biyinzika Enterprises, established in 1990, is Uganda's largest poultry breeder, producing 250,000 broiler chicks and 90,000 layer chicks per week. Ugachick is the region's main supplier of day-old chicks, feed, and dressed chicken, exported to Rwanda, Burundi, the DRC, South Sudan, and Kenya.

Ugandan chicks are 20 percent cheaper than those produced in Rwanda. A Ugandan day-old broiler chick costs UgX 1,600 (USD 0.48 or FRw 352), while a layer chick costs UgX 2,600 (USD 0.78 or FRw 571). Rwanda's two hatcheries (National Hatchery and Rwanda-chick) struggle to maintain reliable deliveries at a price of FRw 500 for a broiler chick and FRw 700 for a layer chick.

Veterinary Products and Services

Poultry farmers in Uganda benefit from a large network of dealers in agricultural supplies. Veterinary products (drugs, vaccines, vitamins, and equipment) are readily available in urban areas, near commercial poultry farms. In addition, Ugandan laboratories have developed a wide range of pharmaceutical products (such as a vaccine against Newcastle disease), which are sold at a lower price than imports. The country also boasts a large number of private veterinary doctors. However, many poultry farmers decry the lack of timely animal-health services, as well as the widespread use of low quality or fake products.

Rwanda's poultry farmers enjoy similar access to inputs through its own national network of agricultural suppliers, encompassing 1,200 dealers. However, poultry vaccines are only available in Kigali City, and only 18 trained technicians are available to poultry farmers across the country.

Market for Poultry Products

Most Ugandan poultry products (eggs and broilers) are consumed domestically.

Traditionally limited to wealthy consumers or special occasions, the market for chicken meat is growing among middle-income consumers as prices fall in relation to beef. At the same time, the changing tastes of a rapidly urbanizing population, especially in Kampala and its suburbs, has led to an increase in the number of takeaway restaurants and snack outlets catering to a "chicken-and-chips" youth.

Prices for local chicken range from UgX 8,000 (USD 3 or FRw 1,760) to Ug X 10,000 (USD 2.40 or FRw 2,200) per kg at the farm gate, to UgX 15,000 (USD 4.50 or FRw 3,300) per kg at a high-end Kigali supermarket. The farm-gate price of an exotic egg can be as low as UgX 200 (USD 0.06 or FRw 44).

Again, prices in Rwanda are 20 to 25 percent higher than in Uganda. The average farm-gate price for a locally prepared chicken from a small-scale producer is FRw 2,250 per kg (only the largest producer, PEAL in Bugesera district, delivers chicken meat to hotels, at FRw 1,850 per kg). The average price of chicken meat in a Kigali supermarket is FRw 3,000 per kg, while the lowest price for an exotic egg is FRw 65.

Despite Uganda's regional competitiveness, however, cheap imports from Brazil, South Africa, and Europe are available on the Kampala market, where an imported prepared chicken can go for UgX 6,500. Ugandan poultry farmers have responded to such competition with a call for import controls.

Rwanda's Comparative Advantage

Marketing of poultry products

Rwanda produced 5,745 tons of chicken meat in 2015—less than one-tenth of Uganda's output of 59,380 tons—and 0.32 billion eggs compared to Uganda's 3.6 billion. Uganda enjoys advantages in terms of market size and rates of consumption: 33 million Ugandans consume an annual per capita average of 32 kg of meat, compared to 11 million Rwandans consuming an annual per capita average of 10.5 kg of meat.

Rwanda's poultry industry has little to offer Uganda, where local producers meet domestic demand as well as exporting to Rwanda, Burundi, Kenya, South Soudan, and the DRC.

Uganda's poultry industry includes a number of large-scale farms. However, the overall strength of the sector is underpinned by a predominance of small-scale producers, employing simple, backyard-farming methods. The sector further gains from three additional factors, not all of which are found in neighboring countries:

Model poultry farms: Multipurpose model poultry farms are in operation in Kampala and surrounding districts, registered as private companies and managed by qualified graduates from local universities and institutes. (Examples of medium-sized model farms include Agroline, Hill Top Farm, Unite Poultry Farm, Biyinzika Enterprises, JB Poultry Farm, Kagodo Farmers, and Ugachick Poultry Breeders.)

Hatcheries: Large hatcheries produce day-old chicks for domestic markets and for export to neighboring countries, mainly the DRC and Rwanda. Some hatcheries supply hundreds of thousands of chicks per week, as well as offering poultry-farm services

and training. (Examples include Ugachick Poultry Breeders, Chicken House, Biyinzika Enterprises, Kigo Prisons, LES, Bulemezi, Kiyita, Nsambya Catholic, Senda, Kagodo Farmers, Walusimbi Farmers, Kiwanuka, and Gesica.)

Commercial feed factories: The growing poultry subsector continues to attract investors in the animal-feed industry. (Examples include Creda Africa, Liberty Trading Co., Formula Feeds, Catholic Secretariat, Engano Millers, Bulemezi Farm Enterprises, Ugachick Poultry Breeders, Kagodo Farm, and Hill Top.)

Investors in Uganda's poultry industry enjoy the additional advantage of "free" land in return, for example, for providing local jobs. Land can also be leased at low cost in many rural areas of Uganda, in contrast to Rwanda where land is scarce and expensive.

As well as factors conducive to production, Uganda's poultry industry benefits from a large domestic market and the ease of setting up roadside snack outlets and bars. Such venues—generally discouraged in Rwanda—have helped drive the consumption of poultry products in Uganda.

For Rwanda's poultry industry it is challenging to compete with regional leaders such as Uganda. However, Rwandan producers would gain from a focus on the domestic market and on exports to the DRC, proximity to which is a key export advantage. Rwandan producers could also diversify output, developing high-quality poultry products (such as indigenous eggs and meat) for the domestic market. Such specialization would complement efforts to establish Rwanda as a value-adding link in the poultry value chain, processing imported chicken for re-export to the DRC.

Appendix K: Tanzania's Poultry Industry

Poultry population and production systems

The Tanzanian poultry subsector is steadily recovering from an outbreak of avian influenza that almost halved the flock, falling from 107 million in 2011 to 58 million in 2012. The poultry population has since increased to 69 million in 2015, of which 37 million (54 percent) are indigenous breeds and the remainder exotic breeds—24 million broilers and 8 million layers. Tanzania produced 4.1 billion eggs and 99,540 tons of poultry meat in 2015. Imports of poultry products into mainland Tanzania have been banned since the outbreak of Avian flu.

Table 46: Evolution of Tanzania's Poultry Population (million heads, 2010-15)

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Population	94.200.000	106.900.000	58.331.312	61.193.417	64.398.860	69.000.000

Source: FAO report, eggs and meat 2011

Tanzania country report, 2015

Many Tanzanian households' rear poultry, with the small-scale village or backyard poultry system accounting for about 70 percent of the national flock. Village farms also supply almost all the poultry meat and eggs consumed in rural areas and some 20 percent of that consumed in urban areas.

The commercial production of layers and broilers is concentrated in the urban areas of Dar es Salaam, Dodoma, Arusha, Iringa, Manza, Tabora, Zanzibar, Mbeya, Tanga, Pwani, Manyara, Kagera, and Mara.

Animal Feeds

Tanzania probably has the cheapest poultry feed in the region, averaging TZS 18,000

per 50-kg bag (USD 8.50 or FRw 125 per kg) in 2015.[27] Local feed manufacturers benefit from relatively affordable ingredients—mainly maize and oilcakes, which account for almost 80 percent of poultry-feed ingredients. Tanzanian maize production has registered average annual growth of 15 percent over recent years, reaching 6.7 million tons in 2014 from 3.5 million tons in 2008.

Poultry-seed market

Day-old chicks (broiler or layers) are affordable, at TZS 119,720 per 100 (USD 0.57 or FRw 417 per chick). Tanzania has recorded steady growth in poultry-seed production, rising to 63.1 million in 2014 from 61 million the previous year. New investment in poultry-breeding farms and hatcheries will further boost domestic production of day-old chicks. A major new facility which is currently at the completion stage alone is expected to produce 15-million-day-old chicks (broilers and layers) annually.

Veterinary Products and Services

Poultry farmers benefit from a large network of dealers in agricultural supplies, covering all cities and most villages hosting significant poultry flocks. The government is also highly supportive of farmer cooperatives offering services to poultry farmers. Other inputs, such as drugs, vaccines, and vitamins, are available at relatively affordable prices.

Market for Poultry Products

Tanzania has a relatively high per capita consumption of meat, especially in urban areas. However, local producers face stiff competition, despite demands by industry

[27] Local-currency prices are converted to USD to facilitate comparisons, using the exchange rate of December 31, 2015, when USD 1 = TZS 2,115.92 = FRw 736.447 = UgX 3,350.19 = KES 100.518 = CDF 908.537 = BIF 1,538.25

representatives (the Tanzania Poultry Breeders Association and the Tanzania Commercial Poultry Association) for a curb on imports.

Poultry products in Tanzania are among the cheapest in the region, with a tray of 30 eggs costing just TZS 4000 (USD 0.06 or FRw 46 per egg). Egg consumption is therefore increasing, reaching a per capita annual average of 106 in 2015.

Rwanda's Comparative Advantage

Tanzania has a number of advantages over Rwanda, including the largest regional market by population, the greatest land resources, affordable raw materials for feed, and supportive government policy. Poultry feed and seeds are very affordable, helping to dampen the price of poultry products (eggs and chicken meat).

However, Tanzanian producers appear to focus mainly on the domestic market, playing a marginal role at the regional level. Tanzanian producers may benefit from growth in regional poultry-market exchanges (Rwanda, Burundi, and the DRC) but exploiting such opportunities are not yet policy priorities.

Rwanda imports the bulk of ingredients used in the production of feed (maize, soybeans, and oilcakes). Despite a cut in VAT on animal feed in Rwanda, poultry feed still costs more than double that in Tanzania (FRw 300 per kg compared to FRw 125 per kg). It may therefore make sense for Rwanda to develop imports of feed from Tanzania instead of producing feed locally.

Appendix L: Kenya's Poultry Industry

Poultry Population and Production Systems

Kenya's poultry population totaled 32 million in 2015—75 percent indigenous (24 million), 22 percent (7 million) exotic breeds (broilers and layers), two percent other species (ducks, geese, turkeys, pigeons, ostriches, guineafowl, and quails—640,000 birds), and one percent breeding stock (320,000 birds).[28]

It is increasingly common for families in Kenya to keep poultry (broilers, layers and/or Kienyeji (indigenous) birds) to meet household demand for meat and eggs. Kenya also has a number of large-scale commercial poultry farms, including:

Brade Gate Poultry Industries: covers the entire poultry value chain, from hatcheries to feed factories, poultry processing, egg and chicken-meat stores and retail shops, employing thousands.

Breedtech: supplies fertilized eggs to hatcheries and chicks to farmers in the Western and the Nyanza regions. Also trains farmers in improved poultry-farming techniques.

Kukuchic: leading East African producer of breeders and supplier of Rainbow Rooster birds and Fast White Rainbow chicks. Facilities include a hatchery (240,000 chicks per month), three breeder farms in Eldoret (Rainbow Rooster parent-stock of over 20,000), and recent investment in poultry-feed mills.

Kenya produces about 56,500 tons of poultry meat and 1.3 billion eggs annually.

[28] Factsheet Kenya, Poultry, Meat & Processing Sector, December 2015).

Animal Feed

The main poultry-feed producers in Kenya are Brade Gate Poultry Industries, Kukuchic, Cooper K-Brands Limited, Leghorn Feeds International, Milele Feeds, Nutrimix, Pembe Feeds Limited, Sigma Feeds, Pioneer Feeds Limited, Mombasa Maize Millers, Joeliz Bone Meal, and Unga Feeds, all of which are members of AKEFEMA[29].

The Kenyan feed industry meets national demand, with surpluses exported to neighboring countries. Poultry-feed prices averaged KES 34 per kg (USD 0.34 or FRw 249—including 16 percent VAT) in 2015—17 percent cheaper than in Rwanda, where the average price in 2015 was FRw 300 per kg of layer feed and FRw 315 per kg of broiler feed.

Poultry-seed Market

The poultry-seed market is dominated by two large hatcheries: Kenchic (the largest hatchery in East Africa) and Brade Gate Poultry Industries. These two giants produce a weekly total of one-million-day-old chicks (broiler, layer, and Kenbro), distributed to small-scale commercial poultry farms in urban areas (Nairobi, Mombasa, Nakuru, Kisumu, Nyeri, and Meru). Other large hatcheries include Breedtech (supplier of chicks and fertilized eggs to hatcheries), Kukuchic (240,000 chicks per month), uguku, Kenbrid and Sigma, Rift Valley, and Wachanga.

Over half (58 percent) of the day-old chicks produced by Kenyan hatcheries are sold domestically, with the rest exported to neighboring countries of Uganda, the DRC,

[29] AKEFEMA - Association of Kenya Feed Manufacturers, founded in 2003

Rwanda, Burundi, South Sudan, and Tanzania.

The average price of a day-old layer chick is KES 100 (USD 1 or FRw 733), while a day-old broiler chick goes for 75 KES (USD 0.75 or FRw 549). These prices are slightly higher than those of day-old chicks produced in Rwanda (FRw 700 for a layer and FRw 500 for a broiler). However, unreliable local supply means that Rwandan poultry farmers often import day-old chicks from Kenya.

Veterinary Products and Services

Veterinary products (drugs, vaccines, vitamins, and equipment) are available from agricultural shops. Poultry farmers enjoy easy access to additional services and advice from a large number of private and public veterinary practitioners, as well as big hatcheries and feed manufacturers.

The poultry industry also benefits from KARI's active research on breeding and the formulation of high-quality poultry feed, with testing for the latter conducted in its own lab.

Market for Poultry Products

Urban areas represent a key market for poultry meat in Kenya, particularly the tourist hubs of Nairobi and Mombasa, which are among the most expensive cities in the region. Chicken breast sells for KES 1,050 (USD 10.5 or FRw 7,700) per kg in Nairobi supermarkets. The price of an exotic egg is KES 12 (USD O.12 or FRw 88), while that of an indigenous egg is KES 15 (USD 0.15 or FRw 110). These relatively high prices (similar to those in Kivu-region cities of the DRC) limit potential Kenyan poultry exports.

Rwanda's Comparative Advantage

Kenyan poultry exports to Rwanda are limited by: the high price of poultry inputs and

products on the domestic market; distance to Kigali (some 1,200 km); and VAT on animal feed. However, one Kenyan supermarket chain (Nakumatt) has successfully exploited the Rwandan niche market for high-quality chicken (*The Farmer's Choice*), targeting top-end Kigali consumers.

Appendix M: Democratic Republic of Congo's (DRC) Poultry Industry[30]

Poultry Population and Production Systems

The poultry population of the North and South Kivu provinces of the DRC is estimated at 19.5 million (2015), the vast majority of which (97 percent) are indigenous chickens raised in rural subsistence-farming systems. The remaining three percent (some 585,000 birds) are exotic broilers and layers raised on small-scale commercial poultry farms—a nascent industry in urban areas (Goma, Uvira, Beni, and Bukavu).

Animal Feed

The Kivu provinces have no local feed industry, due to low demand. Poultry farmers and/or retailers import manufactured poultry feed, mainly from Uganda. The average 2015 price of feed in Goma was CDF 350 (USD 0.39 or FRw 284) per kg for layers and CDF 380 (USD 0.42 or FRw 308) per kg for broilers—comparable to prices in Rwanda (FRw 300/kg for layer feed and FRw 315/kg for broiler feed).

Poultry-Seed Market

A number of hatcheries were established in the Kivu provinces, usually as part of church-run humanitarian and nutrition projects. However, the majority no longer function due to recurring insecurity or mismanagement.

Just two small-scale hatcheries remain in operation, in Rutchuru and Bukavu, producing 8,000 day-old chicks per month at highly subsidized prices. A day-old layer

[30] Only data from Kivu Provinces is available

chick costs CDF 800 (USD 0.88 or FRw 648) and a day-old broiler chick costs CDF 600 (USD 0.66 or FRw 486)—possibly the best offer in the region.

The unreliable local supply of day-old chicks means that small-scale commercial poultry farmers tend to import chicks from hatcheries in Uganda or Kenya, or from Belgium (supplied by Agrotech Rwanda). Agrotech delivers a day-old layer chick at a cost of CDF 1,500 (USD 1.65 or FRw 1,216), while a broiler chick costs CDF 1,300 (USD 1.43 or FRw 1,054)—higher than the price charged on Rwandan markets (FRw 1,020 per layer and FRw 950 per broiler), as chicks must transit in Kigali before reaching eastern DRC. Although orders take one to two months, poultry farmers in Kivu and Rwanda generally prefer chicks imported from Europe, citing higher performance.

Day-old chicks imported from the region (Uganda and Kenya) are more affordable and delivered more promptly (one week). A day-old layer chick from Uganda is delivered to Goma at a price of CDF 900 (USD 1 or FRw 730), while a broiler chick can be as little as CDF 650 (USD 0.72 or FRw 527). Day-old chicks from Kenya are slightly more expensive, delivered to Goma at a price of CDF 1,000 (USD 1.1 or FRw 811) per layer, while broiler chicks are sold at CDF 850 (USD 0.94 or FRw 690—the same price charged for imports to Rwanda). A day-old layer chick imported from Uganda is delivered to Kigali for FRw 790, while a broiler chick goes for FRw 700 (from Uganda) or FRw 720 (from Kenya).

Veterinary Products and Services

The DRC market for poultry-sector inputs is at a very early stage of development. A small number of multipurpose input shops exist in urban areas only (Goma, Bukavu, Butembo, Rutchuru, and Uvira), supplying some veterinary products and poultry feed,

as well as providing support services and advice. Most veterinary products are imported from Uganda, and are widely believed to be counterfeit. An increasing number of poultry farmers therefore cross the border to Rwanda to buy pharmaceutical products, prompting a large number of veterinary pharmacies to open shops in the border districts of Rubavu (Gisenyi) and Rusizi (Kamembe).

Market for Poultry Products

Meat is not yet considered a staple food in the DRC. However, demand for poultry products is expected to grow in line with increasing urbanization. Local production of poultry meat is sufficient to meet just three percent of demand for eggs and broilers in the two Kivu provinces, driving significant volumes of imports. Indeed, DRC has been a major net importer of food for a number of years, importing chicken mainly from Belgium, South Africa, and Brazil. As such, the DRC market represents a major opportunity for regional exporters.

Poultry-product prices in the Kivu provinces are very attractive—CDF 7,000 for a whole chicken of about 1.5 kg (USD 5.1 or FRw 3,782 per kg), CDF 200 (USD 0.22 or FRw 162) per exotic breed (intensively-farmed) egg, and CDF 300 (USD 0.33 or FRw 243) per indigenous egg. These prices are higher than those in Kigali, where a broiler costs FRw 3,000 per kg and an egg costs between FRw 70 (exotic) and FRw 100 (local).

Rwanda's Comparative Advantage

Rwanda is the nearest country to Kivu's largest cities, Goma and Bukavu, which have a combined population of over two million and account for about 80 percent of Rwanda's cross-border food exports (through Rusizi and Rubavu). However, only 30 percent of the eggs and broilers exported to the DRC are produced in Rwanda; 70 percent are re-exports, mainly from Uganda.

The business environment in the DRC has not been conducive to investment for some time, including in intensive poultry farming—a situation that is expected to continue for the foreseeable future. The Kivu provinces are therefore unlikely to make use of their immense resources to meet domestic needs, leaving Rwanda well-positioned to compete for a share of their lucrative market for poultry imports.

However, with current annual production of exotic breeders limited to just 860,000 (2015 estimates), Rwanda barely meets its own needs and will struggle to best neighboring countries on the Congolese market. It is therefore recommended that Rwandan producers seek to specialize in the re-export of poultry products to the DRC.

Appendix N: Burundi's Poultry Industry

Poultry Population and Production Systems

Burundi has the smallest poultry flock in the region, estimated at less than 3 million in 2015—barely half that of Rwanda, with comparable available acreage and population (see Table 47). However, Burundi's poultry sector has shown rapid expansion, registering average annual growth of 13 percent over the past five years to reach 1,215 tons of eggs and 4,264 tons of chicken meat in 2016.

Table 47: Burundi's Poultry Population (thousands)

Year	2010	2011	2012	2013	2014	2015*
Poultry population	1,719	2,449	2,450	1,979	2,984	2,982

*Source: FAO report, eggs and meat, 2011 FAO report, Poultry Industry situation in Burundi, 2015 * estimate*

As in neighboring countries, it is common for rural households in Burundi to maintain poultry as part of an integrated, small-scale system of subsistence farming, with traditional breeds accounting for more than 95 percent of the national flock. Commercial poultry-production units' account for the remaining five percent, most of which are in the suburbs of Bujumbura. The top three are Mutoyi Cooperative, AVICOM Poultry Farm, and Safechicks.

Mutoyi is the oldest and most successful intensive poultry farm, established in Gitega (Central Burundi) by Pilgrims Fathers in 1974. The enterprise encompasses a hatchery supplying day-old chicks to more than 4,000 small-scale rural farmers, as well as facilities to collect meat and eggs for delivery to the Bujumbura market. Mutoyi regularly renews its parent stock and maintains a high level of performance.

Many small-scale poultry farms have been established in urban areas, including AVICOM, Safechicks, Agricultural Operating Company Buterere, Alphonsine Poultry, Hicintuka, Kantungeko, Madebari, Niyonzima, and Sogea SATOM Poultry.

Poultry-feed Industry

Burundi has two main feed manufacturers, Mutoyi Cooperative and Minolac, both of which enjoy a long-standing reputation for producing quality animal feeds. Mutoyi Cooperative produces 3,500 tons of poultry feed a year, while Minolac produces 1,250 tons (compared to estimated annual capacity of 3,000 tons), putting total annual poultry-feed production at 4,750 tons.

Locally produced layer feed is sold at BIF 800 (USD 0.52 or FRw 383) per kg and broiler feed at BIF 900 (USD 0.59 or FRw 430) per kg—one-third higher than poultry-feed prices in Rwanda (FRw 300 and FRw 315 per kg, respectively). Indeed, poultry feed produced in Burundi is among the most expensive in the region. As a result, some poultry farmers import more affordable feed from Uganda.

Poultry-seed Market

Mutoyi Cooperative keeps parental strains imported from Europe for the production of day-old layer and broiler chicks. The Cooperative incubator currently hatches 12,000 chicks per week (9,000 layers and 3,000 broilers), compared to total weekly hatching capacity of 15,000.

Two other Burundian breeders (Ricyland Eggs & Chicken and Safechicks) also produce day-old chicks, with respective capacities of 19,200 and 20,000 eggs per week. Taken together, Burundi's three breeders meet only one-tenth of national demand, resulting in a comparatively high day-old chick price of BIF 2000 (USD1.3 or FRw 958).

Veterinary Products and Services

Veterinary products are only available in the Mutoyi area and Bujumbura, where commercial poultry units are concentrated. The main importers and distributors of veterinary products are COOPER (Burundi) and ARCHEM. The small size of poultry flocks elsewhere in the country is not sufficient to attract local input dealers and veterinary doctors.

Market for Poultry Products

Annual per capita consumption of poultry products is particularly low in Burundi, at just 3.4 kg of meat and two eggs.[31]

The market for poultry products is dominated by indigenous chicken and eggs, supplied mainly to high- and middle-income consumers in urban areas (Bujumbura, Gitega, and Ngozi). Urban markets are supplied by traveling traders, who purchase live chickens from rural bi-weekly markets across the country, delivering 400-500 birds a day to Bujumbura and 100-150 to other cities. Urban-market prices are 50-100 percent higher than those in primary/rural markets—higher still during festive periods, when a live chicken bought for BIF 6,000 (USD 3.9 or FRw 2,900) at a rural market sells for BIF 15,000 (USD 9.8 or FRw 7,200) in Bujumbura.

The broiler market is dominated by Mutoyi Cooperative, which operates the only poultry slaughterhouse in Burundi, with a capacity of 6,000 birds per day.

Imports of poultry products (from Ougachick in Uganda and Kenchick and Kenya) have trended upwards over recent years, particularly eggs, which rose from three tons

[31] DOSE : Document Orientation du Secteur d'Elevage

in 2010 to 23.2 tons in 2015. However, imports of live poultry have begun to slip, to around 90,000 heads in 2015 from 94,500 the previous year, while imports of chicken meat fell to 23.2 tons from 26.5 tons in the same period (see Table 48).

Table 48: Imports of Poultry Products to Burundi (2010-15)

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Live chickens	70,000	68,000	87,700	91,250	94,500	90,580
Eggs (tons)	3	3	19	23	26,5	23,2
Chicken meat (tons)	17	13	18	25	28,7	24

Source: FAO report on Situation of poultry industry in Burundi, 2015

The price of exotic eggs in Burundi is BIF 200 (USD 0.13 or FRw 96) each, while indigenous eggs cost BIF 300 (USD 0.20 or FRw 144) each.

Rwanda's Comparative Advantage

Burundi and Rwanda are both small, densely countries, with a similar resource base. Both are net importers of poultry seeds, poultry feed, and feed ingredients, and both have large numbers of poor who cannot afford poultry products on a regular basis. With similar production costs, it makes little sense for one to set about feeding the other.

However, where Rwanda has seen steady economic growth over the past 15 years, Burundi has been locked in a cycle of insecurity. With low and declining demand for poultry products expected to continue over the mid-term, at least, the Burundian poultry market is expected to remain unattractive to Rwandan producers, further incentivizing a focus on the Kivu market.

Appendix O: Rwanda's Poultry Producers

Layer producers (number and location)

27 large poultry farmers—13 in Kigali, five in Eastern Province, five in Northern Province and four in Southern province

108 medium poultry farmers—28 in Kigali, 24 in Eastern Province, 21 in Northern Province, 20 in Southern province and 15 in Western province

210 small poultry farmers—74 in Northern Province, 54 in Southern province, 41 in Eastern Province, 21 in West Province and 20 in Kigali.

Broiler producers (number and location)

Five large poultry farmers—two in Eastern Province, two in Kigali and one in Southern Province

11 medium poultry farmers—five in Western Province, three in Kigali, one in Eastern Province, one in Northern Province and one in Southern Province

26 small poultry farmers—11 in Western Province, six in Eastern Province, five in Southern Province and four in Kigali.

Two large broiler producers, PEAL in Bugesera and KIME in Kamonyi, have modern poultry slaughterhouses.

Annex P: Rwanda Poultry-feed producers, source of feed ingredients and constraints

The tables 49 to 51 below provides details of Rwanda's poultry-feed producers, country of origin of poultry-feed ingredients and highlights constraints to procurement.

Table 49: Feed Producers, 2012-15

N°	Company/ Location	Status	Feed type, quantity/ month	Main customers	Origin of ingredients
01	Nsabagasani Unit/Kigali	Producer	Layer, 13 tons Broiler, 10 tons	Farmers, RAB	Rwanda, Uganda, Tanzania, Europe
02	Nyabugogo suppliers Ltd	Producer Seller of ingredients	Layer, 6 tons Broiler, 2 tons	Farmers, RAB	Rwanda, Uganda, Tanzania
03	SOPABU/Kigali	Producer	Under rehabilitation		
04	Best Animal Foods/Kigali	Producer	Layer, 8 tons Broiler, 5 tons	Farmers	Rwanda, Uganda, Tanzania
06	Environment husbandry Co.Ltd/Kigali	Producer Seller of ingredients	Layer, 9 tons Broiler, 6 tons	Farmers	Rwanda, Uganda, Tanzania, Europe
07	Havuga Holding Ltd/Kigali	Producer	Layer, 10 tons Broiler, 6.5 tons	Farmers, RAB, NGOs	Rwanda, Uganda, Tanzania, Europe
08	Kabuye Unit/Kigali	Producer	Layers, 15 tons Broiler, 8 tons	Farmers	Rwanda, Uganda, Tanzania, Europe
09	5 Production units/Kigali/ Nyabugogo	Producer	Layer, 55 tons Broiler, 32 tons	Farmers	Rwanda, Uganda, Tanzania
10	7 stores	Sellers of ingredients	Layers, 70 tons Broiler, 45 tons	Farmers	Rwanda, Uganda, Tanzania
11	ZAMURA feeds/Musanze	Producer	Layer, 300 tons Broiler, 130 tons	Cooperatives Big farmers Distributors Project of egg per child	Rwanda, Uganda, Tanzania, Europe (premix)

12	PAFI Animal feed /Rwamagana	Producer	Layer, 95 tons Broiler, 38 tons	Cooperatives Big farmers Distributors Project of egg per child	
13	Rwamagana city	5 producers and sellers of poultry feeds			
14	Rwanda Best/Rulindo	Producer	Layer, 19 tons Broiler, 11 tons	Farmers	Rwanda, Uganda, Tanzania
15	Muhanga district	47 sellers of manufactured feeds and ingredients			
16	Huye district	5 producers and sellers of poultry feeds			
17	BIZIMANA Justin/Ruhango	Producer	Layer, 9 tons Broiler, 8 tons	Farmers	Rwanda, Uganda, Tanzania
18	Nyaruguru district	One producer and seller			
19	Kamonyi district	Two sellers			
20	Gisagara district	UKORIBU (rice bran), KOJYAMUJYI (maize bran)			
21	Gakenke district	No producers, 10 feed sellers (feeds from Zamura/Musanze)			
22	Musanze district	Zamura (producer) + 2 sellers in each public market in Musanze			
23	Umusaruro Agri – Vet/Gicumbi	Producer Producer	Layer, 6 tons Broiler, 10 tons	Farmers, cooperatives	Kigali
24	Gicumbi district	7 feeds sellers in Gicumbi town, no sellers in rural areas			
25	TC UMURIMO BUSINESS LTD/ Rubavu	Producer	Layer, 8 tons Broiler,20 tons	Farmers, DRC	DRC, Uganda, Rwanda, Tanzania
26	One particular/ Rubavu	Producer	Layer, 2 tons Broiler, 4 tons	Local farmers	DRC, Uganda, Rwanda, Tanzania
27	Feed Unit/Bugesera	Producer	Layer, 8 tons Broiler, 5 tons	Local farmers	Uganda, Rwanda, Tanzania
28	GORILLA FEEDS/Kigali	Producer	Layer, 53 tons Broiler, 41 tons	Farmers, DRC	Uganda, Rwanda, Tanzania, India
29	PEAL	Producer	Broiler, 75 tons	Farmers	Rwanda, Uganda

Table 50: Poultry Feed Ingredients by Country of Origin

N°	Ingredient	Main Country of Origin
1	Maize flour	Uganda, Tanzania, Rwanda
2	Maize bran	Rwanda, DRC
3	Soybean meal	Uganda, DRC, Rwanda
4	Fish flour	Tanzania, Uganda
5	Wheat bran	Rwanda
6	Treacle (molasses)	Rwanda (sugar factory)
7	Cottonseed meal	Tanzania, Uganda
8	Bone powder, limestone	Rwanda
9	Egg shells	Uganda, Tanzania
10	DCP	Kenya
11	Other additives[32]	Europe, China, India

Table 51: Constraints to Procurement of Poultry-feed Ingredients

Ingredient	Constraints
Maize	Regarding imports from Uganda and Tanzania Competition with demand for human consumption Fluctuating prices (FRw 110-280 per kg)
Fish	Regarding imports from Uganda and Tanzania High and fluctuating prices (FRw 580-1080 per kg) Inconsistent supply
Cottonseed meal	Regarding imports from Tanzania and Uganda High prices (FRw 280-360 per kg)
Calcium	From eggshells Poor quality Fluctuating prices (FRw 65-135 per kg)
Soya	Low domestic production (25,000 MT in 2013) Regarding imports from Rutchuru (DRC) and Uganda Competition from demand for human consumption

[32] Salt, antibiotic/anti-parasitic additive, premix (lysine, methionine, vit b12, etc)

Appendix P: Poultry Subsector Stakeholders

Table 52: Poultry Subsector Stakeholders

Category	Stakeholders
Chain actor	Seed producers (hatcheries) Feed-ingredient importers Day-old chick importers (Agrotech, Biyinzika, etc) Feed producers (PAFI, Gorilla Feed, PEAL, Zamura Feeds, etc) Veterinary product suppliers Poultry farmers (small, medium and large-scale) Egg traders Broiler traders & exporters Poultry-meat traders & exporters
Chain enablers	MINAGRI (poultry strategy, One Egg Per Child project) RAB (extension service) Appui aux Petit Elevage (APEL) (small stock program) Rwanda Development Board (RDB) (Investment promotion) Rwanda Poultry Industry Association (RPIA) Ministry of Trade and Industry (MINICOM—trade promotion) FAO (rural support and research on poultry production)
Chain supporters	Laboratories Veterinary doctors

Appendix Q: Economic Conversion Factors

Table 53: Economic Conversion Factors for the Analysis of the Poultry Value Chain

Name of the Commodity	Conversion Factor
Fresh or chilled whole chickens	1.0530
Manure	1.0029
Poultry feed	1.0029
DOCs (importable input)	1.0029
DOCs (importable output)	1.0029
Fresh eggs	1.0029
Animal feeding equipment	1.0530
Poultry incubator	1.0530
DC power generator	0.8924
Poultry equipment	1.0530
Tanks and reservoirs	0.8924
Vehicle for transport of goods	0.7139
Car maintenance	0.7529
Antibiotic + Ant parasitic	1.0530
Veterinary Services	0.9903
Packaging	1.0530
Fuel	0.8924
Charcoal	0.8924
Electro-mechanical equipment	0.6864
Vehicle for transport of goods	0.6864
Agricultural inputs	1.0029
Sacks and labels	0.6864
Office supplies	0.6864
Gasoline	0.9157
Construction	0.8840
Electricity	0.8731
Water	0.8731

Telecommunication	0.8622
Transportation	0.8724
Vehicle maintenance	0.7691
Skilled labor	0.8440
Unskilled labor	0.9620
Land	1
All taxes	0