Cost-Benefit Analysis of USAID/Rwanda's Dairy Value Chain Intervention

Final Report

March 8, 2016

This publication was produced by International Development Group LLC, for review by the United States Agency for International Development.

Learning, Evaluation and Analysis Project-II (LEAP-II)

Cost Benefit Analysis of USAID/Rwanda's Dairy Value Chain Intervention

Final Report

Contract Number:

AID-OAA-I-12-00042/AID-OAA-TO-14-00046

This report was prepared by International Development Group (IDG) with Subcontractor Cambridge Resources International (CRI) with the following contributors: George Kuo, Mikhail Miklyaev, Shahryar Afra, Noël Ujeneza, Jean Pierre Ruvuzandekwe, Melani Schultz, and Stephanie Schmidt.

DISCLAIMER

The contents of this report are the sole responsibility of IDG and do not necessarily reflect the views of USAID or the United States Government.

TABLE OF CONTENTS

Table of Contents iii

Acknowledgements v

List of Acronyms vi

List of Tables vii

List of Figures viii

Executive Summary 1

Introduction 3

Project Description 3

Description of Interventions 3

Methodology and Model Description 4

Methodology 4

Model Description 5

Financial Analysis 6

Benefits of RDCP II Interventions 6

Benefits of Productivity Improvement Interventions 6

Benefits of Quality Enhancement and Market Access Improvement Interventions 7

Benefits of Increased Milk Consumption Interventions 9

Incremental Costs of Dairy Farming 11

Economic Analysis 13

Stakeholder Analysis 15

Sensitivity and Risk Analysis 16

Conclusions and Recommendations 20

References 21

Annex A – List of Interviewed Stakeholders 22

Annex B – Indicative Annual Dairy Farm Budget (“Without Project”) 26

Annex C – Indicative Annual Dairy Farm Budget (“With Project”) 27

Annex D – Cost of Boiling Raw Milk 28

Annex E – Dairy VC Description 29

Introduction.....29

Rwanda milk sheds.....29

Market systems 30

Actors in the dairy subsector 31

Dairy chain enablers and supporters 32

Annex F – List of Commodity Specific Conversion Factors.....34

Annex G – Milk Prices 35

Annex H – Sources of Inputs 36

ACKNOWLEDGEMENTS

This report benefited greatly from the valuable assistance of Dennis Karamuzi, Gasana Grace, Charles Bizimana, James Kabera Mumvaneza, and other staff members of Land O'Lakes/Rwanda.

The team is also extremely grateful for the support provided by Patrice Hakizimana (USAID/Rwanda), and for the overall guidance of Peter Malnak Sworn (Mission Director, USAID/Rwanda).

Special thanks is given to the farmers and other stakeholders across the dairy value chain, who generously gave their time to help the team collect data.

LIST OF ACRONYMS

AI	Artificial Insemination
ASIP	Agriculture Sector Investment Plan
CBA	Cost Benefit Analysis
EDPRS	Economic Development and Poverty Reduction Strategy
ENPV	Economic Net Present Value
FEP	Foreign Exchange Premium
FNPV	Financial Net Present Value
GoR	Government of Rwanda
IIA	Integrated Investment Appraisal
IRR	Internal Rate of Return
MCCs	Milk Collection Centers
MERR	Modified Economic Rate of Return
NPV	Net Present Value
PSTA	Strategic Plan for the Transformation of Agriculture in Rwanda
RDCP	Rwanda Dairy Competitiveness Program
USAID	United States Agency for International Development
VC	Value Chain

LIST OF TABLES

Table 1. Summary Impact Figures....1
Table 2. Incremental Financial Analysis (US$)....6
Table 3. Incremental Economic Analysis of RDCP II (USD)....13
Table 4. Distributive Analysis (US$ millions)....15
Table 5. Change in the Calving Interval (USD millions)....16
Table 6. Change in the Daily Milk Yield (USD millions)....17
Table 7. Change in the Price of Napier Grass (USD millions)....17
Table 8. Change in the Calves' Mortality Rate (USD millions)....18
Table 9. Change in the Farm Gate Milk Price (USD millions)....18
Table 10. Change in Optimal Herd Size (USD millions)....19

LIST OF FIGURES

Figure 1. RDCP II Interventions across the Dairy VC. 3

Figure 2. Benefits of Productivity Improvement Interventions. 7

Figure 3. Benefits of Quality Enhancement and Market Access Improvement Interventions. . 8

Figure 4. Milk-Consumer Benefits. 10

Figure 5. Gain in Consumer Surplus of High-Income Households. 10

Figure 6. Gain in Consumer Surplus of Low-Income Households. 11

EXECUTIVE SUMMARY

The United States Agency for International Development (USAID) has been supporting agriculture development and improvements in food security in many countries through technical assistance under its Feed the Future (FtF) initiative. To evaluate these programs, USAID has begun conducting cost benefit analyses (CBAs) of the various activities currently in process or already completed. In order to support this process, USAID Washington requested IDG under its LEAP (Learning Evaluation and Analysis Project) II to conduct several of these CBA activities. This report presents the findings of the CBA of USAID/Rwanda's work with the dairy value chain (VC). The analysis looks at evaluating the recent FtF activities implemented under the Rwanda Dairy Competitiveness Program II (RDCP II).

RDCP II falls within a larger portfolio of U.S. Government interventions in Rwanda to improve food security through the Feed the Future initiative. The program commenced in 2012 and will be completed in 2017. RDCP II is being implemented in line with the Government of Rwanda's (GoR) strategic objectives, including its Vision 2020 and the Strategic Plan for the Transformation of Agriculture in Rwanda, each of which includes the objectives of enhancing the dairy VC and increasing domestic consumption of milk-based products. The RDCP II aims to increase the competitiveness of Rwandan dairy products in regional markets and to improve rural households' incomes by increasing quality and efficiency throughout the dairy VC.

The project provided a wide range of interventions along the VC aimed at increasing the quality of milk, enhancing farm level productivity, strengthening vertical and horizontal linkages in the VC, and promoting domestic milk consumption. Annual milk yield increased from 608 to 1,949 liters (lt) of milk/cow on average. In addition, improved quality of milk and enhanced market access created by the project resulted in a one-third increase in the farm-gate milk price.

USAID investments have resulted in an increase in the annual incomes of dairy farmers by more than 40 percent. The analysis has also revealed that because of project interventions, the VC has reached a stage when investments in dairy farming are financially feasible without government or other donors support. The analysis estimates consumer gains at US$ 18.83 million. However, these gains cannot be exclusively attributed to 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 RDCP II.

Table 1. Summary Impact Figures

		ERR*	ENPV**
Impact Rwanda Country Perspective		**23.0%**	**US$ 48.5 mill**
Present Value of USAID Investment			US$ 12.4 mill
Impact USAID Perspective		**18.7%**	**US$ 36.4 mill**

*Economic Rate of Return

**ENPV-Economic Net Present Value

The project has produced positive financial and economic returns with an ERR of 18.7 percent and an ENPV of US$ 36.4 million. The key risk areas include:

- The biggest milk processing plant, Inyange Industries, is the main, and in certain regions the only, purchaser of raw milk. This monopsony power to set the price of raw milk represents a significant risk factor to RDCP II activities and to dairy farmers over the long term.
- The use of artificial insemination (AI) services is low, with just 58 percent of farmers having access to the service.[1] Timely access to such services is a critical factor in the reproductive performance of dairy cattle. The limited accessibility of AI services in some parts of the country can partially explain the low adoption rate, which is a risk variable to project returns.
- A forthcoming Ministerial Order regulating the handling, collection, transport, and sale of milk is expected to boost the quality of raw milk throughout the VC.[2] However, it is also likely that the new rules will push a number of milk collectors and milk kiosks out of the market, with a short-term negative effect on the farm-gate price of milk.

This report makes three key recommendations.

1. **Expand domestic production of dairy products.** First, RDCP II's dual focus on expanding milk production at the farm level and improving milk quality throughout the VC has resulted in positive economic returns. However, future efforts should be directed toward increasing the market for raw milk. This can be achieved by promoting local, small-scale production of pasteurized milk, butter, yogurt, cheese, and other dairy products. The project piloted domestic production of butter, cheese, and yogurt and found to be highly successful. There is strong evidence to suggest that major gains from market creation are passed to dairy households through an increase in the farm-gate price for milk.
2. **Explore options for grass-conservation.** A critical constraint to the expansion of dairy herds is limited landholdings for grazing. This issue can be addressed through the introduction of legumes, which enable the feeding of more cattle from the same acreage. Training on grass-conservation schemes will help to stabilize seasonal fluctuations in the milk supply.
3. **Transfer Milk Collection Center Ownership.** Ownership of Milk Collection Center (MCC) facilities should be transferred from the GoR to farmer cooperatives. This will improve farmers' access to credit while incentivizing milk cooperatives to reinvest financial returns and to further improve their productivity and profitability.

[1] RDCP II Midterm Project Evaluation Report.
[2] The ministerial order is expected to become effective in the near future.

INTRODUCTION

PROJECT DESCRIPTION

The United States Agency for International Development (USAID) requested a cost-benefit analysis (CBA) of the USAID/Rwanda's Dairy Competitiveness Program II (RDCP II), implemented 2012-17. RDCP II aims 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 quality and efficiency throughout the value chain (VC).

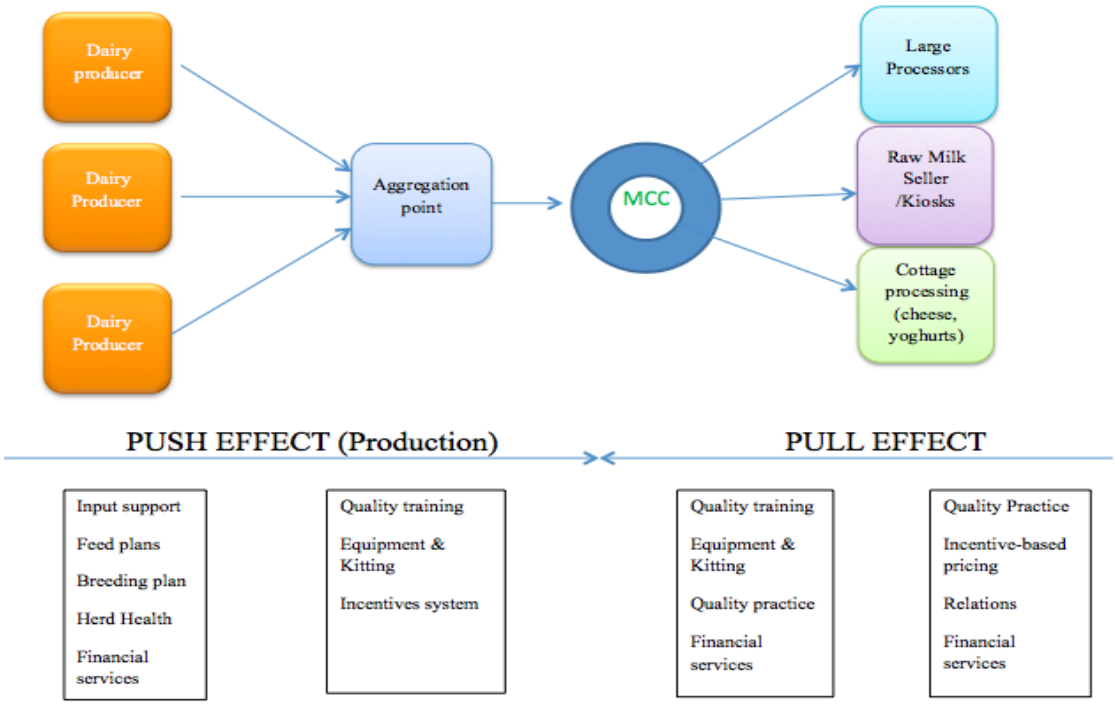
RDCP II implemented in line with the Government of Rwanda's (GoR's) strategic objectives. These include its Vision 2020, Economic Development and Poverty Reduction Strategy (EDPRS), Strategic Plan for the Transformation of Agriculture in Rwanda (PSTA II), and Agriculture Sector Investment Plan (ASIP), each of which includes the objectives of enhancing the dairy VC and increasing consumption of milk-based products. The project also works in close collaboration with the "Girinka/One Cow Per Family" program.

The team conducted the CBA on the basis of data and information collected through interviews with RDCP II staff and various stakeholders as well as a literature review. A detailed list of the stakeholders interviewed is provided in Annex A.

DESCRIPTION OF INTERVENTIONS

The project entailed a wide range of interventions aimed at improving the productivity of the dairy VC and enhancing the quality of outputs. 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 1:

Figure 1. RDCP II Interventions across the Dairy VC[3]



[3] Source: Land O'Lakes

RDCP II's push-and-pull strategy 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 in turn 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 interventions according to three functional areas of activity:

1. ***Productivity improvement interventions*** – Interventions that result in higher annual milk yield. These interventions affect major production parameters such as lactation, milk yield, and the calving interval. The interventions include:
    - Training of service providers
    - Training of farmers
    - AI provision and support
    - Facilitation of access to veterinary services
2. ***Quality enhancement and market access improvement interventions*** – Interventions that directly improve 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:
    - Creation/enhancement of market linkages
    - Expansion grants to Milk Collection Centers (MCCs) and producers of dairy products
    - Input support (equipment and testing kits)
    - Training of MCC staff and processors on quality improvement and new product development
3. ***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:
    - National milk consumption campaign "Shisha-Wumva"
    - Support in development and roll-out Milk zones

The complexity of the dairy VC means that an increase in productivity is unlikely to be the result of a single intervention. For example, while training can help farmers boost milk yields, they may remain reluctant to increase investment in feed without market linkages to facilitate the sale of increased output. However, by grouping interventions according to functional activity, a VC-based analysis of RDCP II is able to demonstrate the direct benefits attributable to each group of activities—an approach greatly facilitated by the clear and efficient design of the project itself.

METHODOLOGY AND MODEL DESCRIPTION

METHODOLOGY

The Integrated Investment Appraisal (IIA) model offers a means of evaluating both the financial and the socio-economic effectiveness 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 are often carried out by independent analysts at different stages of project development, and which therefore rarely provide an opportunity for experts to adjust and improve project design.

The IIA of USAID's RDCP II begins with an evaluation of the profitability of the investment (financial module). 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,[4] 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[5] (FNPV), and economic rate of return (ERR), analogous to internal rate of return[6] (IRR).

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 a 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.

Statistical analysis and field visits 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. Land O'Lakes staff also confirmed this finding. The "without-project" scenario therefore 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. USAID investment cost is then compared with the net incremental economic benefits of RDCP II to derive the net present value (NPV) of the USAID investment.

[4] See "Three Basic Postulates for Applied Welfare Economics", A. Harberger, 1971.

[5] In finance, the net present value (NPV) is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time. Economic Net Present Value (ENPV) then looks at incoming and outgoing resources which are defined beyond just cash flows and are described as benefit and cost resource flows, respectively.

[6] 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.

FINANCIAL ANALYSIS

The team collected primary data for the financial analysis during a data collection trip in November 2015. Consultations with agricultural experts and RDCP II implementers, as well as a literature review, were used to analyze and adjust the data. The team then prepared a set of farm budgets for the "without-project" and "with-project" scenarios (see Annexes B and C), adjusted for an increase in farm-level production costs. The farm budgets were prepared based on mean values, excluding statistical outliers from the analysis.

Table 2 presents a summary of the project incremental financial analysis of the project.

Table 2. Incremental Financial Analysis (US$)

RDCP II Beneficiaries	IRR	FNPV
Household	20.9%	1,663
Total	**20.9%**	**39.6 mill**

The adoption of RDCP II-promoted farming practices has resulted in positive financial returns for dairy farmers. For the first three years of the project (2012-2015), dairy farmers will experience a temporary reduction in their annual cash flow. This is a transition period, when farmers are expanding their stocks from two to three 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.

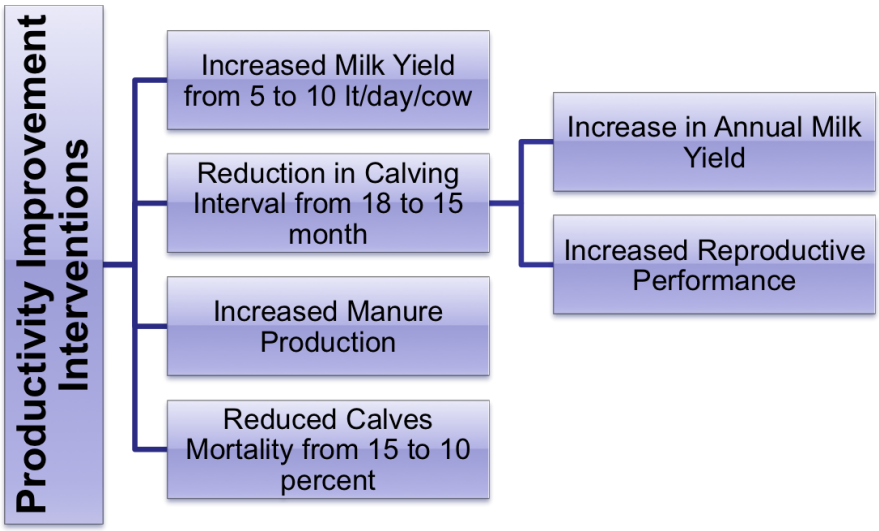
BENEFITS OF RDCP II INTERVENTIONS

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 for the purchase

of much-needed motorcycles to reach clients, as well as to trained farmers and inseminated 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 2. 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. Therefore, the annual milk yield per cow increased from 608 liters to 1,949 liters.[7] 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.

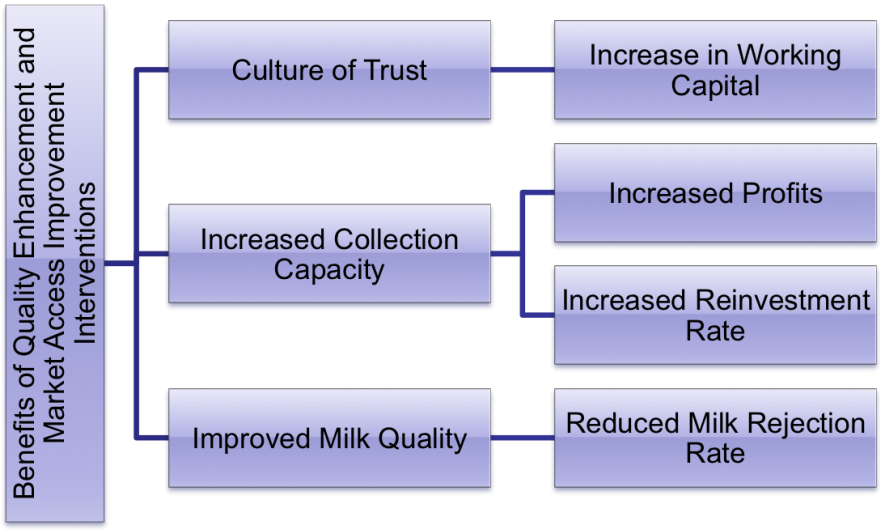
Benefits of Quality Enhancement and Market Access Improvement Interventions

RDCP II has linked individual dairy producers to dairy cooperatives and MCCs.[8] 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. Significant investments were also made throughout the VC to improve milk quality, including purchasing milk quality testing kits and providing grants to cooperatives to buy motor vehicles to transport milk from milk aggregation points, expanding the capacity of MCCs.

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

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

Figure 3. 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 on a monthly basis for milk delivered to the MCCs, minus the cost of maize bran and feed concentrates purchased from the MCCs.[9] MCC members can also borrow money from the cooperatives. By paying farmers monthly, MCCs are able to maintain sufficient working capital to operate, while farmers are able to save and plan their investments. Better linkages with farmers also allow the MCCs to increase capacity utilization and, in many instances, even expand 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 dropped dramatically thanks to training farmers in techniques for the prevention of mastitis and distributing milk quality testing kits to MCCs and individual milk collectors (see Box 1).

[9] 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 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:

1. 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.
2. 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.

BENEFITS OF INCREASED MILK CONSUMPTION INTERVENTIONS

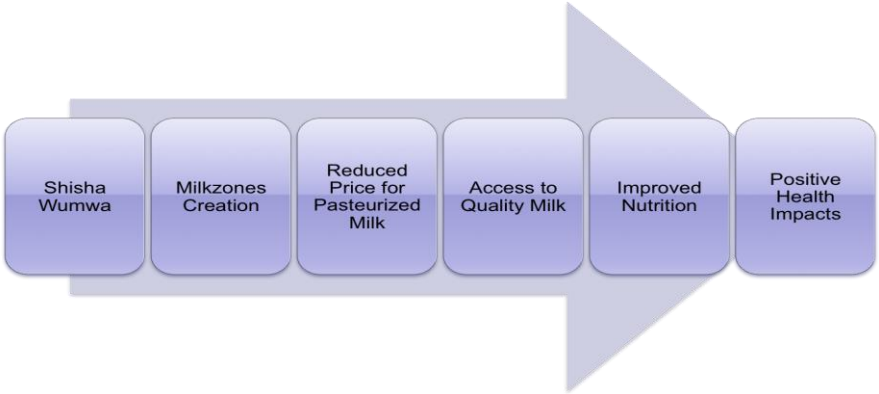
The enhanced productivity of Rwanda's dairy VC has resulted in significant gains for consumers. RDCP II sponsored a national milk consumption campaign, "Shisha Wumva,"[10] which reached more than 650,000 households. Although the analysis does not attempt to estimate the increase in milk consumption due to Shisha Wumva, it is reasonable to expect the 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 as a result of the project produced such a sharp increase in the supply of raw milk to processing plants

[10] Which roughly means, "If you drink milk you will grow strong."

that Inyange Industries was unable to sell all the milk provided by the MCCs as an expensive packaged product. The result was an innovative development known as milk zones.

Figure 4. Milk-Consumer Benefits



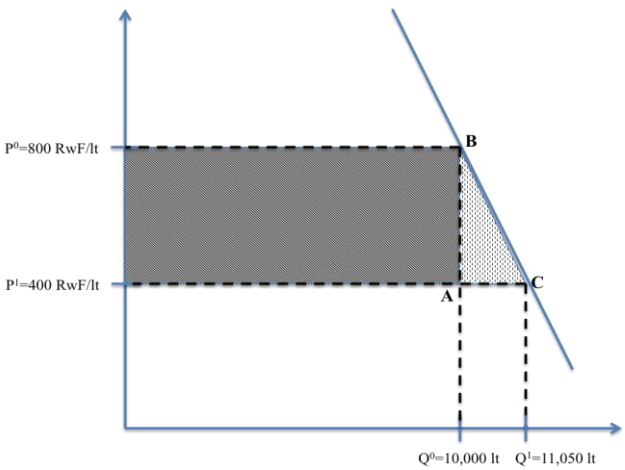
Inyange Industries launched the first milk zone in Kigali in 2014, selling pasteurized milk "on tap" at half the price of its packaged milk (US$ 0.53/lt vs. US$ 1.05/lt). Within 18 months of its launch, Inyange Industries had established 70 milk zones, with daily sales of pasteurized milk reaching 28,000 liters—an increase of 17,000 lt/day. RDCP II played an active part in operationalizing Inyange Industries' milk zone idea.

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.[11] At a price of US$ 1.05/lt, it is reasonable to assume that only relatively high-income households will exhibit 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 $PV_{2012}^{12\%}$ of these annual gains over the 20-year period of analysis is US$ 14.89 million.

Figure 5. Gain in Consumer Surplus of High-Income Households

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

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

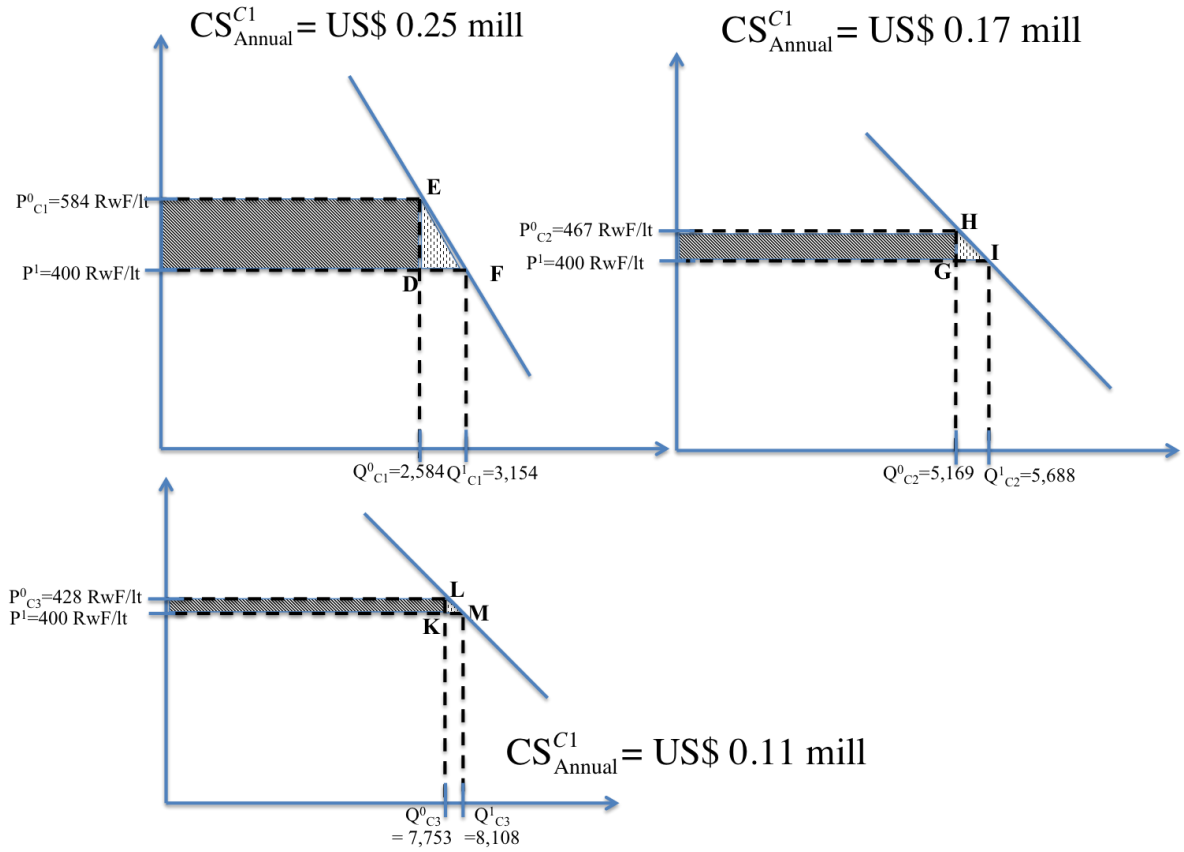


Low-level income households, who previously used to boil raw milk, consume the remaining 16,950 lt per day. The average Rwandan urban household purchases one to three liters of raw milk per day. In Kigali, raw milk currently trades at US$ 0.46/lt (RWF 350/lt). An important additional cost, however, is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

[11] Dairy Development in Kenya, FAO, 2011

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).

Figure 6. 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 $PV_{2012}^{12\%}$ 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 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 RDCP II.

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:

1. **Construction of cattle shelters.** RDCP II 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).
2. **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 kilograms 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.

3. **Increase in veterinary costs.** Average annual veterinary costs increase from US$ 61 per cow/year to US$ 70 per cow/year.
4. **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

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 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.

This analysis uses commodity-specific conversion factors[12] to adjust cash flows to derive net resource flows from dairy farming. The net resource flows are then scaled up according to the number of RDCP II beneficiaries to capture total net economic benefit.[13]

USAID investment in the dairy VC amounts to US$ 15 million. The PV of this cost is US$ 12.4 million, which is deducted from the PV of net economic benefits to calculate the ENPV of the project from the USAID perspective.[14] Table 3 presents a summary of the economic analysis.

Table 3. Incremental Economic Analysis of RDCP II (USD)

RDCP II Beneficiaries		ERR	ENPV
Household		23.0%	2,038
Total		**23.0%**	**48.5 million**
Present Value of USAID Investment			12.2 million
ENPV USAID PERSPECTIVE:			**36.3 million**
ERR USAID PERSPECTIVE:			**18.7%**

The analysis treats milk as an importable project output. Although no statistics on milk imports to Rwanda are available, interviews with Ministry of Agriculture staff indicate that, prior to 2012, Rwanda imported significant quantities of milk from Uganda. However, domestic production now appears sufficient to satisfy domestic demand. Moreover, a number of sources report increasing exports of Rwandan dairy products.[15] All non-processed agricultural and livestock products are exempt from VAT, as is locally processed milk. The only distortion on milk is the foreign exchange premium (FEP), which is estimated at 5.3 percent for Rwanda.[16]

[12] The commodity-specific conversion factors were obtained from http://rwanda-cscf.minecofin.gov.rw.
[13] See Annex F for a complete set of conversion factors used in the analysis.
[14] The PV and NPVs are expressed as of 2012, the year the RDCP II commenced.
[15] Land O'Lakes, FAO.
[16] Kuo, 2014.

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.

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 RDCP II:

1. Dairy farmers
2. Government of Rwanda
3. Milk consumers
4. USAID

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 Rwanda exports large quantities of meat to the Democratic Republic of the Congo.

The cost of USAID investments is nominal at US$ 15 million over the life of RDCP II. This translates into a PV at 12 percent of US$ 12.4 million. Table 4 presents the results of distributive analysis.

Table 4. Distributive Analysis (US$ millions)

Stakeholder	PV of Gains/Losses
Dairy Farmers	US$ 39.6 mill
Government of Rwanda	US$ 8.9 mill
USAID 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.

SENSITIVITY AND RISK ANALYSIS

A sensitivity analysis estimates the impact of changes to the main assumptions/parameters on deterministic returns of RDCP II. The team conducted a sensitivity analysis 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 not only affects the number of births per period, but it also has a significant impact on annual milk yield. A change in this parameter therefore 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 5. Change in the Calving Interval (USD millions)

		Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. USAID
-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. In fact, this parameter varies significantly according to a number of factors, including cattle breed, age, feed ration, and point of lactation cycle, as well as 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 USAID perspective. A drop from 10 lt/day to 8 lt/day results in a negative FNPV and ENPV from the USAID perspective. However, dairy farmers will always seek to ensure financial profitability by adjusting feed rations according to milking performance.

Table 6. Change in the Daily Milk Yield (USD millions)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. USAID
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 traded rarely as it is the main component of feed, and farmers therefore 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 USAID perspective.

Table 7. Change in the Price of Napier Grass (USD millions)

		Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. USAID
-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 USAID perspective falls 14.1 percent, from US$ 36.37 million to US$ 31.24 million.

Table 8. Change in the Calves' Mortality Rate (USD millions)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. USAID
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 USAID 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 9. Change in the Farm Gate Milk Price (USD millions)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. USAID
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 herd size remains at two dairy cows, the FNPV and ENPV from the USAID perspective increases by 14 percent and 8 percent, respectively. An increase in herd size results in lower cash flows in 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 increase 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 10. Change in Optimal Herd Size (USD millions)

	Financial NPV	Econ. (Rwanda) NPV	Fiscal NPV	Econ. USAID
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

CONCLUSIONS AND RECOMMENDATIONS

RDCP II has produced positive financial and economic returns, with an ERR of 18.7 percent and an ENPV of US$ 36.37 million. The analysis attributes additional US$ 18.8 million in consumer gains to the creation of milk zones.

Following the successful piloting of activities aimed at boosting domestic production of butter, cheese, and yogurt under RDCP II, it is recommended that future USAID 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. USAID/Rwanda and the project may also consider providing a number of MCCs with grants for the purchase of milk pasteurizing equipment as part of a pilot intervention to expand the market for raw milk.

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

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, USAID, 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 RDCP II's key recommendations 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.

The transfer of ownership of MCC facilities from the GoR to farmers' cooperatives will improve access to credit, as well as provide additional incentives for milk cooperatives to reinvest profits and to further improve productivity and profitability. In addition, increased reinvestment by farmers' cooperatives will improve market access for individual dairy farmers.

Total consumer gains of US$ 18.8 million from the creation of milk zones cannot be exclusively attributed to RDCP II or any other stakeholder in the dairy VC. However, the finding is important even if the analysis does not include the gains as a benefit in its estimate of economic returns of the project.

Finally, a forthcoming Ministerial Order regulating the handling, collection, transport, and sale of milk is expected to further improve the quality of raw milk throughout the VC. However, it is also likely that the new rules will push a number of milk collectors and milk kiosks out of the market, with a short-term negative effect on the farm-gate price of milk.

REFERENCES

Development & Training Services. (2015). Midterm Performance Evaluation of the Rwanda Dairy Competitiveness Program II (RDPC II). United States Agency for International Development, USAID

Jenkins, G.P., Kuo, C.Y. and Harberger, A.C. (2014) Cost-Benefit Analysis for Investment Decisions, John Deutsch International, Queen's University, Canada.

Kuo, C. Y., Salci, S., & Jenkins, G. P. (2014). Measuring the Foreign Exchange Premium and the Premium for Non-Tradable Outlays for 20 Countries in Africa. South African Journal of Economics.

Land O'Lakes, Inc. (2015). Rwanda Dairy Competitiveness Program II, Quarterly Report.

Land O'Lakes, Inc. (2015). Rwanda Dairy Competitiveness Program II, Work Plan.

MINECOFIN. (2014). Ministry of Finance and Economic Planning. Retrieved from Commodity Specific Conversion Factors Database for the Republic of Rwanda: http://rwanda-cscf.minecofin.gov.rw. (Alternative website: http://rwanda-cscf.cri-world.com)

Rwanda Revenue Authority, Annex to Ministerial Order Nº 003/Fin of 17/03/2004 Amending Ministerial Order Nº 001 of 13/01/2003. Providing for Value Added Taxation Rules and Procedures

TechnoServe Rwanda (2008). The Dairy Value Chain in Rwanda. East Africa Dairy Development Program.

ANNEX A – 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,	Rwamagana district Kigabiro Sector	Urwego Opportunity Bank (Rwamagana Branch) - Daniel Ndahayo/Credit Officer

2015		
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

ANNEX B – 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***
Other Costs			
Rental cost of land (Ha/Land)	0.75	60,000	45,000
Shelter	0	0	0
Labor	0.2	180,000	36,000
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.

ANNEX C – 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			
Veterinary expense	1	30,000	30,000
Bull / AI Services	1.60	3,000	4,800
Sprayings (Anti Tick)	104	80	8,320
Vitamins / Deworming	1	10,000	10,000
Total Veterinary Expense			***53,120***
Other Costs			
Rental cost of land (Ha/Land)	0	60,000	0
Rental value of shelter**	0.33	39,000	13,000
Labor	0.33	180,000	60,000
Total other costs			**73,000**
Total Costs			**455,738**
Net Income			**118,146**

* The indicative farm budget is prepared assuming optimal herd size of three dairy cows.
** The corresponding shelter rental value is used to calculate the shelter's construction cost.

ANNEX D – COST OF BOILING RAW MILK

Fresh milk from the farm

Quantity = 2 liters

Price = 350 RwF/liter

Cost 1 – Cleaning the casserole

1. Time[17]: 5 min = RwF 33
2. Soap: Negligible
3. Water (5 liters) @ RwF 390/m^3) = RwF 2.0

Cost 2 – Burning the brasero

1. Time: 10 min = RwF 66
2. Other: Negligible
3. Charcoal = RwF 40

Cost 3 – Time

1. Monitoring: 12 minutes (boiling time),
2. Cooling: N/A
3. 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 volumers of between 1 and 5 liters.

[17] 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

ANNEX 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[18]. A typical household rears 1 to 2 cross-breed cows.

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.

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

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.

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[19].

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 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.

[19] *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.*

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[20] and LISP[21]). 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 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"

[20] *PADEBL: Projet d'Appui au Development de l'Elevage Bovin Laitier (Dairy livestock Development Support Project)*
[21] *LISP: Livestock Infrastructure Support Program*

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)

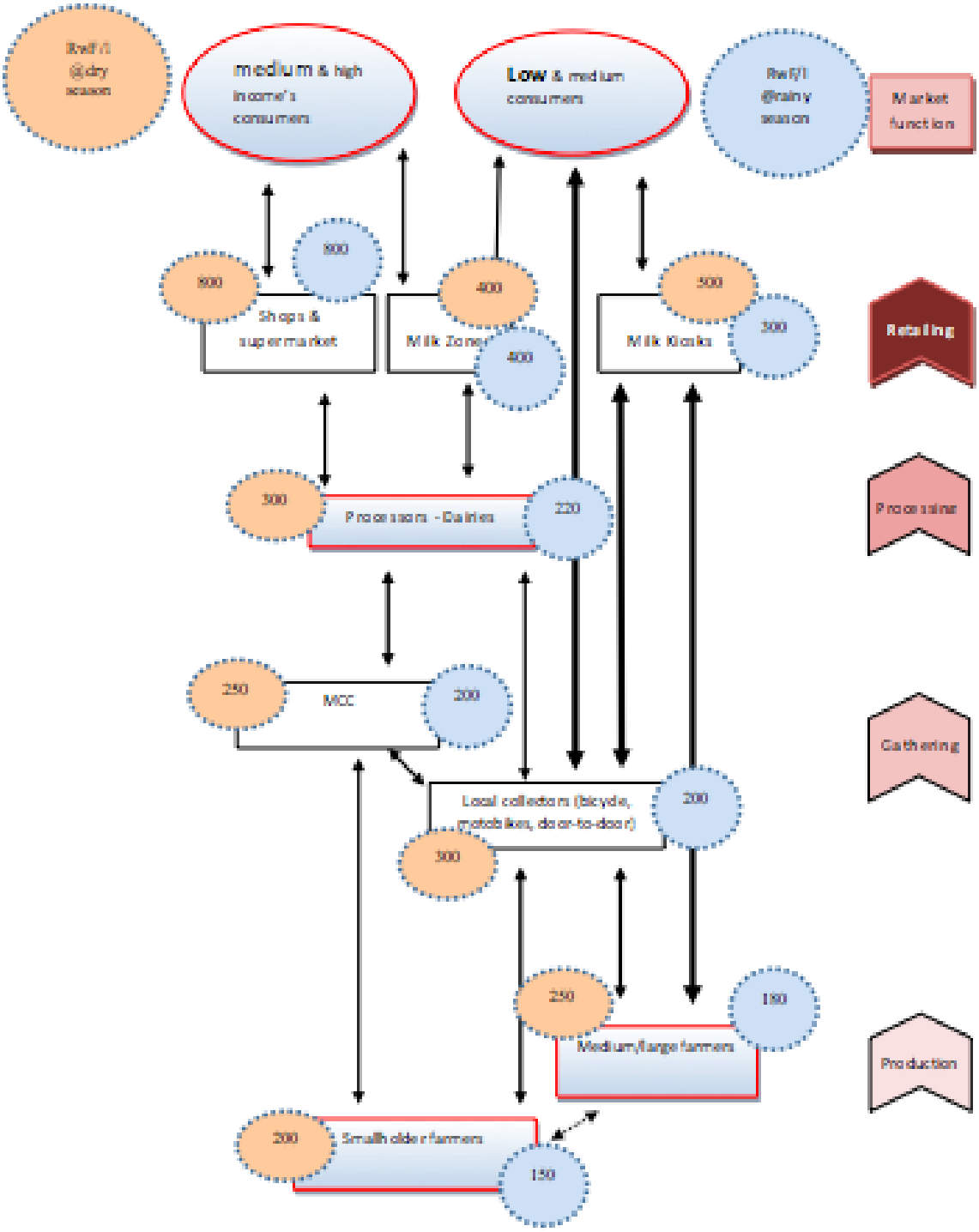
The Feed the Future’s initiative is the second phase of a previous project implemented by Land O'Lakes and partners since 2007. The overall objective is to increase competitiveness of Rwandan dairy products in both domestic and regional markets. The program provides technical and financial assistance 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.

ANNEX F – LIST OF COMMODITY SPECIFIC CONVERSION FACTORS

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

Annex G – Milk Prices



Annex H – Sources of Inputs

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[22]
Price index – US (Row 240)	• Function of US inflation
Rwanda inflation rate (Row 241)	• IMF
Price index – Rwanda (Row 242)	• Function of Rwanda inflation

[22] 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=