Determining Rwanda's comparative advantage in rice: Eastern Province case study

By

Benjamin Nkurunziza

Thesis presented in partial fulfilment of the requirements for the degree
of *Master of Science in Agriculture (Agricultural Economics) in the*
Faculty of AgriSciences at
Stellenbosch University

Supervisor: Ms Lulama Traub

December 2015

Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights, and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

December 2015

Abstract

As agriculture remains the economic engine of rural Africa, reducing poverty in Africa will depend largely on stimulating agricultural growth. To realize this growth, the efficient allocation of a country's scarce natural resources becomes a prerequisite. Rwanda is endowed with extensive wetlands with a high potential for rice production due to its hilly topography, abundant rainfall, and warm temperatures. However, many of these wetlands remain uncultivated despite the prevailing rice deficit in the domestic and regional markets.

Over the past decade, Rwanda has increasingly become dependent on regional and global markets for rice, as domestic supply is unable to keep pace with the growing domestic demand. This production deficit has limited the potential gains that farmers and the nation could realize in the form of income and foreign exchange earnings.

The main objective of this study is to determine Rwanda's comparative advantage in rice and to identify constraints limiting efficiency. To achieve this objective, this study utilizes the Policy Analysis Matrix (PAM) to measure the comparative advantage in rice production and the level of inefficiencies within the rice subsector in the Eastern Province of Rwanda. The key findings of the analysis demonstrate that this province has a comparative advantage in rice. However, within the sample, 68 % of rice farmers' cooperatives, cultivating rice on 25% of the total area under study, have no comparative advantage.

In terms of net welfare gains, due to market distortions, domestic rice prices are artificially high, which creates a deadweight loss in the rice market. In particular, the protectionist policies (i.e. rice import tariffs and farm inputs subsidization) induce the private farm profit to outweigh the social farm profit. This abnormal profit allows rice production to become financially profitable even where there is a comparative disadvantage.

On the demand side, although the domestic price of imported rice in Rwanda is slightly higher than the local rice price, the majority of consumers prefer imported rice to local rice, due to its long grain shape, aroma, and good quality. The low domestic demand for bold and short grain rice, which is cultivated by 70 % of Rwandan rice farmers, limits domestic rice producers' market share.

Given the study's findings, the policy recommendations are threefold. The first involves technology dissemination and adoption. In order to improve the domestic rice production capacity and competitiveness, without compromising efficiency, it is imperative for rice farmers to adopt labour saving technologies. This technology adoption would allow for an increase in the area on which rice can be grown efficiently, due to a reduced social production cost. The second recommendation is that government should encourage research on the identification of aromatic and long grain rice varieties that can adapt to Rwanda's agroecology, thereby meeting consumers' demand preferences. Finally, though rice import tariffs protect domestic farmers against foreign competition, these policies decrease consumers' welfare due to a reduction in the range of rice consumed in the domestic market. This study recommends the government to facilitate exportation of local rice in regional markets, and reduce rice import barriers. This intervention would benefit both farmers and consumers, while stabilizing the trade balance.

Opsomming

Aangesien landbou steeds die ekonomiese enjin van landelik Afrika is, sal die vermindering van armoede grootliks afhang van die stimulering van groei binne landbou. Die doeltreffende toedeling van ‘n land se skaars hulpbronne is ‘n voorvereiste om hierdie groei te verwesenlik. Rwanda het ekstensiewe vleilande met ‘n hoë potensiaal vir rysproduksie as gevolg van die heuwelagtige topografie, oorvloedige reënval en warm temperature. Baie van die grond is egter steeds onbewerk desnieteenstaande die heersende rystekort in die plaaslike en streeksmarkte.

Oor die afgelope dekade het Rwanda toemend afhanklik geraak van streeks- en globale markte vir rys aangesien plaaslike aanbod nie kan byhou met die toemane in plaaslike vraag nie. Die produksietekort het die potensiële voordele wat boere en die volk kan realiseer in die vorm van inkomste en buitelandse valuta, beperk.

Die hoofdoelwit van die studie is om Rwanda se vergelykende voordeel in rys te bepaal en om die beperkings ten opsigte van doeltreffendheid te identifiseer. Om hierdie doelwit te bereik, het die studie die Beleidsanalise Matriks gebruik om die vergelykende voordeel in rysproduksie en die vlak van ondoeltreffendheid in die ryssubsektor van die Oostelike Provinsie van Rwanda, te meet. Die kern bevindinge van die analise dui daarop dat die Oostelike Provinsie van Rwanda ‘n mededingende voordeel in rys het. In die steekproef is daar egter 68% van die rysprodusente koöperasies wat geen mededingende voordeel het nie.

In terme van netto welvaartsvoordele, as gevolg van verwringing in die mark, is die plaaslike prys van rys onnatuurlik hoog, wat ‘n dooieverlies skep in die rysmark. Spesifiek, die beskermende beleide (d.i. rys invoertariewe en plaas insetsubsidies) het tot gevolg dat private boerdery wins groter gewig dra as die sosiale boerdery wins. Die abnormale wins laat toe dat rysproduksie finansiëel winsgewend word selfs al is daar ‘n vergelykende nadeel.

Aan die vraagkant, al is die plaaslike prys van ingevoerde rys in Rwanda ‘n klein bietjie hoër as die plaaslike rysprys, verkies die meeste verbruikers die ingevoerde rys eerder as die plaaslike rys, as gevolg van die lang korrel vorm, aroma en goeie kwaliteit. Die lae plaaslike verbruik vir vet kort korrel rys, wat verbou word deur 70% van die Rwandese rysboere, beperk die plaaslike rys produsente se markaandeel.

Gegewe die studie se bevindings, is die beleidsaanbevelings drieledig. Die eerste behels tegnologie oordrag en aanvaarding. Om plaaslike rysproduksie kapasiteit en mededingendheid te verbeter sonder om doeltreffendheid af te skeep, is dit noodsaaklik vir rysboere om arbeidsbesparende tegnologie te aanvaar. Die tegnologie aanvaarding sal die area wat doeltreffend onder rys verbou word, vergroot as gevolg van verminderde sosiale produksiekoste. Die tweede aanbeveling is dat regering navorsing oor die identifisering van aromaties en lang korrel rys varieteite moet aanmoedig om aan te pas by Rwanda se agro-ekologie; om sodoende verbruikers tegemoet te kom met hulle vraagvoorkeure. Laastens, al beskerm invoertariewe van rys die plaaslike boere teen internasionale mededinging, verlaag hierdie beleide die verbruikerswelvaart as gevolg van ‘n verlaging in die verskeidenheid rys wat in die plaaslike mark verbruik word. Die studie beveel aan dat die regering die uitvoer van plaaslike rys in streeksmarkte fasiliteer en die invoerbeperkings op rys verminder. Die ingryping sal beide boere en verbruikers bevoordeel, terwyl die handelsbalans gestabiliseer word.

Dedication

I dedicate this thesis to Almighty God and to all the members of my family. Without them, I would have not achieved this.

Acknowledgements

I am heavily indebted to my supervisor, Ms Lulama Traub, for her support and guidance. I would also like to express my sincere gratitude to all the staff in the Department of Agricultural Economics at Stellenbosch University for the large amount of knowledge that I have acquired from the Department. My special thanks go also to all individuals and organizations that assisted me during data collection. These include, among others, the Rwanda Agricultural Board, farmers' rice cooperatives, rice farmers, the Rwanda Revenue Authority, Rwanda Bonded Warehouses' staff, rice milling plants' staff, Bolloré Africa Logistics' staff, and truck drivers.

Table of contents

List of Figures

List of Tables

List of abbreviations

AGOA: African Growth and Opportunity Act

APNI: 'Appui au Programme National Intrants' (Support to the National Inputs Program)

BNR: 'Banque National du Rwanda' (National Bank of Rwanda)

CET: Common External Tariff

CIF: Cost Insurance and Freight

COMESA: Common Market for Eastern and Southern Africa

DRC: Domestic Resource Cost

EAC: East African Community

ECGLC: Economic Community of the Great Lakes Countries

EPC: Effective Protection Coefficient

FAO: Food and Agriculture Organization

FAS: Foreign Agricultural Services

FOB: Free On Board

Frw: 'Franc Rwandais'

FTA: Free Trade Area

GAIN: Global Agricultural Information Network

GATT: General Agreement on Tariffs and Trade

GDP: Gross Domestic Product

GIEWS: Global Information and Early Warning System on food

GSP: Generalized System of Preferences

Ha: Hectare

HS: Harmonized System

ICM: Inter City Mills

IDF: Importation Distribution Fertilizer

IFAD: International Fund for Agricultural Development

IMF: International Monetary Fund

IPP: Import Parity Price

ITC: International Trade Centre

Kg: Kilogram

LDCs: Least Developed Countries

MAGERWA: 'Magasin Généraux du Rwanda' (Rwanda Bonded Warehouses)

MFN: Most Favoured Nation

MINAGRI: 'Ministère de l' Agriculture et de l'élevage' (Ministry of Agriculture and Animal Resources)

MINICOM: 'Ministère du Commerce' (Ministry of Trade and Industry, of Rwanda)

MINITERE: Ministry of Lands, Environment, Forests, Water, and Mines, of Rwanda

MT: Metric Ton

NEP (NSP): Net Economic (Social) Profitability

NISR: National Institute of Statistics of Rwanda

NLP: National Land Policy

NPC: Nominal Protection Coefficient

NPCI: Nominal Protection Coefficient for tradable Inputs

NPCO: Nominal Protection Coefficient for Output

NPK: Nitrogen, Phosphorous, and Potash

OPROVIA: 'Office pour la Promotion, la Vente, et l'Importation des Produits Agricoles' (Office for the Promotion, Sale, and Importation of Agricultural Products)

PAM: Policy Analysis Matrix

PCR: Private Cost Ratio

RAB: Rwanda Agriculture Board

RBS: Rwanda Bureau of Standards

RDB: Rwanda Development Board

RHS: Right-hand side

RRA: Rwanda Revenue Authority

SADC: Southern African Development Community

SRP: Subsidy Ratio to Producers

TFTA: Tripartite Free Trade Area

UN: United Nations

USDA: United States Department of Agriculture

VAT: Value Added Tax

WFP: World Food Programme

WTO: World Trade Organization

Chapter 1 : Introduction

1.1 Problem statement

As agriculture remains the economic engine of rural Africa, reducing poverty in Africa will depend largely on stimulating agricultural growth (Christiaensen & Demery, 2007:30). Agriculture is an important sector in the Rwandan economy. In 2012, 71.7% of the total labour force derived their livelihood from agriculture (NISR, 2014b:93). In terms of national income, agriculture accounts for 33.3 % of the gross domestic product (GDP), making it the second largest contributor after the services sector, which contributes 45.1% (BNR, 2014a).

Given the importance of the sector, it is therefore critical for the government of Rwanda to engage in appropriate policy-making to stimulate economic growth and reduce poverty. To realize this growth, the efficient allocation of a country's scarce natural resources is a prerequisite. Appropriate policies that would stimulate the efficient allocation of resources include, among others, reducing trade barriers and promoting competition in domestic factor and outputs markets.

Due to the importance of agriculture in achieving the national priority objectives of sustainable economic growth, food security, and poverty alleviation, the government of Rwanda has been actively involved in the agriculture sector. In 2004 the government prioritized the development of a select group of crops. These crops were chosen on the basis of the degree of their contribution to import substitution, export revenues, food security, sector growth potential, and profitability (MINAGRI, 2004b:16; MINAGRI, 2009:11-12). Rice was among the selected priority commodities[1]. In 2004 under the Rural Sector Support Project (RSSP), the government started to reclaim marshland, mainly for extending the area under rice cultivation (The Government of Rwanda, 2010:4). By 2007 under the crop intensification program, rice was again among the six priority crops selected (Kathiresan, 2011:13-14). This program consisted of a variety of sub-programmes that aimed at improving farmers' productivity.

[1] Refer to MINAGRI (2004a:20); MINAGRI (2004b:16)

Although the strategic government intervention has resulted in a consistent increase in rice production over the past decade, Rwanda has increasingly become dependent on regional and global markets for rice. The domestic rice supply has been unable to keep pace with the growing domestic demand for rice. Furthermore, Rwanda remains a deficit rice producer, in spite of an estimated 79 200 hectares of high-potential land available for rice production. To date, more than 80 % of this land remains uncultivated, thereby limiting the potential gains that farmers and the nation could realize in the form of income and foreign exchange earnings (Refer to NISR, 2014a:4).

1.2 Objectives of this study

It is, therefore, imperative to understand why Rwanda remains dependent on rice importation, despite its endowment of abundant unused land with a high potential for rice production. In order to address this issue, this study attempts to achieve the following objectives:

- Determine empirically Rwanda's comparative advantage in rice production,
- Identify areas of inefficiencies within the rice subsector, and
- Determine the appropriate policy measures to mitigate these inefficiencies.

In order to achieve these objectives, the following sub-objectives must be fulfilled:

1. Assess the policy environment pertaining to the Rwandan rice subsector.
2. Illustrate how the Rwandan rice value chain is structured, organized, and performing.
3. Gather data on input-output coefficients for rice farming in Rwanda.
4. Determine the farm gate prices for these inputs and outputs, and then estimate corresponding social (economic or shadow) prices.
5. Use the Policy Analysis Matrix to measure the comparative advantage of Rwanda in rice, and the level of inefficiencies induced by market distortions.
6. Provide policy recommendations that can lead to the efficient use of resources.

The underlying hypotheses of the study are the following:

1. Given Rwanda's abundance of wetlands, with a high potential for rice production and a relatively high rice yield in the region, Rwanda should have comparative advantage in rice production.

2. Market distortions, within input and output markets, result in a loss of Rwanda's competitive position within domestic and regional rice markets.
3. These distortions can be corrected through appropriate policy actions.

1.3 Outline of the study

The remainder of this report comprises five parts. Chapter 2 evaluates the policy environment that shapes the Rwandan rice subsector and assesses the structure, conduct, and performance of the Rwandan rice value chain. Chapter 3 reviews the available literature on the theoretical framework under which this study has been constructed. This purpose is accomplished by defining *comparative advantage*, explaining how comparative advantage determines the trade flow, elucidating different sources of market distortions, and how they affect social welfare and trade flow. Chapter 4 explains, in detail, the PAM as a computation model that is used to measure the comparative advantage of the Eastern Province of Rwanda in rice production, as well as the level of market distortions within the rice subsector. Next, the data required for constructing the PAM and the different methods used to gather this data are explained. Chapter 5 is devoted to the presentation and interpretation of the study findings. In the first part of the chapter, the primary data collected by means of a farm survey are presented through a descriptive analysis of the key variables of the study. The data are useful for illustrating the yields, input quantities, expenditure, and revenue of a typical rice farming system in the Eastern Province of Rwanda. In the second part of the chapter, how input costs are disaggregated into tradable and non-tradable components is illustrated; this is followed by a presentation and discussion of the PAM results. Chapter 6 provides a summary of this study, by highlighting what its main purpose is, how the research questions are addressed, and what the results revealed. The chapter concludes by providing policy implications and recommendations.

Chapter 2 : Overview of the Rwandan rice subsector

2.1 Introduction

The rice subsector is important for the Rwandan national economy (MINAGRI, 2004b:19). Rice is produced by an estimated 94 275 households, and it accounts for 18 % of per capita energy supplied derived from cereals[2] (NISR, 2014b:110; FAO Stat, 2014). Despite its natural endowments, Rwanda remains a net importer of rice, and in 2013 spent USD 27.6 million on imported rice, making rice the largest contributor to import values across all agriculture, forestry, and fishery products [3](ICT, 2014).

Given its importance as a staple cereal, it is therefore critical to understand the operational environment that underpins to the Rwandan rice subsector. The objective of this chapter is to provide the context for the study, by outlining the policy environment that currently shapes the Rwandan rice subsector, and describing the structure, conduct, and performance of the Rwandan rice value chain.

2.2 Basic condition: policy environment

This section highlights the key policies that shape the Rwandan rice subsector. Table 2-1, below, summarizes the chronology of policies and events relevant to the Rwandan rice subsector from 1975 to 2014.

Table 2-1: Chronology of policies and events that affected the Rwandan rice subsector

1975	Establishment of the state marketing organization *Office pour la Promotion, la Vente et l'Importation des Produits Agricoles* (OPROVIA). Its duties included managing food-aid distribution, as well as stabilizing market prices, through intra-regional food distribution and providing grain storage facilities.
1985	Establishment of the parastatal APNI (*Appui au Programme National Intrants*). Its duties included importing and distributing mineral fertilizers and pesticides. Due to the subsidization of these inputs, the private sector was unable to compete with this parastatal institution.
1986	The government introduced minimum producer prices for most basic food commodities, including rice.
1992	Removal of quantitative restrictions on trade for all products imported.

[2] Beer excluded
[3] Disaggregated at Harmonized System (HS) 4

1995	Start of the European Union (EU) fertilizer import programme, with a 50 % fertilizer price subsidy. A significant reduction in import tariffs. Among all imported products, the maximum tariff was reduced from 100 % to 60 %.
1995-1996	Liberalization of the foreign exchange and interest rate; removal of price control programmes. The domestic marketing of agricultural commodities was liberalized.
1996	Presidential order n°08/14 of 03/05/1996 established the institutional framework for the privatization of government companies.
1997	In order to conform to regional integration goals under the Cross-Border Initiative (CBI), Rwanda reduced the average tariff rate for all commodities, on aggregate, by two-thirds. Moreover, all export taxes and nontariff barriers were eliminated.
1998	The level of fertilizer price subsidization declined from 50 to 20 %. Continued reduction in import tariffs; the maximum applied tariff rate declined to 40 %.
1999	Issue of the ministerial degree banning the distribution of free or subsidized farm inputs, except in the cases of production shortage and emergency poverty alleviation programmes. This intervention was aimed at promoting private sector involvement in the input supply market, as they had been unable to compete with cheaper subsidized inputs.
1999-2000	The private sector took a 100 % share of fertilizer importation.
2000	Parliament approved law No. 05/2000 of April 19, 2000 and law No. 06/2000 of April 19, 2000, which respectively removed import duties and sales taxes for imported agricultural inputs.
2004	Issuing of the Rwanda land policy, which transferred marshland ownership from individuals to the state. Under a world bank supported project called the Rural Sector Support Project (RSSP), the government started to reclaim marshland, mainly for extending the area under rice cultivation.
2006	The government replaced private sector chemical fertilizer importation. Since then, the government has started to issue tenders to international companies, which would compete to supply it with inorganic fertilizers. Government would then sell these fertilizers to farmers at subsidized prices.
2007	Start of the Crop Intensification Program (CIP), which aims at improving farmers' productivity, mainly by facilitating farmers' access to farm inputs (improved seeds and fertilizers), promoting land consolidation, providing extension services, and improving post-harvest handling and storage mechanisms. The six priority crops under this program are maize, wheat, rice, Irish potato, beans, and cassava.
2009	Rwanda integrated into the East African Community (EAC) customs union, where the Common External Tariff (CET) for rice was set at 75%.
2012	Issuing of instruction of the minister of trade and industry N^{0}19 of 3rd November, 2012 on rice processing and trading. The main regulations are explained in the domestic trade and price support programme section (2.2.1.1) and in the value chain conduct section (2.4).
2013	The government of Rwanda again handed over responsibility for importing and distributing chemical fertilizer to the private sector. The memorandum of understanding was signed between the government and three private companies: Top Services Enterprises Ltd, Alfred Nkubiri and Sons (Enas), and One Acre Fund-Tubura. The Rwanda Official gazette released on 16/06/2013 reemphasized that marshland areas belong to the state, and that marshland shall be leased to a person based on a mutual agreement between the two parties.

Sources: Baydas, Graham and Bicamumpaka (1995:15,31); GAIN (2012); IMF (2000); Kathiresan (2011:13-14); Kelly, Mpyisi, Shingiro and Nyarwaya (2001:6); Loveridge (1991:98); MINAGRI (2009:35); MINICOM (2012:4-7); MINITERE (2004: 28-45); Monitor Group (2012: 8-11); Office of the Prime Minister (2013); Pottier (1993:5-15); Pottier (2002:21); RDB (2014); The government of Rwanda (2010:4); Umuhinzi (2013); Vitalle, Morrison and Ramesh (2013:1)

2.2.1 Domestic agricultural marketing policies

2.2.1.1 Domestic trade and price support programme

Prior to 1994, agricultural commodity markets were controlled and underpinned by the twin objectives of food security and production self-sufficiency. In 1982, the Rwandan government initiated the commodity price stabilization system, which was mainly implemented by its parastatal marketing enterprise 'OPROVIA' (Pottier, 1993:5). OPROVIA's role was also to buy agricultural commodity surpluses at prices above free market prices, store, and then sell the stock during food supply shortages, at prices below free market prices (Pottier, 1993:6, 15). By 1986, the government had set minimum prices for staple commodities (Loveridge, 1991:98). While these floor prices were beneficial for farmers, they were at the expense of rural net food buyers (Loveridge, 1991:98).

Following regional liberalization trends, in 1995 and 1996, the government undertook the process of reforming most of its economic policies. During this period, not only were the exchange and interest rates deregulated, but the government also liberalized agricultural commodity markets (IMF 2000:9-10). Furthermore, in 1996, the presidential order n^{o}08/14 of 03/05/1996 established the institutional framework for the privatization of government companies (RDB, 2014). This framework resulted in the privatization of the rice milling sector.

However, starting from 2010, the government re-entered the rice market, citing concerns about the quality of locally produced rice as a justification (Kathiresan, 2011:7). By 2012, under the instruction of the Minister of Trade and Industry (N^{o}19), a single-channel fixed-price marketing scheme was established for rice; local rural traders were banned, and small-scale rice mills were eliminated. Under this scheme, rice farmers were required to create or integrate into regional cooperatives. These cooperatives bulked and stored paddy rice from member farmers, and sold directly to licensed rice millers.

2.2.1.2 Input supply policies

Fertilizers: Prior to 1994, fertilizer importation was constrained by a policy that restricted imports for the benefit of stabilizing the balance of payments (Verwimp, 2002:25-27). Moreover, government policies were biased toward export industries (tea and coffee), so that available fertilizers were directed mostly towards the production of these commodities (Verwimp, 2002:27). Between 1995 and 1999, European donors took on the responsibility of importing fertilizers, with a 50 % rate of subsidization, which declined to 20 % in 1998 (Kelly et al., 2001:6).

Between 1999 and 2000, the government issued new policy regulations that restricted the distribution of subsidized farm inputs and that removed duties and sales taxes on imported agricultural inputs (Kelly et al., 2001:6). However, from 2006, under the CIP, fertilizer subsidization was reintroduced, with government being directly involved in fertilizer importation and price-setting. As a result, by 2012, government purchases accounted for 90 % of all imported fertilizers (Kathiresan, 2011:13-14; Monitor Group, 2012:8-11).

It was in 2013 that the input importation and distribution system was restructured. The government withdrew its direct intervention in importing and distributing fertilizer, but continued to subsidize fertilizers (Green World Consult, 2014:91; MINAGRI, 2014b:12).

Land market policies: Until 2004, Rwanda's land tenure system in rural areas was mainly dominated by a customary law, under which the market for marshland was minimally regulated[4]. Given the excessive land fragmentation under customary land tenureship, in 2004 the Government established the National Land Policy (NLP). This land policy limited private property rights on marshland resources by converting traditional land to 'state private land' (MINITERE, 2004:28). Furthermore, the new land policy stipulated that the government shall lend marshlands to farmer's groups (i.e. associations or cooperatives), with priority given to the landless poor (MINITERE, 2004:44-45). Under these land tenureship agreements, farmers would, depending on the region and agro-ecological requirements of the marshland, commit to producing specific crops, as determined by the government (MINITERE, 2004:45).

[4] Farmers had the 'right to use' marshlands, and they could easily transfer this right through the land rental market.

As mentioned by Gathani and Stoelinga (2013:109), the limited land use rights, in Rwanda, are a potential barrier for agro processing industries, including rice mills, willing to integrate into the upstream level of the commodity value chains. Most of these processing industries operate under capacity due to a shortage of raw materials.

2.2.2 Domestic trade policy (tariffs and trade agreements)

Prior to 1993, Rwandan trade policies were restrictive: the lowest applied average tariff rate was 35%, and one third of government revenue was generated from international trade taxes (IMF, 2000:42). By 1993, Rwanda had become part of the Cross Border Initiative (CBI). The objectives set out under the CBI were to reduce the Most Favoured Nation (MFN) maximum tariff to 25% and to eliminate all intraregional trade barriers (IMF, 2000:42). As result, from 1995 to 1999 Rwanda reduced its maximum MFN tariff rate from 100 % to 25 %, and the share of international trade taxes in total government revenue declined from one-third to one-fifth (IMF, 2000:42-43). As a result of these policy actions, Rwanda's trade restrictiveness index, as computed by the IMF, improved from eight in 1997 to two in 1999, making Rwanda the fastest trade-liberalizing country within sub-Saharan Africa.

Due to its integration in regional economic communities, Rwanda was induced to default on its tariff rate commitments under the World Trade Organization (WTO) agreement. For example, in 2009, Rwanda adopted the East African CET, which resulted in 263 applied MFN tariff rates that exceed the WTO's tariffs bound rates (WTO, 2012). Of these tariffs, there was the EAC-CET for rice, which was set at 75% ad valorem in 2005, as rice was classified within the group of sensitive products, due to a perceived need to protect regional rice producers (GAIN, 2012; WTO, 2012). Despite the 75% EAC-ECT, Rwanda has often negotiated for a lower rice import tariff. In most of the cases, Rwanda was allowed to keep its import tariff at 30 % (EAC Gazette, 2009:2; EAC Gazette, 2010:2; EAC Gazette, 2013:2). Table 2-2, below, summarizes Rwandan rice import duties from 2000 and the countries that have been benefiting from preferential trade agreements with Rwanda.

Table 2-2: Import duties for rice (semi-milled or wholly-milled) imported by Rwanda[5]

	Total ad valorem equivalent tariff									
Tariff Regime	2000	2002	2003	2006	2008	2010	2011	2012	2013	2014
MFN applied duty	5.0%	30%	30%	30%	30%	30%	30%	75%	30%	52.4%
Preferential tariff for EAC countries	-	-	-	-	-	0%	0%	0%	0%	0%
Regional tariff preference (COMESA[6]) for Eritrea	-	-	-	3%	6%	6%	6%	15%	6%	10.5%
Regional tariff preference for (COMESA) for Ethiopia	-	-	-	-	-	-	-	68%	27%	47.2%
Preferential tariff for COMESA countries members of the FTA[7]	-	-	-	0%	0%	0%	0%	0%	0%	0%
Regional tariff preference (COMESA) for Uganda	-	-	-	6%	6%	6%	6%	15%	6%	10.5%

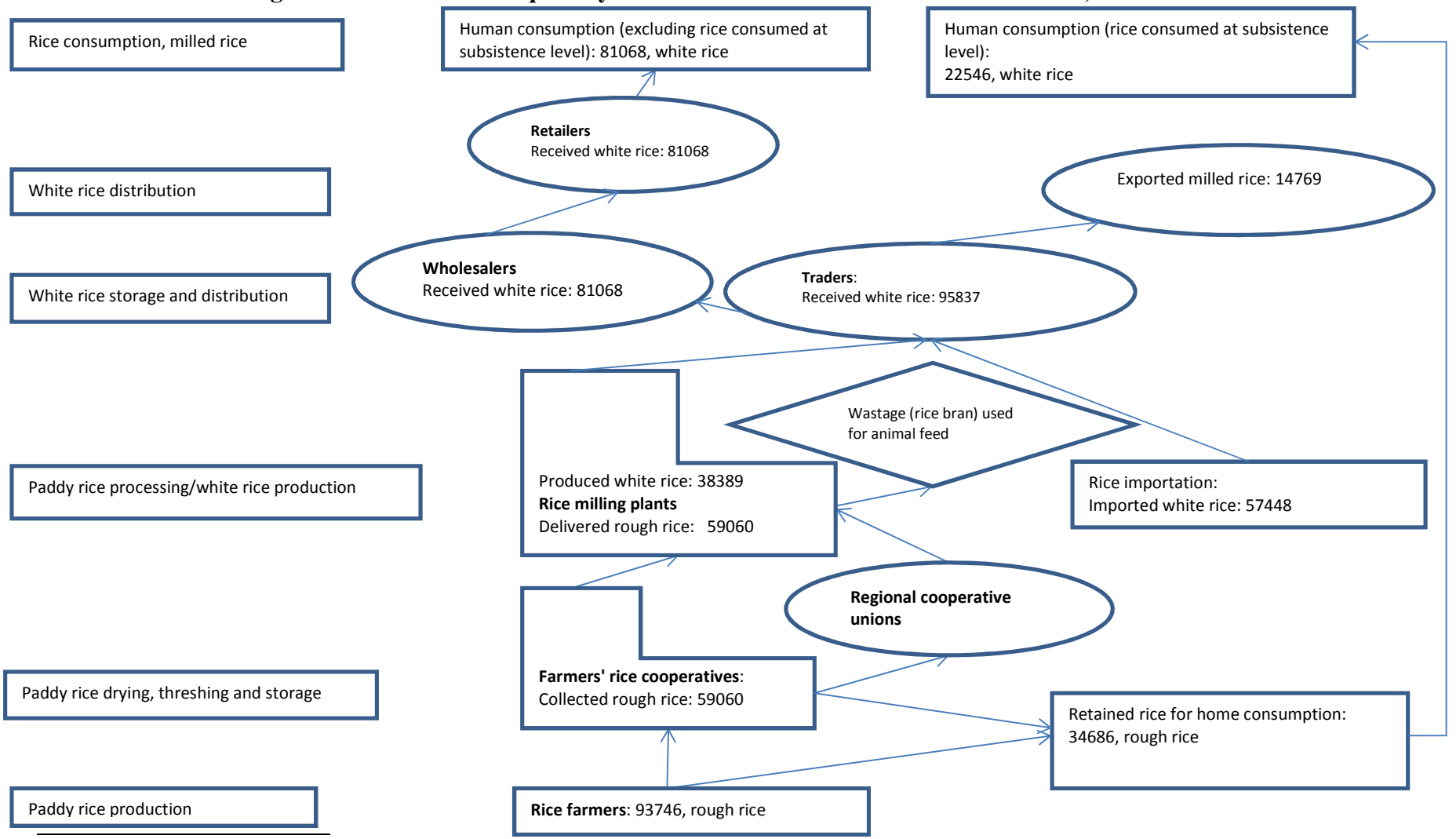
Source: Mac Map (2014)

2.3 Domestic market structure

The Rwandan rice value-chain comprises six distinct levels; these include input supply, primary rice production, processing, milled rice distribution, wholesaling, and retailing. The following section provides a brief description of each activity, which actors are involved at each stage, and how they are organized. Figure 2.1, below, graphically illustrates the Rwandan rice value chain structure, along with the volume flow of rice along the chain in 2013. The section concludes with a brief analysis of the value-chain, utilizing the Industrial Organization (IO) Structure-Conduct-Performance (S-C-P) framework.

[5] Data for 2001, 2004, 2005, 2007 and 2009 were unavailable.
[6] COMESA: Common Market for Eastern and Southern Africa
[7] FTA: Free Trade Agreement

Figure 2-1: Structure and quantity flow of the Rwandan rice value chain in MT[8], 2013



[8] Assumptions: The proportion of paddy rice harvested that is retained by farmers for home consumption was assumed to be 37 %, as it was estimated in Franchis (2012:14). 2. Paddy rice-to-milled rice conversion factor: 0.65. The proportion of rice used as seeds and wasted was assumed to be low; hence, it was not estimated.

2.3.1 Farm input distribution

Both the private sector and government play a major role in the supply of inputs used in rice farming. The government leases marshland to rice farmers, and through the Rwanda Agriculture Board' (RAB), facilitates farmers' access to improved rice seed varieties. In addition, chemical fertilizers are imported by three licensed private companies, namely Importation Distribution Fertilizer (IDF) Co Ltd, Alfred Nkubiri and Sons, and One Acre Fund (Green World, 2014:91). The fertilizers are then sold at a subsidized price to farmers' cooperatives through a voucher system.

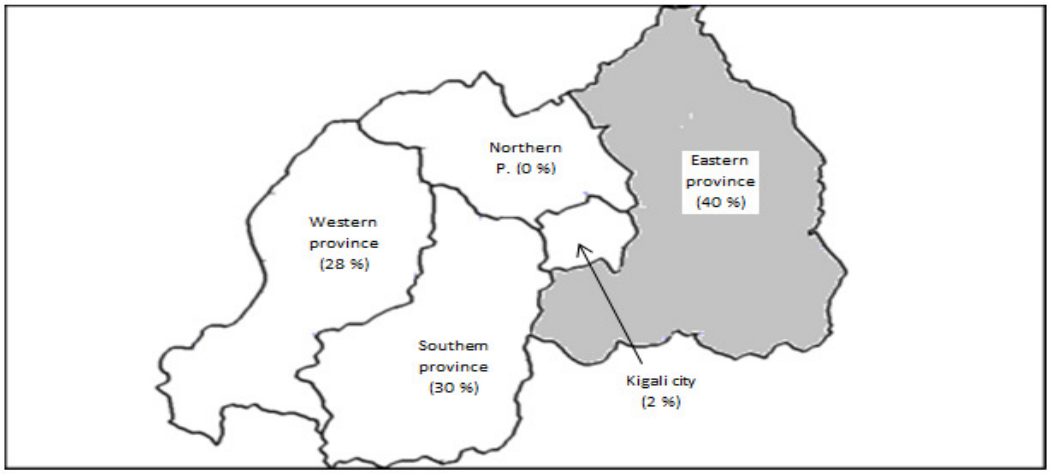
The private sector is involved in the supply and distribution of other farm inputs, such as tools, equipment, and pesticides, through retail shops and/or agro dealers who sell directly to farmers' cooperatives.

2.3.2 Paddy rice production and sale

Production area and distribution: Rwanda is endowed with extensive wetlands with a high potential for rice production due to its hilly topography, abundant rainfall, and warm temperate climate (Carana Corporation, 2010:41; Gathani & Stoelinga, 2013:108; MINAGRI, 2011c:2). In general, rice is grown twice a year: firstly, during agricultural season A, which spans September to February of the following year; secondly, during Agricultural season B, which starts in March and ends in July of the same calendar year (NISR, 2014a:1). In 2014 the total area planted to rice was approximately 15 000 hectares, of which approximately 65% was double-cropped, while the remaining 35% was cultivated for one agricultural season, due to the high risk of flooding and insufficient water (*The New Times Rwanda*, 2014; Carana Corporation, 2010:41).

The study area was the Eastern Province of Rwanda. This province is the largest producer of rice in Rwanda. Between 2007 and 2013, the Eastern Province accounted for 40 % of the national paddy rice produced, as compared with the Southern and Western provinces, with 30 % and 28% respectively (See Figure 2-2, below).

Figure 2-2: Distribution of rice production across Rwandan provinces; share in total national production between 2007 and 2013



Source: Own compilation based on MINAGRI (various years)

Farmers' cooperatives: The number of rice farmers in Rwanda was estimated at 94 275 (NISR, 2014b:110). Each of these farmers is a member of one of 95 cooperatives (RAB, 2014). Rice farmers in each rice marshland are integrated into one or more cooperatives, depending on the size of the marshland. In the Eastern Province, rice is produced in over 32 marshlands, under 40 rice farmers' cooperatives (RAB, 2014). The average farm size per cooperative and farmer, across the 31 sampled cooperatives, was 135.3 ha and 0.19 ha, respectively. The farmers' cooperatives not only facilitate farmers' access to inputs and markets, but they also serve as an institutional framework through which the government and its development partners offer different supports to farmers, aimed at increasing farmers' productivity.

Harvest, post-harvest activities and sale: At harvest, rice farmers in each cooperative take cut rice panicles to their respective cooperative's storage facilities, which are often constructed within walking distance of the marshland. Farmers subsequently thresh, dry (under the sun), manually winnow, bag, and store the rice off-farm, at their respective cooperative. To identify rice owners, each rice bag is marked specifically as belonging to the owner. Afterwards, at the time of delivery, in the presence of the farmer, the cooperative weighs and records each farmer's rice quantity. Finally, the cooperative sells paddy rice, on behalf of farmers, directly to milling plants or through cooperative unions.

Figure 2-3: Rice farmers threshing rice manually in Rwanda, at a cooperative's drying and storage facilities

Source: IRRI (2011), https://www.flickr.com/photos/ricephotos/5880122320/

2.3.3 Paddy rice processing (milled rice production)

Licensed milling plants purchase paddy rice from farmers' cooperatives, with which they have marketing agreements. Paddy rice is then processed into white (milled) rice.

Table 2-3: Rice milling plants operating in Rwanda

N	Province	District	Milling plant	Installed capacity
1	Eastern Province	Bugesera	Mayange rice mill	2.5 MT/h
2		Gatsibo	Gatsibo rice mill	2.5 MT/h
3		Kirehe	Kirehe rice company Ltd	6720MT/year
4		Ngoma	Corimi	2.3 MT/h
5		Nyagatare	Nyagatare rice mill	2.5 MT/h
6		Nyagatare	Kayonza rice	1.8 MT/h
7		Rwamagana	Inter City Mills (ICM) Rwamagama	3 MT/h
8	Southern province	Gisagara	ICM Gikonko	45 MT/day
9		Gisagara	Mukunguri rice	2.5 MT/h
10		Huye	Rwabuye rice	1.5 MT/h
11		Ruhango	Gafunzo rice	2.5 MT/h
12	Western province	Rusizi	Ishema rice	5 MT/h
13		Rusizi	Bugarama rice (ICM Company Ltd)	4.5 MT/h
14		Rusizi	Mashyuza rice mill	2.5 MT/h
15		Rusizi	Dukorerehamwe Company Ltd	2.5 MT/h
16		Rusizi	Coticori	2.5 MT/h

Source: Compiled based on The Government of Rwanda (2013:18); MINICOM (2013); MINICOM and RBS (2013)

As summarized in Table 2-3, above, in 2013 the number of operating rice mills in Rwanda was 16. At that time, all rice mills could utilize less than 35 % of their combined capacity (Gathani & Stoelinga, 2013:117). This low capacity usage can be attributed to different factors, including among others, a shortage of primary rice supply, as reported by Gathani and Stoelinga (2013:117).

2.3.4 White rice trading, wholesaling and retailing

Licensed traders collect milled rice from milling plants and foreign rice exporters, store it, and then sell it to wholesalers (Kathiresan, 2013:13). Wholesalers then sell the rice to retailers, who collect and distribute it across the country through formal and informal retail outlets. According to Kathiresan (2013:19), domestic rice is consumed mainly in rural markets, as 65 % of rural household expenditure on rice is allocated to the local variety. On the other hand, imported rice is consumed mainly in urban markets, accounting for 62 % of urban household expenditure on rice.

In general, 70% of domestic consumers prefer aromatic rice and long-grain rice (Kathiresan (2013:19). Although almost all imported rice is aromatic and long-grain, 70 % of Rwandan rice farmers produce short- and bold-grain rice, which is preferred by only 14 % of domestic consumers (Kathiresan, 2013:19). Moreover, local rice is of relatively low quality, due to a high impurity content and rice that is broken (Jagwe et al., 2003:28; MINAGRI, 2011:11).

2.4 Market conduct

Rwandan rice farmers are horizontally integrated. They are integrated into cooperatives and act collectively to control and manage the cooperatives. Each farmer has an agreement with the cooperative to supply all rice harvested to it. Furthermore, each farmer is required to adhere to the cooperative's regulations. These require using all appropriate inputs (i.e. fertilizers, pesticides, seeds, drying and storage facilities, etc.) availed by the cooperative to improve the rice yield and quality. Farmers are also required to respect the crop calendar for each farming activity as announced by the cooperative.

Farmers' rice cooperatives are vertically linked and integrated with the downstream rice milling level through forward marketing contracts as well as direct ownership. The 2012 "instructions of the minister of trade and industry on rice processing and trading" set out the terms of forward

contracts and required that farmers' cooperatives had at least a 40% share in all rice milling plants[9] (MINICOM, 2012:7).

In some instances, rice mills provide extension services to cooperative member farmers as a means of ensuring the appropriate quality of paddy rice. There is low vertical integration between rice mills, traders, wholesalers, and retailers, as often they are inclined to work independently. However, there are instances where processors are vertically integrated with the wholesale/retail level of the value-chain; for example, ICM processing plant owns 12 retail outlets across the country (Gathani & Stoelinga, 2013:118).

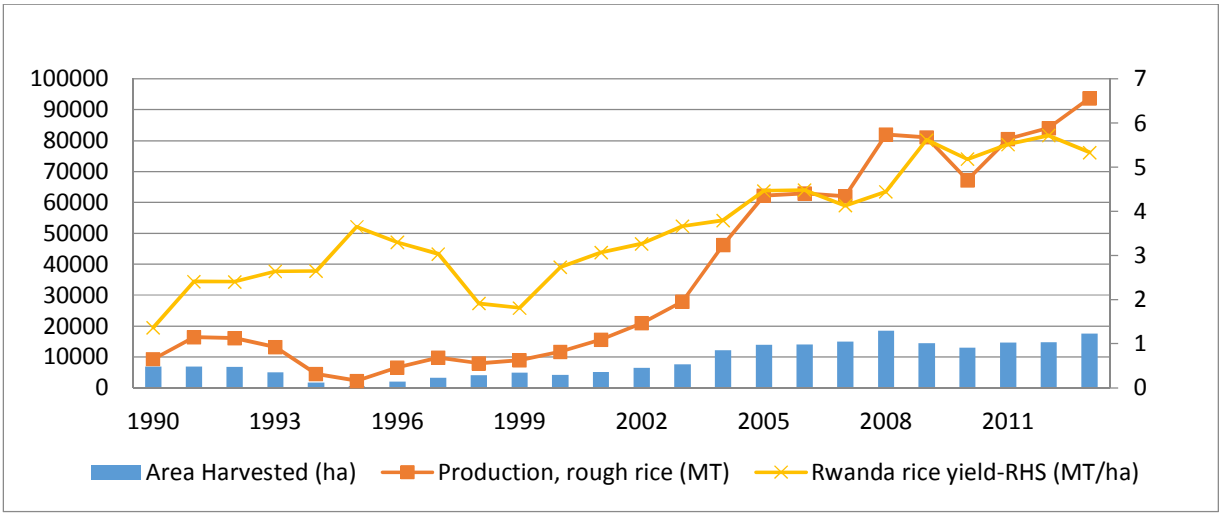
2.5 Value chain performance

Production trend: Annual rice production increased tenfold between 1990 and 2013, rising from 9 305 MT to 93 746 MT. This growth in output is attributed to both area expansion and yield increases. During this period the area harvested for rice rose from 6 816 hectares to 17 568 hectares, while yields rose from 1.4 to 5.3 MT/ha[10], see Figure 2-4, below (FAO Stat, 2013). This significant growth in rice production was underpinned by the government's intervention in the rice subsector, through financing marshland reclamation and rehabilitation, and by facilitating farmers' access to improved inputs.

[9]Refer to MINICOM (2012:7). ICM, the largest rice processing plant in Rwanda, is a joint venture between a foreign investor owning 60 % of the stake and farmers' cooperatives with 40 % (Gathani & Stoelinga, 2013:65) (Gathani & Stoelinga, 2013)

[10] The 5.3 MT/ha Rwanda rice yield is higher than the global average rice yield of 4.5 MT/ha, and higher than rice yields in regional countries such as Tanzania, Uganda, Kenya, Democratic Republic of Congo and Burundi, with 2.4, 2.3, 5.2, 0.7 and 1.9 MT/ha respectively (FAO Stat, 2014).

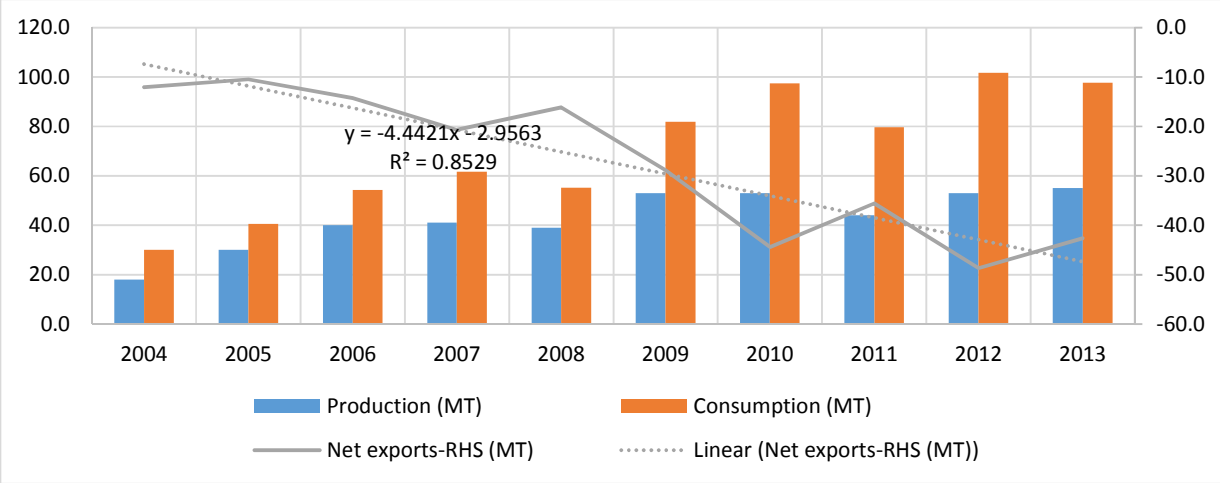
Figure 2-4: Rwanda rice production trends: 1990-2013



Source: FAO Stat (2014)

Domestic rice consumption: Since 2004, Rwanda has experienced significant growth in rice consumption. Between 2004 and 2013, milled rice consumption increased from 30 000 MT of milled rice to 97 600 MT, see Figure 2.5, below.

Figure 2-5: Consumption[11] trend and sources of milled rice, HS100620; 100630; 100640 (1000 MT)



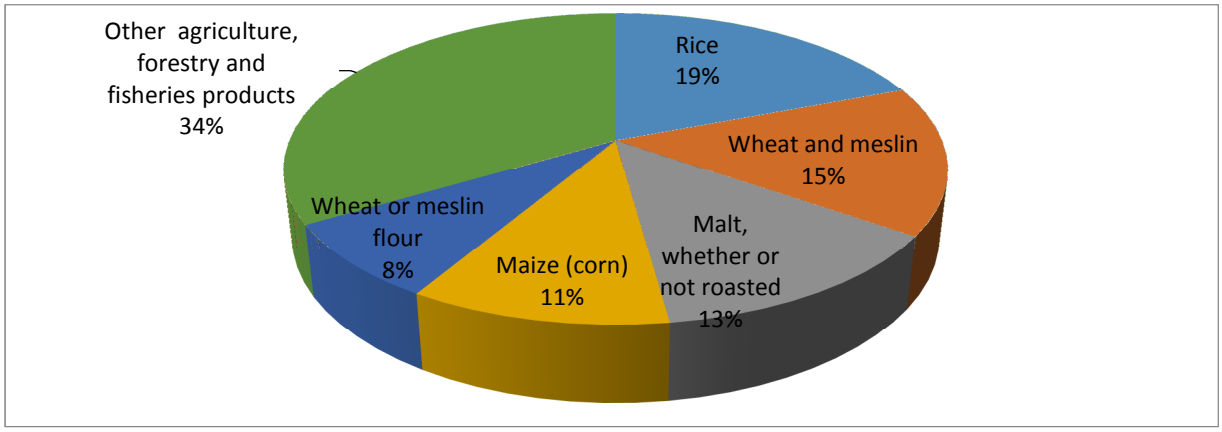
Sources: USDA FAS (2014); ITC (2014); FAO Stat (2014)

[11]Due to a lack of sufficient information on stock variation, feed, waste, and other uses, consumption was roughly estimated using the formula 'Production+imports-Exports'. However, it is believed that missing data for these variables represent too small share for estimated consumption to divert significantly from the true consumption figures.

Though rice production has risen over the past decade, the increase is not sufficient to keep pace with growing rice demand, and as a result, Rwanda is increasingly becoming dependent on rice importation. Since 2004 the rice trade deficit has been increasing by 4 442 MT of milled rice each year, from 13 279 MT in 2004 to 42 638 MT in 2013 (see Figure 2.5, above).

Trade: Given its deficit position in rice production, between 2004 and 2013, Rwanda spent, on average, USD 12.193 million each year on rice imports, making rice the largest contributor to import values among all agriculture, forestry and fisheries products (see Figure 2-6, below).

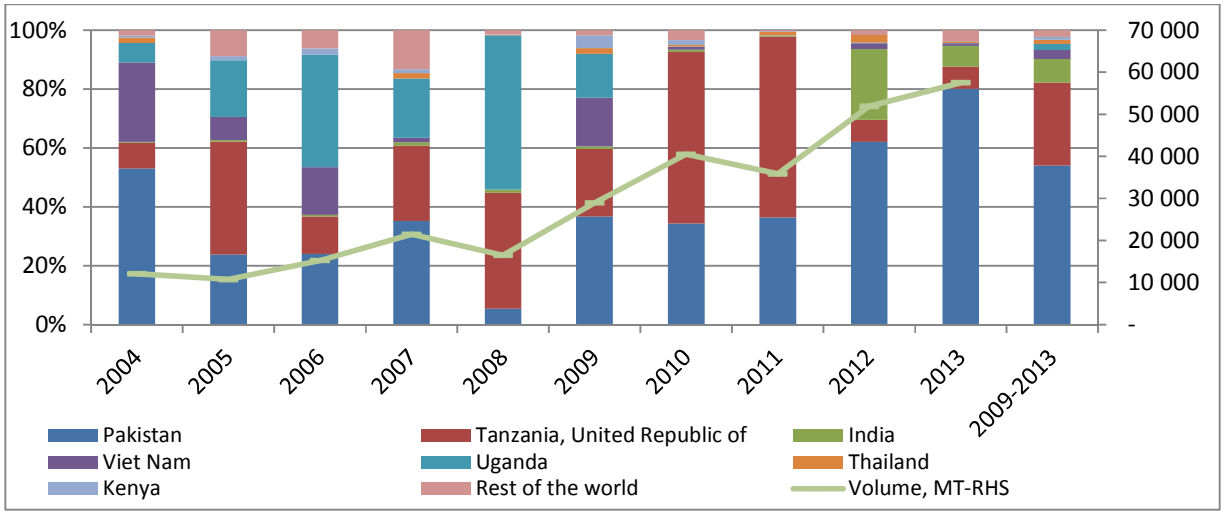
Figure 2-6: Imports of agriculture, forestry and fisheries products (HS01-14) between 2004 and 2013, in thousands US dollars, and ranked by order of importance



Source: ITC (2014)

The major source of rice for Rwanda is Pakistan, accounting for over 54 % of the total quantity of rice imported between 2009 and 2013. Tanzania and India follow with 28 % and 8 % of the market share, respectively (see Figure 2-7, below). However, there is substantial variability in the market share allocated to each country each year, due to production and price fluctuations in global rice markets.

Figure 2-7: Major exporters of rice (HS1006) to Rwanda, and rice importation trend, by volume, MT

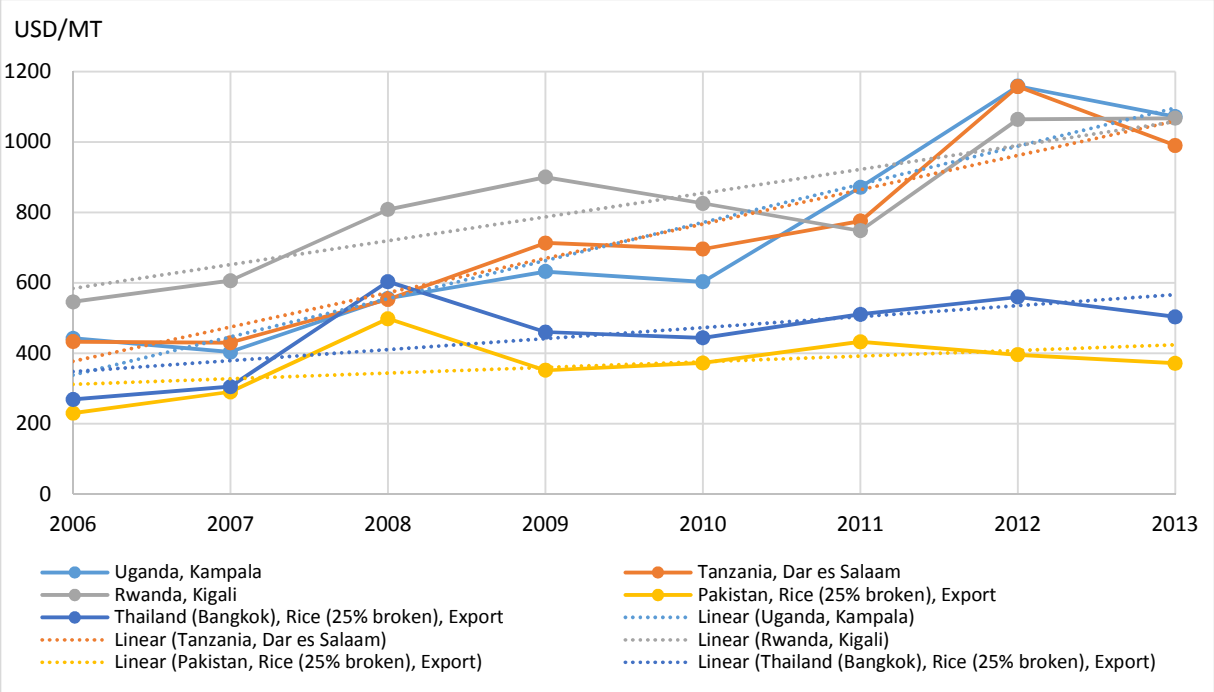


Source: ITC (2014)

Price Movements: As illustrated in Figure 2-8, below, domestic rice prices are relatively higher than world rice prices. The higher relative domestic prices can be explained by the landlocked nature of Rwanda[12], but also exist because of protective rice import tariffs (refer to Table 2-2, Import Duties for Rice). It seems that the reduction in the gap between domestic rice prices and regional[13] rice prices, from 2006 to 2013, was induced by the removal of import duties for rice originating from EAC member countries, following Rwanda's integration into the EAC in 2009 (Refer to Tables 2-1 and 2-2). During the same period, the growth rate in domestic and regional rice prices was, however, higher than the growth rate for world rice export prices, which might have been induced by trade diversion and increasing transportation costs.

[12] According to The World Bank (2010:217), as a landlocked country, transportation and related costs account for more than 40 % of the value of goods imported by Rwanda.
[13] Wholesale rice prices for other regional countries, such as Burundi, DRC Congo and Kenya were unavailable.

Figure 2-8: Trend in wholesale real rice prices, constant 2013 prices, and world export rice prices. A comparative analysis among Rwanda and a selection of countries



Source: FAO GIEWS (2014)

2.6 Summary

In this chapter various factors were explored that affect the competitiveness of the Rwandan rice subsector. Section 2.2 is devoted to the policy environment relating to rice. It is illustrated that, in general, the government uses protectionist policies to provide incentives for domestic rice production. These policies consist of farm input subsidization, paddy rice price regulation, and rice import tariffs. On the other hand, the land policy that limits private ownership and usage rights pertaining marshlands has the potential to create disincentives for rice production.

Sections 2.3 and 2.4 assessed respectively the domestic market structure and the value chain's conduct. It is shown that farmers' cooperatives have improved the level of horizontal and vertical linkages within the rice subsector, which is likely to reduce transaction costs.

In terms of demand, local rice varieties are mainly consumed in rural markets, while imported rice is mostly consumed in urban markets. Although most of the farmers cultivate short and bold rice, the majority of consumers prefer long rain and fragrant rice, of most of which is imported.

This final section provides a brief overview on the performance of the industry in terms of production, trade and price movements. It is illustrated that though Rwanda has recorded a consistent increase in rice production over the last decade, Rwanda is increasingly becoming dependent on rice importation. Moreover, this section reveals that domestic rice prices in Rwanda and the region are higher than those of the rest of the world, which can be attributed to existing protective rice trade policies, but also the landlocked nature of countries such as Rwanda.

Chapter 3 : Theoretical framework

3.1 Introduction

This chapter develops the theoretical framework of the study. This involves an explanation of the theory of comparative advantage and a nation's sources of comparative advantage as a means of predicting trade patterns. The second half of the chapter examines the nature of state-created market distortions and their effect on trade flows and welfare distribution.

3.2 International trade theory

3.2.1 Mercantilists

The first writings on international trade date from the 17th and 18th centuries (Salvatore, 1990:20). During this period, a group consisting of merchants, bankers, government officials, and philosophers were promulgating a philosophy known as Mercantilism (Salvatore, 1990:20). According to this philosophy, trade was viewed as a zero-sum game (Pugel, 1990:33, Salvatore, 1990:21). Mercantilists encouraged governments to impose import restriction measures and subsidize export industries in order to achieve positive net exports, which ultimately resulted in a national accumulation of precious metals (Pugel, 2007:33).

3.2.2 Classical theories of trade

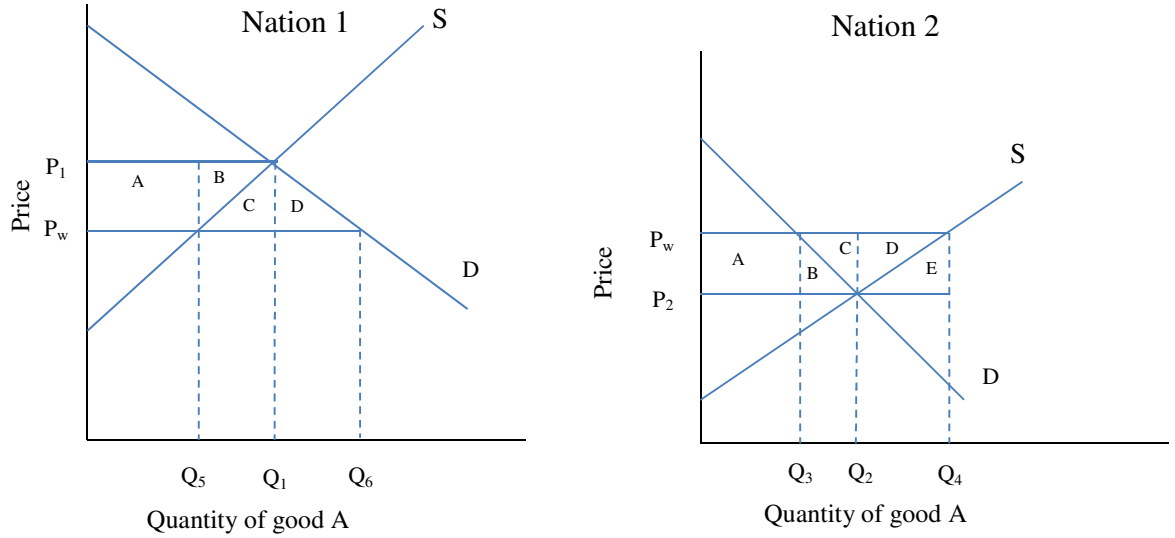
Starting in the late 18th century, a new school of thought on trade theory emerged. Contrary to mercantilism, which encouraged governments' intervention in trade, classical trade theorists viewed trade as a positive-sum game, and therefore argued in favour of free trade (Pugel, 2007:33; Salvatore, 1990:20).

3.2.2.1 Absolute advantage

In 1776, Adam Smith, a moral philosopher and political economist, introduced the absolute advantage theory of trade, as a rationale for why nations engage in trade (Winch, 1992:91; Salvatore, 1990:22). This theory predicts that two nations should gain from trade if each of them can produce and export to the other the commodity in which they have absolute advantage. In other words, a country should specialize in the production of the good it can produce more efficiently than other countries (Pugel, 2007:32; Salvatore, 1990:22).

Using a market model, Smith illustrated the positive gains that could be realized through specialization and trade (see Figure 3-1, below).

Figure 3-1: Gains from trade, partial equilibrium



Source: Adapted from Brown and Hogendorn, (1994:41)

Gains from trade: Under autarky, Nation 1 produces and consumes Q_1 units of good *A*, whereas Nation 2 produces and consumes Q_2 units of good A. Since the domestic price (P_1) of good *A* is lower than the world price (P_w), Nation 2 has absolute advantage in good *A*. Therefore, according to Smith, Nation 2 should specialize in the production of good *A* and trade with Nation 1.

Under a free trade scenario, the domestic price of good *A* decreases from P_1 to P_w for Nation 1, while prices increase from P_2 to P_w for Nation 2. With rising prices, Nation 2 increases domestic production to Q_4, of which Q_4-Q_3 is exported; while for Nation 1, domestic production decreases to Q_5, with Q_6-Q_5 being imported to meeting rising domestic demand.

In terms of welfare, for Nation 1, consumer welfare increases by *A*+*B*+*C*+*D*, while the producer welfare decreases by *A*+*B*, resulting in a net welfare gain of area *C*+*D*. Likewise, for Nation 2, consumer welfare decreases by *A*+*B*, while the producer welfare increases by *A*+*B*+*C*+*D*, resulting in a net welfare gain of area *C*+*D*.

3.2.2.2 Comparative advantage

In 1817, David Ricardo further refined Smith's Classical Trade Theory by developing the concept of comparative advantage and trade (Brown & Hogendorn, 1994:25, 28). According to

Ricardo, two nations will gain from trade if each specializes in the production and exportation of the commodity that it can produce at a lower relative cost; i.e. in which it has a comparative advantage (Heller, 1973:36). Therefore, though one of the two nations might be efficient (inefficient) at producing all the commodities, they can still gain from mutual trade as long as the two nations can produce these commodities at different relative costs (Pugel, 2007:35).

The gains from trade, as explained by David Ricardo, can be illustrated using the production possibility curves (PPC[14]) and community indifference curves (CIC)[15]. In this simplified two-good, two-country model, under autarky, for each nation, market equilibrium is indicated by the point where the production possibility curve is tangent to the community indifference curve. At this point, the slope of the tangent to the PPC and CIC is equal to the price ratio (Px/Py)[16]. Nation 1 produces and consumes at point *A* (50 units of *X* and 60 units of *Y*), and Nation 2 produces and consumes at point *A* (80 units of *X* and 40 units of *Y*).

Since the price[17] ratio P_x/P_y is relatively lower for Nation 1 ($P_A = P_x/P_y = ¼$) than for Nation 2 ($P_A' = P_x/P_y = 4$), nation 1 has a comparative advantage in the production and exportation of commodity *X* because it can produce *X* at lower relative opportunity cost. On the other hand, since the inverse of P_x/P_y (or P_y/P_x) is relatively lower for nation 2 ($1/P_a' = 1/4$) than in Nation 1 ($1/P_a = 4$), Nation 2 has a comparative advantage in the production of *Y* because it can produce *Y* at a relatively lower opportunity cost.

[14] The PPC shows a combination of products that a nation could produce using all of its available resources and technology (Heller, 1973: 30). The PPC is concave from the origin since each nation must give up more and more of one commodity (increasing opportunity cost or marginal rate of transformation) by releasing just enough resources to produce each additional unit of the second commodity (Salvatore, 1990:47).

[15] The community indifference curves (CICs) show a combination of commodities *X* and *Y* that give the same level of satisfaction to consumers. The CICs are negatively sloped and convex from the origin, since at the same level of satisfaction, the more *X* is consumed, the less and less *Y* must be consumed (decreasing marginal rate of substitution), and vice versa (Brown & Hogendorn, 1994:32; Salvatore, 1990:50). The higher the indifference curve is, the higher is the level of satisfaction.

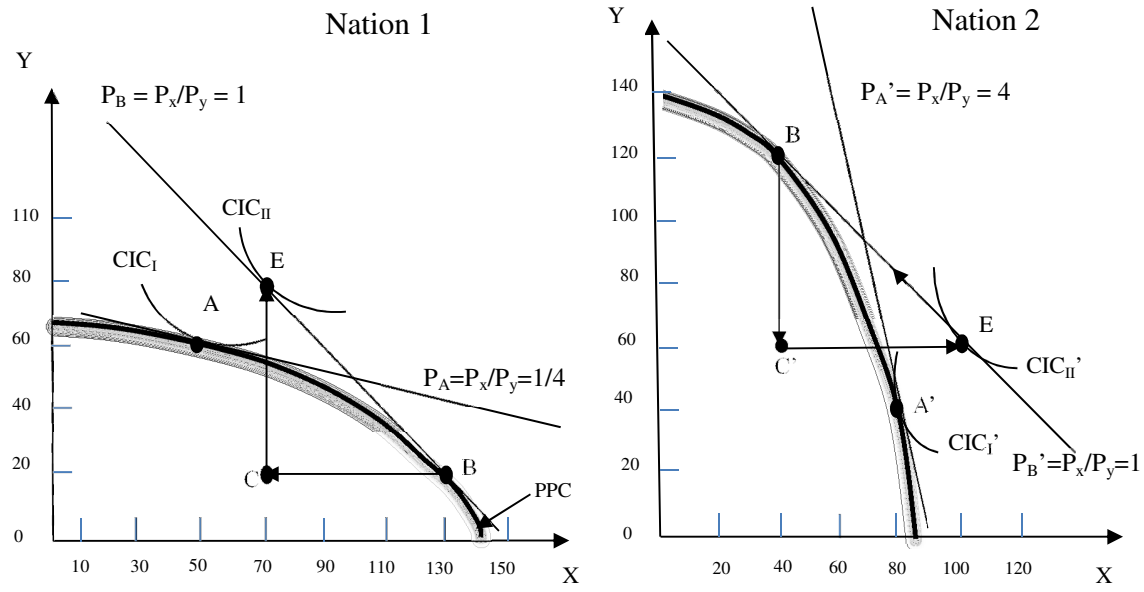
[16] This tangent represents also the national budget constraint, as it shows the combinations of *X* and *Y* that the nation can consume given available income. Reference is made to Pugel (2007:52,53).

[17] The comparative advantage theory was based on the labour theory of value, according to which, relative commodity prices are a reflection of the comparative cost of production, which was measured in terms of labour productivity (Heller, 1973:39). In 1936, Gottfried Haberler introduced the 'opportunity cost theory of international trade' (Heller, 1973:39). Through this theory, the comparative advantage theory was further refined by measuring the comparative cost of production in terms of alternative production forgone (Heller, 1973: 39). This reformulation was aimed at addressing the limitations set by the assumption of labour being the only factor of production (Heller, 1973: 39).

When the two countries open to trade, given their relative price rations, Nation 1 should specialize in the production and exportation of good *X*, while Nation 2 should specialize in the production and exportation of good *Y*.

Under free-trade, at the market equilibrium, *X*'s and *Y*'s relative prices will be the same in both nations ($P_B=P_B'=P_x/P_y=1$). At this price ratio, the market clears. In other words, the quantity of *X* that Nation 1 is willing to export (60 units of *X*) is equal to the quantity of *X* that Nation 2 is willing to import; and vice versa.

Figure 3-2: Gains from trade; general equilibrium



Source: Adapted from (Salvatore, 1990: 53, 56)

Due to specialization there are 40 additional units of good *X* and *Y* produced. This incremental output is shared between the two nations through trade. The gains from trade are indicated by a shift to a higher community indifference curve (from CIC_I to CIC_{II} for Nation 1 and from CIC_I' to CIC_{II}' for Nation 2). After trade, the consumption level for each nation is beyond the production possibility capacity for each nation.

The gains from trade for each nation are attributed to two factors. The first is the ability of both nations to sell at world prices, rather than at autarky prices, and the second is increased output as a result of specialization (Brown & Hogendorn, 1994:38).

3.2.3 Neo-classical theories of trade (sources of comparative advantage)

According to classical economists, comparative advantage arises from differences in labour productivity, as labour was explicitly considered as the only factor of production (Salvatore, 1990:103). However, they did not explain what the basis for productivity differences (PPCs shapes) was, apart from the likely differences in climate (Brown & Hogendorn, 1994:56; Salvatore, 1990:103).

The neo-classical school of thought further refined Classical Trade Theory by examining the basis of comparative advantage. The most prominent neo-classical theory was modelled by the Swedish economists Eli Hesckscher and Bertin Ohlin in the 1920s and 1930s respectively (Brown & Hogendorn, 1994:57).

The HO theory is constructed under two fundamental hypotheses. The first hypothesis is that countries are endowed with different factors of production, which are immobile between countries (Leamer, 1984:1). The second hypothesis states that these factors are used in different proportions to produce different goods (Leamer, 1984: 1). The HO theory argues that "a country will export the product(s) that use its relatively abundant factor(s) intensively, and import the product(s) that use its relatively scarce factor(s) intensively (Pugel, 2007:60).

It should be noted that the HO model assumes only two factors of production, namely labour and capital, and the basis for the two nations to engage in trade is the prevailing differences in relative product prices across the two nations (Salvatore, 1990:104; Pugel (2007:59). These relative price differences arise from production capability differences, due to factor endowments (illustrated as different PPCs positions and slopes) and differences in consumer preferences (illustrated as different CIC positions and slopes) between the two nations (Pugel, 2007:59).

3.3 Market distortions and their effect on trade flow and welfare

Global trade patterns do not reflect the predicted trade flows of the Classical and Neoclassical Trade Theories[18]. For instance, trade between industrialized countries accounts for almost 50% of global trade, with more than 70% of industrialized countries' exports flowing to other

[18] While empirically testing the Heckscher-Ohlin model, in 1951, Wassily Leontief found that U.S exports were labour intensive and imports capital intensive, though U.S was relatively capital intensive than the rest of the world (Salvatore, 1990:142-143).

industrialized countries (Pugel, 2007:88)[19]. For Classical Trade Theory outcomes to hold, factor and commodity markets must be perfectly competitive, and there should be no impediments to trade (Salvatore, 1990:104; Lipsey, 1989:347; Winters, 1991: 24).

In reality, these assumptions do not hold true, due to prevailing distortions in factor and output markets. Market distortions derive from two main sources. The first is market failure (i.e. market power or monopolistic structures, imperfect information, externalities, and public goods), and the second is policy distortions.

The remaining part of this section focuses on policy-induced market distortions. Monke and Pearson (1989:22) classify these policies into three main categories, namely commodity, factor, and macroeconomic policies.

3.3.1 Commodity price policies[20]

Distorting commodity price policies are defined as those "commodity-specific actions that cause domestic prices to differ from world prices" (Monke & Pearson, 1989:22). Where these policies are applied, commodity market (private) prices diverge from corresponding social prices, creating a wedge between the interests of producers and consumers (Kirsten, Ohene-Anyang & Van Rooyen, 1998:528). These policies include subsidies (positive subsidies and taxes), direct intervention, and trade policies.

Subsidies: According to Monke and Pearson (1989:22), subsidies can be classified as either positive, which is a payment made by the government, or negative, otherwise known as a tax (Monke & Pearson, 1989:22). In agriculture, negative and positive subsidies include (Ellis (1992:71-72):

- a producer subsidy that is paid to farmers to cover the price differential between the targeted and actual farm gate prices,
- taxes (levies) deducted on farm gate prices when farmers sell their produce to specific marketing agents,

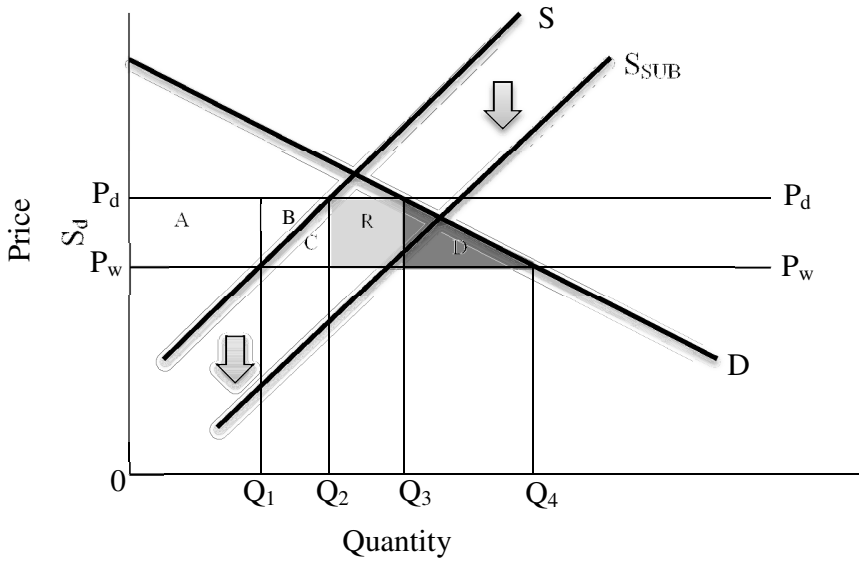
[19] As reported by Krugman (1979), Lancaster (1980), Gruber (1967), Posner (1961), Vernon & Wells (1966), and Porter (1990), non-comparative advantage trade is driven by factors such as economies of scale, product differentiation, technology change, product cycle, and strategic government choices.

[20] These policies are used for different purposes, including increasing agricultural output to achieve food security and food self-sufficiency, stabilizing farmers' income, stabilizing food prices, reducing the foreign exchange deficit through generating and saving foreign exchange, generating government revenue through collecting taxes, and promoting industrial growth by keeping the level of raw material prices low (Bale & Lutz, 1979:8; Ellis, 1992:69-70; Krueger, 1972:48; Liefert, Wescott & Wainio, 2013:9-10).

- taxes levied on raw materials (agriculture commodities) at the processing plants' gate,
- consumption subsidies applied on food commodities sold by retailers to specific consumer groups,
- a consumption tax which is levied at the wholesale or retail levels.

The effects of a positive production subsidy on trade flows and social welfare is illustrated in Figure 3-3. Without a subsidy, the good is sold in the domestic market at the world price (P_W); quantity demand is Q_4, of which Q_1 is sourced from the domestic market, while Q_4-Q_1 is imported.

Figure 3-3: Effect of a production subsidy on trade flows and social welfare



Source: Brown and Hogendorn, 1994:174

When the government introduces a unit price subsidy S_d, the supply curve shifts down and to the right, from S to S_{SUB} because producers per unit cost have declined. The domestic consumption remains at Q_4 because the world price (P_W) prevails in the domestic market. On the other side, domestic producers gain competitiveness as they increase their production to Q_2; the imports decrease to Q_4-Q_2.

Since consumers are tax payers, the total amount of subsidy $A+B+C$ provided by the government to domestic producers is a reflection of a consumer welfare loss. Of this consumer welfare loss $A+B$ is gained by producers, while C is a deadweight loss to the economy.

Direct interventions: Commodity markets are also distorted by government interventions in regulating commodity prices. The common types of interventions entail using uniform, fixed or minimum commodity farm gate prices[21] and regulation of staple food prices by setting fixed or maximum prices (Ellis, 1992:72). In some instances, due to food security concerns, the state buys surplus production directly from farmers, thereby setting a floor price in the market (Ellis, 1992:72).

Trade policies[22]: Trade flow patterns are also influenced by domestic trade policies. According to Brown and Hogendorn (1994:105), and Pugel (2007:147), these policies are classified into two broad categories: tax and non-tax policies. Tax policies comprise import and export tariffs, while non-tax policies include non-tariff barriers (i.e. import quota, discriminatory product standards, voluntary export restraints, etc.) and subsidies.

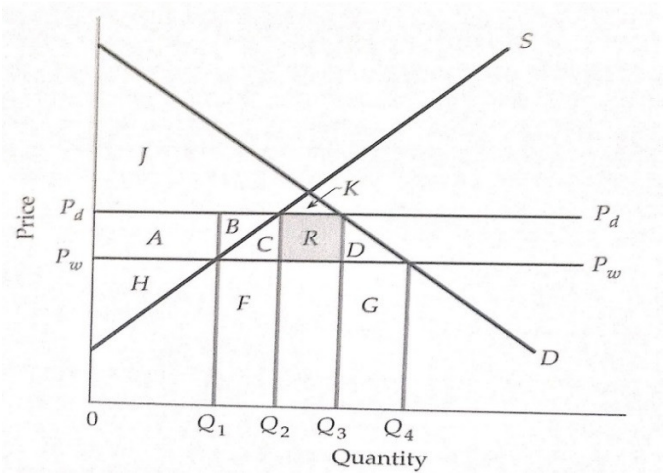
Figure 3-4 illustrates that, for a small country[23], an import tariff raises the domestic product market price above the world price. As a consequence, domestic consumption reduces from Q_4 to Q_3. The domestic producers gain market share in the domestic market, since they increase production from Q_1 to Q_2. The imports decrease from Q_4-Q_1 to Q_3-Q_2.

In terms of welfare, an import tariff reduces national wellbeing. As illustrated in Figure 3-4, consumers' welfare decreases by $A+B+C+R+D$, of which $A+B$ is gained by domestic producers, while R is the government tariff revenue (consumption tax). There is a deadweight loss of $C+D$, since consumers lose more than the government, and producers gain.

The area C reflects the extra cost of using resources in the production of the additional output Q_2-Q_1, instead of importing the same quantity of the good in cheaper foreign markets (Brown and Hogendorn, 1994:114-115; Pugel, 2007:144). On the other hand, the area D reflects the loss in consumer satisfaction, due to a reduction in total consumption of the protected good (Brown and Hogendorn, 1994:114-115).

[21] These prices are usually communicated to farmers prior to the crop season (Ellis, 1992:72).
[22] Trade policies are mostly used in developing countries, and they have been the most distorting policies used due to their effective ability to create a wedge between domestic product prices and world prices, as well as their cost affordability relative to output and input subsidies, which are costly for the government (Anderson, Valenzuela & van der Mensbrugghe 2010:52; Krueger, 1972:48).
[23] A country is small if its trade cannot affect the world price (Pugel, 2007:131)

Figure 3-4: Effect of an import tariff on trade flows and welfare of a small country



Source: Brown and Hogendorn, (1994:112)

3.3.2 Factor policies

As mentioned in section 3.2.3 (sources of comparative advantage), relative commodity prices between nations determine comparative advantage and trade patterns. These commodity prices are determined mainly by prevailing factor prices. Therefore, any government policy that distorts factor markets would indirectly affect commodity prices; hence, affecting free flow of commodities.

Distorting factor policies comprise mainly:

Price-regulating policies: In this category are included all regulations that directly affect the factor market price, by raising (or lowering) the factor market price above (or below) the free market price. There are among these policies, for instance, minimum wage regulations for unskilled labour, low land rental prices and fixed specific variable input (i.e. fertilizers) prices (Ellis, 1992:129; FAO 1960:72; Monke Pearson 1989:42).

Taxes and subsidy policies: Governments may also distort factor markets by using tax and subsidy policy instruments. Often, the government uses taxes to raise revenue. On the other hand, input subsidies[24] are provided, especially when there is a need to improve farmers' income, through reduced farm production costs, or as an incentive for farmers to adopt a new farming production technology (Cleaver, 1985:3,26; FAO, 1960:70-71).

[24] The government pays the subsidy directly to the input importer, to the domestic manufacturing plant of the input, or else to the parastatals involved in the distribution of the inputs to farmers (Ellis, 1992:129).

3.3.3 Macroeconomic policies

There are different macroeconomic policies that distort factor and output markets. These include fiscal, budgetary, and monetary policies. Additionally, there are the exchange, interest, and wage rates, as important policy tools that are used to regulate the national economy (Monke and Pearson, 1989:52).

This section explains the impact of the exchange rate. It will focus only on this policy instrument, since the exchange rate is often considerably distorted in most developing countries (Kruger, 1972:58; Krueger, Schiff & Valdés, 1988:255). Moreover, government policies that indirectly affect agriculture through overvaluing the currency and protecting domestic industry have a greater impact on the agricultural sector than the other agriculture price policies do (Krueger et al., 1988:267).

Exchange rate: Often, in most developing countries and centrally planned economies, governments intervene in the foreign exchange market, through overvaluing the currency. This generally results in higher domestic price inflation relative to inflation for the major trading countries (Cleaver, 1985:17). Currency overvaluation can also be a result of import restriction measures (i.e. tariffs and quotas). These restrictions raise domestic product prices relative to world prices, and consequently, overvalue the real purchasing power of the local currency relative to other foreign currencies (Cleaver, 1985:17).

When the currency is overvalued, tradable products become mispriced relatively to non-tradable products (Anderson, Martin & van der Mensbrugghe, 2006:170; Little & Mirrlees, 1974:30), which affects the efficient allocation of resources. For instance, when domestic exporters exchange foreign currency received from selling abroad at world prices, at the official exchange rate, they receive less in domestic currency (Cleaver, 1985:17). This overvaluation creates, therefore, a disincentive for producing export commodities. Moreover, as a result of currency overvaluation, imported goods become relatively cheap in the domestic currency, thus discouraging the domestic production of import substitute goods (Cleaver 1985:17, 24, Little & Mirrlees: 1974:30)[25].

[25] Governments also intervene in exchange markets by assigning multiple exchange rates to different exported and imported goods, as a strategy to restrict or promote the trade of those goods (FAO 1960:20); these multiple exchange rates have similar effects as other commodity trade policies (FAO 1960:20).

3.4 Summary

Chapter 3 is devoted to explaining of the theoretical framework for this study. Section 3.2 illustrates how nations gain from trade, due to the benefits arising from specialization. This specialization is based on comparative advantage, since each country tends to produce and export those commodities that they can produce at a relatively lower opportunity cost than the rest of the world can, in exchange for those commodities that it can produce at relatively higher opportunity cost.

It is emphasized that countries have comparative advantage in the production of those commodities whose production requires intensive use of the factors of production with which they are abundantly endowed. However, though comparative advantage theory is broadly consistent in developing countries and agricultural sectors, it is emphasized that in industrialized countries and for non-food manufactured goods, trade is mostly based on factors other than comparative advantage. These factors include, among others, economies of scale, product differentiation, the technology gap, the product cycle, and production seasonality differences.

Section 3.3 illustrates how factor and commodity market distortions alter trade flows (as determined by comparative advantage), which decrease social welfare. These market distortions arise from market failures and distorted government policies. Illustrated in the next chapter (Research Methodology) is how these market distortions are measured empirically, by using Policy Analysis Matrix parameters and indicators.

Chapter 4 : Research methodology

4.1 Introduction

As highlighted in Chapter 3, under Classical Trade Theory, comparative advantage determines patterns of specialization and trade flows between nations, ultimately resulting in net welfare gains for both nations. As agriculture remains the economic engine for Rwanda, reducing poverty and ensuring household food security will depend largely on stimulating agricultural growth. To achieve this growth, Rwanda should specialize in the production of the commodities in which it has comparative advantage. The objective of this study is to determine whether Rwanda has a comparative advantage in rice.

In section 4.2 of this chapter, different measures of comparative advantage are discussed. In the subsequent section 4.3, a detailed explanation of the Policy Analysis Matrix (PAM) theoretical model is presented. This model is used to determine the comparative advantage of the Eastern Province of Rwanda in rice and the level of distortions in input and output markets. Moreover, this section focuses on the variable estimates required to model the PAM., and describes the data used to construct the PAM as well as different data collection methods used. Finally, Section 4.4 summarizes this chapter.

4.2 Literature review: empirical methods of measuring comparative advantage

This section reviews the different methods that are used to measure comparative advantage, including among others, the net social profitability (NSP), the domestic resource cost ratio (DRC), the social cost benefit ratio (SCB), the revealed comparative advantage (RCA), and the Policy Analysis Matrix (PAM). These methods have been used to measure comparative advantage in different countries, across different industries. For instance, using the NSP and DRC measures, Shahabuddin, Hossain, Mustafi and Narciso (2002) analyzed the comparative advantage of different rice production systems in Bangladesh, and revealed that this country has no comparative advantage in upland aus crop and deep water aman rice.[26]

[26] According to Razzaque and Rafiquzzaman (2007:64), Bangladesh has three major rice growing seasons, namely Aus, Aman, and Boro. The growing period for Aus, Aman, and Boro rice varieties ranges from mid-March to mid-August, mid-June to November, and mid-December to mid-June, respectively. While Aus rice varieties are dwarf,

Moreover, Kirsten et al. (1998) demonstrated that South Africa has relatively more comparative advantage in inland wheat than irrigated wheat. Also, by using the DRC and SCB, Liefert (2002) revealed that Russia has a relatively higher comparative advantage in agricultural input industries than in agricultural production industries. With regard to the RCA measure, Coxhead (2007) revealed that poor Southeast Asian nations lost their comparative advantage in labour-intensive industries, and gained a comparative advantage in natural resource industries as a result of China's economic prosperity. On the other hand, using the PAM, Yao (1997) demonstrated that Thailand's government intervention in promoting crop diversification may create welfare inefficiencies because it has more comparative advantage to produce rice than other alternative crops.

Among other studies that used one or a combination of these methods to measure comparative advantage are Ferto and Hubbard (2003), Mucavele (2000), Jooste and Van Zyl (1999), Kannapiran and Fleming (1999), Murphy (1989), and Estudillo, Fujimura and Hossain (1999). The following subsections illustrate how these measures are estimated.

4.2.1 Net social profitability[27]

This approach entails measuring and comparing the opportunity cost of producing and marketing an incremental unit of a commodity to the border price (Gonzales, Kasryno, Perez and Rosegrant, 1993:40). This comparison allows for the determination of whether the production system has (or does not have) comparative advantage.

Net social profitability can be expressed as the following formula:

$$NSP = \left(P_i^b - \sum a_{ij} P_j^s - \sum b_{ik} P_k^s\right) * Y_i \qquad (4\text{-}1)$$

Source: Gonzales, et al., (1993:41)

Where P_i^b is the import/export parity price for the output i; a_{ij} is the quantity of the tradable input j^{th} used in the production of one unit of i; P_j^s is the import/export parity price for the tradable input j^{th}; b_{ik} is the quantity of the non-tradable input k^{th} used in the production of one unit

thermosensitive, favorable under summer conditions, higher yielding, and of relatively poor quality; Aman rice varieties are photoperiod sensitive, higher yielding, and of good quality (Parsons, Newbury, Jackson, and Ford-Lloyd, 1999:588).

[27] 'Net social profitability' is also known as 'net economic profitability'.

of i; P_k^S is the shadow (social) price for the non-tradable input k^{th}; and Y_i is the per hectare yield of the output i.

An $NSP>1$ implies that the production system has comparative advantage, since the border price outweighs the opportunity cost of producing i. On the other hand, an $NSP < 1$ is an indicator of comparative disadvantage, since the border price is less than the opportunity cost of producing i.

One of the important disadvantages of the NSP approach is that it generates an absolute value, expressed in unit measures such as \$/ha, \$/ton, etc. (Masters & Winter-Nelson, 1995:244). This absolute value makes it difficult to compare production systems with different unit measures (Masters & Winter-Nelson, 1995:244).

4.2.2 Domestic resource cost (DRC)

The DRC measures the "opportunity cost of producing or saving foreign exchange" (Bruno, 1972:16). It is the ratio of total domestic factor social costs over the value added in tradable goods (inputs and outputs) (Bruno, 1972:16).

The DRC ratio is expressed as the following formula:

$$DRC_i = \frac{\sum_r N_r X_{ri}}{P_i Q_i - \sum_j R_j Q_{ji}} \qquad (4\text{-}2)$$

Source: Hassan and Faki (1993:7)

Where i is the product of the system under analysis, N is the opportunity cost of the domestic factor r, X_{ri} is the quantity of domestic factor r used in the production of i, P_i is the import/export parity price for the tradable product i, Q_i is the quantity of the output, Rj is the import/export parity for the tradable input j, while Q_{ji} stands for the quantity of the tradable input j used to produce the product i.

For a production system to have comparative advantage, two requirements need to be fulfilled. First, the production system must earn foreign exchange. To achieve this, the foreign exchange cost of all tradable inputs used must be less than the foreign exchange value of all produced tradable outputs. From the formula (4-2), above, this occurs when the denominator is positive. In other words, $P_i Q_i - \sum_j R_j Q_{ji} > 0$.

Second, the foreign exchange earned must outweigh the opportunity cost of domestic factors used. It should be noted that there are two ways of calculating the ratio. The first is in local currency; in this case the interpretation of DRC depends on its absolute value relative to 1. The

second is to express the numerator in local currency and the denominator in foreign currency; in this case the interpretation of DRC depends on its absolute value relative to the effective or parallel exchange rate (*e)*. In other words:

- If the $0 < DRC_i < 1$ or $DRC_i < e$, it implies that the use of domestic factors in the production of the product *i* save foreign currency. In other words, the production system has a comparative advantage, since less domestic currency is spent to produce *i* than would be spent if the product was imported.
- If the $DRC_i > 1$ or $DRC_i > e$, it indicates that the country would spend more local currency to produce *i* than would be spent if *i* was imported. Thus, the production system under analysis has a comparative disadvantage.

One of the disadvantages of the DRC indicator is that it overstates the profitability of production systems with significant uses of tradable inputs (Masters & Winter-Nelson, 1995:244).

4.2.3 Social cost benefit (SCB) ratio

The social cost benefit ratio is another alternative measure of comparative advantage. The SCB is obtained by subtracting the ratio of the net social profit over social farm revenue from 1. This ratio is expressed as the following formula:

$$SCB = 1 - \frac{NSP\ (Q_i)}{P_i Q_i} \qquad (4\text{-}3)$$

Source: Masters and Winter-Nelson (1995:245)

Where Q_i is the quantity of output for commodity *i*, P_i is the unit social opportunity cost for the output (which is the import/export parity price in the case of tradable output), and $NSP\ (Q_i)$ is the production system's net social (economic) profit, as defined in Equation (4-1).

If the absolute value of the SCB falls between 0 and 1, this is an indication of comparative advantage, while an SCB value of greater than 1 indicates that the production system has no comparative advantage (Masters & Winter-Nelson, 1995:245).

Contrary to the NSP, the DRC and SCB ratios can be used to compare different production systems whose budgets are expressed in different unit measures. Moreover, with the SCB ratio, one can overcome the likely modelling errors that may derive from the separation of tradable and non-tradable components within the input costs, as is the case for the DRC ratio (Masters & Winter-Nelson, 1995:245).

4.2.4 Revealed comparative advantage (RCA)

Since it would be otherwise difficult (if not impossible) to get autarky price data to measure comparative advantage, the RCA uses realized trade flow as a reflection of comparative advantage (Balassa, 1977:327). The RCA export ratio is expressed as the following formula:

$$RCA_{ij} = \frac{x_{ij}}{X_i} / \frac{x_{wj}}{X_w} \qquad (4\text{-}4)$$

Source: Adapted from Bowen (1983:465); Yeats (1985:61)

Here the subscripts *i* and *j* represent the product and country under analysis respectively. The subscript *w* stands for the world. x_{ij} represents country *j's* exports value of product *i*, and x_{wj} for the world's total exports of product *i*. On the other hand, X_j stands for country *j*'s total exports, and X_w for the world's total exports.

An RCA_{ij} of less than 1 implies that country *i* has a revealed comparative disadvantage in product *j*, while an RCA_{ij} of greater than 1 is an indicator of revealed comparative advantage.

4.2.5 Policy Analysis Matrix (PAM)

The PAM is an accounting matrix, constructed using enterprise budget data. Through a comparison of private and social values, the PAM generates six indicators of comparative advantage, economic efficiency, and the level of market distortions in inputs and output markets.

Given its multipurpose uses, it has been used extensively in the trade literature to determine comparative advantage in developing countries. For instance, Khai and Yabe (2013:161) used the PAM to measure the comparative advantage of soybean production in Vietnam; Mahlanza, Mendes and Vink (2003), for the comparative advantage of wheat production in the Western Cape, South Africa; and Finkelshtain, Kachel and Rubin (2011), for studying the competitiveness and agricultural trade of Israeli agriculture. Moreover, Basavaraj et al. (2013:31) used the PAM to assess the competitiveness of sweet sorghum for ethanol production in India; Fang and Beghin, (2000), for studying food self-sufficiency, comparative advantage and agricultural trade in Chinese agriculture; and Kydd, Pearce and Stockbridge (1997:323), for an economic analysis of the commodity systems, by extending the Policy Analysis Matrix to account for environmental effects and transaction costs.

The PAM derives its strengths from its ability to perform a detailed level of disaggregation and to reveal various policy-induced effects on the economic efficiency of a production system (Basavaraj, Rao, Achoth & Reddy, 2013:34). However, its major weakness is that it is a static[28] model. This weakness is overcome by doing a sensitivity analysis, in which key drivers of comparative advantage are changed to determine to what extent comparative advantage is sensitive to each key driver (Mohanty, Fang & Chaudhary, 2003:68; Kirsten et al., 1998:535).

As mentioned in chapter one, this study is constructed under two fundamental hypotheses. Firstly, since Rwanda is endowed with abundant marshland with a high potential for rice production and a relatively higher rice yield than the global rice yield, Rwanda has a comparative advantage in rice. Secondly, market distortions within input and output markets result in a loss in Rwanda's competitive position within domestic and regional rice markets.

To test these hypotheses, this study addresses two main objectives: firstly, to determine empirically Rwanda's comparative advantage in rice production, and secondly, to identify areas of inefficiencies within the rice subsector. To achieve these objectives, the PAM method was chosen and used because it measures both comparative advantage and the level of market distortions. Additionally, the PAM generates the NEP and DRC ratio indicators, which were illustrated in section 4.2, as alternative measures of comparative advantage. To overcome the static weakness nature of the PAM, a sensitivity analysis is conducted.

The next section explains in detail the PAM model, and illustrates variable estimates required to model the PAM.

4.3 Research methodology

The Policy Analysis Matrix (PAM) is a computational framework developed by Monke and Pearson (1989). It is used in policy analysis to assess the impact of policies on the competitiveness and economic efficiency of farm production systems. According to Monke and Pearson (1989:10), the PAM is primarily used to address:

- the extent to which government policies affect farm profitability or competitiveness,
- the likely impact of planned public investment on the economic efficiency or comparative advantage of a production system,

[28] Measures comparative advantage at one point in time

- the impact of research policies on technological change.

For the purposes of this study, the PAM is used to determine the comparative advantage position of Rwanda in rice, and the impacts of government policies on the competitiveness of the rice subsector.

4.3.1 Data description and collection methods

The data that were required for modelling the PAM were rice yields, input requirements, farm gate prices for inputs and outputs, international world prices for tradable inputs and outputs, transportation and marketing costs, insurance costs, the exchange rate, taxes, and subsidies. The data on yields, input requirements, and farm gate private prices were primary data collected by means of a farm survey. This survey was conducted in August 2014, in the Eastern Province of Rwanda.

Though the study aimed at studying rice production in all 40 rice farmers' cooperatives operating in the Eastern Province of Rwanda, only 31 (77.5 %) farmers' rice cooperatives were included in the analysis[29]. These cooperatives are located within the seven administrative districts of the Eastern Province, and they produce rice on a total area of 4 194.24 hectares. In each of the cooperatives, the cooperative's agronomist and five key informant farmers were consulted through a focus group interview. These interviews were conducted by means of a questionnaire. The respondents were requested to interactively identify production and cost data for an assumed representative (typical) farm in their cooperative (see Appendix A for the farm survey questionnaire).

Freight on board international export prices, given as FOB, for the major rice exporter to Rwanda and globally were used as estimates of the social price of rice. These prices were obtained from the online Food and Agriculture Organization (FAO) database.[30] The transportation, insurance, and other costs incurred for the transportation of rice from exporting countries[31] to Rwanda were gathered from the transportation company Bolloré Africa Logistics and informal interviews with commodity traders. The market exchange rate that was used to convert these prices from foreign

[29] This incomplete coverage was due to the unavailability of the cooperatives' management and the time constraint of the field work period.
[30] http://www.fao.org/economic/est/publications/rice-publications/the-fao-rice-price-update/en/.
[31] Where the FOB prices are recorded.

currency to domestic currency was obtained from the National Bank of Rwanda's online database[32].

The domestic transportation and marketing costs needed to be adjusted for these world prices to be comparable with farm gate prices. These include handling and storage costs at Rwanda Bonded Warehouses[33], which were collected by means of an informal interview with an employee at this company. The domestic transportation and other marketing costs incurred along the chain were obtained through informal interviews with a selection of domestic truck drivers, milling plant personnel, as well as through a farm survey.

The direct transfer payments (i.e. taxes, subsidies, and import tariffs) needed to adjust the private prices of tradable inputs to their respective social values were sourced from the Rwanda Revenue Authority (RRA) and Market Access Map[34], specifically applied taxes and tariff rates. The data on applied direct subsidies were gathered with a farm survey.

Table 4-1, below, summarizes the main variables used for the purpose of this study. These are separated into two categories, namely quantity measures and price measures. The quantity measures consist of the determinants of the quantities (weights and volumes) of all the inputs and outputs of a production system. The price measures consist of the determinants of the private and social farm gate prices for all the inputs and outputs of the rice production system.

[32] http://www.bnr.rw/
[33] The debarkation point of imported goods, prior to and during the customs clearance process. This institution is known as 'Magasin Généraux du Rwanda' (MAGERWA).
[34] http://www.macmap.org/.

Table 4-1: Research variables

Domain	Category	Variable Name	Variable definition
Determinants of private and social farm expenses	Quantity measures	Qty_TradFixedInput__i	Quantity of 'tradable fixed input i' used
		Qty_NonTradFixedInput__i	Quantity of 'Non-tradable fixed input i' used
		ShareRiceUse_TradFixedInput_i_%	Share (%) of rice production in the total use of the tradable fixed input i
		ShareRiceUse_NonTradFixedInput_i_%	Share (%) of rice production in the total use of the non-tradable fixed input i
		UsefulLife_TradFixedInput_i	The useful life of the tradable fixed input i
		UsefulLife_NonTradFixedInput_i	The useful life of the non-tradable fixed input i,
		Qty_TradIntermInput_j	Quantity of 'tradable intermediate input j' used
		Qty_NonTradIntermInput_j	Quantity of 'non-tradable intermediate input j' used
		Qty_ExtLabour	Quantity of external (paid) labour used,
		Qty_FamLabour	Quantity of family labour used,
	Price measures	PFGP_TradFixedInput__i	Private farm gate price for the tradable fixed input i
		IPP_TradFixedInput__i	Import parity price (IPP), comparable at farm level, for the tradable fixed input i
		PFGP_NonTradFixedInput__i	Private farm gate price for the non-tradable fixed input i
		OC_NonTradFixedInput__i	Opportunity cost for the non-tradable fixed input i
		PFGP_TradIntermInput_j	Private farm gate price for the tradable intermediate input j
		IPP_TradIntermInput__j	Import parity price, comparable at farm level, for the tradable intermediate input i
		PFGP_NonTradIntermInput__j	Private farm gate price for the non-tradable intermediate input j
		OC_NonTradIntermInput__j	Opportunity cost for the non-tradable intermediate input input j
		Wage_ExtLabour	Labour wage
		OC_ExtLabour	Opportunity cost of external labour
		OC_FamLabour	Opportunity cost of family labour
Determinants of private and social revenue	Quantity measure	Qty_PaddyRice	The most likely quantity of paddy rice harvested
	Price measures	PFGP_PaddyRice	Private farm gate price for paddy rice
		IPP_PaddyRice	Import parity price, comparable at farm level, for rice

Note, the letter *i* stands for fixed inputs such as land, machinery, tools, and other equipment, while the letter *j* represents intermediate inputs such as fertilizers, pesticides, seeds, etc.

4.3.2 Construction of the PAM

The PAM is structured as the product of two accounting identities. The first identity is *profitability*, which is defined as the difference between the revenues and costs[35] of a commodity production system. This profit measure is calculated in two ways: the first as private profit (D), i.e., using private market prices[36], and the second as social profit (H), i.e., using social prices[37].

[35] These cost data are disaggregated into two components: tradable inputs and domestic factors (non-tradable inputs).
[36] The private price is the actual market price that farmers or other actors along the chain pay/receive for the purchase/sale of the good or service.

The second identity of the PAM is *divergence*, which is the difference between private and social profit (L), revenue (I), and costs (J:K), as summarized in Table 4-2, below.

Table 4-2: Structure of a Policy Analysis Matrix

	PROFIT	REVENUE	COSTS	
			TRADABLE INPUTS	DOMESTIC FACTORS
Private prices	D = A-(B+C)	A = $\sum(P^p_x Q_x)$	B = $\sum(P^p_i Q_i)$	C = $\sum(P^p_j Q_j)$
Social prices	H = E-(F+G)	E = $\sum(P^s_x Q_x)$	F = $\sum(P^s_i Q_i)$	G = $\sum(P^s_j Q_j)$
DIVERGENCES	L = D-H	I =A-E	J = B – F	K = C - G

Source: Adapted from Monke and Pearson (1989:11-12); Mahlanza (2001:89)

In this table; Q_x is the quantity of rice produced, P^p_x is the private price of rice, P^s_x is the social price of rice, Q_i is the quantity of tradable input i^{th}, P^p_i is the private price of tradable input i^{th}, P^s_i is the social price of tradable input i^{th}, Q_j is the quantity of domestic factor j^{th}, P^p_j is the private price of domestic factor j^{th}, and P^s_j is the social price of domestic factor j.

4.3.2.1 Definition of the PAM parameters

***Private profitability*:** The first row of the PAM measures private profit (D), which is obtained by deducting private costs (B+C) from private revenues (A) (see Table 4-2). This private profit is based on the actual (observed) market prices received by farmers and paid by farmers, as well as other actors along the chain (Monke & Pearson, 1989:12). Therefore, it is an indicator of the competitiveness of the farm system, given the prevailing technology, market prices, and government policies (Monke & Pearson, 1989:12; Shapiro & Staal, 1995: 77).

If private profit is negative (D<0), it implies that the system is unprofitable for private producers as it is associated with a negative rate of return (Monke & Pearson, 1989:12). On the other hand, a positive private profit (D>0) implies that the system under analysis is profitable for private farmers, as it is earning a positive rate of return. The latter system is expected to expand, unless it is constrained by the available farm land, or if there are other crop production systems that are more profitable (Monke & Pearson, 1989:12-13).

[37] The social (accounting, economic, efficient, or shadow) price is the price that reflects the opportunity cost of a resource to society (the nation). Little and Mirrlees (1974:68) describe this price as "a relative measure that shows the rate at which real goods and services can be exchanged for each other". The social prices are more accurate when estimating the social benefits and costs of a project for the nation, because market prices are often distorted (UNIDO & IDCAS, 1986:21). Lanfranco, Ferraro and Rava (2014:4), and Touré, Groenewald, Seck and Diagne (2013:71) highlight that while social prices reflect the scarcity or best alternative use of the resources under consideration (technical efficiency), market prices reflect market failure and/or policy induced transfers.

Social profitability[38]: The second row of the PAM measures social profit (H), using social prices. The social valuation of goods and services is relatively more complicated than the private valuation. While the latter is based on observable market (private) prices, the former is based on prices that would exist if markets were competitive and free. When social profit is positive (H>0), it is an indicator that the production system has comparative advantage and that the system is economically efficient (Basavaraj et al., 2003:33; Mohanty et al., 2003:67). On the other hand, a negative social profit (H<0) implies that the system has no comparative advantage and that it is economically inefficient[39].

According to Gittinger (1982:251) and Squire and Van der Tak (1975:19), when adjusting private values to social values, the first step entails eliminating direct transfer payments from private values. These direct transfer payments are defined by Gittinger (1982:251) as "payments that do not represent the use of real resources, but only the transfer of claims from one person in the society to another"[40]. The second step entails adjusting private values for price distortions. In this case different steps are followed depending on whether the good or service under consideration is traded, non-traded (domestic factor) or semi-traded.

Below follows a brief discussion on the social valuation of tradable goods (i.e. agricultural commodities, fertilizers, seeds, pesticides, etc.) [41], non-tradable goods (i.e. bulky goods, highly perishable goods, labour, capital, land, electricity, water, marketing and legal activities, etc.)[42], as well as an adjustment of the foreign exchange rate from market distortions.

---

[38] UNIDO and IDCAS (1986:52) use the term 'commercial profitability' and 'national profitability' to reflect respectively private profitability and social profitability. According to UNIDO and IDCAS, (1986:52), while commercial profit is measured in monetary terms (based on market prices), national profitability is measured in real terms (adjusted market prices to reflect social prices), hence representing the real contribution of the project to national welfare (UNIDO and IDCAS, 1986:52).

[39] It should be noted that production systems with comparative disadvantage can only specialize through government support, such as subsidies and import tariffs (Mahlanza, 2001:90). However, protective government policies reduce social welfare due to the inefficient allocation of resources. Shapiro and Staal (1995:78) argue that social profit is an indicator of the long run viability of a production system, especially when government policy interventions are not sustainable.

[40] These payments include taxes, direct subsidies, interest payments, etc.

[41] A good is tradable if its domestic production costs are less than its FOB export price, hence it is exported; or if its domestic costs of production are greater than its CIF price; hence it is imported (Gittinger 1982:251).

[42] A product is qualified as non-tradable if the domestic cost of its production is greater than its FOB export price and less than its CIF price. (Gittinger 1982:251-253; Monke, Pearson 1989:78).

Determination of social prices for tradable goods

For tradable goods, whether they are domestically produced or imported, the corresponding world prices are used as proxies to reflect their social prices (Monke & Pearson 1989:68; Shapiro & Stall 1995:78). Little and Mirrlees (1974:68) argue that as long as the production of a good affects its exportation/importation, its border price should be used in place of its accounting (social) price, because the border price reflects the real opportunity cost/benefit of its production or use. These world prices are the cost insurance freight (CIF) and free on board (FOB) prices for imported and exported goods/services respectively (Mohanty et al., 2003:69; Monke & Pearson, 1989:13; Squire & Van der Tak, 1975:31-32).

The world prices are then adjusted to allow for the transportation and marketing costs between the point of import/export and the farm gate to be comparable at the farm level (Mohanty et al., 2003:69; Monke & Pearson, 1989:13). No import duties or other taxes should be added to these border prices (Squire & Van der Tak, 1975:32). However, Monke and Pearson (1989:138) pointed out that when there is a lack of information on world prices, but information is available on policy transfers, one can estimate social prices for tradable goods by removing the effects of policy transfers from their domestic market prices.

In this study, the social price for paddy rice is estimated by adjusting the international FOB rice export price from the primary exporter (Pakistan) of rice to Rwanda, with transport and marketing costs to be comparable at each marshland, for each cooperative.[43] The social prices for tradable inputs are estimated by eliminating direct transfer payment subsidies, value added tax (VAT), and import tariffs from their respective private values.

Table 4-3, below, summarizes the weighted average social IPP comparable at farm level across all the cooperatives under the scope of the study.[44] The weighted average social IPP, comparable at the farm gate, was USD 252.82/MT in 2014. This IPP is 23.63 % lower than the estimated prevailing farm gate price of USD 331.04/MT.

[43] Refer to Appendix B for the domestic marketing costs along each cooperative's rice value chain

[44] Transport and marketing costs along each cooperative's rice value chain were weighted based on the share of each cooperative in total paddy rice produced by all sampled cooperatives, during agricultural season 2014A, as specified in Appendix C. The price margins between farms and milling plants gates were used as a proxy for representing all transportation and marketing (processing, packaging, etc.) costs incurred between these two stages.

Table 4-3: Estimation of the social import parity price for rice comparable at farm gate

Stage/Steps	Amount
FOB Pakistan rice (25 % broken) (USD/MT)	392.00
+ Freight cost. Karachi port to Kigali/Rwanda[45] (USD/MT), 18 MT container	175.00
+ Insurance cost (0.5 % of CIF)	2.85
CIF at Kigali/Rwanda Bonded Warehouses (MAGERWA) (USD/MT)	569.85
* Official exchange rate (Frw/USD)	684.42
CIF at Rwanda Bonded Warehouses (Frw/MT)	390016.22
+ Handling cost (Unloading, reloading, etc.) (Frw/MT), 10 Frw/kg	10000.00
+ Parking fees (Frw/ton), 18 ton container, Frw 10 000 lump sum	555.56
+ Storage cost (Frw/ton), 1 Frw/day (the first 3 days are free of charge)[46]	2000.00
IPP at Rwanda Bonded Warehouses' exit gate (Frw/MT)	402571.78
+ Transport cost to rice wholesale market (Frw/ton), 15 ton container	16883.24
IPP at wholesale market (Frw/MT)	419455
- Transport cost milling plant to wholesale market (Frw/MT)	3787.3
- Loading cost (Frw/MT)	2000
IPP at milling plant gate, (Frw/MT)	413667.7
* Conversion factor (Paddy rice to Milled rice)	0.65
IPP (Paddy rice equivalent) at milling plant gate, (Frw/MT)	268884
Price margin between farm and milling plant gate[47]	55%
/ (1+Marketing margin)	
IPP at farm gate level (Frw/MT)	172991.84
IPP at farm gate level (USD/MT)	252.82

Source: Compiled based on author's farm survey findings; Bahati (2014); BNR (2014b); Bolloré Africa logistics (2014); Bwimba (2014); Fao Rice Price Update (2014); Murangira (2014); CORIMI (2014); Mukaparadi (2014); Itegeri (2014); Mutsindashyaka (2014); Ndayizeye (2014); Basabira (2014); Nkubiri (2014); Seyanga (2014)

If the 52.4% rice import tariff[48], which was prevalent in 2014, could have been included in the estimation of the IPP; this IPP could have been USD 348.82/MT (See IPP estimation in Appendix D). This IPP would be 5.4% higher than the survey's estimated private farm gate price.

The social prices of farming tools (excluding the winnower and basket) were obtained by eliminating direct transfer payments of a 10 % import tariff and 18% VAT from their domestic market prices. The private prices for the fertilizers NPK and UREA were also adjusted to social prices by eliminating the Frw 105/kg (USD 0.15/kg) direct price subsidy received by famers in

[45] The distance between Karachi port to Rwanda Bonded warehouses is estimated at 4453.58 km (2404.7 nautical miles) from Karachi port to Mombasa/Kenya port using the sea way, and then 1435 km from Mombasa port to Kigali, using road (Google Map, 2014; Sea Distances, 2015).

[46] We assumed an arbitrary 5 days for imported rice stored in Rwanda Bonded Warehouses, during commodity customs declaration.

[47] The average paddy rice farm gate price and milled rice price (at milling plant gate) were estimated respectively at Frw 226.6/kg (USD 0.33/Kg) and Frw 541.13/kg (USD 0.79/Kg). The paddy rice to milled rice conversion factor is 0.65.

[48] Due the EAC Common External Tariff, all import tariffs are applied on the CIF of goods valued at the first point of entry in the EAC region; which is usually Mombasa/Kenya port for goods that are imported by Rwanda.

30 cooperatives.[49] On the other hand, the market prices for pesticides and seeds were used without any adjustment in the social analysis without any adjustment, since they were exempted of taxes and subsidies.

Determination of social prices for domestic factors (non-tradable goods)

Domestic factors do not have corresponding world prices, because they are traded domestically, and are therefore assumed to be immobile across borders (Monke & Pearson, 1989:84). According to Gittinger (1982:254), if the domestic market for a non-tradable good is thought to be relatively competitive, its market price will reflect its marginal cost (opportunity cost). In this case, the market price can be used in social analysis.

However, if there are distortions in the factor markets, the factor market price will have to be adjusted for price distortions. The social price (opportunity cost) will be estimated as the income forgone by not allocating the domestic factor in the next best alternative use. In this study, there are two main domestic factors used in rice production in Rwanda, namely unskilled labour and land.

- **Unskilled labour social valuation**

The social value (opportunity cost) of labour is measured as the marginal product of labour forgone elsewhere by using this labour in the project under consideration (Squire & Van der Tak, 1975:29). According to Gittinger (1982:258), where labour markets are perfectly competitive, the market wage is a good indicator of the marginal product of labour. When demand is high, during peak seasons (i.e. planting and harvesting periods), the labour wage rate is a good indicator of the opportunity cost of labour, since the labour market structure is competitive (Gittinger, 1982:258).

However, during off-peak seasons, when labour supply is high, the marginal product of labour is close to zero, zero or negative[50] (Gittinger, 1982:258-259, Lewis, 1994:60). Though the market wage would naturally reflect this low marginal product, the former is often artificially kept higher due to social pressure and other traditional practices of paying an acceptable wage (Gittinger, 1982:258-259; Weckstein, 1972:484). Therefore, the labour market wage, during off-peak

[49] For farming tools, social prices were obtained by multiplying the market price for each tool with the reciprocal of 1 plus the summation of the tariff and VAT rates expressed in decimal terms; and for fertilizers, social prices were obtained by summing up the Frw 105 (USD 0.15) to the price of 1 Kg of each subsidized fertilizer.

[50] Due to higher unemployment prevailing during slack seasons, if one labourer within the community were to be taken away to be used in a new project, the output forgone would be little or nothing.

seasons, is not a good indicator of the opportunity cost of labour used in off-peak seasons; hence, it needs to be adjusted to reflect the opportunity cost of labour.

Therefore, the social price of labour is estimated as the weighted average of the peak-season wage and the off-peak-season wage. This approach is recommended by Yao (1993, cited by the Office of the Sustainable Development Bureau for Africa,1999:11).

In this study, the average hourly off-peak-season wage, of Frw 83.16 (USD 0.12), was less than the average hourly peak-season wage[51], of Frw 139.23 (USD 0.20), and even less than the minimum wage, of Frw 100 (USD 0.15) per hour, as specified in the 1973 Rwandan labour law.[52] In short, the market wage was adjusting to market conditions. However, since the market wage is assumed to be higher than the marginal product of labour during off-peak seasons, in this study, it is assumed that the social price of labour during slack seasons was 75% of the prevailing labour wage. This proportion is higher than the 50 % assumed by the Office of the Sustainable Development Bureau for Africa (1999); Dunmola, Omobowale and Iyabo (2015); Ogbe, Okoluwa and Saka (2011); and Nguyen and Heidhues (2004).

Briefly, the social price (shadow wage) of labour is estimated using the formula:

$$SP_L = \frac{W_P + 0.75\, W_o}{2} \qquad (4\text{-}5)$$

Source: Adapted from the Office of the Sustainable Development Bureau for Africa (1999:11 cited Yao, 1993)

Where SP_L is the social price of labour, W_P is the peak-season labour wage and W_0 is the off-peak-season labour wage.

The shadow wage was consequently estimated at Frw 100.8 (USD 0.15), and was used to valuate hired and family labor used. It should be noted that during sensitivity analysis, the market wage is

[51] The hourly market labour wage during the peak season was estimated as the weighted average of the ratio of the total remuneration of hired labour over total quantity of hired labour used during farming activities that take place during the general period of planting and harvesting. The activities that take place during the general period of planting are land preparation, seedbed preparation, seedbed follow-up, ploughing and puddling, transplanting and planting, and applying NPK fertilizer. The activities that take place during the general period of harvesting are harvesting, transporting the rice panicles to drying facilities, threshing, winnowing and packaging. Likewise, the hourly market wage during the off-peak season was estimated in the same way, except for the farming activities, first weeding, first Urea fertilizer application, first pesticide application, second weeding, second Urea application, second pesticide application, third weeding, third pesticide application, fourth weeding, water channelling and bird scaring.

[52] Refer to *The New Times Rwanda* (2015) for the minimum labour wage

also used as a proxy for the social value of unskilled labor to assess what could have been the results if the labor wage was not distorted.

- **Land social valuation**

The social valuation of land consists of estimating the opportunity of using land, which depends on available alternative uses of land (Ahmed, 1983:73). Gittinger (1983:256) defines this opportunity cost as the "the value of production forgone when the use of the land is changed from its without-project use to its with-project use".

The opportunity cost of land is mostly estimated as the net return to land, computed based on the net profitability of the best alternative crop (or competing crops)[53]. It is also estimated as the amount that other land users, besides those in the production system under analysis, are willing to pay for the land (Little & Mirrlees, 1974:222-223). Furthermore, where the land rental market is thought to be competitive, the land rental value can be used as a proxy of the social value of land (Gittinger 1982:257).

Due to enforced government regulations, rice is the only crop produced in marshlands, by the cooperatives. However, in 2002 (before the issuing of the Rwandan land policy that transferred marshland ownership from individuals to the state), a rice marketing survey conducted in Rwanda by Jagwe et al. (2003:20) estimated the marshland rental per season at Frw 12500/ha (USD 18.26/ha). This rental value is assumed to reflect the opportunity cost of land during that time. It is consequently compounded with a 10.71% interest rate[54] to derive its equivalent in 2014.

The following forward price formula is therefore used to estimate the future value of the 2002 marshland rental:

$$F_o = S_o e^{rT} \qquad (4\text{-}6)$$

Source: Hull (2002:46)

[53] Some of the studies that have used this approach are Mohanty, Fang and Chaudhary (2003:69); Yao (1997:215); Fang and Beghin, (2000). This net return to land can be estimated by subtracting all farm production costs (external labour and family labour allowances as well as capital interest included) from the value of the farm output, all valued at market prices (Gittinger, 1982:258)

[54] The 2014 Rwandan discount rate, as specified in BNR (2015), was used for compounding purposes.

Where F_o is the forward marshland rental value for 2014; S_o is the marshland rental value in 2002; e is the exponential function; r is the risk free interest rate; and T is the elapsed time, in years, between 2002 and 2014.

The land social value was, consequently, Frw 50290.27/ha (USD 73.48/ha). It is 137.9 % higher than the estimated average actual rental value paid by farmers to the local government. This estimated value is used as a proxy for the social value of marshland for the year 2014, and generalized for the Eastern Province of Rwanda.

- **Other domestic factors**

The market prices for the non-tradable inputs winnower and basket were assumed to reflect their respective social opportunity costs; hence they were used in social analysis. Furthermore, though in few (three) cooperatives, where compost is used, farmers use their own manure produced, in the social analysis, compost was valued at the market price at which users other than rice farmers purchased compost. The market price of compost was Frw 20/kg (USD 0.03/kg), at the time of the survey, and was also assumed to reflect the opportunity cost of compost

Social valuation of semi tradable inputs

Intermediate inputs that were identified in this study include farmers' contributions to cooperatives for paying for different services received from the cooperative. The private value of these services was used in the social analysis without any adjustment.

Adjusting private values for distortions in the foreign exchange market

According to Gittinger (1982:247), due to distorting trade policies, such as import tariffs and export subsidies, there is a premium paid on tradable goods over non-tradable goods. This premium causes tradable goods to appear relatively cheaper and domestic goods/services relatively more expensive. It reflects the additional amount domestic consumers are willing to pay to acquire one additional unit of tradable goods (Gittinger, 1982:247). When the prices of non-tradable goods are converted to domestic currency, using the prevailing foreign exchange rate, this premium is not properly reflected.

Gittinger (1982:247) states that there are two important approaches that are used to adjust the foreign exchange rate from the foreign exchange premium[55]. The first approach is to generate the shadow exchange rate (SER), which is estimated by multiplying the official foreign exchange rate (OER) by 1 plus the foreign exchange premium (FEP). This SER is then used to convert the price of tradable goods to domestic currency, in place of the OER. The following equation (4-7) shows how the SER is estimated:

$$SER = OER * (1 + FEP) \qquad (4\text{-}7)$$

Adapted from Gittinger (1982:249) and Squire and Van der Tak (1975:93)

The second approach, which is used in the present study[56], consists of using a standard conversion factor (SCF). The conversion factor approach entails "reducing the domestic currency value of non-tradable items by an amount sufficient to reflect the premium" (Gittinger, 1982:247). In a social analysis, the SCF is used to adjust the private cost of each domestic factor (non-tradable input) in order to eliminate the effect of distortions in the foreign exchange market (Gittinger, 1982:248).

According to Squire and Van der Tak (1975:35), in some cases, a conversion factor is estimated for each group of related non-tradable goods, and in other cases, one conversion factor is used for all non-tradable goods. The SCF is estimated as the ratio of the exports and imports value, expressed in border prices, to their respective value, expressed in domestic currency (Squire & Van der Tak, 1975:93). It can also be estimated as the reciprocal of 1 plus the foreign exchange premium rate (expressed in decimal terms) (Gittinger, 1982:249). Equation (4-8) illustrates how the SCF is estimated:

$$SCF = \frac{1}{1+FEP} \qquad SCF = \frac{OER}{SER} \qquad (4\text{-}8)$$

Adapted from Gittinger (1982:249) and Squire and Van der Tak (1975:93)

The foreign exchange premium (FEP) for Rwanda was estimated by Kuo, Salci and Jenkins (2014:281) at 5.37 %. In other words, the shadow exchange rate for Rwanda is 5.37 % higher than the market exchange rate. Consequently, based on this exchange rate premium, in social

[55] Kuo, Salci and Jenkins (2014:269) define the foreign exchange premium as the "proportion by which the economic value of the foreign exchange exceeds the market exchange rate of that country" (Kuo, Salci & Jenkins, 2014:269).

[56] The results may not have been reliable if the SER approach was used, because tradable input social prices were estimated indirectly based on their respective domestic prices, and not directly based on corresponding world prices.

analysis, private values were adjusted from distortions in the foreign exchange market by multiplying the cost of each domestic factor (non-tradable input) by a standard conversion factor (SCF) of 0.949.

Net transfers (divergences): The second identity of the PAM matrix (the third row of the PAM) measures net policy transfers (L), which are obtained by deducting social profit (H) from private profit (D). Here, (L) is a measure of the extent to which distorting policies and market failures affect the production system's efficiency (Monke & Pearson, 1989:14). If social profit diverges from private profit, it suggests that resources are used inefficiently.

A positive net policy transfer (L > 0) indicates that the system is positively protected, as there are incentives that are provided for the production of the commodity. On the other hand, a negative net transfer implies that there are disincentives that restrain producers from producing that specific commodity.

Besides the private, social, and divergence estimates, the PAM generates additional ratio indicators of competitiveness, comparative advantage, and efficiency, as highlighted in Monke and Pearson (1989:16-18); Basavaraj et al. (2013:34); Ellis (1992:57-59); Khai and Yabe (2013:164-165); and Stoforos, Kavcic, Erjavec and Mergos (2000:94-96). These ratio indicators are the:

- Private cost ratio (PCR), where PCR = C/(A-B), which is an indicator of competitiveness,
- Domestic resource cost ratio (DRC), where DRC = G/(E-F), which is an indicator of comparative advantage and economic efficiency,
- Effective protection coefficient (EPC), where EPC = (A-B)/(E-F), which is an indicator of inefficiencies within both tradable outputs and inputs markets,
- Nominal protection coefficient in outputs (NPCO), where NPCO = A/E, which is an indicator of inefficiencies within tradable output market,
- Nominal protection coefficient in tradable inputs (NPCI), where NPCI = B/F, which is an indicator of inefficiencies within tradable inputs markets,
- Subsidy ratio to producer (SRP), where SRP = L/E = (D-H)/E, which is also an indicator of the level of inefficiencies within the production system.

Below is a brief description of each ratio.

4.3.2.2 Definition of the PAM ratio indicators

The private cost ratio (PCR) is the ratio of domestic factor private costs (C) over the 'value added in private prices' (A-B)[57], or $PCR = C/(A - B)$. This indicator shows the ability of the system to pay for domestic factors and still remain competitive. It is an indicator of the viability of the system under prevailing market conditions and government intervention. A PCR>1 is an indicator of private loss or competitive disadvantage, while a PRC < 1 is an indicator of private profit or competitiveness.

The **domestic resource cost ratio (DRC)**, as discussed above, is the ratio of domestic factor social costs (G) over the value added in social prices (E-F)[58], or $DRC = G/(E - F)$. This ratio measures the economic efficiency or comparative advantage of the system. A DRC>1 is an indicator of economic inefficiency or comparative disadvantage, as it costs more in domestic currency to produce one unit of the commodity than to import it. A DRC<1 is an indicator of economic efficiency or comparative advantage. In short, production systems contribute to social welfare by generating social revenue that outweighs domestic factor social costs.

The **effective protection coefficient (EPC)** is the ratio of the value added in private prices (A-B) over the value added in social prices (E-F), *or* $EPC = (A - B)/(E - F)$. This ratio measures the degree of transfers as induced by both output and tradable input policies. An EPC>1 is an indicator that there are distorting policies, such as import tariffs, import quotas, and input subsidies, that create incentives for the production of that commodity. An EPC<1 is an indicator that there are distorting policies that increase the cost of tradable inputs, therefore creating disincentives for the production of the commodity.

The **nominal protection coefficient for tradable output (NPCO)** is the ratio of private revenue (A) over social revenue (E), ***or*** $NPCO = A/E$. This ratio measures prevailing incentives and disincentives for the production of the commodity, as induced by government policies in output markets. An NPCO > 1 implies that producers are positively protected through implicit subsidies, since the domestic price for the output is relatively higher than the corresponding parity price. On the other hand, an NPCO < 1 implies that there is an implicit tax on output that creates a disincentive for the production of the commodity.

[57] The value added in private prices is obtained by subtracting the total private costs for tradable inputs (F) from private revenue (E).
[58] The value added in social prices is obtained by subtracting tradable input social costs (F) from social revenue (E).

The **Nominal protection coefficient for tradable inputs (NPCI)** is the ratio of tradable input private costs (B) over tradable input social costs (F), *or* $NPCI = B/F$. This ratio measures prevailing incentives and disincentives for the production of a specific commodity, as induced by government policies in tradable input markets. A NPCI>1 implies that tradable inputs are taxed. In this case, the domestic prices for tradable inputs are relatively higher than corresponding parity prices. On the other hand, an NPCI<1 implies that tradable inputs are subsidized.

The **subsidy ratio to producers (SRP)**, or $SRP = L/E.$, is equal to net transfers (L) divided by social revenue (E). It is interpreted as the "proportion of total social revenues in world prices that would be required if a single subsidy or tax were substituted for the entire set of commodity and macroeconomic policies" (Monke & Pearson, 1989:18).

4.4 Summary

This chapter focuses on illustrating the methodology used to address the research questions. Among the various other measures of comparative advantage, as explained in section 4.2, the PAM is selected. Section 4.3 covers the research methodology used. In subsection 4.3.1, the scope of the study is given, among others, stating that there are 31 rice farmers' cooperatives operating in the Eastern Province of Rwanda. The data collection methods comprised a farm survey, informal interviews with different players within the rice subsector, and consultation of secondary sources of data. The last subsection (4.3.2) illustrates that the PAM uses farm budget data (revenue and expenditure), firstly expressed in private prices and secondly in social prices. Through a comparison of private and social values, the PAM generates different parameters, which are used to estimate different indicators of comparative advantage, competitiveness, and efficiency.

Chapter 5 Presentation and interpretation of the results

5.1 Introduction

In this chapter, the results of the study are presented and discussed. Section 5.2 sets out a descriptive analysis of the key variables used in the construction of the PAM.[59] Section 5.3 is about estimating how input costs were disaggregated into tradable and non-tradable components, while the last section (5.4) presents and interprets the PAMs results.

5.2 Descriptive analysis

5.2.1 Characteristics of farmers' cooperatives

This study conducted a survey on 31 rice farmers 'cooperatives, consisting of 22580 farmers, distributed across all the seven districts of the Eastern Province of Rwanda. These cooperatives cultivated rice on a total farming area of 4 187 ha.

Table 5-1: Total area cultivated disaggregated by cooperatives

Districts	Number of cooperatives	Farming Area (ha)	Number of farmers
Gatsibo	2	1280	5820
Nyagatare	4	812	2292
Kirehe	5	762	4925
Bugesera	9	616	4576
Ngoma	4	373	2944
Rwamagana	4	210	1107
Kayonza	3	135	916
Total area cultivated	**31**	**4187**	**22580**

In terms of kind distribution, the farming area per cooperative ranged from 8 ha to 900 ha, with an average of 135 ha per cooperative. It was distributed and used by farmers, members of these cooperatives. On average, each cooperative comprises 728 farmers (see Table 5-2).

[59] The data for these key variables, excluding for cooperatives characteristics (Section 5.2.1), were weighted based on the share of each cooperative in total paddy rice produced by all sampled cooperatives, during agricultural season 2014A, as specified in Appendix C.

Table 5-2: Farming area and cooperative membership

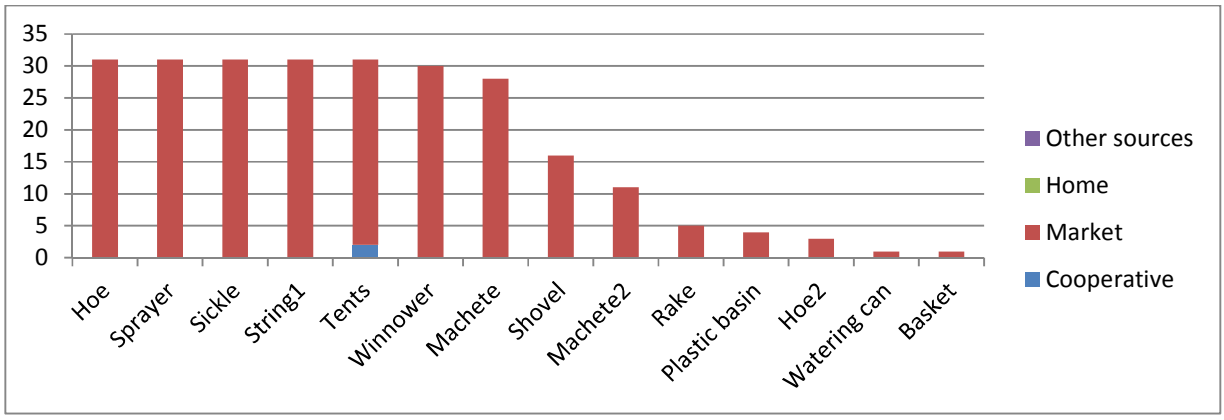
	N	Min	Max	Mean	SD
Farming area per cooperative (ha)	31	8	900	135	201
Number of farmers per cooperative	31	131	4300	728	873

5.2.2 Uses and expenditure on farm inputs

Based on the survey results, inputs used by farmers in the Eastern Province of Rwanda were identified. These inputs consisted of the non-tradable inputs such as land, labour, compost, and farming tools (winnower and basket[60]). Tradable inputs consisted of chemical fertilizers, pesticides, seeds, and all of the remaining farm tools, such as, hoe, sprayer, tents, machete, etc.

Land and farm equipment: The average land rental value paid by farmers to the local government was on average USD 30.9/ha each season. Farming equipment comprised of hand tools, because agriculture sector in Rwanda comprises mostly of small-scale farming that is labour-intensive and little mechanized. The common and most frequently used tools were the hand-held hoes, machetes, string, sprayers, sickles, tents, and winnowers. Farmers buy these tools mainly from local shops and markets (see Figure 5-1).

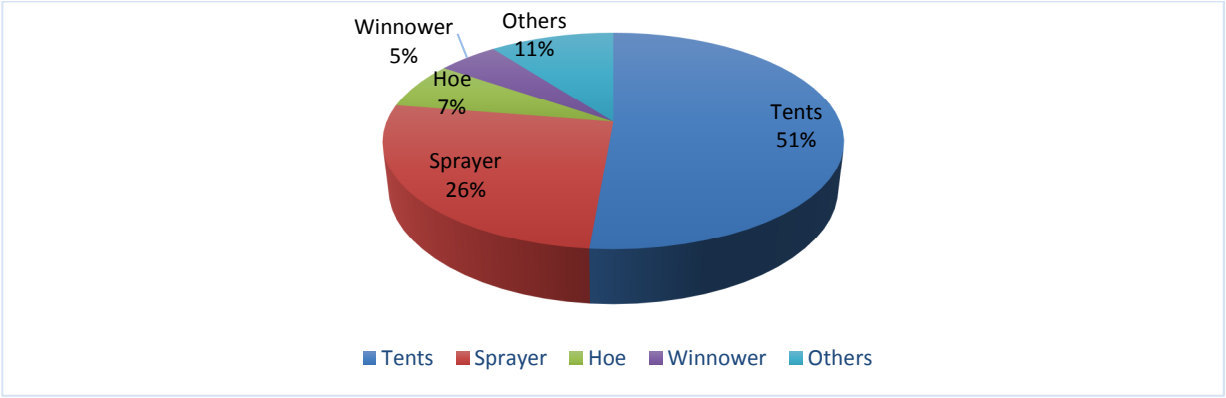
Figure 5-1: Equipment used by rice farmers and its market source



Given the prices at the farm gate, the useful life, and the extent to which each tool is used in rice farming; the tools were depreciated on average for each season of rice growing, by USD 113.9/ha. Of this amount, 51% was allocated to the tradable input tent, which is used in post-harvesting activities. Pesticide, sprayer, and hoe were ranked 2nd and 3rd with 26% and 7 %, respectively.

[60] Due to their bulkiness, winnower and basket are locally produced, and are rarely traded across borders.

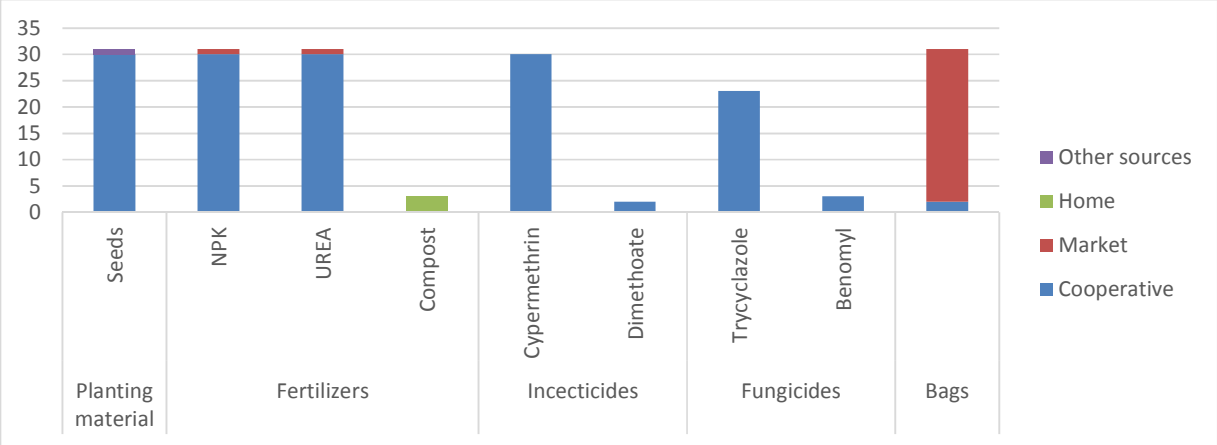
Figure 5-2: Average expenditure on farm equipment



Intermediate inputs: With regard to the use of intermediate inputs, all cooperatives used NPK and UREA (inorganic fertilizers). Organic fertilizer compost was used only in approximately 10% of the cooperatives[61] (see Figure 5-3). All cooperatives stated that they use insecticides. The most frequently used insecticide was Cypermethrin, which was used by 30 cooperatives. The second, Dimethoate, was used in only 2 cooperatives. Regarding uses of other intermediate inputs, 77.4 % of the cooperatives listed fungicides among the intermediate inputs used. The two aforementioned fungicides used were Trycyclazole (Beam) and Benomyl (Benlate). No herbicide was reported as being used. In terms of packaging, polypropylene bags were used by all cooperatives in order to transport rice to milling plants. As illustrated in Figure 5-3, below, the primary source for these inputs was through the cooperatives.

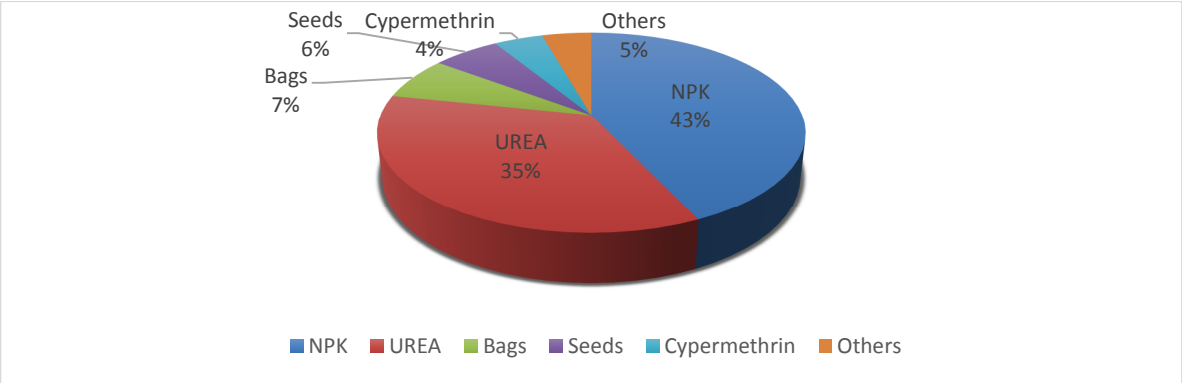
[61] According to Promar Consulting (2012:65), the main factor explaining the low usage of compost (in rice farming in Rwanda) is the inability of farmers to move compost due to the long distance between their homes, where livestock is raised, to the marshland areas

Figure 5-3: Frequency of use of intermediate inputs disaggregated by source



From the surveys, on average farmers spent USD 367.5/ha on intermediate inputs, each season. Of this amount, 78 % was allocated to imported fertilizers NPK and UREA (see Figure 5-4). Though these fertilizers accounted for the largest share of total cost of intermediate inputs, their prices were subsidized. In 2014, 30 of the 31 cooperatives reported farmers' received a direct price subsidy of USD 0.15/kg for NPK and UREA purchased[62].

Figure 5-4: Expenditure on intermediate inputs



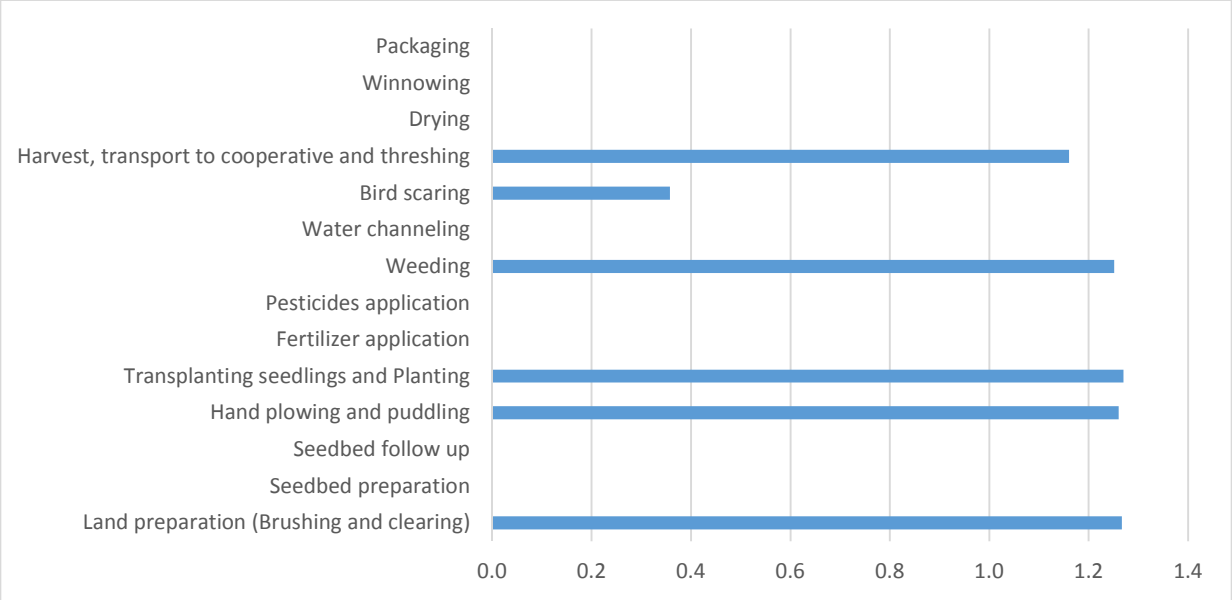
Labour: The average quantity of labour used for each season of growing rice was estimated at 6589.41 labour hours per hectare. Given that rice production is labour intensive[63], 84% of total labour was hired, while family labour accounted for only 16% of the total labour.[64] Labour

[62] The actual amount that farmers were paying for NPK and UREA was on average USD 0.84 and USD 0.72/kg; respectively.
[63] Rice production requires twice as much labour as the production of other grains and legumes (Barker, Herdt & Rose, 1985:123).
[64] Though most of the major food crops, in Rwanda, are produced at subsistence level; rice is a commercialized food crop, as 63 % of paddy produced is sold on the market (MINAGRI, NISR & WFP, 2012:14). The proportion of

activities included; bird scaring, which accounts for 30.8% of the total labour hours, followed by weeding, 23.8% of total labour hours, and harvesting activities (cutting and transportation of rice panicles to cooperatives, drying, and threshing), which accounted for 11.6 % of the total labour hours.

In terms of costs, the farmers surveyed spent an average of USD 831.3/ha on labour, for the entire season. Though bird scaring was the most labour intensive activity, based on the total quantity of hours spent on this activity, it was ranked in third position relative to total expenditure on labour, representing 14.2 % of the total labour cost. Bird scaring was ranked after weeding and harvesting activities, which accounted for 36.3 % and 17.1 % of labour cost, respectively. Figure 5-5, below, illustrates that hired labour for bird scaring is paid relatively lower than labour used in other farming activities (i.e. land preparation, plowing, planting, harvesting, etc.).

Figure 5-5: Labour cost per day, in USD



Note: Farming activities seedbed follow-up and preparation, pesticides and fertilizer application, water channeling, drying, winnowing, and packaging are mainly conducted by unpaid family labour.

harvest that is sold on the market for the major food crops beans, sweet potatoes, maize, cooking banana, Irish potatoes, cassava and sorghum is 12%, 11%, 22%, 30%, 32%, 23%, and 54%; respectively (MINAGRI, NISR & WFP, 2012:14).

As part of the farming expenditure, there were also contributions paid by farmers to their respective cooperatives. These contributions aimed at contributing to the development of farmers' cooperatives, and at paying for the different services rendered by the cooperative to farmers. The average amount for these contributions was estimated at Frw 14819.2/ha (USD 21.7/ha). [65]

5.2.3 Rice yield and prices

Farmers were additionally requested to estimate the most likely quantity of paddy rice that would be harvested under normal weather conditions, from the prototypical farm. The average yield was estimated at 6.05 MT/ha. In terms of producer prices, Table 5-3, below, shows that the price paid by milling plants to the farmer, at the time that the data was collected, was on average USD 356.46/MT. Of this amount, cooperatives deducted an average amount of USD 25.42/MT for covering marketing costs and other activities incurred by the cooperative, the union of cooperatives, and the federation. The farmer was left with an average farm gate price of USD 331.04/MT.

Table 5-3: Paddy rice yield and farm gate price

	Unit	Quantity/Amount
Yield	MT/Ha	6.05
Paddy price (As paid by the milling plant)	Frw/MT	243968.72
	USD/MT	356.46
Deductible by cooperative (for marketing costs)	Frw/MT	17399.42
	USD/MT	25.42
Farm gate price	Frw/MT	226569.30
	USD/MT	331.04

Source: Survey findings

5.3 Disaggregation of inputs into tradable and non-tradable components:

It is a prerequisite to disaggregate input costs into tradable and non-tradable components in order to construct the PAM. Monke and Pearson (1989:105) recognized the difficulty in disaggregating precisely input costs to their respective tradable and non-tradable components. Where there is a lack of information, the authors recommend that the input be classified to its primary category.

[65] These farmers' contributions of Frw 14819.2/ha do not include the amount deducted by the cooperative (per each 1 Kg of paddy rice sold by the farmer) for marketing activities incurred by the cooperative. These marketing costs were deducted from the price paid by the milling plant to the farmer (for paddy rice delivered) during the estimation of the farm gate price. (Refer to rice yield and prices section 5.2.3)

Table 5-4, below, shows that the market prices for fertilizers, pesticides, seeds, and hand tools were consequently considered as wholly tradable (i.e. 100 % of these costs fall into the tradable component of the PAM (Refer to equation B, in Table 4.2); and those for labour, land lease, compost, winnower, and basket treated as wholly non-tradable.

Table 5-4: Disaggregation of input costs into tradable and domestic factor components

Item	Tradable component (%)	Domestic factor component (%)
Fertilizer	100%	0%
Compost	0%	100%
Pesticide	100%	0%
Hand tools (winnower and basket excluded)	100%	0%
Inputs transport costs	33.33%	66.67%
Winnower and basket	0%	100%
Labour	0%	100%
Land rental	0%	100%
Farmers 'contributions to cooperative	33.33%	66.67%

However, farmers' contributions and input transport costs were disaggregated into two-thirds non-tradable and one-third tradable (see Table 5-4, above). This approach is recommended by Monke and Pearson (1989:106), when dealing with semi-tradable goods, for which it is difficult to identity the primary category.

5.4 Presentation and interpretation of the PAMs

Prior to illustrating the PAM results, the net farm income, estimated using both private and social prices, is presented in Table 5-5. The revenue and expenditures are for all farms, within the sampled cooperatives.

On average, rice production private costs averaged USD 1365.2/ha in the Eastern Province of Rwanda. The domestic factor labour accounted for the largest share of total farm production costs, at 60.89 %. Imported chemical fertilizers and farm tools (mostly imported) were ranked at the 2nd and 3rd positions respectively, with 21.08 % and 8.34 % of total farm production costs. Land rental accounted only for 2.26 % of these costs.[66] It is clear from Table 5-5, below, that rice

[66] These results are not far different from Kathiresan (2013:23,24)'s findings, where total rice production cost in Rwanda was estimated at Frw 1'017'510/ha (USD 1'569.8/ha), of which 52 % was allocated to labour.

production was both financially and economically profitable. However, the financial profit was much higher than economic profit.

Table 5-5: Farm revenue and expenditures[67], USD/ha

Item	Financial (private)	Economic (social)
I. Farm revenue	2007.3	1535.9
II. Variable costs		
Labour	831.3	913.2
Family labour	0.0	150.2
External Labour	831.3	763.0
Seeds	22.1	22.1
Compost	0.0	4.6
Chemical fertilizers	287.8	338.6
NPK	158.0	183.8
UREA	129.8	154.8
Pesticides	32.3	32.3
Cypermethrin	16.2	16.2
Dimethoate	0.2	0.2
Trycyclazole/Beam	15.8	15.8
Benomyl/Benlate	0.1	0.1
Other variable costs	25.3	19.8
Total variable costs	1198.8	1330.5
Gross margin	808.5	205.3
V. Overhead costs		
Land rental	30.9	69.7
Contributions to cooperatives	21.7	20.9
Farm tools depreciation	113.8	89.9
Total overhead costs	166.4	180.5
Total production costs	1365.1	1511.1
V. Net farm revenue (Net Farm profit)	642.1	24.8

5.4.1 PAMs results

As summarized in the PAM below (Table 5-6), on the farmers' perspective, rice farming was profitable in the Eastern Province of Rwanda. This profitability was indicated by a net private farm profit of Frw 439478.4/Ha (USD 642.1 US$/ha). On the other hand, the social analysis shows that by taking into consideration the opportunity cost for all farm inputs and outputs, rice production generated an Frw 16964.1/ha (USD 24.8/ha) of net social profit (see Table 5-6). In other words, the Eastern Province of Rwanda has a comparative advantage in rice. It is economically efficient to allocate resources for rice production in this province.

[67] Refer to Appendix E for more details on the weighted averages for expenditure on inputs and farm revenues across the sampled cooperatives.

The divergence between the net farm profit and net social profit, of Frw 422514.3 (USD 617.3), indicates a positive net policy transfer. In other words, the rice subsector is protected as the existing government policies provided an incentive for rice production.

A detail analysis of the sources of market distortions showed that both output and input markets were distorted. For instance, the private farm revenue was greater than social farm revenue, as indicated by a positive output transfer of Frw 322637.0/ha (USD 471.4). This positive output transfer suggests that there were subsidies paid to farmers for paddy rice sold.

In addition, the private farm costs of tradable inputs were less than the corresponding social farm costs by Frw 14846.3 (USD 21.7), due to the subsidization of tradable inputs. The domestic factor markets were also distorted, as revealed by a negative factor transfer of Frw 85031.1 (USD 124.2). This factor transfer was the combined effect of the subsidization of land rental price, a distorted labour wage, and the use of family labour (refer to the farm budget above, Table 5-5).

On average, all distorting policies and market failures raised private profit above social profit by Frw 422514.3/Ha (USD 617.3/ha). Of this amount, 76 % was derived from implicit subsidies in output markets, 20 % was from distortions in domestic factor markets, while distortions in tradable input markets accounted for 4 %. Briefly, inefficiencies, within the rice subsector, arose mainly from commodity markets.

Table 5-6: The Policy Analysis Matrix for rice production in the Eastern Province of Rwanda

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	439 478.4	642.1	1 373 814.0	2 007.3	328 701.8	480.3	605 633.9	884.9
Social prices	16 964.1	24.8	1 051 177.0	1 535.9	343 548.0	502.0	690 664.9	1 009.1
DIVERGENCES	422 514.3	617.3	322 637.0	471.4	-14 846.3	-21.7	-85 031.1	-124.2

Source: Research findings

The ratio indicators of competitiveness, comparative advantage, and market distortions are summarized in Table 5-7, below:

Table 5-7: PAM indicators, disaggregated per cooperative

	Name of the cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.67	1.06	1.34	0.88	1.60	0.38
2	Cocuricyi	0.50	0.89	1.34	0.87	1.54	0.47
3	Cocuribu	0.74	1.29	1.34	0.89	1.60	0.45
4	Cocuriga	1.05	2.34	1.34	0.91	1.81	0.60
5	Cocurire	0.91	2.88	1.34	0.95	1.87	0.87
6	Coperig	0.62	1.21	1.34	0.93	1.64	0.48
7	Coprimwa	0.26	1.13	1.34	0.89	1.62	0.82
8	Cocurigi	0.82	1.53	1.34	0.91	1.60	0.51
9	Coproriz	0.61	0.98	1.30	0.96	1.41	0.40
10	Corimak	0.61	0.95	1.30	0.96	1.44	0.36
11	Coprorika	0.73	1.57	1.32	0.96	1.69	0.50
12	Codervam	0.49	0.89	1.32	0.94	1.52	0.43
13	Corvny	0.51	0.91	1.32	0.93	1.57	0.41
14	Corinyaburiba	0.67	1.28	1.32	0.95	1.49	0.53
15	Twizamure	0.88	1.98	1.32	0.95	1.63	0.63
16	Inkingi y'ubuhinzi	0.61	1.67	1.32	1.05	1.49	0.75
17	Jyambere nyarugenge	0.77	1.56	1.32	1.00	1.65	0.46
18	Koterwa	0.54	1.29	1.32	0.98	1.52	0.61
19	Korivarwi	0.50	1.01	1.32	0.97	1.52	0.49
20	Copauki	0.83	1.50	1.32	0.99	1.53	0.46
21	Copriki cyunuzi	0.58	0.83	1.27	0.93	1.42	0.29
22	Isabane	0.81	1.28	1.27	0.99	1.46	0.33
23	Mushikiri rice growers	0.67	0.92	1.27	0.95	1.40	0.27
24	Kijumbura rice growers	0.76	1.15	1.27	0.99	1.40	0.33
25	Corimu	0.74	1.72	1.27	1.02	1.50	0.58
26	Cocuriru	0.55	0.91	1.34	0.96	1.50	0.41
27	Corimaru	0.53	0.76	1.32	1.04	1.46	0.30
28	Kopetwiteki	0.85	1.41	1.32	0.93	1.61	0.37
29	Cocurivam	0.71	1.27	1.34	0.91	1.62	0.45
30	Corimi	0.27	0.56	1.34	0.97	1.50	0.45
31	Coprimu	1.05	1.90	1.32	0.95	1.73	0.38
	Weighted average (All)	0.58	0.98	1.31	0.96	1.48	0.40

Source: Research findings

- The Private Cost ratio, PCR=0.58<1 indicates that under prevailing market conditions, rice production in the Eastern Province has the ability to pay for domestic factors and remain competitive.
- The Domestic Resource Cost ratio was estimated at 0.98, meaning that for each 100 Frw generated in social value, there was only Frw 98 spent on the domestic factors used, valued at their opportunity costs. In other words, the Eastern Province had a comparative advantage in rice production, since it cost less domestic currency to produce than would have been spent if rice was imported.

- The effective protection coefficient, EPC (estimated at 1.48) >1, implying that there was in general positive protection over rice production. The government policies created incentives for rice production.
- The nominal protection coefficient for the output market, NPCO (estimated at 1.31) >1, suggesting that rice subsector is protected. In other words, the domestic price of rice was 31% higher than the reference world rice price due to implicit subsidies in the output markets.
- The nominal protection coefficient for the input market, NPCI, was 0.96, suggesting that there is a positive protection over domestic rice production, through input subsidization. The domestic prices of tradable inputs were on aggregate 4 % lower than corresponding world prices[68].
- The subsidy ratio to producers (SRP) was estimated at 0.40, which indicates that if policy support and market failure were eliminated, 40 % increase in social farm revenue would be required to maintain current farm profit levels.

PAM indicators: Aggregate versus disaggregated results:

- Only two cooperatives had a PCR >1. In other words, under prevailing market conditions, technology, and government policies, farmers within Cocuriga and Coprimu cooperatives operated at a loss and were not competitive. The farm loss was due to poor rice yield[69].
- Although on aggregate the results indicated that the Eastern Province had comparative advantage in rice production, when the DRC ratio was calculated at the cooperative level, 21 of the 31 cooperatives had a DRC>1. In other words, 67.7 % of farmers' cooperatives had comparative disadvantage.
- The 21 cooperatives, with no comparative advantage, cultivated rice on 25 % of the area under study. They were composed by an average of 406.7 farmers per cooperative, cultivating rice on a 50.3 ha farm area, with an average farm size per farmer of 0.12 ha.
- The remaining 10 cooperatives, with DRC<1, i.e. those with comparative advantage, cultivated rice on 75% of the total area under study. They were composed by an average

[68] The survey findings showed that farmers were receiving an Frw 105/kg (USD 0.15/kg) direct subsidy on fertilizers NPK and UREA purchased. However, this support in tradable inputs, is partly offset by taxation on imported farming tools, as it is summarized in the private and social budgets (Table 5-5)

[69] Farmers in Cocuriga and Coprimu cooperatives had a 4.0 and 4.4 MT/ha yields; respectively, compared to the average rice yield of 6.05 MT/ha across sampled cooperatives.

of 1403.9 farmers per cooperative, cultivating rice on a 313.8 ha farm area, with an average farm size per farmer of 0.22 ha.

- Based on the previous two points, it is clear that the larger the rice farms, the more farmers had comparative advantage and the more they were efficient.
- Consistent with regional estimate, farmers in each of the 31 rice farmers' cooperatives were positively protected by government policies, as indicated by an EPC > 1.
- Likewise, farmers in each cooperative sold rice in domestic market at prices higher than corresponding world rice prices, as indicated by NPCO > 1, due to subsidies in the output markets.
- With regards to inputs markets, the majority, 27 of the 31 cooperatives, of rice farmers purchased tradable inputs on aggregate at prices lower than corresponding world prices, as indicated by NPCI less than 1. These results were consistent with regional estimates.
- The proportion of increase in social farm revenue that would be required to maintain current farm profit levels, if policy support and market failures were eliminated, ranged from 27 % to 87 % across the sampled cooperatives.

5.4.2 PAMs results under sensitivity analysis

The PAM is static and conditional on prevailing government's policies, technology, and market conditions. For a dynamic analysis, the PAM is re-estimated under six scenarios: 1) Falling world prices, 2) Changing trading partners, 3) Rising mechanization, 4) Improved seed adaption, 5) market labour wage = shadow labour wage, 6) Impact of protective trade policies.

First scenario: Knowing that commodity prices are volatile on the world market, this study assumed a situation where there was a 20 % decrease in world rice prices while other factors held constant. Under this scenario, the Eastern Province of Rwanda would lose its comparative advantage. Rice production would incur a net economic loss of Frw 120082.3 (USD 175.5). The DRC ratio would increase to 1.21 (see Table 5-8 and Table 5-14). Only 2 or 6.5 % of the farmers' cooperatives would have a comparative advantage (see Appendix F).

Table 5-8: PAM in a 20 % decrease in world rice prices scenario

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	439 478.4	642.1	1 373 814.0	2 007.3	328 701.8	480.3	605 633.9	884.9
Social prices	-120 082.3	-175.5	914 130.6	1 335.6	343 548.0	502.0	690 664.9	1 009.1
DIVERGENCES	559 560.7	817.6	459 683.4	671.6	-14 846.3	-21.7	-85 031.1	-124.2

Source: Research findings

Second scenario: This study used Pakistan's FOB rice price of USD 392 per MT as the reference world price because Pakistan was the major exporter of rice to Rwanda (ICT, 2014). In the second scenario, the FOB world price for rice exported by India (the major global exporter of rice)[70], of 385 USD/MT, was used as a reference (see Appendix G).

In this scenario, the Eastern Province of Rwanda would have no comparative advantage in rice production. Rice production would incur an Frw 21492.8/ha (USD 31.4/ha) net social loss. The DRC would increase to 1.03 (see Table 5-9 and Table 5-14). Only 8, or 25.8 %, of the cooperatives would have a comparative advantage (refer to Appendix H).

Table 5-9: PAM in a scenario where FOB rice price for India rice is used as reference price

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	439 478.4	642.1	1 373 814.0	2 007.3	328 701.8	480.3	605 633.9	884.9
Social prices	-21 492.8	-31.4	1 012 720.1	1 479.7	343 548.0	502.0	690 664.9	1 009.1
DIVERGENCES	460 971.2	673.5	361 093.9	527.6	-14 846.3	-21.7	-85 031.1	-124.2

Source: Research findings

Third scenario: A comparative analysis of rice production costs between the Eastern Province of Rwanda and a selection of major global exporters of rice was conducted, as summarized in Appendix I. The comparative analysis showed that Rwanda has a higher relative labour cost per ha, due a high relative labour usage. For instance, the Asian countries Thailand and Vietnam use between 200 and 2030 labour hours/ha, on which they spend less than USD 220. On the other hand, in the Eastern Province of Rwanda, 6589.41 labour hours/ha are used, costing rice farmers USD 831.3.

[70] Reference is made to ICT (2014)

It is very likely that the relatively higher quantity of labour used in Rwanda is due to a lack of mechanization. For instance, farmers in Thailand and Vietnam use labour saving technologies such as wheel tractors, power tillers, combine harvesters, irrigation pumps, herbicides, etc. (Agribenchmark, 2014:12-25). This technology use is uncommon in rice farming in Rwanda.

Therefore, the third scenario assumed a situation where farmers would adopt a new farming technology that could reduce the labour quantity use by 25 %, assuming that production costs for other inputs remain constant. In this scenario, the Eastern Province of Rwanda would gain a comparative advantage, as indicated by an Frw 173214.6/ha (USD 253.1/ha) net social profit and a DRC of 0.76 (see Table 5-10 and Table 5-14). The farmers 'cooperatives with a comparative disadvantage would decrease from 67.7 % to 45.2 % (refer to Appendix J).

Table 5-10: PAM in a scenario where the quantity of labour used is reduced by 25 %

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	581 709.8	849.9	1 373 814.0	2 007.3	328 701.8	480.3	463 402.5	677.1
Social prices	173 214.6	253.1	1 051 177.0	1 535.9	343 548.0	502.0	534 414.4	780.8
DIVERGENCES	408 495.2	596.8	322 637.0	471.4	-14 846.3	-21.7	-71 012.0	-103.8

Source: Research findings

Fourth scenario: The fourth scenario assumed reduction in yield of 25% for each cooperative, compared with the basic scenario. In this scenario, the average rice yield reduced from 6.05 MT/ha to 4.49 MT/ha. As a result, the Eastern Province of Rwanda would lose comparative advantage in rice, as indicated by a net social loss of Frw 245830.2 (USD 359.2). The DRC ratio would increase to 1.55 (see Table 5-11 & Table 5-14). Only one cooperative would have a comparative advantage (Refer to appendix K).

Table 5-11: PAM in a 25 % rice yield decrease scenario, in each cooperative.

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	96 024.9	140.3	1 030 360.5	1 505.5	328 701.8	480.3	605 633.9	884.9
Social prices	-245 830.2	-359.2	788 382.8	1 151.9	343 548.0	502.0	690 664.9	1 009.1
DIVERGENCES	341 855.1	499.5	241 977.7	353.6	-14 846.3	-21.7	-85 031.1	-124.2

Source: Research findings

Fifth scenario: In this scenario, the actual labour wage is used as a proxy for the social price of both hired and family labour. In this scenario, the Eastern Province of Rwanda would have no comparative advantage, as indicated by an Frw 842.3/ha (USD 1.2/ha) net social loss and a DRC of 1.001 (see Table 5-12, Table 5-14, and Appendix L).

Table 5-12: Prevailing labour market wage used in the social valuation of both family and hired labour

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	439 478.4	642.1	1 373 814.0	2 007.3	328 701.8	480.3	605 633.9	884.9
Social prices	-842.3	-1.2	1 051 177.0	1 535.9	343 548.0	502.0	708 471.3	1 035.1
DIVERGENCES	440 320.7	643.3	322 637.0	471.4	-14 846.3	-21.7	-102 837.4	-150.3

Source: Research findings

Sixth scenario: The sixth scenario measures the impact of a 52.4 % MFN rice import tariff, which was prevalent in 2014, on the protection of domestic rice subsector. As summarized in Table 5-13 below, if this import tariff was to be included in the estimation of the IPP, the social farm profit would have increased by 24 times, from Frw 16964.1 (USD 24.8) to Frw 409102.5/ha (USD 597.7), and would diverge from the actual private farm profit by only Frw 30375.9/ha (USD 44.4/ha).[71] This scenario implies that the rice import tariff increases significantly the domestic price of imported rice, which improves the price competitiveness of domestic rice farmers. (Refer to Appendix D, for the IPP added with the rice import tariff).

Table 5-13: Impact of rice import tariff on domestic rice protection

	PROFIT		REVENUE		COSTS			
					TRADABLE INPUTS		DOMESTIC FACTORS	
	Frw	USD	Frw	USD	Frw	USD	Frw	USD
Private prices	439 478.4	642.1	1 373 814.0	2 007.3	328 701.8	480.3	605 633.9	884.9
Social prices	409 102.5	597.7	1 443 315.5	2 108.8	343 548.0	502.0	690 664.9	1 009.1
DIVERGENCES	30 375.9	44.4	-69 501.5	-101.5	-14 846.3	-21.7	-85 031.1	-124.2

Source: Research findings

[71] Refer to Appendix M for the PAM indicators results under this scenario.

Table 5-14: PAM ratio indicators under different scenarios

N	Scenarios	NSP (USD/ha)	PCR	DRC	NPCO	NPCI	EPC	SRP
0	Basic scenario: current conditions	24.8	0.58	0.98	1.31	0.96	1.48	0.40
1	Falling world prices	(-) 175.5	0.58	1.21	1.50	0.96	1.83	0.61
2	Changing trading partners	(-) 31.4	0.58	1.03	1.36	0.96	1.56	0.46
3	Rising mechanization	253.1	0.44	0.76	1.31	0.96	1.48	0.39
4	Improved seed adaption	(-) 359.2	0.86	1.55	1.31	0.96	1.58	0.43
5	Market labour wage=Social labour wage	(-) 1.2	0.58	1.00	1.31	0.96	1.48	0.42
6	Impact of rice import tariff	44.4	0.58	0.63	0.95	0.96	0.95	0.02

Source: Research findings

From these scenarios, it can be inferred that the factors that would contribute positively to the comparative advantage of Rwanda in rice production, if other factors are held constant, are an increase in the world rice price, a reduction in the social domestic factor (i.e. labour) cost, and a higher rice yield. The factors that would contribute negatively to the comparative advantage include, among others, a decrease in world rice price and poor rice yield.

Furthermore, since the Eastern Province of Rwanda has a net social profit of close to zero, the 2nd and 5th scenarios showed that if the FOB India rice export price or the prevailing labour market wage could have been used respectively as a proxies for the social price of rice and labour, the Eastern Province of Rwanda would have had no comparative advantage.

5.5 Summary

The chapter 5 presents and provides a discussion on the data. It shows that the Eastern Province of Rwanda had a comparative advantage in rice production. However, it was not economically efficient at producing rice in all marshlands. Due to protective government policies (i.e. import tariffs, farm input subsidies), rice production was financially profitable, even in those marshlands with a comparative disadvantage.

Different scenarios are provided. These show that a persistent downward trend in world rice prices would negatively affect the comparative advantage of Rwanda in rice. Consequently, farmers would abandon rice production for other profitable crops. On the other hand, the adoption of labour saving technologies would significantly improve the comparative advantage position of the Province, since labour is the largest contributor to farm production costs.

Chapter 6 Conclusion and policy recommendations

Since agriculture is the economic engine of rural Africa, allocating agricultural resources efficiently would stimulate poverty reduction. Though more than 80% of the marshlands with a high potential for rice production in Rwanda are uncultivated, during the last decade, the country has been recording increasing domestic rice trade deficit. This study is aimed at assessing why Rwanda has remained a net importer of rice despite its endowment of abundant unused marshland resources. In order to address this issue, this study assessed whether Rwanda has comparative advantage in rice production and then identified different factors limiting efficiency. The scope of the study was the Eastern Province of Rwanda, which is the major province producer of rice.

6.1 Thesis overview

Chapter two reviews the literature and other available information on the policy environment relating to the Rwandan rice subsector, as well as the structure, conduct, and performance of its value chain. In section 2.2 some policy instruments that have the potential to distort inputs and output markets were identified. These include protectionist policies such as fertilizer price subsidization, the rice import tariff, and regulation of the paddy rice price. On the other hand, the land policy that limits private ownership and usage rights of marshland also has the potential to create disincentives for rice production.

The structure and conduct of the rice value chain are discussed in sections 2.3 and 2.4, respectively. It is shown that until 2014, the importation and distribution of fertilizers took place under a less competitive market. In addition, the land rental market was not competitive, as the government was the sole owner (lessor) of marshland. On the other hand, farmers' integration into cooperatives has improved the level of vertical integration along the rice value chain. For instance, it has become easier for farmers to get forward marketing contracts through their cooperatives. Besides this, there is an easy flow of information among farmers and other actors along the chain.

It is shown that despite a prevailing rice deficit in the domestic market, milling plants overall operate at below capacity due to insufficient raw materials. Furthermore, although 70 % of domestic rice farmers cultivate short and bold types of rice, only 14 % of domestic consumers

prefer this type of rice. The majority of consumers prefer long grain and fragrant rice, most of which is imported.

Section 2.5 focuses on the performance of the value chain. In this section it is illustrated that over the last decade, Rwanda has been recording an increasing rice trade deficit. This increasing rice deficit is due to the inability of domestic rice production to keep pace with increasing rice demand in the domestic market. Furthermore, domestic rice prices are relatively high compared with the rest of the world, which is a hindrance for the competitiveness of locally produced rice.

In chapter three, comparative advantage is defined as the ability of a country to produce a product at the lowest opportunity cost relative to the rest of the world. Here, it is explained that in developing countries and in the agricultural sector, trade is mostly determined by comparative advantage. Countries tend to specialize in the production of those commodities that they can produce at a lower relative opportunity cost than the rest of the world, in exchange for those commodities that they can produce at a higher relative opportunity cost.

In other cases, especially in developed countries and in manufacturing sectors, trade is based on factors other than comparative advantage. These factors include, among others, economies of scale, product differentiation, the technology gap, and product cycle. It is also illustrated how input and output market distortions alter trade flows (as determined by comparative advantage), hence reducing social welfare.

Chapter 4 is devoted to explaining the methodology used to address the research questions. Among the different measures of comparative advantage that are presented, the PAM is the option chosen. Here, it is explained that the PAM is basically about the uses of farm budget data to measure the private and social profitability of a specific crop production system. In a private analysis, cost and price data are expressed in actual market prices. Consequently, private profit measures the competitiveness of private farmers, given prevailing policies and market failures.

On the other hand, in a social analysis, cost and price data are expressed in social prices, which are those prices that reflect the opportunity cost of resources. Social profit measures the comparative advantage and economic efficiency of a production system. The divergences between private and social values indicate the extent to which input and output markets are distorted.

The chapter sets out the different data that were required to construct the PAM as well as the different data collection techniques that were used to gather it. These techniques consist of a farm

survey, informal interviews with different stakeholders within the rice subsector, and consultation of secondary sources of data.

Chapter 5 is devoted to presenting and discussing the research findings. The PAM's results reveal that from the farmers' perspective, rice farming in the Eastern Province of Rwanda was profitable. This profitability was indicated by a net farm private (financial) profit of Frw 439 475.3/ha (USD 642.3/ha). On the other hand, the social (economic) analysis revealed that rice production was marginally profitable at Frw 16964.1/ha (USD 24.8/ha). This social profitability was also indicated by a DRC of 0.98, implying that for each Frw 0.98 of domestic factors used in rice production, valued at their opportunity cost, there was Frw 1 of value added in social prices. In other words, the Eastern Province of Rwanda had a static comparative advantage in rice.

The private farm profit was higher than the social farm profit, as indicated by a positive net transfer of Frw 422514.3 (USD 617.3), implying that there were inefficiencies within the rice subsector. Of this net transfer, 76 % (or Frw 322637/ha) were derived from output markets, 20 % (or Frw 85028) from domestic factor markets, and 4 % (or Frw 14846.3/ha) from tradable inputs markets. Briefly, inefficiencies within the rice subsector derived mainly from output markets.

The EPC, of 1.48, was much greater than 1, implying that there is a high level of incentivization given by the government to farmers for producing rice. For instance, the NPCO was estimated at 1.31, implying that domestic rice prices were 31 % higher than reference world rice prices. Furthermore, the NPCI was 0.96, suggesting that domestic prices of tradable inputs are on aggregate 4 % lower than corresponding world prices.

A detailed analysis shows that, though overall the Eastern Province had a comparative advantage for rice, 21 or 67.7 % of the cooperatives had a comparative disadvantage. However, due to protective government policies, rice production was financially unprofitable only for 2 (or 6.5% of) cooperatives.

6.2 Key findings

- The study findings reveal that generally in free trade and competitive markets, farmers would rather sell rice in the domestic market at competitive prices than imported rice.
- Because rice production is not economically efficient for all cooperatives, some of the rice marshlands that are currently used for rice production would be allocated to the production of other crops that would generate the highest social profit.

- Since the objective of the government is to make Rwanda self-sufficient in rice production[72]; under current conditions, the government restricts the importation of rice by using import tariff policy instruments. Moreover, the government provides input subsidies for farmers to improve the rice yield, through using more adequate inputs, as well as reducing farm production costs.[73] The protective policies allow rice farming to be financially profitable even for those marshlands with comparative disadvantage, therefore, allowing farmers to gain domestic market share.
- Since imported rice is differentiated from domestic local rice, at the prevailing imported rice price, some domestic consumers are willing to buy imported rice. This willingness to pay explains why rice importation prevails, despite imported rice's relatively higher domestic market price.

6.3 Policy recommendations

- **Allocate wetland resources efficiently**. It was revealed that under the area of study, 10 of the 31 cooperatives, cultivating rice on 75 % of the total area under study, are the only efficient at producing rice. In these 10 cooperatives, the average farm size per farmer, of 0.22ha, is higher than the average farm size per farmer, of 0.12ha, in the remaining 21 cooperatives with no comparative advantage. In short, the larger were farms the more farmers were efficient. Due to Rwanda government high concern on land distribution, large scale farming in Rwanda is very limited, which limits exploitation of economies of scale. Therefore, in order to increase the area where rice is produced efficiently, the government should promote non-farm activities that would absorb excess number of small rice farmers to allow efficient farmers to hold larger pieces of land.
- **Research and development: Mechanization**. In order to improve the comparative advantage position of Rwanda rice subsector, it is a prerequisite to minimize rice production social costs. The research findings revealed that labour accounted for the largest share (60.89%) of the total paddy production cost. 53.4 % is allocated to weeding, harvesting, and post-harvesting activities (threshing, winnowing and drying). Though in several rice producing countries farmers use labour saving technologies (i.e. herbicides,

[72] Refer to MINAGRI (2011c:20)
[73] These protective policies are consistent with government's priority objectives of making Rwanda self-sufficient in rice production and reducing the rice trade deficit

power tillers, draft animals, combine harvesters, etc.) to minimize production costs[74]; the use of this technology is uncommon in the Eastern Province of Rwanda, where all of these farming and post-harvesting activities are done manually. An assumed scenario where the quantity of labour hours used was arbitrarily reduced by 25%, assuming that other input costs remain constant, revealed that the number of cooperatives with a comparative advantage will increase from 10 (or 32.3%) to 17 (or 54.8%). Therefore, government should engage in promoting research, innovation, and information dissemination that would improve the use of appropriate labour saving technologies for rice farming.

- **Research and development: Varietal improvement.** Since imported rice is differentiated from local rice by grain shape, fragrance, and quality, comparative advantage is not a sufficient condition for domestic farmers to compete in the domestic market. Since the majority of domestic rice consumers prefer long grain and fragrant rice varieties, which are mostly imported[75]; it would remain a challenge for domestic rice farmers to gain domestic market share. Therefore, further research on identifying long grain and fragrant rice varieties that can adapt to the Rwandan agro-ecology should be conducted. Moreover, farmers should be incited to adopt farming practices that preserve rice quality.

- **Reduce rice trade barriers**: During sensitivity analysis, it was illustrated that the rice import tariff improves domestic rice price competitiveness against imported rice. Although the rice import tariff protect domestic rice producers from foreign competition, higher domestic rice prices reduce the range of rice that is consumed in the domestic market[76], which hence negatively affects domestic consumers. Even though the Rwandan agro-ecology favours the production of short grain and bold types of rice, which have a limited market demand relative to imported rice, there are potential opportunities for the exportation of the excess supply in regional markets where rice traded is free of duties. Increasing the exportation of domestic rice and eliminating rice import tariffs would benefit both domestic rice producers and consumers, while keeping the rice trade balance

[74] Reference for labour saving technology use in other rice producing countries is made to Agribenchmark (2014:16-27) ; Barker, Herdt & Rose (1985:88-115); Hussain, Khattak & Khan (2008:746); Shariff (2011:113-116)
[75] Refer to MINAGRI (2011c:13); Kathiresan (2013:19)
[76] Refer to chapter three on the impact of import tariff on the domestic consumption of the protected commodity.

stable. Therefore, this study recommends that the government should encourage exporting domestic rice in the region as well as reducing existing trade barriers to importing rice.

- **Promote usage of organic fertilizers:** In order to improve comparative advantage, therefore, use agricultural resources more efficiently, farmers have to minimize social farm production costs. The research findings showed that imported chemical fertilizers are the second-largest contributor to paddy production cost, at 21%. As a landlocked country, higher transportation and related costs along the transport corridor[77] are among the important determinants of higher relative cost of imported inputs. Yet, the use of compost remains low, as on average, only 158.1 Kg of compost is applied on 1 ha of marshland, with only 9.7 % of cooperatives using compost.[78] Various studies demonstrated that inorganic fertilizers are more efficient when used in combination with rice straw-based compost.[79] In other words, at the same rice yield, farmers can reduce the amount of inorganic fertilizers used, by using rice straw-based compost. Therefore, Rwandan rice farmers should be incited to substitute expensive chemical fertilizers with rice straw-based compost.

[77] According to the World Bank (2010:217), as a landlocked country, transportation and related cost account for more than 40 % of the value of goods imported by Rwanda.
[78] This low usage of compost was attributed, by Promar Consulting, (2012:65), to the inability of Rwandan rice farmers to move compost due to a long distance between homes (where farmers raise livestock) to rice marshlands.
[79] Refer to Hesse (1984:40); Eagle, Bird, Horwath, Linquist, Brouder, Hill & van Kessel (2000;1102)

References

Agribenchmark. 2014. *Economics of South East Asian rice production*. Report 2014/1 [Online]. Available: http://www.agribenchmark.org/fileadmin/Dateiablage/B-Cash-Crop/Reports/Report-2014-1-rice-FAO.pdf [2015, June 02].

Ahmed, S. 1983. *Shadow prices for economic appraisal of projects. An application to Thailand.* Washington: The International Bank for Reconstruction and Development/the World Bank.

Anderson, K., Martin, W. & van der Mensbrugghe, D. 2006. Distortions to world trade: Impacts on agricultural markets and farm incomes. *Applied Economic Perspectives and Policy*, 28(2):168-194.

Anderson, K., Valenzuela, E. & van der Mensbrugghe, D. 2010. Global welfare and poverty effects: Linkage model results, in K. Anderson, J. Cockburn & W. Martin (eds.). *Agricultural price distortions, inequality, and poverty*. Washington: The International Bank for Reconstruction and Development/the World Bank. pp:49-85.

Bahati, E. 2014. Personal interview. Domestic transportation costs. Truck driver. 21 August, Bugesera (Rwanda).

Balassa, B. 1965. Trade liberalization and "revealed" comparative advantage1. *The Manchester School*, 33(2):99-123.

Balassa, B. 1977. Revealed comparative advantage revisited: An analysis of relative export shares of the industrial countries, 1953-1971. *The Manchester School*, 45(4):327-344.

Bale, M.D. & Lutz, E. 1979. Price distortions in agriculture and their effects: An international comparison. *American Journal of Agricultural Economics*, 63(1):8-22.

Barker, R., Herdt, R.W. & Rose, B. 1985. *The rice economy of Asia*. Vol. 2. Washington: Resources for the future, Inc.

Basabira, L. 2014. Correspondence. Milled rice price at mill gate. Nyagatare rice milling plant Managing Director. 30 December, Nyagatare (Rwanda).

Basavaraj, G., Rao, P.P., Achoth, L. & Reddy, C.R. 2013. Assessing competitiveness of sweet sorghum for ethanol production: A policy analysis matrix approach. *Agricultural Economics Research Review*, 26(1):31-40.

Baydas, M., Graham, D.H. & Bicamumpaka J. 1995. Input and output distribution networks in the agribusiness sector in Rwanda. Markets or pre-markets? Ohio: Ohio State University [Online]. Available: http://pdf.usaid.gov/pdf_docs/pnabx467.pdf [2015, June 28].

BNR. 2013. *Monetary survey 2013* [Online]. Available: http://www.bnr.rw/index.php?id=171&tx_damfrontend_pi1%5Bpointer%5D=4#test [2015, June 02].

BNR. 2014a. *Gross domestic product by kind of activity, at current price* [Online]. Available: http://www.bnr.rw/index.php?id=213 [2014, December 29].

BNR. 2014b. *Monetary survey 2014* [Online]. Available: http://www.bnr.rw/index.php?id=171&tx_damfrontend_pi1%5Bpointer%5D=1#test [2015, June 03].

BNR. 2015. *Interest rate structure up to May 2015* [Online]. Available: http://www.bnr.rw/index.php?id=329 [2015, June 27].

Bolloré Africa Logistics. 2014. International transportation and insurance costs, Email to B. Nkurunziza [online], 13 August. Available E-mail: Alexis.KAGABO@bollore.com.

Bowen, H.P. 1983. On the theoretical interpretation of indices of trade intensity and revealed comparative advantage. *Weltwirtschaftliches Archiv*, 119(3):464-472.

Brown, W. B. & Hogendorn, J.S. 1994. *International Economics: Theory and Contexts*. Massachusetts: Addison-Wesley Publishing Company.

Bruno, M. 1972. Domestic resource costs and effective protection: Clarification and synthesis. *The Journal of Political Economy*, 80(1):16-33.

Bwimba, E. 2014. Correspondence. Milled rice price at mill gate. ICM Ltd sales Assistant. 5 November, Kigali (Rwanda).

Carana Corporation. 2010. *Assessment of post-harvest opportunities in Rwanda.* Rwanda: USAID [Online]. Available: http://pdf.usaid.gov/pdf_docs/PNADU495.pdf [2014, December 29].

Christiaensen, L. & Demery, L. 2007. *Down to earth. Agriculture and poverty reduction in Africa*. Washington: The international bank for reconstruction and development/the world Band [Online]. Available: http://siteresources.worldbank.org/INTPOVERTY/Resources/335642-1130251872237/DownToEarth_final.pdf [2015, April 17].

Christiaensen, L., Demery, L. & Kuhl, J. 2011. The (evolving) role of agriculture in poverty reduction: An empirical perspective. *Journal of Development Economics*, 96(2):239-254.

Cleaver, K.M. 1985. *The impact of price and exchange rate policies on agriculture in sub-Saharan Africa*. Washington: World Bank.

Corimi. 2014. Correspondence. Milled rice price at mill gate. Corimi Rice Milling Plant Accountant. 13 October, Ngoma (Rwanda).

Coxhead, I. 2007. A new resource curse? Impacts of China's boom on comparative advantage and resource dependence in Southeast Asia. *World Development*, 35(7):1099-1119.

De Carvalho, B. R. P. 2013. Science meets reality: Economic efficiency, markets, institutions and food security. *International Journal on Food System Dynamics*, 4(2):88-105.

Dunmola, A.O., Omobowale, O. & Iyabo, A. 2015. Competitiveness of cocoa-based farming household in Nigeria. *Journal of Development and Agricultural Economics*, 7(2):80-84.

EAC Gazette. 2009. *The protocol on the establishment of the East African Community customs union*. Gazette – 2 July 2009. Legal notice no. EAC/7/2009. Arusha: East African Community [Online]. Available: http://www.eac.int/customs/index.php?option=com_docman&task=doc_details&gid=155&Itemid=123 [2014, December 24].

EAC Gazette. 2010. *The protocol on the establishment of the East African Community customs union*. Gazette – 29 June 2010. Legal notice no. EAC/11/2010. Arusha: East African Community [Online]. Available: http://www.eac.int/customs/index.php?option=com_docman&task=cat_view&gid=56&Itemid=123 [2014, December 24].

EAC Gazette. 2013. *The protocol on the establishment of the East African Community customs union.* Legal notice no. EAC/37/2013. Gazette – 30th June 2013. Arusha: East African Community [Online]. Available: http://www.eac.int/customs/index.php?option=com_docman&task=cat_view&gid=62&Itemid=123 [2014, December 24].

Eagle, A.J., Bird, J.A., Horwath, W.R., Linquist, B.A., Brouder, S.M., Hill, J.E & Van Kessel, E. 2000. Rice yield and nitrogen utilization efficiency under alternative straw management practices. *Agronomy Journal*, 96(6):1096-1103.

Ellis, F. 1992. *Agricultural policies in developing countries*. Cambridge: Cambridge University Press.

Epplin, F.M. & Wetzstein, M.E. 2012. Market failures and land grant universities. *Journal of Agricultural and Applied Economics*, 44(3):281-289.

Estudillo, J.P., Fujimura, M. & Hossain, M. 1999. New rice technology and comparative advantage in rice production in the Philippines. *The Journal of Development Studies*, 35(5):162-184.

Fang, C. & Beghin, J.C. 2000. Food self-sufficiency, comparative advantage, and agricultural trade: A policy analysis matrix for Chinese agriculture. Iowa: Iowa State University.

FAO GIEWS. 2014. Website: http://www.fao.org/giews/pricetool/

Fao Rice Price Update. 2014. *Export prices for rice.* Rome: FAO [Online]. Available: http://www.fao.org/economic/est/publications/rice-publications/the-fao-rice-price-update/en/ [2014, December 15].

FAO Stat. 2014. Website: http://faostat3.fao.org/home/E.

FAO. 2002. *The role of agriculture in the development of least-developed countries and their integration into the world economy*. Rome: FAO.

Ferto, I. & Hubbard, L.J. 2003. Revealed comparative advantage and competitiveness in Hungarian agri-food sectors. *The World Economy*, 26(2):247-259.

Finkelshtain, I., Kachel, Y. & Rubin, O. 2011. Policy, competitiveness and agricultural trade: An application of the Policy Analysis Matrix (PAM) to Israeli agriculture. Working paper. Jerusalem: the Hebrew University of Jerusalem.

Franchis. 2012. *Comprehensive food security, vulnerability analysis and nutritional survey. Rwanda*. Rome: World Food Programme [Online]. Available: http://documents.wfp.org/stellent/groups/public/documents/ena/wfp255144.pdf , [2015, July 11].

GAIN. 2012. *EAC rice import tariffs and food security update.* FAS report No. 9036 update [Online]. Available: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/EAC%20Rice%20Import%20Tariffs%20and%20Food%20Security%20Update_Nairobi_Kenya_4-26-2012.pdf [2014, December 26].

Gandolfo, G. 1994. *International economics I: The pure theory of international trade.* 2nd ed. Revised. Berlin: Springer.

Gathani, S. & Stoelinga, D. 2013. *Understanding Rwanda's agribusiness and manufacturing sectors.* London: The International Growth Center [Online]. Available: http://www.theigc.org/wp-content/uploads/2013/10/Gathani-Stoelinga-2013.pdf [2014, December 26].

Gittinger, J.P. 1982. *Economic analysis of agricultural projects.* 2nd ed. Completely revised and expanded. Washington: The International Bank for Reconstruction and Development / the Word Bank.

Gonzales, L.A., Kasryno, F., Perez, N.D. & Rosegrant, M.W. 1993. *Economic incentives and comparative advantage in Indonesian food crop production*. Research report 93. Washington: International Food Policy Research Institute.

Google Maps. 2014. Website: https://www.google.co.za/maps.

Green World Consult. 2014. *Impact of Fertilizer Use in Rwanda*. Final report [Online]. Available: file:///E:/Impact_of_Fertlizer_use_in_Rwanda_2014.pdf [2015, June 19].

Groenewegen, J., Spithoven, A.H.G.M., & Van den Berg, A. 2010. *Institutional economics: An introduction*. New York: Palgrave Macmillan.

Grossman, G.M. & Helpman, E. 1989. Product development and international trade. *Journal of political economy*, 97(6):1261-1283.

Grubel, H.G. & Lloyd, P.J. 2003. The empirical measurement of intra industry-trade, in P.J. Lloyd & H.G. Grubel (eds.). *Intra-industry trade*. Cheltenham: Edward Elgar Publishing. pp:494-517.

Gruber, H. G. 1967. Intra-industry specialization and the pattern of trade. *Canadian Journal of Economics and Political Science/Revue Canadienne de l'Economiques et Sciences Politiques*, 33(03):374-388.

Gruber, W., Mehta, D. & Vernon, R. 1967. The research and development factor in international trade and international investment of United States industries. *The Journal of Political Economy*, 75(1): 20-37.

Hassan, R.M. & Faki, H.H. 1993. *Economic policy and technology determinants of the comparative advantage of wheat production in Sudan*. Vol. 6. México: CIMMYT [Online]. Available: http://repository.cimmyt.org/xmlui/bitstream/handle/10883/896/43136.pdf?sequence=1 [2015, December 05].

Heller, H.R. 1973. *International trade theory and empirical evidence*. 2nd ed. New Jersey: Prentice-Hall.

Helpman, E. & Krugman, P.R. 1985. *Market structure and foreign trade. Increasing returns, imperfect competition, and the international economy*. Massachusetts: Massachusetts Institute of Technology.

Hesse, P.R. 1984. Potential of organic materials for soil improvement, in International Rice Research Institute (IRRI) (ed.). *Organic matter and rice.* Los Banos Laguna: IRRI. pp:35-43.

Hillman, A. L. 1980. Observations on the relation between "revealed comparative advantage" and comparative advantage as indicated by pre-trade relative prices. *Review of World Economics*, 116(2):315-321.

Hull, J.C. 2002. *Fundamentals of futures and options markets.* 4th ed. New Jersey: Prentice Hall.

Hussain, A.H., Khattak, N.U.R.K. & Khan, A.Q.K. 2008. Costs benefit analysis of different rice varieties in district Swat. *Agric*, 24(4):745-748.

IMF. 2000. *Rwanda: Recent economic developments.* IMF staff country report. No4. Washington: International Monetary Fund [Online]. Available: http://www.imf.org/external/pubs/ft/scr/2000/cr0004.pdf [2014, December 26].

ITC. 2014. Website: http://www.trademap.org/Index.aspx.

Itegeri, D. E. 2014. Correspondence. Milled rice price at milling plant gate. Gatsibo Rice Mill Ltd. Chief Executive Officer. 30 December, Gatsibo (Rwanda).

Jagwe, J., Okoboi, G., Hakizimana, P., Tuyisinge, J. & Rucibigango, M. 2003. Marketing survey of the rice sub-sector in Rwanda. Kigali: ATDT-CIAT/ISAR/IITA-FOODNET [Online]. Available: http://www.foodnet.cgiar.org/market/Rwanda/reports/RiceFinal%20Draft%20report.pdf [2014, December 26].

Jooste, A., & van Zyl, J. 1999. *Regional agricultural trade and changing comparative advantage in South Africa.* Technical paper No.94. Washington: Amex International.

Kannapiran, C.A. & Fleming, E. 1999. Competitiveness and comparative advantage of tree crop smallholdings in Papua New Guinea. Working paper series in Agricultural Resource Economics. No. 99-10. Armidale: University of New England.

Kathiresan, A. 2011. Strategies for sustainable crop intensification in Rwanda. Shifting focus from producing enough to producing surplus. Kigali: MINAGRI [Online]. Available: http://www.minagri.gov.rw/fileadmin/user_upload/documents/CIP/CIP_Strategies_2011.pdf [2014, December 26].

Kathiresan, A. 2013. Rwanda's rice commodity chain. Facing globalization Kigali: MINAGRI [Online]. Available: http://www.minagri.gov.rw/fileadmin/user_upload/documents/agridocs/RiceCommodity-Report_Kathir.pdf [2015, March 24].

Kelly, V.A., Mpyisi, E., Shingiro, E. & Nyarwaya, J.B. 2001. Agricultural intensification in Rwanda: An elusive goal. Fertilizer use and conservation investments. Minnesota: University of Minnesota [Online]. Available: http://ageconsearch.umn.edu/handle/54585 [2014, December 26].

Khai, H.V. & Yabe, M. 2013. The comparative advantage of soybean production in Vietnam: A policy analysis matrix approach, in J.E. Board (ed.). *A comprehensive survey of international soybean research: genetics, physiology, agronomy and nitrogen relationship*. Rijeka: InTech. pp: 161-179.

Kirsten, J. F., Ohene-Anyang, E. & van Rooyen, J. 1998. An analysis of the comparative advantage and policy incentives of commercial wheat production in South Africa. *Agrekon*, 37(4): 528-540.

Krueger, A.O. 1972. Evaluating restrictionist trade regimes: Theory and measurement. *The Journal of Political Economy*, 80(1): 48-62.

Krueger, A.O., Schiff, M. & Valdés, A. 1988. Agricultural incentives in developing countries: Measuring the effect of sectoral and economy wide policies. *The World Bank Economic Review*, 2(3):255-271.

Krugman, P.R. 1979. Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9(4): 469-479.

Krugman, P.R. 1981. Intra-industry specialization and the gains from trade. *Journal of Political Economy*, 89(5): 959-973.

Kuo, C., 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,* 83(2):269-285 [online]. Available: http://onlinelibrary.wiley.com/doi/10.1111/saje.12068/epdf [2015, July 11].

Kydd, J., Pearce, R. & Stockbridge, M. 1997. The economic analysis of commodity systems: extending the policy analysis matrix to account for environmental effects and transactions costs. *Agricultural Systems*, 55(2):323-345.

Lancaster, K. 1980. Intra-industry trade under perfect monopolistic competition. *Journal of International Economics*, 10(2):151-175.

Lanfranco, B., Ferraro, B. & Rava, C. 2014. Private and social profits and the effects on the competitiveness of Uruguay beef export chain. Unpublished paper prepared for presentation at the EAAE 2014 congress '*Agri-Food and Rural Innovations for Healthier Societies*'. Ljubljana, Slovenia [Online]. Available: http://ageconsearch.umn.edu/handle/182667 [2014, December 27].

Leamer, E.E. 1984. *Sources of international comparative advantage. Theory and evidence*. Massachusetts: Massachusetts Institute of Technology.

Lewis, W.A. 1994. Economic development with unlimited supplies of labour, in R. Kanth (ed.). *Paradigms in Economic development: Classic perspectives, critiques, and reflections*. New York: M.E. Sharpe, Inc. pp:59-98.

Liefert, W.M. 2002. Comparative (dis?)advantage in Russian agriculture. *American Journal of Agricultural Economics*, 84(3):762-767.

Liefert, W.M., Wescott, P. & Wainio, J. 2013. Modifying export taxes and quotas to make them less market-distorting. Working paper No. 13-04. Washington: International Agricultural Trade Research Consortium [Online]. Available: http://ageconsearch.umn.edu/bitstream/155284/2/IATRC_WP%2013-04%20Liefert%20Westcott,%20Wainio.pdf [2014, December 27].

Ligon, E. & Sadoulet, E. 2008. *Estimating the effects of aggregate agricultural growth on the distribution of expenditures.* Washington: World Bank [Online]. Available: https://openknowledge.worldbank.org/handle/10986/9096 [2014, December 27].

Lipsey, R.G., 1989. *An introduction to positive economics.* 7th ed. New York: Oxford University Press.

Lipsey, R.G., Courant, P.N. & Ragan, C.T.S. 1999. *Economics.* 12th ed. Massachusetts: Addison-Wesley.

Little, I.M.D. & Mirrlees, J.A. 1974. *Project appraisal and planning for developing countries*. London: Heinemann Educational Books.

Loveridge, S. 1991. Marketing in Rwandan imports and infrastructure. *Food Policy*, 16(2):95-104.

Mac Map (Market Access Map). 2014. Website: http://www.macmap.org/.

Mahlanza, B. 2001. Modelling the relative comparative advantage of organic wheat production in the Western Cape. Unpublished master's thesis. Stellenbosch: Stellenbosch University.

Mahlanza, B., Mendes, E., & Vink, N. 2003. Comparative advantage of organic wheat production in the Western Cape. *Agrekon*, 42(2):144-162.

Mankiw, N.G. & Taylor, M.P. 2006. *Microeconomics*. London: Thomson Learning.

Masters, W.A. & Winter-Nelson, A. 1995. Measuring the comparative advantage of agricultural activities: Domestic resource costs and the social cost-benefit ratio. *American Journal of Agricultural Economics*, 77(2):243-250.

McKenzie, R.B. 2008. *In defence of monopoly: How market power fosters creative production.* Ann Arbor: University of Michigan Press.

MINAGRI. 2004a. *National Agricultural Policy.* Kigali: MINAGRI.

MINAGRI. 2004b. *Plan stratégique de transformation de l'agriculture au Rwanda. Le développement des filières, la compétitivité et la promotion des cultures de marché.* Kigali : MINAGRI [Online]. Available: http://www.ifad.org/english/operations/pf/rwa/i671rw/web/theme/filieres.pdf [2014, December 27].

MINAGRI. 2009. *Strategic plan for the transformation of agriculture in Rwanda. Phase II.* Kigali: MINAGRI [Online]. Available: http://www.gafspfund.org/sites/gafspfund.org/files/Documents/Rwanda_StrategicPlan.pdf [2014, December 27].

MINAGRI. 2011a. *Crop assessment 2011A season. Crop area, yield and production*. Kigali: MINAGRI.

MINAGRI. 2011b. *Crop assessment 2011B season. Crop area, yield and production*. Kigali: MINAGRI.

MINAGRI. 2011c. *National rice development strategy*. Kigali: MINAGRI [Online]. Available: http://www.riceforafrica.org/new/downloads/NRDS/rwanda_en.pdf [2014, December 27].

MINAGRI. 2012a. *Crop assessment 2012A season. Crop areas, production and agriculture activities*. Kigali: MINAGRI.

MINAGRI. 2012b. *Crop assessment 2012B season. Crop areas, production and agriculture activities*. Kigali: MINAGRI.

MINAGRI. 2013a. *Crop assessment 2013A season: 2013A crop growing conditions, harvested areas, crop yield, crop production and food security*. Kigali: MINAGRI.

MINAGRI. 2013b. *Crop assessment 2013b season: 2013b crop growing condition, harvested areas, crop yield, crop production and food security*. Kigali: MINAGRI.

MINAGRI. 2014a. Rwanda agricultural statistics from agricultural season 1998A to 2010B, E-mail to B. Nkurunziza [Online], 18 August. Available E-mail: ngapaul08@gmail.com (A professional internee in MINAGRI).

MINAGRI. 2014b. *National fertilizer policy*. Kigali: MINAGRI [Online]. Available: http://www.minagri.gov.rw/fileadmin/user_upload/documents/STRAT.PLC/FERTILIZER_POLICY_-FINAL.pdf [2015, June 19].

MINICOM & RBS. 2013. The 2013 rice mills assessment report. E-mail to B. Nkurunziza [Online], 16 May. Available E-mail: gasorolivier@yahoo.fr (Services, industry, development policy specialist at the Ministry of Trade and Industry of Rwanda).

MINICOM. 2010. *Rwanda trade policy.* Kigali: MINICOM [Online]. Available: http://www.minicom.gov.rw/fileadmin/minicom_publications/policies/Trade_Policy_Rev_NPC_.pdf [2014, December 27].

MINICOM. 2012. *Instructions of the minister of trade and industry n°19 of 3rd November, 2012 on rice processing and trading.* Kigali: MINICOM [Online]. Available: http://www.minicom.gov.rw/fileadmin/minicom_publications/Decisions_and_orders/Minicom_rice_regulations_03-11-2012-2.pdf [2015, June 19].

MINICOM. 2013. *Itangazo ryo kugena igiciro cy' umuceri udatonoye (public announcement of the seasonal paddy rice price)*. Kigali: MINICOM [Online]. Available: http://www.minicom.gov.rw/spip.php?article755 [2014, December 27].

MINITERE. 2004. *National land policy.* Kigali: MINITERE [Online]. Available: http://www.rema.gov.rw/rema_doc/Policies/National_land_policy_english_version_.pdf [2014, December 27].

Mohanty, S., Fang, C. & Chaudhary, J. 2003. Assessing the competitiveness of Indian cotton production: A policy analysis matrix approach. *The Journal of Cotton Science*, 7:65-74.

Monitor Group. 2012. The business case for investing in the import and distribution of fertilizer in Rwanda [Online]. Available: http://www.usaid.gov/sites/default/files/documents/1860/The%20Business%20Case%20

for%20Investing%20in%20the%20Import%20and%20Distribution%20of%20Fertilizer%20in%20Rwanda.pdf [2014, December 27].

Monke, E.A. & Pearson, S.R. 1989. *The policy analysis matrix for agricultural development*. No. E10P362. Ithaca: Cornell University Press [Online]. Available: http://web.stanford.edu/group/FRI/indonesia/documents/pambook/pambook.pdf [2014, December 27].

Mucavele, F.G. 2000. *Analysis of comparative advantage and agricultural trade in Mozambique*. Technical paper No. 107. Washington: USAID Bureau for Africa, Office of Sustainable Development.

Mukaparadi, S. 2014. Personal interview. Storage costs, handling costs and other charges during the process of customs clearance. Rwanda Bonded Warehouses (MAGERWA Ltd) tally officer. 24 July, Kigali (Rwanda).

Murangira, F. 2014. Personal interview. Domestic transportation costs. The truck driver and president of COCTRAMAVKY (A cooperative of truck drivers in the neighbourhood of Rwanda Bonded Warehouses). 13 August, Kigali (Rwanda).

Murphy, E. 1989. Comparative advantage in dairying: An intercountry analysis within the European community. *European Review of Agricultural Economics*, 16(1):19-36.

Mutsindashyaka, E. 2014. Personal interview. Domestic transportation costs. Truck driver assistant. 25 August, Rwamagana (Rwanda).

Ndayizeye, O. 2014. Personal interview. Domestic transportation costs. Truck driver. 26 August, Nyagatare (Rwanda).

Nguyen, M.H. & Heidhues, F. 2004. Comparative advantage of Vietnam's rice sector under different liberalization scenarios. Discussion paper No. 01/2014. Stuttgart: University of Hohenheim.

NISR. 2014a. *The 2013 Seasonal agricultural survey report. Rwanda.* Kigali: NISR [Online]. Available: http://www.statistics.gov.rw/publications/seasonal-agricultural-survey-report-2013 [2014, December 27].

NISR. 2014b. *The third integrated household living conditions survey (EICV3). Main indicators report.* Kigali: NISR [Online]. Available: http://www.statistics.gov.rw/publications/third-integrated-household-living-conditions-survey-eicv-3-main-indicators-report [2014, December 27].

NISR. 2014c. Domestic and imported retail rice prices in Rwanda. E-mail to B. Nkurunziza [Online], 17 Apr. Available E-mail: oscar.sibomana@statistics.gov.rw (The NISR principal research statistician in charge of prices).

Nkubiri, A. 2014. Correspondence. Milling plant gate milled rice price. Kirehe Milling Plant Managing Director. 30 December, Kirehe (Rwanda).

Office of the Prime Minister. 2013. *Rwanda Official Gazette. No Special of 16/06/2013*. Kigali: Office of the Prime Minister [Online]. Available: http://www.primature.gov.rw/index.php?id=8&tx-filelist-pi1-36%5Bpath%5D=Official%20Gazettes%2F2013%20Official%20Gazettes&cHash=85fc825d2bdd984047a3dfbc2c373b34 [2014, December 24].

Office of the Sustainable Development Bureau for Africa. 1999. *Analysis of the comparative economic advantage of alternative agricultural production options in Tanzania*. Technical paper No. 102. Washington: Amex International.

Ogbe, A.O., Okoruwa, V.O. & Saka, O.J. 2011. Competitiveness on Nigerian rice and maize production ecologies: A policy analysis approach. *Tropical and Subtropical Agroecosystems*, 14: 493-500.

Parsons, B.J., Newbury, H.J., Jackson, M.T. & Ford-Lloyd, B.V. 1999. The genetic structure and conservation of aus, aman, and boro rices from Bangladesh. *Genetic Resources and Crop Evolution*, 46(6):587-598.

Porter, M.E. 1990. *Competitive advantage of nations*. New York: Free Press.

Posner, M.V. 1961. International trade and technical change. *Oxford Economic Papers*, 13(3):323-341.

Pottier, J. 1993. Taking stock: Food marketing reform in Rwanda, 1982-89. *African Affairs*, 92(366):5-30.

Pottier, J. 2002. *Re-imagining Rwanda: Conflict, survival and disinformation in the late twentieth century. Vol. 102*. Cambridge: Cambridge University Press.

Promar Consulting. 2012. Agriculture, forestry and fisheries of Rwanda. Fact-finding survey for the support of aid to developing countries. Fiscal year 2011 research project. Tokyo: Promar Consulting [Online]. Available: http://www.promarconsulting.com/site/wp-content/uploads/2012/05/Rwanda_2012.pdf [2014 June, 09].

Pugel, T.A. 2007. *International Economics*. 13th ed. Boston: Mc Graw-Hill Companies.

RAB. 2014. List of farmers' cooperatives and production statistics for agricultural seasons 2013B and 2014A. E-mail to B. Nkurunziza [Online], 28 Apr. Available E-mail: edkaquera88@yahoo.co.in (Professional in charge of farmers cooperatives development).

Razzaque, M.A. & Rafiquzzaman, S. 2007. Comparative analysis of T. Aman rice cultivation under different management practice in coastal area. *Journal of Agriculture and Rural Development*, 5(1&2):64-69.

RDB. 2012. *Rwanda. Ideal conditions for high value products. Investment opportunity: Rice production and processing.* Kigali: Rwanda Development Board (RDB) [Online]. Available:

http://www.rdb.rw/fileadmin/user_upload/Documents/Agriculture/Rice%20production%20and%20processing.pdf [2014, April 23].

RDB. 2014. *Privatization overview* Kigali: Rwanda Development Board (RDB) [Online]. Available: http://www.rdb.rw/departments/asset-and-business-management/privatization.html [2014, June 24].

Salvatore, D. 1990. *International Economics*. 3rd ed. New York: Macmillan Publishing Company.

Samuelson, P.A. 1967. *Economics. An introductory analysis*. 7th ed. New York: McGraw-Hill, Inc.

Schmitz, A. 2010. *Agricultural policy, agribusiness, and rent-seeking behavior*. 2nd ed. Toronto: University of Toronto Press Incorporated.

See Rates. 2014. Website: http://www.searates.com/reference/portdistance/. Edinburgh: SeaRates LP.

Seyanga, E. 2014. Correspondence. Milling plant gate milled rice price. UCOPRIBU Rice Union and Mayange Rice Milling Plant Agronomist. 17 October, Kigali (Rwanda).

Shahabuddin, Q., Hossain, M., Mustafi, B.A.A. & Narciso, J. 2002. Assessment of comparative advantage in rice cultivation in Bangladesh, in M. Sombilla, M. Hossain, & B. Hardy. (eds.). *Developments in the Asian Rice Economy*. Metro Manila: International Rice Research Institute (IRRI). pp:369-384.

Shapiro, B.I. & Staal, S.J. 1995. The Policy analysis matrix applied to agricultural commodity markets, in G. J. Scott (ed.). *Prices products and people: Analyzing agricultural markets in developing countries*. Colorado: Lynne Rienner Publishers. pp:73-97.

Sharif, A. 2011. Technical adaptations for mechanized SRI production to achieve water saving and increased productivity in Punjab, Pakistan. *Paddy and Water Environment*, 9(1):111-119.

Squire, L. & van der Tak, H.G. 1975. *Economic analysis of projects*. Washington: The International Bank for Reconstruction and Development.

Stoforos, C., Kavcic, S., Erjavec, E. & Mergos, G. 2000. Agricultural policy analysis model for Slovenian agriculture, in D.A. Giannias (ed.). *Selective readings on economies in transition. Cahiers Options Méditerranéennes n.44*. Chania: CIHEAM. pp:91-102.

The government of Rwanda (Kirehe District). 2013. *District potentialities assessment for the integrated and self-centered local economic development*. Kirehe: The Government of Rwanda [Online]. Available: http://www.kirehe.gov.rw/uploads/media/Economic_Potentialities_of_Kirehe_District.docx [2014, December 26].

The government of Rwanda. 2010. *The 2010 Rwanda Irrigation Master Plan*. Nairobi: World Agroforestry Centre (ICRAF) [Online]. Available: http://www.worldagroforestry.org/downloads/Publications/PDFS/B16738.PDF [2014, December 28].

The New Times Rwanda. 2014. *Rice farmers seek government intervention over water shortage, irrigation systems.* Kigali: The New Times Rwanda [online] Available: http://www.newtimes.co.rw/section/article/2014-12-26/184417/ [2014 December, 26].

The New Times Rwanda. 2015. *Expedite approval of new minimum wage law.* Kigali: The New Times Rwanda [Online]. Available: http://www.newtimes.co.rw/section/article/2015-01-27/185351/ [2015, June 2015].

The World Bank. 2010. Budgeting for effectiveness in Rwanda: From reconstruction to reform. World Bank working paper No. 205. Washington: The International Bank for Reconstruction and Development/the World Bank.

Touré, A., A., Groenewald, J., Seck, P. A., & Diagne, A. 2013. Analysing policy induced effects on the performance of irrigated rice. *African Journal of Agricultural and Resource Economics*, 8(1):68-77.

Umuhinzi. 2014. *Private sector takes up fertilizer distribution.* Kigali: Umuhinzi [Online]. Available: http://www.umuhinzi.com/programs/5375/private-sector-takes-up-fertilizer-distribution/ [2014, December 28].

UNdata. 2014. *Agriculture, value added (% of GDP)* New York: United Nations Statistics Division [Online]. Available: http://data.un.org/Data.aspx?d=WDI&f=Indicator_Code:NV.AGR.TOTL.ZS [2014, December 28].

United Nations Industrial Development Organization (UNIDO) & Industrial Development Center for Arab States (IDCAS). 1986. *Manual for evaluation of industrial projects*. Vienna: UNIDO [Online]. Available: http://www.unido.org/fileadmin/user_media/Publications/download/Manual_for_Evaluation_of_Industrial_Projects.pdf [2015 May, 02].

United Nations. 2013. *The Least Developed Countries Report 2013* New York: United Nations [Online]. Available: http://unctad.org/en/PublicationsLibrary/ldc2013_en.pdf [2014 December, 28].

USDA FAS. 2014. Website: http://apps.fas.usda.gov/psdonline/psdQuery.aspx.

Vernon, R. & Wells, L. T. 1966. International trade and international investment in the product life cycle. *Quarterly Journal of Economics,* 81(2):190-207.

Verwimp, P. 2002. Agricultural policy, crop failure and the 'Ruriganiza' famine (1989) in Southern Rwanda: A prelude to genocide? Discussion paper. Leuven: Catholic University of Leuven.

Vitalle, A., Morrison, J. & Ramesh, S. 2013. The East African Community common external tariff on cereals: An analysis of stakeholder perceptions. FAO Commodity and Trade Policy Research Working Paper. Rome: FAO [Online]. Available: http://www.fao.org/docrep/017/aq374e/aq374e.pdf [2014, December 28].

Weckstein, R.S. 1972. Shadow prices and project evaluation in Less-Developed Countries. *Economic Development and Cultural Change*, 20(3):474-494.

Winch, D. 1992. Adam Smith: Scottish moral philosopher as political economist. *The Historical Journal*, 35(01):91-113.

Winters, L.A. 1991. *International economics.* 4th ed. London: HarperCollins Academic.

WTO. 2012. *Trade Policy Review. Reports by the East African Community members.* Geneva: The World Trade Organization [Online]. Available: https://www.wto.org/english/tratop_e/tpr_e/tp371_e.htm [2015, July 13].

Yao, S. 1993. *Policy Analysis Matrix. The Major Crops of Pakistan*. Report for Food and Agriculture Organisation of the United Nations and the Ministry of the Pakistan Government.

Yao, S. 1997. Comparative advantages and crop diversification: A policy analysis matrix for Thai agriculture. *Journal of Agricultural Economics*, 48(1-3):211-222.

Yao, S. 2005. Economic transition and the decline of agricultural production in Estonia. *Journal of international development*, 17(4):495-509.

Yeats, A. J. 1985. On the appropriate interpretation of the revealed comparative advantage index: implications of a methodology based on industry sector analysis. *Weltwirtschaftliches Archiv*, 121(1):61-73.

APPENDICES

APPENDIX A: Farm survey questionnaire

Questionnaire Code ☐☐ **Date of interview: … …/… …/ … …. ….**

Introduction

This farm survey is being conducted by Benjamin Nkurunziza for the purpose of completing his master's thesis in agricultural economics. The aim of this survey is to identify the input quantity requirements, yields, expenditure on inputs and paddy rice farm gate price, for a typical rice farm in the Eastern Province of Rwanda. Knowing this information would help the researcher to estimate the comparative cost advantage of Rwanda in rice production relative to the rest of the world.

This survey is anonymous. We would appreciate if you could answer the following questions authentically.

A. Farmer's Identification

A.1 Cooperative name:			
A.2 Cell Name:		A.3 Sector Name:	
A.4 District Name:		A.5 Province Name:	

Instructions:

- This survey is based on one agricultural season, and it uses current market prices.
- The estimated quantity of inputs used in rice production and farm yields are those of a representative farm of the size that is estimated in question B.1.

B. Farm Size and Land Rental Value

<table>
<tr><td colspan="3">B.1 What is the average size of a representative (most common) farm in your cooperative?

Codes for unit:
Square meters: …….....1
Hectare:…….……..…2
Area…...……..…...3
Other (Specify):…....….4</td><td>B.2 What is the total rental value for that farm? (In Frw, as paid to the local government)</td><td>B.3 What is the rental value of a farm of approximately equal size to the representative farm, if rented from upland (in a private market)? (In Frw)

Note: If an in-kind payment, please, assist the respondents by estimating the equivalent in monetary terms, using prevailing market prices.</td></tr>
<tr><td></td><td>Unit</td><td>Quantity</td><td>Rental value in Frw</td><td>Rental value in Frw</td></tr>
<tr><td>Farm size</td><td></td><td></td><td></td><td></td></tr>
</table>

C. Uses of Intermediate Inputs (Seeds, Fertilizers, Pesticides and Fuel)

C.1 What are the intermediate inputs used by the farmer? C.2 What quantity of each intermediate input does the farmer use on this representative farm? Codes for intermediate inputs: Seeds……..……1 NPK…….……..2 UREA……3 Compost…….....4 Cypermethrin…….……5 Beam (Trycyclazole)……..6 Benomyl (Benlate)…….7 Fuel……....8 Codes for unit: mgs…….1/grs……..….2 Kgs…….3/ml……..…..4 cl…….5/l…….……6 Others (specify)….....			C.3 Where does the farmer source each of these inputs? Source of the input: Home……..…..1 Another farmer.....2 Cooperative.....3 Market …….5 Other (specify)…..6 C.4 In which district does the farmer source the input?		C.5 Does the farmer get any direct price support on this purchased input? Yes…...1/No……2 (Please tick) C.6 If support is received, what amount of money does the farmer pay for each unit of this input? C.7 What amount of money would the farmer pay without price support?			C.8 What is the distance between the farm and the source of the input? Codes for unit: Minutes walking..1 Km……...2 m……..……....3 Other(specify)…..4		C.9 What is the mode of transport used? Code: Codes for mode of transport On foot……1 On own bicycle …2 On a bicycle taxi...3 Other (specify)…..4	C.10 If the famer carries the input himself / herself to the farm, by foot or with own bicycle, how much time is spent travelling back and forth? Unit for time: Hours…..…1 Minutes…...2		C.11 If the famer uses a taxi (bicycle, motor bicycle, truck) as a mode of transport, how much money does the farmer spend in total to carry these inputs at farm?
Input	Unit	Quantity	Source: Institution	Source: District	Yes/ No	Paid price (with support)	Paid price (without support)	Unit	Quantity	Mode of transport	Unit	Quant ity	Amount (Frw)		

D. Uses of agricultural equipment (machinery, vehicles and tools) on the representative farm

D.1 What are the different types of equipment (machinery, vehicles and tools) used by the farmer, in rice farming?

D.2 What is the quantity of each item of equipment that the farmer uses on this representative farm?

Code for equipment:
Hoe……..…..…..1
Machete 1……..……....2
Machete 2…….……3
Shovel……..……....4
Rake……..……5
Sickle.…….……..6
Sprayer……...…...7
Bags……..8
Tent…….……...…9
Other (specify)……10

D.3 Where does the farmer source each of these items of equipment?

Source of the input:
Home……...1
Another farmer…....2
Cooperative.....3
Market ……....5
Other (specify)…....6

D.4 In which district does the farmer source the input?

D.5 Does the farmer get any direct price support on this purchased equipment?
Yes…...1/No……2

D.6 If support is received, what is the amount of money that the farmer pays for each unit of this equipment?

D.7 If there is no price support, what is the unit acquisition price for this equipment?

D.8 What is the distance between the farm and the source of the equipment?

Codes for unit:
Minutes walking..1
Km……..……...2
m…….....3
Other (specify)....4

D.9 What is the mode of transport used?

Code:
Codes for mode of transport
On foot……....1
On own bicycle...2
On a bicycle taxi.3
Other (specify)...4

D.10 If the famer carries the equipment on the farm himself / herself, on foot or with own bicycle, how much time is spent going back and forth?

Unit for time:
Hours……1
Minutes……....2

D.11 If the famer uses a taxi (bicycle, motor bicycle, truck) as a mode of transport, how much does the farmer spend in total to bring these items of equipment to the farm?

Equipment	Unit	Quantity	Source: Institution	Source: District	Yes/ No	Paid price (with support)	Paid price (Without support)	Unit	Quantity	Mode of transport	Unit	Quantity	Amount (Frw)

In this section, list the equipment used as specified in D.1	D.12 Does the farmer use this equipment in the production of other crops? Yes/No (Please tick) Code: Yes…1 No…2 D.13 If yes, what proportion (%) of the total use of this equipment does the farmer allocate to rice production?		D.14 What is the useful life for each item of equipment? Codes for useful life? Seasons……1 Years……...2		D.15 After the useful life of the equipment, what does the farmer do with it? Codes for uses after the useful life: Throw it away……1 Sell it…….....2 Other (specify)…….…....3 D.16 If the equipment is sold, how much money would the farmer expect to get from the sale of the equipment? (in Frw)		D.17 Is this equipment maintained and/or repaired? Yes…..1/No……2 (Please tick) D.18 if yes, how much money on average does the farmer spend on the maintenance and repair of this equipment each season?	
Equipment	'Yes' if used elsewhere, 'no' if not	Proportion (%)	Unit	Quantity	Uses	Amount (Frw)	Yes/No	Amount (Frw)

E. Equipment hire

E.1 Does the farmer use any hired equipment (machinery and vehicles) in rice production? Yes ……1 No……..2 If No, Skip to F1. E.2 If yes, specify which type of equipment.		E.3 What is the quantity of each type of hired equipment that the farmer uses?	E.4 Does the farmer use the equipment in the production of crops, other than rice? Yes/No (Please tick) CODE: Yes…1 No…2 E.5 If yes, what proportion (%) of total use of that equipment does the farmer allocate to rice production?	E.6 For how much does the farmer rent each type of equipment, for one agricultural season?	
Equipment	**Description**	**Quantity hired**	**Proportion (%)**	**Amount (Frw)/unit**	**Amount (Frw)/all**

F. Labour use

F.1 In this section, list all of the rice farming activities requiring the use of labour.	F.2 How many family members (including the farmer) does the farmer use for each activity on the representative farm? F.3 How many external (paid) labourers does the farmer use for each activity on the representative farm?		F.4 For how many weeks do those labourers work? F.5 During each week, how many days does each labourer work? F.6 During a day, how many hours does each labourer work?			F.7 What total amount of money does the farmer pay as remuneration of this labour? Note: If an in-kind payment, assist the farmers to estimate the equivalent in monetary terms using prevailing market prices.
	Quantity		Weeks	Days	Hours	Amount (Frw)
	Family labour	External labour				
Land preparation						
Seedbed preparation						
Seedbed follow-up						
Ploughing and puddling						
Transplanting seedlings and planting						
NPK fertilizer application						
First weeding						
First UREA application						
First pesticide application						
Second weeding						
Second UREA application						
Second pesticide application						
Third weeding						
Third pesticide application						
Fourth weeding						
Water channeling						
Bird scaring						
Harvesting, transportation to cooperative, and threshing						
Drying						
Winnowing						
Packaging						

G. Harvesting and transportation of bundles of rice to cooperative's drying and storage facilities

G.1 What is the estimated distance between the farm and the cooperative's drying and storage facilities? Codes for unit : Minutes walking ……..…...1 Km……..….2 m……...…...3 Other (specify)……..4		G.2 What is the mode of transport used to take the produce (bundles of rice) to the cooperative's facilities? Codes for mode of transport On foot……1 On own bicycle……....2 On a bicycle taxi……..3 Other (specify)……4	G.3 If the famer uses a taxi (bicycle, motor bicycle, truck) as a mode of transport, how much money does the farmer spend on that transportation?
Unit	Distance	Mode of transport	Amount (Frw)

H. Preliminary post-harvesting activities incurred at the cooperative's facilities

H.1 What are different post-harvest activities conducted at cooperatives before the produce is sold to the milling plant? Threshing……..…..…..1 Drying……...…...2 Winnowing...……..…..3 Storing…….…….....4 Other (please specify)……..……5	H.2 How (in which way) does the cooperative charge the farmer for these activities conducted at the cooperative?		
Activity	Mode of payment	Amount (Frw)	Total Amount (Frw)

I. Sale of paddy rice

I.1 Under normal weather conditions, what is the mostly likely quantity of paddy rice that the farmer would expect to produce from the representative farm? Code for unit: Kgs……1 Tons……..…..2 Other (Specify……..……...3		I.2 What is the name of the milling plant to which the farmers' cooperative sells paddy rice?	I.3 What is the estimated distance between the milling plant and the cooperative's storage facilities? Codes for unit : Km…….……...1 Truck Hours…….2 m…....…….…...3 Other (specify)…..4		I.4 What amount of money does the milling plant pay the farmer for 1 kg of paddy? I.5 How much money is deducted by the cooperative (excluding the amount deducted as a repayment for inputs taken by the farmer on loan) I.6 How much money is deducted for taxes?		
Unit	Quantity	Name	Unit	Quantity	Price, Amount (Frw)	Amount deducted by cooperative, (Frw)	Taxes (Frw)

APPENDIX B: Determinants of domestic marketing costs along each cooperative's rice value chain

Category	Variable	Unit	Mean
Determinants of the marketing cost along the rice value chain, for each cooperative	TransportCost_RwandaBondedWarehousesToRiceWholesaleMarket	Frw/MT	16883.2
	TransportCost_ RwandaBondedWarehousesToRiceWholesaleMarket	USD/MT	24.7
	Distance_ RwandaBondedWarehousesToRiceWholesaleMarket	Km	98.2
	TransportCost_RiceMillToWholesaleMarket	Frw/MT	3787.3
	TransportCost_RiceMillToWholesaleMarket	USD/MT	5.5
	Distance_RiceMillToWholesaleMarket	Km	13.3
	MilledRicePrice_MillGate	Frw/Kg	541.1
	MilledRicePrice_MillGate	USD/Kg	0.8
	PaddyRicePrice_MillGatePriceEquivalent	Frw/Kg	351.4
	PaddyRicePrice_MillGatePriceEquivalent	USD/Kg	0.5
	FarmGatePrice_PaddyRice	Frw/Kg	226.6
	FarmGatePrice_PaddyRice	USD/Kg	0.3
	PriceMargin_PaddyRice_FarmGateToMillGate	%	55.4

Source: Survey data, Google Map (2014)

APPENDIX C: Paddy rice production in the Eastern Province of Rwanda during agricultural season 2014A. Disaggregated by farmers' cooperatives

N	Cooperative	District	Marshland	Area Planted (ha)	Production (MT)
1	Twizamure	Bugesera	Gatare	25.0	120.0
2	Inkingi y'ubuhinzi	Bugesera	Kibaza	25.0	125.0
3	Copauki	Bugesera	KizanyeI	15.0	80.0
4	Kopetwiteki	Bugesera	KizanyeII	24.0	60.0
5	Corinyaburiba	Bugesera	Nyabuliba	33.0	150.0
6	Coriru	Bugesera	Rurambi	300.0	1500.0
7	Cogiriru	Bugesera	Ruvubu	55.0	250.0
8	Koterwa	Bugesera	Rwabikwano	40.0	240.0
9	Korivarwi	Bugesera	Rwintare	48.0	312.0
10	Jyambere nyarugenge	Bugesera	-	11.0	72.0
11	Dukundamahoro	Bugesera	-	10.0	40.0
12	Corimak	Gatsibo	Kanyonyomba	380.0	1800.0
13	Cooproriz ntende	Gatsibo	Ntende	485.0	2570.5
14	Cocurika	Kayonza	Kabare	15.0	54.6
15	Cocurivam	kayonza	Kayonza	43.0	197.8
16	Cocuriru	Kayonza	Ruramira	32.0	150.4
17	Mrgc	Kirehe	Binoni/mushikiri	46.0	193.2
18	Coopriki	Kirehe	Kibaya cyunuzi	472.0	2171.2
19	Isabane	Kirehe	Kinyogo	72.0	345.6
20	Corimu	Kirehe	Musaza	12.0	60.0
21	Kijumbura rice growers	Kirehe	-	12.0	72.0
22	Cocurire	Ngoma	Buriba	35.0	161.0
23	Duhuzimbaraga	Ngoma	Gahombo	11.0	60.0
24	Cocurigi	Ngoma	Gisaya	65.0	292.5
25	Coperig	Ngoma	Gitinga	60.0	270.0
26	Kopamunya	Ngoma	Mutendeli	46.0	230.0
27	Coprimwa	Ngoma	Mwambu	88.0	404.8
28	Krf	Ngoma	-	60.0	92.0
29	Corimi	Ngoma	Mirenge	185.0	888.0
30	Corivanya	Nyagatare	Corivanya	120.0	300.0
31	Co-dervam	Nyagatare	P1,2,3(muvumba)	400.0	1200.0
32	Cooprorika	Nyagatare	P4(muvumba)	141.0	562.0

N	Cooperative	District	Marshland	Area Planted(ha)	Production (MT)
33	Coprimu	Nyagatare	P5(muvumba)	137.0	203.2
34	Cooperative	Nyagatare	P8(Kirimburi)	282.0	1551.0
35	Abahindi	Nyagatare	P8(Kirimburi)	350.0	1050.0
36	Cocuricyi	Rwamagana	Cyimpima	49.8	248.8
37	Cocuribu	Rwamagana	Bugugu	27.0	121.5
38	Cocuricya	Rwamagana	Cyaruhogo	70.3	330.2
39	Cocuriga	Rwamagana	Gashara	30.0	135.0
40	Cocurimu	Rwamagana	Muhazi	5.0	21.0

Source: RAB (2014)

APPENDIX D: Import parity price for rice (import tariff included).

Stage/Steps	Amount
FOB Pakistan rice (25 % broken) (USD/MT)	392
+ Freight cost. Karachi port to Mombasa/Kenya (USD/MT), 18 tons container	36.1
+ Insurance cost, Karachi port to Mombasa (0.5 % of CIF), USD/MT	2.15
CIF at Mombasa (USD/MT)	430.25
+ Freight cost. Mombasa port to Kigali/Rwanda (USD/MT), 18 tons container	138.9
+ Insurance cost Mombasa to Kigali (0.5 % of CIF), USD/Ton	2.86
CIF at Kigali/Rwanda bonded warehouses (MAGERWA) (USD/MT)	572.01
+ Import Tariff, (52.4 % of CIF at Mombasa port)	225.45
+ VAT, (18 % of CIF at Rwanda bonded warehouses)	
IPP at Rwanda Bonded warehouses, USD/MT	797.46
* Official Exchange rate (Frw/USD)	684.24
IPP at Rwanda bonded warehouses (Frw/MT)	545654
+ Handling cost (Unloading, reload etc.) (Frw/MT), 10 Frw/Kg	10000
+ Parking fees (Frw/MT), 18 tons container, Frw 10000 lump sum	555.56
+ Storage cost (Frw/Ton), 1 Frw/day (The first 3 days are free of charge)	2000
+ VAT, (18 % of Handling, parking and storage costs)	
IPP at Rwanda bonded warehouses exit gate (Frw/MT)	558209.6
+ Transport Cost to rice wholesale market (Frw/MT), 15 tons container	16883.24
IPP at wholesale market (Frw/MT)	575092.8
- Transport cost milling plant to wholesale market (Frw/MT)	3787.3
- Loading cost (Frw/MT)	2000
IPP at milling plant gate	569305.5
* Conversion factor (Paddy rice to Milled rice)	0.65
IPP (Paddy rice equivalent) at milling plant gate	370048.6
price margin between farm and milled rice gate	55%
/ (1+Marketing margin)	
IPP at farm gate level (Frw/MT)	238741
IPP at farm gate level (USD/MT)	348.8224

Source:Compiled based on farm survey findings; Bahati (2014); BNR (2014a); Bolloré Africa logistics (2014); Bwimba (2014); Mac Map (2014); Murangira (2014); CORIMI (2014); Mukaparadi (2014); Itegeri (2014); Mutsindashyaka (2014); Ndayizeye (2014); Basabira(2014); Nkubiri (2014); Seyanga (2014).

APPENDIX E: Weighted averages for expenditure on inputs and farm revenues (over 1 ha), during one agricultural season.[80]

Category	Variables	Mean (Frw)	Mean (USD)
Output	Farm Revenue	1373814.01	2007.27
Land	LandRental_Marshland	21135.75	30.88
Equipment/Tools	Hoe_Expenditure	5440.30	7.95
	Machete1_Expenditure	1098.07	1.60
	Basin_Expenditure	401.03	0.59
	WateringCan_Expenditure	5.38	0.01
	Machete2_Expenditure	1353.71	1.98
	Sprayer_Expenditure	20387.49	29.79
	Shovel _Expenditure	1270.81	1.86
	Sickle_Expenditure	1932.43	2.82
	Tents_Expenditure	40024.35	58.48
	Basket _Expenditure	22.01	0.03
	Winnower_Expenditure	3928.22	5.74
	String1 _Expenditure	1113.82	1.63
	String2 _Expenditure	76.54	0.11
	Rake _Expenditure	820.36	1.20
	Hoe2 _Expenditure	105.14	0.15
	Bags_Expenditure	17244.51	25.20
Labour	FamilyLabour_Expenditure	0.00	0.00
	ExternalLabour_Expenditure	568925.60	831.25
Fertilizers	NPK_Expenditure	108166.60	158.04
	UREA_Expenditure	88819.95	129.77
	Compost_Expenditure	0.00	0.00
Pesticides	Cypermethrin_Expenditure	11056.6033	16.15
	Dimethoate_Expenditure	169.7114	0.25
	Beam_Expenditure	10812.5036	15.80
	Benomyly_expenditure	85.4160	0.12
Seeds	Seeds	15120.11	22.09
Contributions Cooperative	Contributions to cooperative	14819.22	21.65

Source: Research findings

[80] They were estimated based on the share of each cooperative in the total paddy rice produced by the 31 cooperatives under the scope of this study, during agricultural season 2014 A (refer to appendix C).

APPENDIX F: PAM indicators in a 20 % decrease in world rice price scenario

	Name of cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.67	1.34	1.55	0.88	2.02	0.59
2	Cocuricyi	0.50	1.10	1.55	0.87	1.89	0.69
3	Cocuribu	0.74	1.63	1.55	0.89	2.02	0.67
4	Cocuriga	1.05	3.21	1.55	0.91	2.48	0.84
5	Cocurire	0.91	4.17	1.55	0.95	2.70	1.16
6	Coperig	0.62	1.56	1.55	0.93	2.11	0.71
7	Coprimwa	0.26	1.44	1.55	0.89	2.06	1.10
8	Cocurigi	0.82	1.94	1.55	0.91	2.03	0.74
9	Coproriz	0.61	1.19	1.49	0.96	1.71	0.60
10	Corimak	0.61	1.16	1.49	0.96	1.76	0.56
11	Coprorika	0.73	2.14	1.51	0.96	2.30	0.73
12	Codervam	0.49	1.11	1.51	0.94	1.90	0.65
13	Corvny	0.51	1.15	1.51	0.93	1.99	0.62
14	Corinyaburiba	0.67	1.59	1.52	0.95	1.84	0.76
15	Twizamure	0.88	2.62	1.52	0.95	2.16	0.88
16	Inkingi y'ubuhinzi	0.61	2.14	1.52	1.05	1.91	1.02
17	Jyambere nyarugenge	0.77	2.15	1.52	1.00	2.27	0.68
18	Koterwa	0.54	1.63	1.52	0.98	1.93	0.86
19	Korivarwi	0.50	1.28	1.52	0.97	1.91	0.72
20	Copauki	0.83	1.92	1.52	0.99	1.96	0.68
21	Copriki cyunuzi	0.58	1.02	1.46	0.93	1.75	0.48
22	Isabane	0.81	1.63	1.46	0.99	1.86	0.52
23	Mushikiri rice growers	0.67	1.13	1.46	0.95	1.71	0.46
24	Kijumbura rice growers	0.76	1.43	1.46	0.99	1.74	0.53
25	Corimu	0.74	2.29	1.46	1.02	1.99	0.82
26	Cocuriru	0.55	1.12	1.55	0.96	1.85	0.62
27	Corimaru	0.53	0.95	1.52	1.04	1.81	0.49
28	Kopetwiteki	0.85	1.84	1.52	0.93	2.10	0.58
29	Cocurivam	0.71	1.62	1.55	0.91	2.08	0.67
30	Corimi	0.27	0.69	1.55	0.97	1.86	0.68
31	Coprimu	1.05	2.61	1.51	0.95	2.37	0.59
	Regional	0.58	1.21	1.50	0.96	1.83	0.61

Source: Research findings

APPENDIX G: Estimation of the IPP for rice, with FOB export price for India used as reference

Stage/Steps	Amount
FOB India rice (25 % broken) (USD/MT)	385.00
+ Transport cost from India, Kakinada port to Kigali, Rwanda (USD/MT)[81]	160.00
+ Insurance cost (0.5 % of FOB & Freight cost)	2.74
CIF at Kigali, Rwanda customs depots (USD/MT)	547.74
* Official Exchange rate	684.42
CIF at Rwanda customs depots (Frw/MT)	374883.32
+ Handling cost (Unloading, reload etc.) (Frw/MT)	10000.00
+ Parking fees (Frw/MT)	555.56
+ Storage cost (Frw/MT)	2000.00
IPP at customs depots exit gate (Frw/MT)	387438.87
+ Transport Cost to rice wholesale market	16883.24
IPP at entry gates of wholesale markets	404322.11
- Transport cost milling plant to wholesale market (Frw/MT)	3787.30
Loading cost (Frw/MT)	2000.00
IPP at exit gate of the milling plant (Frw/MT)	398534.81
* Conversion factor (Paddy rice to Milled rice)	0.65
IPP (Paddy rice equivalent) at exit gate of the milling plant (Frw/MT)	259047.63
Marketing margin between the milling plant and the farm gate	0.55
/ (1+Marketing margin)	
IPP at farm gate level(Frw/MT)	167127.50
IPP at farm gate level (USD/MT)	244.19

Source: Compiled based on the farm survey findings; Bahati (2014); BNR (2014a); Bolloré Africa logistics (2014); Bwimba (2014); Murangira (2014); CORIMI (2014); Mukaparadi (2014); Itegeri (2014); Mutsindashyaka (2014); Ndayizeye (2014); Basabira (2014); Nkubiri (2014); Seyanga (2014)

[81] The distance between India, Kakinada port to Kigali/Rwanda Bonded Houses is estimated at 4504.24 km (nautical miles 2432.1) from Kakinada port to Mombasa/Kenya port using the sea way, and then 1435 km from Mombasa port to Kigali, using road (Google Map, 2014; Sea Rates, 2014).

APPENDIX H: PAM indicators in a scenario where the FOB rice price for India is used as reference

	Name of cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.67	1.13	1.39	0.88	1.70	0.43
2	Cocuricyi	0.50	0.94	1.39	0.87	1.62	0.52
3	Cocuribu	0.74	1.37	1.39	0.89	1.70	0.50
4	Cocuriga	1.05	2.53	1.39	0.91	1.96	0.66
5	Cocurire	0.91	3.16	1.39	0.95	2.04	0.95
6	Coperig	0.62	1.29	1.39	0.93	1.75	0.54
7	Coprimwa	0.26	1.21	1.39	0.89	1.72	0.89
8	Cocurigi	0.82	1.63	1.39	0.91	1.70	0.57
9	Coproriz	0.61	1.03	1.35	0.96	1.48	0.45
10	Corimak	0.61	1.00	1.35	0.96	1.51	0.41
11	Coprorika	0.73	1.70	1.37	0.96	1.83	0.56
12	Codervam	0.49	0.94	1.37	0.94	1.61	0.49
13	Corvny	0.51	0.97	1.37	0.93	1.67	0.47
14	Corinyaburiba	0.67	1.35	1.37	0.95	1.57	0.59
15	Twizamure	0.88	2.12	1.37	0.95	1.75	0.69
16	Inkingi y'ubuhinzi	0.61	1.78	1.37	1.05	1.59	0.82
17	Jyambere nyarugenge	0.77	1.69	1.37	1.00	1.79	0.51
18	Koterwa	0.54	1.37	1.37	0.98	1.62	0.67
19	Korivarwi	0.50	1.08	1.37	0.97	1.61	0.55
20	Copauki	0.83	1.60	1.37	0.99	1.63	0.51
21	Copriki cyunuzi	0.58	0.87	1.32	0.93	1.50	0.34
22	Isabane	0.81	1.36	1.32	0.99	1.56	0.38
23	Mushikiri rice growers	0.67	0.97	1.32	0.95	1.48	0.32
24	Kijumbura rice growers	0.76	1.22	1.32	0.99	1.48	0.38
25	Corimu	0.74	1.85	1.32	1.02	1.61	0.64
26	Cocuriru	0.55	0.96	1.39	0.96	1.59	0.46
27	Corimaru	0.53	0.81	1.37	1.04	1.54	0.35
28	Kopetwiteki	0.85	1.51	1.37	0.93	1.72	0.42
29	Cocurivam	0.71	1.35	1.39	0.91	1.73	0.50
30	Corimi	0.27	0.59	1.39	0.97	1.59	0.51
31	Coprimu	1.05	2.06	1.37	0.95	1.87	0.44
	Weighted average (All)	0.58	1.03	1.36	0.96	1.56	0.46

Source: Research findings

APPENDIX I: Rice production cost for a selection of farm inputs: a comparative analysis of Rwanda, Thailand and Vietnam

	Eastern Province of Rwanda	Thailand, typical farm		Vietnam, (typical farm)	
		Rain fed	Irrigated[82]	First farm[83]	Second farm
Labour (hours/ha)	6445.98	200.00	791.50	2026.67	280.00
Item					
Seeds	22.10	97.66	129.78	82.50	151.88
Fertilizers, total	287.80	357.22	243.09	306.99	291.53
Plant protection (pesticides)	32.30	0.00	101.63	93.75	204.50
Labour	831.30	182.09	164.22	213.50	187.75
Total direct costs	1173.50	636.97	638.72	696.74	835.66
Depreciation (machinery)	0.00	199.63	347.89	13.89	112.50
Depreciation (farm buildings)	0.00	62.50	15.63	41.67	30.00
Depreciation on (farming tools)	113.80	0.00	0.00	0.00	0.00
Total overhead costs	113.80	262.13	363.52	55.56	142.50
Total production costs	1287.30	899.09	1002.23	752.30	978.16

Source: Agribenchmark (2014:16-27), author's survey

Note: Land costs and administrative costs are excluded from this comparison since they were not mentioned in Agribenchmark (2014) where the data was retried for a comparative analysis.

[82] Average production cost for the dry and wet seasons.

[83] Since there were three crop rotations (rice-rice-corn), and since the data for labour hours and depreciation were not disaggregated for each crop, this study roughly divided the production data by 3 to get the share allocated for rice production for one season.

APPENDIX J: PAM in a scenario where labour quantity is reduced by 25 %

	Name of cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.51	0.83	1.34	0.88	1.60	0.39
2	Cocuricyi	0.38	0.69	1.34	0.87	1.54	0.46
3	Cocuribu	0.57	1.00	1.34	0.89	1.60	0.44
4	Cocuriga	0.81	1.81	1.34	0.91	1.81	0.56
5	Cocurire	0.70	2.23	1.34	0.95	1.87	0.76
6	Coperig	0.47	0.93	1.34	0.93	1.64	0.46
7	Coprimwa	0.20	0.88	1.34	0.89	1.62	0.72
8	Cocurigi	0.63	1.18	1.34	0.91	1.60	0.48
9	Coproriz	0.46	0.75	1.30	0.96	1.41	0.38
10	Corimak	0.47	0.73	1.30	0.96	1.44	0.35
11	Coprorika	0.56	1.23	1.32	0.96	1.69	0.48
12	Codervam	0.37	0.69	1.32	0.94	1.52	0.42
13	Corvny	0.38	0.71	1.32	0.93	1.57	0.41
14	Corinyaburiba	0.52	1.02	1.32	0.95	1.49	0.51
15	Twizamure	0.68	1.53	1.32	0.95	1.63	0.56
16	Inkingi y'ubuhinzi	0.49	1.31	1.32	1.05	1.49	0.65
17	Jyambere nyarugenge	0.62	1.22	1.32	1.00	1.65	0.41
18	Koterwa	0.43	1.03	1.32	0.98	1.52	0.56
19	Korivarwi	0.39	0.78	1.32	0.97	1.52	0.45
20	Copauki	0.63	1.15	1.32	0.99	1.53	0.43
21	Copriki cyunuzi	0.44	0.64	1.27	0.93	1.42	0.29
22	Isabane	0.63	1.00	1.27	0.99	1.46	0.32
23	Mushikiri rice growers	0.52	0.71	1.27	0.95	1.40	0.27
24	Kijumbura rice growers	0.58	0.89	1.27	0.99	1.40	0.32
25	Corimu	0.57	1.32	1.27	1.02	1.50	0.51
26	Cocuriru	0.43	0.71	1.34	0.96	1.50	0.40
27	Corimaru	0.42	0.60	1.32	1.04	1.46	0.30
28	Kopetwiteki	0.66	1.10	1.32	0.93	1.61	0.37
29	Cocurivam	0.54	0.98	1.34	0.91	1.62	0.44
30	Corimi	0.21	0.43	1.34	0.97	1.50	0.43
31	Coprimu	0.81	1.49	1.32	0.95	1.73	0.39
	Regional	0.44	0.76	1.31	0.96	1.48	0.39

Source: Research findings

APPENDIX K: PAM indicators in a 25% decrease of rice yield for each cooperative

	Name of cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.99	1.74	1.34	0.88	1.77	0.39
2	Cocuricyi	0.72	1.38	1.34	0.87	1.64	0.51
3	Cocuribu	1.11	2.14	1.34	0.89	1.77	0.48
4	Cocuriga	1.71	4.85	1.34	0.91	2.30	0.69
5	Cocurire	1.57	6.97	1.34	0.95	2.61	1.05
6	Coperig	0.96	2.12	1.34	0.93	1.86	0.53
7	Coprimwa	0.40	1.90	1.34	0.89	1.81	0.98
8	Cocurigi	1.24	2.55	1.34	0.91	1.77	0.57
9	Coproriz	0.89	1.47	1.30	0.96	1.47	0.43
10	Corimak	0.90	1.46	1.30	0.96	1.51	0.38
11	Coprorika	1.21	3.22	1.32	0.96	2.08	0.57
12	Codervam	0.73	1.44	1.32	0.94	1.65	0.47
13	Corvny	0.78	1.54	1.32	0.93	1.74	0.45
14	Corinyaburiba	0.99	2.02	1.32	0.95	1.59	0.60
15	Twizamure	1.41	3.70	1.32	0.95	1.90	0.73
16	Inkingi y'ubuhinzi	0.97	2.86	1.32	1.05	1.62	0.90
17	Jyambere nyarugenge	1.31	3.23	1.32	1.00	2.01	0.50
18	Koterwa	0.83	2.15	1.32	0.98	1.66	0.71
19	Korivarwi	0.75	1.67	1.32	0.97	1.64	0.55
20	Copauki	1.29	2.56	1.32	0.99	1.68	0.51
21	Copriki cyunuzi	0.86	1.30	1.27	0.93	1.51	0.30
22	Isabane	1.28	2.20	1.27	0.99	1.60	0.35
23	Mushikiri rice growers	0.99	1.43	1.27	0.95	1.47	0.27
24	Kijumbura rice growers	1.15	1.84	1.27	0.99	1.48	0.35
25	Corimu	1.24	3.31	1.27	1.02	1.71	0.69
26	Cocuriru	0.81	1.42	1.34	0.96	1.60	0.43
27	Corimaru	0.81	1.21	1.32	1.04	1.54	0.29
28	Kopetwiteki	1.33	2.52	1.32	0.93	1.84	0.39
29	Cocurivam	1.07	2.16	1.34	0.91	1.82	0.48
30	Corimi	0.40	0.87	1.34	0.97	1.59	0.49
31	Coprimu	1.76	4.03	1.32	0.95	2.18	0.41
	Weighted average (All)	0.86	1.55	1.31	0.96	1.58	0.43

Source: Research findings

APPENDIX L: PAM indicators in a scenario where labour market wage is used as an estimate of the social price (shadow wage) of labour

	Name of cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.67	1.12	1.34	0.88	1.60	0.42
2	Cocuricyi	0.50	0.92	1.34	0.87	1.54	0.49
3	Cocuribu	0.74	1.28	1.34	0.89	1.60	0.44
4	Cocuriga	1.05	2.19	1.34	0.91	1.81	0.53
5	Cocurire	0.91	2.49	1.34	0.95	1.87	0.71
6	Coperig	0.62	1.19	1.34	0.93	1.64	0.47
7	Coprimwa	0.26	0.86	1.34	0.89	1.62	0.65
8	Cocurigi	0.82	1.59	1.34	0.91	1.60	0.55
9	Coproriz	0.61	1.02	1.30	0.96	1.41	0.43
10	Corimak	0.61	0.96	1.30	0.96	1.44	0.37
11	Coprorika	0.73	1.45	1.32	0.96	1.69	0.44
12	Codervam	0.49	0.89	1.32	0.94	1.52	0.44
13	Corvny	0.51	0.95	1.32	0.93	1.57	0.44
14	Corinyaburiba	0.67	1.39	1.32	0.95	1.49	0.60
15	Twizamure	0.88	1.93	1.32	0.95	1.63	0.60
16	Inkingi y'ubuhinzi	0.61	1.64	1.32	1.05	1.49	0.73
17	Jyambere nyarugenge	0.77	1.63	1.32	1.00	1.65	0.49
18	Koterwa	0.54	1.29	1.32	0.98	1.52	0.61
19	Korivarwi	0.50	1.02	1.32	0.97	1.52	0.50
20	Copauki	0.83	1.59	1.32	0.99	1.53	0.52
21	Copriki cyunuzi	0.58	0.87	1.27	0.93	1.42	0.32
22	Isabane	0.81	1.37	1.27	0.99	1.46	0.38
23	Mushikiri rice growers	0.67	1.00	1.27	0.95	1.40	0.33
24	Kijumbura rice growers	0.76	1.25	1.27	0.99	1.40	0.40
25	Corimu	0.74	1.78	1.27	1.02	1.50	0.61
26	Cocuriru	0.55	0.96	1.34	0.96	1.50	0.44
27	Corimaru	0.53	0.82	1.32	1.04	1.46	0.34
28	Kopetwiteki	0.85	1.49	1.32	0.93	1.61	0.41
29	Cocurivam	0.71	1.29	1.34	0.91	1.62	0.46
30	Corimi	0.27	0.60	1.34	0.97	1.50	0.49
31	Coprimu	1.05	2.02	1.32	0.95	1.73	0.44
	Weighted average (All)	0.58	1.00	1.31	0.96	1.48	0.42

Source: Research findings

APPENDIX M: PAM indicators under a scenario where the rice import tariff is included in the estimation of the IPP

	Name of cooperative	PCR	DRC	NPCO	NPCI	EPC	SRP
1	Coricya	0.67	0.67	0.97	0.88	1.01	0.00
2	Cocuricyi	0.50	0.58	0.97	0.87	1.00	0.07
3	Cocuribu	0.74	0.81	0.97	0.89	1.00	0.05
4	Cocuriga	1.05	1.31	0.97	0.91	1.02	0.16
5	Cocurire	0.91	1.53	0.97	0.95	0.99	0.36
6	Coperig	0.62	0.73	0.97	0.93	0.99	0.08
7	Coprimwa	0.26	0.71	0.97	0.89	1.01	0.32
8	Cocurigi	0.82	0.96	0.97	0.91	1.00	0.10
9	Coproriz	0.61	0.66	0.95	0.96	0.94	0.02
10	Corimak	0.61	0.63	0.95	0.96	0.95	-0.01
11	Coprorika	0.73	0.90	0.96	0.96	0.96	0.10
12	Codervam	0.49	0.57	0.96	0.94	0.97	0.05
13	Corvny	0.51	0.57	0.96	0.93	0.97	0.03
14	Corinyaburiba	0.67	0.83	0.96	0.95	0.96	0.11
15	Twizamure	0.88	1.16	0.96	0.95	0.96	0.18
16	Inkingi y'ubuhinzi	0.61	1.03	0.96	1.05	0.92	0.27
17	Jyambere nyarugenge	0.77	0.88	0.96	1.00	0.93	0.06
18	Koterwa	0.54	0.80	0.96	0.98	0.95	0.17
19	Korivarwi	0.50	0.64	0.96	0.97	0.95	0.09
20	Copauki	0.83	0.92	0.96	0.99	0.94	0.06
21	Copriki cyunuzi	0.58	0.54	0.93	0.93	0.93	-0.06
22	Isabane	0.81	0.79	0.93	0.99	0.90	-0.03
23	Mushikiri rice growers	0.67	0.61	0.93	0.95	0.92	-0.07
24	Kijumbura rice growers	0.76	0.74	0.93	0.99	0.91	-0.03
25	Corimu	0.74	1.01	0.93	1.02	0.88	0.15
26	Cocuriru	0.55	0.59	0.97	0.96	0.98	0.02
27	Corimaru	0.53	0.49	0.96	1.04	0.93	-0.06
28	Kopetwiteki	0.85	0.85	0.96	0.93	0.97	-0.01
29	Cocurivam	0.71	0.78	0.97	0.91	1.00	0.05
30	Corimi	0.27	0.36	0.97	0.97	0.97	0.05
31	Coprimu	1.05	1.07	0.96	0.95	0.97	0.01
	Weighted average (All)	0.58	0.63	0.95	0.96	0.95	0.02

Source: Research findings