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Marketing Survey of the Rice sub-sector in Rwanda

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Executive Summary

This report provides an overview of the rice production and marketing system in Rwanda an insight of the future role the rice sub sector in food security and export. Rwanda is not self sufficient in production. At present, Rwanda produces about 18,000 MT of paddy (11,700 MT of milled rice) from 5,500 hectares, which translates into a yield of 3.27 MT of paddy per hectare per annum. With the estimated national demand at 35,000 MT of milled rice (54,000 MT of paddy), Rwanda faces a deficit of about 24,000 MT of milled rice per annum or 36,000 MT of paddy. This means that 11,300 hectares of paddy fields have to be added to what is grown presently to cater for the deficit. To supplement national production, Rwanda imports rice mainly from Tanzania, India, Pakistan, Vietnam and China.

Rice consumption in Rwanda is on the rise due to increasing urbanization and increasing acceptance by the population. The objective of the government is for rice to become a staple food in the near future. Rice consumption in Rwanda is an urban phenomenon and rural consumption is yet to catch up. From the current population of about 9 million, consuming some 35,000 MT of milled rice, government agricultural policymakers estimate that by 2010, an estimated population of about 12 million is likely to consume over 40,000 MT of milled rice. It is this consumption estimate that has drawn government attention for a remarkable increase in production to march expected demand. Given the good political will and donor funding, it is almost certain that Rwanda's rice output and yields are set to rise tremendously in the near future.

Findings from the study seem to indicate that there is potential for growth of the domestic market for rice especially with the advantageous attributes of rice as global modernization changes are setting in. The national target is to produce sufficient rice to meet its national demand and then export by 2010. At present, rice production in Rwanda is not competitive enough to put the commodity in a favorable position on the world market. The competitiveness index for the domestic resource cost utilization for rice production in Rwanda stands at 0.932. However, with minor adjustments in the domestic resource factor usage, the breakeven level of competitiveness (i.e. CI = 1) can be easily achieved. The higher the CI, the more favorable it will be to engage the domestic resource factors in the production of paddy. These adjustments among others, include reduction in usage of imported inputs and the utilization of cheaper and more efficient domestic factors.

Prospects for a major breakthrough of Rwanda's rice sector into the regional and global can be possible if

- The hydro agricultural infrastructure is improved to cater for water control and drainage in the rice growing areas
- Productivity is improved through selection of better varieties in terms of yields, disease tolerance and grain quality
- The extension services are improved and farmer associations strengthened

Steps towards attaining these three strategies are already underway through the Rice program in ministry of Agriculture and multilateral and bilateral arrangements to avail funds to implement these strategies have already been made.

Rice production in Rwanda has been heavily constrained by a dilapidated irrigation infrastructure, poorly managed rice schemes and lack/limited use of inputs including seeds, fertilizers and pesticides. There is underutilization of installed capacity of the country's rice processing infrastructure i.e. less than 10% of the processing capacity of the eight large scale rice processing mills is utilized due to low national production.

However, the recent decision by the government of Rwanda to invest in the sub sector, especially in the rehabilitation of the rice growing schemes and also in the opening up of new rice growing areas is quite a positive move. With support from multilateral donor agencies funds have been availed to embark on this process. This study outlines the financial benefits bound to accrue from this investment and they will be positive until the year 2015.

The government of Rwanda through the ministry of Agriculture rice program and ISAR are embarking on a process of identifying suitable varieties with desired qualities such as good yield, disease tolerance, grain shape, size and aroma. This process has gone a long way and is near successful completion.

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Acronyms

ATDT	Appropriate Technology Development & Transfer project
ASARECA	Association for Strengthening Agricultural Research in East & Central Africa
GNP	Gross National Product
Ha	Hectare
IITA	International Institute of Tropical Agriculture
ISAR	**I**nstitut des **S**ciences **A**gronomiques du **R**wanda
FAO	Food and Agriculture Organization
Frw	Rwanda's Franc (US$ 1 = Frw 480)
US$	United States Dollars
USAID	United States Agency for International Development
M	Meters
MinAgri	Ministry of Agriculture, Animal Resources and Forestry
NPK	Nitrogen, Phosphorus and Potassium fertilizer
PASAR	**P**rojet d'**A**ppri a' la **S**ecurite **A**limentaire au **R**wanda

Exchange rate (US$ 1 = Frw 460)

1.0 Background to the study

This is one of the several studies that were commissioned by the government of Rwanda through its national agricultural research body ISAR under the "Appropriate Technology development and Transfer project" ATDT which is funded by CIAT. This study was executed by FOODNET[1] staff working in collaboration with ISAR. Other studies conducted in this series of studies include Sweet Potatoes, Beans, Maracouja, Maize and Bananas.

The methodology used in this study was developed by J. Holtzmann, 1995. This methodology involves a thorough analysis of secondary data available and primary data collected through interviews held with key informants in the marketing chain. These may include key traders in the rural and urban areas, key producers and processors of the commodity and also interviews ought to be held with key consumers of the commodity. The methodology also involves holding a series of feedback interviews with local persons who are particularly knowledgeable on the topic under study. These persons include researchers, government bureaucrats and any other persons working with organisations involved in the commodity being studied.

The collection of primary data is facilitated with the use of a checklist (appendix 1), which contains a summary of topic on which questions ought to be asked when meeting key informants. The checklist is carried along with a notebook to jot down responses and the interviews were held by 2 persons one of who was a socio economist focusing on economic issues while another was an agronomist focusing on the production of the commodity.

1.1 Introduction

Rwanda has a surface area of 26,000 km^2 and an estimated population of about 9 million and growth of 5.2% per annum. The country has one of the highest population densities of about 337 people per square km and also one of the highest population growth rates in Africa of about 3.6%. With an estimated GNP per capita of US $250, Rwanda is one of the poorest countries in Africa (Rwanda Development Indicators, 2001).

Since the 1980s, Rwanda has been unable to meet its domestic food needs from national production. The food deficit has been filled in by commercial imports and to a large extent food aid. In order to create a more self-reliant food balance in the country, the government has developed a strategy to a number of food crops, which include maize, beans, rice, maracouja and sweet potatoes. The reason for focusing on these crops is that they are crops which offer better trade and value added prospects than the traditional food staples.

[1] FOODNET is a regional Post Harvest and Marketing research network under ASARECA and is funded by USAID / REDSO.

1.2 Importance of Rice to the Rwanda Economy

The production of rice has been given a high priority and so the government is seeking to increase productivity from the flood prone valley bottoms that are conducive for rice growing. It has also been observed that rice is capable of giving very high yields of over 7 MT per Ha per growth cycle, which is far above the yield from any other crops that can be planted in marshlands. Therefore, rice production is considered the most profitable enterprise as regards the utilization of the hydro-agricultural investments laid out.

Rice as a food commodity is steadily growing in demand and consumption is mainly institutional or urban. Rice requires less energy to cook than most of the other staples such as beans, banana and potatoes hence preferred by many urban dwellers. Other desirable features of rice include its ease of storage, handling and shelf life. When processed, rice gives off several useful by-products, which can be utilized in the animal feed industry, breweries and other industries.

Prospects for increasing rice production in Rwanda have attracted great attention from government and donors. The government of Rwanda has secured funding from multilateral and bilateral agencies to finance various projects in the rice sub-sector that aim to revitalize rice production to meet the high local demand in Rwanda and to position the crop as a major competitive export commodity in the region.

Through the Agricultural Production Revival Urgent Actions Project, the African Development Bank is financing US$ 4 million to rehabilitate and promote rice growing in Rwamagana and Bugarama while the Belgian Cooperation is part financing US$ 370,000 to rehabilitate Butare rice scheme. The 15-year Rural Sector Support Project funded to the tune of US$ 79 million by World Bank has also a major component focusing on towards the reclamation and rehabilitation of over 20,000 ha of marshland. Other donors active in the rice sub sector include USAID, European Union and The Peoples Republic of China.

Clearly, there is an enormous political support towards a rapid increase rice production in Rwanda. The reasons forwarded by government for prioritizing rice production in Rwanda are that rice will;

Offer an efficient utilization of the abundant natural resource (marshland).
Increased employment of the abundant labor force
Improve incomes to stakeholders in the rice sub sector
Provide sustainable food security
Improve the balance of trade position through exporting rather than importing rice.

2.0 The Supply Analysis

2.1 Global Rice Production

Rice is the staple food for half the people of the world and is grown on about 146 million hectares. It is especially important in Asia where approximately 92% of the world's rice is grown (Table 1). The annual global production is about 590 million tons of unmilled, rough rice, of which 91% of the total was produced by Asian farmers, with two countries, the People's Republic of China (including Taiwan) and India, producing 55% of the total crop.

Table1: World paddy Rice production in recent years (Quantity) and Area Planted

Production	**1997**	**1998 (M/Tons)**	**1999 (M/Tons)**	**2000 (M/Tons)**	**2001 (M/Tons)**
Worldwide Production (MT)	576,816,805	582,665,263	611,251,382	598,307,226	595,267,724
Area planted (Ha)	151,027,599	151,646,356	156,888,894	153,785,367	151,623,334
Asia Production (MT)	527,823,803	535,324,508	555,442,706	545,110,848	542,307,939
Area planted (Ha)	135,911,317	136,415,176	140,427,340	137,761,803	136,077,513
Europe Production (MT)	3,163,984	3,189,952	3,242,678	3,153,196	3,158,187
Area planted (Ha)	603,257	575,982	593,282	603,489	565,429
N. America Production (MT)	10,667,211	10,589,308	11,625,391	10,923,786	11,887,267
Area planted (Ha)	1,947,804	1,984,032	2,029,961	1,878,542	1,956,855
S. America Production (MT)	17,009,823	16,094,550	22,092,304	20,670,415	19,794,434
Area planted (Ha)	4,964,986	4,981,155	6,016,734	5,705,424	5,149,773
Africa Production (MT)	16,879,389	16,129,053	17,435,560	17,329,338	16,338,766
Area planted (Ha)	7,427,885	7,540,131	7,662,140	7,695,986	7,679,614
Australia Production (MT)	1,254,610	1,330,900	1,389,800	1,100,700	1,759,500
Area planted (Ha)	164,000	141,200	151,700	133,300	186,100

Source: FAO Statistics, 2002

Rice is the most important food crop in Asia, where 60% of the world's population is dependent on it as a staple food. Rice is the primary source of human energy in the humid and sub humid tropics.

Asian farmers cultivate about 89% of the word's harvested rice in terms of area. In Bangladesh, Cambodia, Indonesia, Lao PDR, Myanmar, Thailand, and Vietnam, rice provides 56-80% of the total calories consumed. The production in Rwanda is compared with that of the world's top rice producing countries.

Table 2: Top rice-producing countries worldwide ('000MT)

Country	1999/2000	2000/01	2001/02	2002/03
China	138,936	131,536	124,320	123,200
India	89,700	84,871	91,600	80,000
Indonesia	33,445	32,548	32,422	32,500
Bangladesh	23,066	25,086	25,500	26,000
Vietnam	20,926	20,473	20,670	20,500
Thailand	16,500	16,901	16,500	16,500
Burma	9,860	10,771	10,440	10,440
Philippines	7,772	8,135	8,450	8,300
Japan	8,350	8,636	8,242	8,200
Brazil	7,768	7,062	7,480	7,600
United States	6,502	5,941	6,764	6,457
Korea, South	5,263	5,291	5,515	5,300
Egypt	3,787	3,965	3,575	3,800
Pakistan	5,156	4,700	3,740	3,500
EU	1,751	1,567	1,620	1,792
Taiwan	1,349	1,342	1,245	1,197
Australia	787	1,259	930	965
Others	28,282	27,270	27,575	28,156
WORLD TOTAL	**409,200**	**397,354**	**396,588**	**384,407**

Source: USDA, Foreign Agricultural Services (FAS), Aug 2002.

After a record 409.2 million MT in 1999/2000, world rice production has shown a general decline in production year-on-year, with 397.35, 396.59 and 384.4 million MT in 2000/01, 2001/02 and 2002/03, respectively. Rice output in 2002/03 is expected to fall by 3 percent from 2001/02, with lower output in major producing nations like India, Pakistan, Vietnam and the US, as well in other nations including the Philippines, South Korea, Japan and Taiwan. This prediction may be due to several factors including unfavorable weather - particularly the El Nino phenomenon, reduction of growing areas and unattractive prices.

2.2 Rice Production in Rwanda

Rice was introduced into Rwanda in the 1950s with simple trials being made by the Chinese, through their mission known as "Formose", in the regions of Bugarama in Cyangugu and Kabuye. By 1967, significant progress had been made which resulted in the development of several rice schemes across the country. At present, there are seven formal rice-producing schemes in Rwanda (Figure 2) and their details are given in Table 3 below;

Table 3: The Rice growing Schemes in Rwanda

Scheme	Prefecture	Rice grown by Area (Ha)	Altitude	Edaphic conditions
Bugarama	Cyangugu	830	Low altitude < 1,200 M	Alluvial and clay soils
Butare	Butare	1,239	Mid altitude 1,200 – 1,700 M	Low organic matter content High risk of iron toxicity
Mukunguri	Gitarama	240	Mid altitude 1,200 – 1,700 M	Sandy soils with eroded material
Rwamagana	Kibungo	670	Mid altitude 1,200 – 1,700 M	Well maintained organic material content in soils
Mutara	Umutara	280	Mid altitude 1,200 – 1,700 M	Alluvial soils with vertisols that break down in dry season
Bugesera	Bugesera	200	Mid altitude 1,200 – 1,700 M	Low organic matter content
Kabuye	Kigali	320	Mid altitude 1,200 – 1,700 M	Well maintained organic material content in soils

Source: ISAR

These rice schemes cover nearly 4,000 hectares of mainly marshland and were designed to meet the food needs of the growing urban population. The rest of the rice is produced on out grower fields and these presently cover about 1,500 hectares and this makes the total production area countrywide to be about 5,500 hectares. In Bugarama, the People's Republic of Korea participated in the Rice development program and in Butare, the American government through ACDI / VOCA[2] has contributed financially towards the construction of hydro agricultural infrastructure of some of the rice schemes managed by CODERVAM (**Co**operative de **De**velopement **R**izicole des **Va**llees du **M**utara).

[2] ACDI/VOCA is a private, non-profit organization that promotes broad-based economic growth and the development of civil society in emerging democracies and developing countries.

Table 4: Rice Production in Rwanda, 1986 - 2001

Year	Paddy Production (MT)	Milled Rice Production (MT)	Area (Ha)	Yield (MT/Ha)
1986	8,400	5460	3,600	2.3
1987	6,000	3900	2,900	2.1
1988	6,900	4485	3,274	2.1
1989	8,100	5265	3,088	2.6
1990	9,305	6048.25	6,800	1.4
1991	16,300	10595	4,000	4.1
1992	16,100	10465	5,000	3.2
1993	13,200	8580	2,500	5.2
1994	8,500	5525	2,500	3.4
1995	2,100	1365	630	3.3
1996	6,596	4287.4	2,000	3.3
1997	9,805	6373.25	3,233	3.0
1998	7,935	5157.75	4,144	1.9
1999	8,919	5797.35	4,919	1.8
2000	11,654	7575.1	4,266	2.7
2001	17,682	11493.3	5,449	3.2
2002	18,000	11700	5,500	3.2

Source: FAO database, 2000.

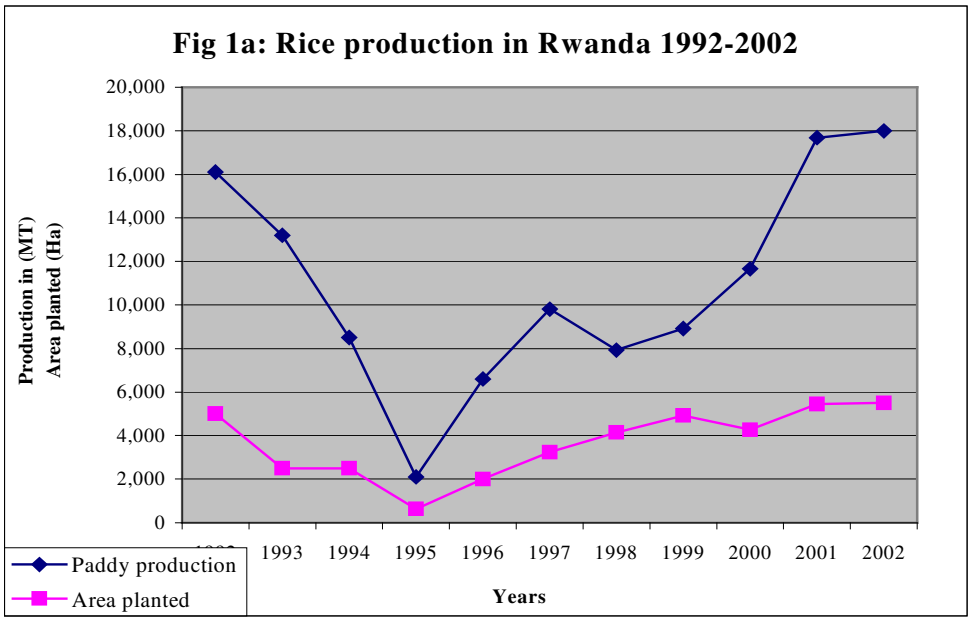
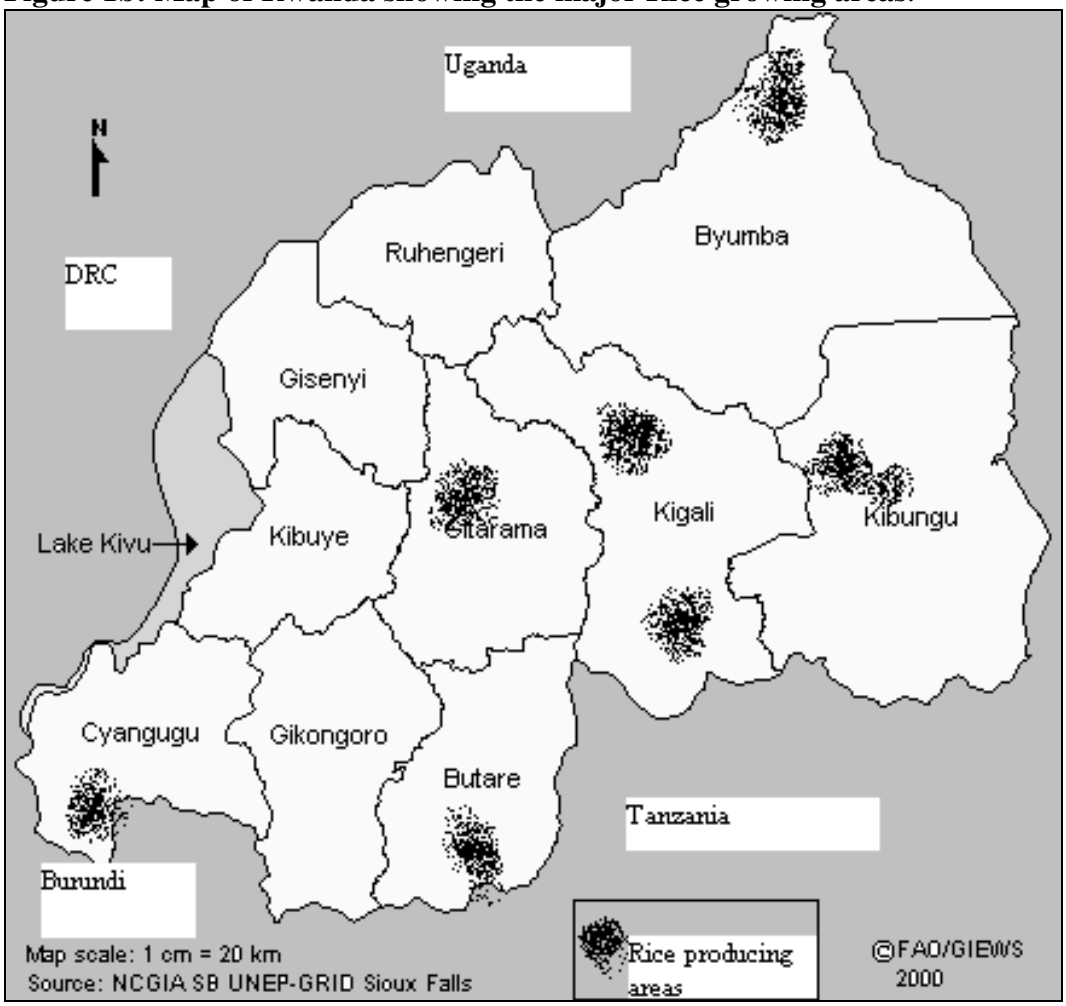


Figure 1b: Map of Rwanda showing the major Rice growing areas.



Source: Survey Data, 2002

The challenge facing rice production in Rwanda is to increase production in order to remove the supply deficit that is currently experienced. This requires rational production in order to make the enterprise profitable to both producers and processors through increasing yields and improving processing. This ought to result into a decrease in production costs and therefore make locally produced rice competitive on the local market.

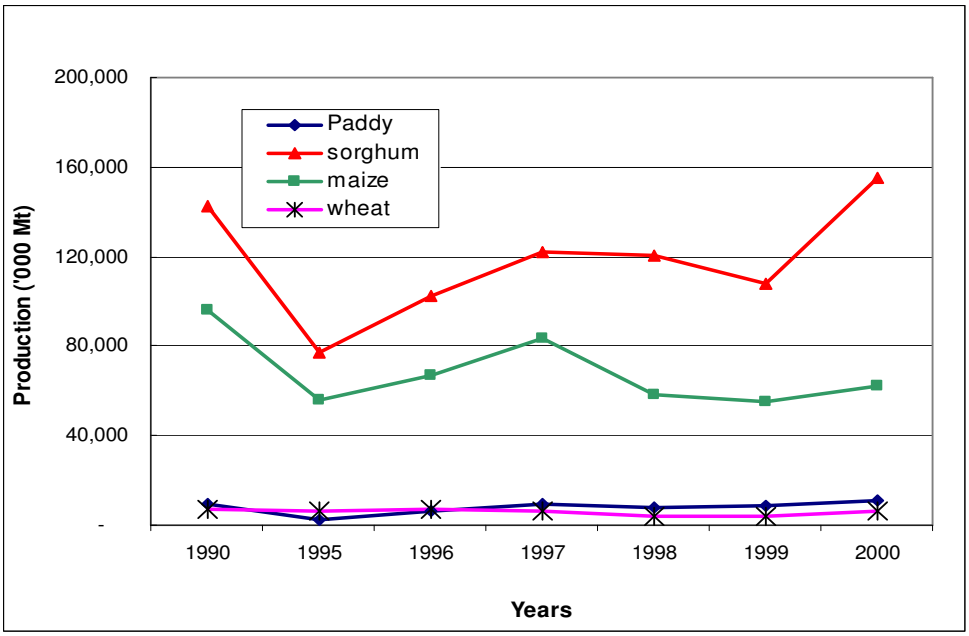
It is also important that the already existent hydro agriculture infrastructure is rehabilitated and modernized in order to irrigate the 4,000 hectares efficiently. The government of Rwanda has a 4-year plan in which it will rehabilitate the already existent 4,000 hectares under the schemes and also open up about 1,000 hectares for rice growing (GoR, MINAGRI, 2001). This is to be done scheme by scheme stepwise and over the given period and about 400 hectares will be initially developed. Under the same development plan, there is intension to set up a research program for medium and long-

term goals. The best varieties of rice will be selected and distributed while ensuring that a functional input supply system is put in place. A performing extension to popularize the appropriate agronomic practices is recommended.

Producers shall be organized to take charge of the maintenance of the secondary and tertiary irrigation canals, leveling the fields and the supply of inputs. A system shall be put in place whereby a fee shall be charged to each farmer based on the area cultivated, to cover the general maintenance and extension service costs. Rice production is presently limited by degenerated varieties and absence of a production optimizing technological package. Research shall concentrate on variety selection for high yielding and disease tolerant varieties and also on the grain quality. The long aromatic, translucent grain is most preferred by the consumers.

At the post harvest level, the drying areas and the stores shall be rehabilitated. Suitable threshing technology shall be introduced and factories shall be managed better. The processing capacity shall be increased and the milling capacity is to increase in order to improve competitiveness of domestic rice for both local and international markets. It is intended that rice schemes be privatized once they've been rehabilitated and rationalized.

Figure 2: Trends of Production ('000 MT) of Major Cereals in Rwanda



Data source: Rwanda Development Indicators.

As with all economic activities, the production of rice and other cereals in Rwanda were severely affected by the 1994 war. Production is only just recovering to the levels before the 1994 war. Maize was particularly worst hit and by the year 2000, production was still far below the 1990 level. Wheat production has stagnated while sorghum and paddy production has just advanced past 1990 production level (Figure 2).

2.3 Seasonality of Rice production and the Ag-ecological zones in Rwanda

There are two rice-growing seasons per year in Rwanda (Appendix 6). The 1st season runs from December to May while the 2nd season runs from June to November (MINAGRI, 2001). The crop has high labor demands, as it requires that seed is planted in a bed and when seedlings are ready, they are transplanted into a well-prepared field. Satisfactory preparation of the field requires one or more passes of a plough. During the growth period of the crop, it is important that both weeds and vermin are controlled. It is vital to also maintain the irrigation infrastructure in order to obtain good water supply to the plants and good drainage and these water-based operations must be done at the landscape level.

The entire nation of Rwanda has a varied range of Ag-Ecological Zones. These range from low altitude areas that are <1,200M to mid altitude zones that are 1,200M to about 1,700M and then high altitude areas that are above 1,700M. The mid and high altitude zone do have fairly low temperatures and most rice schemes namely; Butare (Cyili), Rwamagana, Mutara, Kabuye, Mukunguri and Bugesera all lie in the mid altitude zone. The Chinese varieties are found to do well in the mid altitude zones while Basmati, IRON and BR are most suited for the low altitudes. The Bugarama rice scheme is the only one located in the low altitude zone. The temperature is higher and the altitude is about 800M this enhances resistance to the Rice blast and Sheath blight diseases.

2.4 The varieties of Rice grown in Rwanda

The Chinese varieties have been the most commonly grown for the past 30 years or more. These were introduced in the 1960s and when the government of Rwanda introduced large-scale production of paddy. Of recent, varieties such as Basmati, BG, IITA, IRON and FAC have been introduced in Rwanda and some of them are on high demand due to some of their attributes which include; good grain quality, good aroma, length of grain (long preferred), tolerance to diseases and yield. A summary of the varieties of rice grown in Rwanda, the rice schemes where which variety is grown and the salient aspect of the varieties are summarized in Table 5 below.

Table 5: Varieties of Rice in Rwanda and their quality aspects

Variety	Rice Scheme where variety is grown	Variety aspects
Zhong geng (Local name *Kigoli*)	Rwamagana, Cyili, Kabuye, Nyagatare, Bugesera, Mukunguri	-Short grain, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
Yun keng 136	Rwamagana, Cyili, Kabuye, Nyagatare, Bugesera, Mukunguri	-Short grain, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
Yun yine 4	Rwamagana	-Short grain, -Susceptible to Rice blast, Sheath brown rot (Pseudomonas sp.)
Yunertian 01	Rwamagana, Cyili, Kabuye, Nyagatare, Bugesera, Mukunguri	-Short grain, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
Xinun 175	Nyagatare, Rwamagana	-Short grain -Very susceptible to Rice blast, Sheath brown rot (Pseudomonas sp.)
Fac V046	Cyili (new release)	-Short grain, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
Basmati 370	Bugarama	-Long grain, good aroma, low yield, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
IRON 280	Bugarama	-Short grain, resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
BG 400-1	Bugarama	-Long grain, high yield, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)
IRAT	Bugarama	-Long grain, High yield, -Resistant to Rice blast, Sheath brown rot (Pseudomonas sp.)

Source: Survey data, 2002

2.5 Cost of Rice production in Rwanda

The cost of producing rice in Rwanda ranges between Frw 270,000 and Frw 360,000 per hectare grown and the variation is heavily dependent on location and also on availability of labour. In this particular study a couple of small-scale producers of rice from two different areas were interviewed and the following were the findings (Table 6 & 7).

It is important to note that the cost of production can be reduced significantly if family labor is utilized rather than hired labor. Since most of the rice growing in Rwanda is done

through farmer cooperatives, the farmers enjoy some economies of scale and so they may incur less cost on some of the practices such as drying, winnowing and vermin control.
Scenario 1

Table 6: Cost of producing Paddy rice per Hectare in Butare prefecture

Item	Unit	Quantity of inputs/labour	Family Labour	Unit cost (Frw)	Total cost (Frw)	Cost in (US$)
Seed	kg	70		120	8,400	18.27
Pesticide	kg	0.5		4,000	2,000	4.35
Hoe		1		1,000	1,000	2.18
Slasher		1		1,000	1,000	2.18
Fertilizer NPK	kg	150		200	30,000	65.22
Fertilizer UREA	kg	100		200	20,000	43.48
Land rent	ha	1		12,500	12,500	27.18
Seed bed preparation	Man days	20	FL	300	6,000	13.05
1st digging	Man days	60		300	18,000	39.14
2nd digging	Man days	60		300	18,000	39.14
3rd digging	Man days	70		300	21,000	45.66
Planting	Man days	60		300	18,000	39.14
Weeding	Man days	160	FL	300	48,000	104.35
Water channeling	Man days	30		300	9,000	19.57
Apply fertilizer	Man days	5	FL	300	1,500	3.27
Apply pesticide	Man days	10	FL	300	3,000	6.53
Bird / vermin control	Man days	20		300	6,000	13.05
Harvesting	Man days	120		300	36,000	78.27
Transport	Man days	10		300	3,000	6.53
Drying	Man days	30	FL	300	9,000	19.57
Weighing	Man days	12		300	3,600	7.83
Total cost of Prodn					**275,000**	**597.96**

Source: Survey data, 2002

NB:

Yield per Ha = 3-4 Tons,
Cost of production = Frw 69.4 per Kg,
(1US$ = Frw 460),
Minimum Paddy Price = Frw 82 per Kg

Scenario 2

Table 7: Cost of Production analysis of a small-scale producer in Mutara prefecture

Activity	**Cost in (Frw/ Ha)**	**Cost in US$ per Ha**
Cost of seed (100kg)	1,600	3.48
Grass cutting	20,000	43.48
1st ploughing	18,000	39.13
Paddling	14,000	30.43
2nd Ploughing	20,000	43.48
Weed control	58,000	126.1
Fertilizer application	10,000	21.72
NPK (200kg @ 250Frw)	50,000	108.7
Urea (100kg @ 250Frw)	25,000	54.35
Maintenance of irrigation infrastructure	48,000	104.35
Vermin control	10,000	21.74
Harvesting (Cutting & Threshing)	30,000	65.22
Drying & winnowing	36,000	78.26
Total Cost	**340,600**	**740.44**

Source: Survey data

Yield per Ha: 5 – 6 Tons
Farmgate price: Frw 70 – 90 per KG
Plot area: 0.05 hectares
1US$ = Frw 460

2.6 Profitability of paddy growing in Rwanda

The growing of paddy in Rwanda is a profitable venture and this is further enhanced by the increasing consumption and demand for the commodity. At farm level, it is important that the correct agronomic practices are adhered to in order to obtain high yields as anticipated by research. Two different scenarios of cost of production for rice producers from a couple of rice schemes in Butare and Mutara prefectures are shown in Tables 5 and 6 above. As per the interviews held in this study, the costs of production per hectare range between US$ 600 and US$ 750. A cost and benefit scenario shown in Table 8 below shows that profitability could range from US$ 100 to US$ 500 per hectare depending on the variety grown, the yield obtained and the farm gate price offered.

Table 8: Cost / Benefit Analysis for paddy production in Rwanda.

Item	**Quantities**	**Unit cost (Frw)**	**Total Cost (Frw)**	**Total Cost (in US$)**
Land rent	1Ha	12,500	12,500	27.18
Seed	70KG	120	8,400	18.27
Pesticide	0.5KG	4,000	2,000	4.35
Fertilizer NPK	150KG	200	30,000	65.22
Fertilizer (Urea)	100KG	200	20,000	43.48
Tools / implements	-	-	2,000	4.36
Seed bed preparation	20	300	6,000	13.05
1st, 2nd, 3rd Ploughings	190 Md[3]	300	57,000	123.91
Planting	60 Md	300	18,000	39.14
Weeding	160 Md	300	48,000	104.35
Water channeling	30 Md	300	9,000	19.57
Fertilizer application	5 Md	300	1,500	3.27
Pesticide application	10 Md	300	3,000	6.53
Bird / vermin control	20 Md	300	6,000	13.05
Harvesting	120 Md	300	36,000	78.27
Transport	10 Md	300	3,000	6.53
Drying	30 Md	300	9,000	19.57
Weighing	12 Md	300	3,600	7.83
Total cost of Prodn			275,000	597.93
Yield		4 MT of paddy per Hectare p.a.		
Farm gate price (Lowest)		Frw 80 per KG (Paddy)		
Farm gate price (Highest)		Frw 130 per KG (Paddy)		
Gross Income (Lowest)		Frw 320,000 (US$ 696)		
Gross Income (Highest)		Frw 520,000 (US$ 1,130)		
Net Income (Profit)- Lowest		Frw 45,000 (US$ 97.82)		
Net Income (Profit)- highest		Frw 245,000 (US$ 532.60)		

Source: Survey data, 2002

NB

Profitability of the enterprise could be greatly enhanced if family labor is used in the some of the agronomic practices shown above. Some of the practices where family labor could be used include; seed bed preparation, weeding, fertilizer application, and drying.

[3] Units of labor: 6 hrs of work per day by 1 man

2.7 Major constraints to Rice Production in Rwanda

According to the managers of several rice schemes, which account for most of the rice production in Rwanda, the most limiting constraints to production are;

- The most important disease in most rice growing areas in Rwanda is Rice blast caused by *P. Oyzae*. It is common in Cyili and attacks the Yunyine4 variety when grown for more than 3 consecutive seasons on a large scale. This disease is capable of causing 80% loss in terms of yield. Other diseases include Sheath brown rot caused by *Pseudomonas fuscovaginae* and this is found in areas above 1,500M such as Cyili, Rwamagana and Kabuye. The other disease is fungal caused by *Sarocladium oryzae* and is common in Bugarama.
- Most of the rice producers countrywide do complain about the stalked-eyed fly (*Diopsis thoracica*) whose larvae eat rice tillers causing them to dry out. Insecticides such as *Sumithion* and *karate* are recommended for use to control this pest.
- Deterioration and destruction of the drainage and irrigation infrastructure. This has resulted into the silting of canals, deterioration of water catchments points and destruction of leveled plots set up.
- Low quality seed production based on 'massal' selection plus high degeneration of seeds often used in a mix of different varieties.
- Insufficient research as a result of inadequate human, technical and financial resources resulted in lack of improved rice varieties. This resulted in increased susceptibility to diseases and degeneration of good grain characteristics.
- Insufficient use of agricultural inputs, both in terms of quality and quantity, resulted into the degeneration of the input supply chain at a national and local level.
- Lack on knowledge on input usage and the high cost of inputs especially inorganic fertilizers, came out as the reasons for low or no input usage in Rice production in Rwanda (V.A. Kelly et.al. 2001). In order to obtain high yields, input usage ought to correspond likewise.
- Gross mismanagement of the rice schemes resulting in deterioration of drying areas, threshers, huskers and stores leading to degeneration of the quality of rice produced after processing.
- Inadequate entrepreneurial skills and mismanagement resulting into increased debt burdens to the schemes due to unpaid bills and unprofitable sales of the commodity. This was a result of lack of competent private sector management to run the schemes instead of the government.
- Most of the Chinese varieties that have been grown over the last 30 years are less superior to the newly introduced and the imported varieties such as Basmati and the Pakistan varieties. The newly introduced and important varieties have better desired qualitative such as a good aroma, long grain, easier to cook and most are tolerant to the notorious rice blast disease. The implication of this less superiority is that lower farm gate prices are offered for the Chinese varieties hence making the enterprise less profitable.

- Most of the rice producers are price takers rather than setters and this is due to their urgent liquidity needs therefore they are usually offered the lowest farm gate prices for their produce. This greatly reduces the profitability of the enterprise.
- There is lack of adequate drying facilities in some of the rice schemes visited and this severely affect the quality of rice and reduces the milling recovery rate.

2.8 Paddy processing in Rwanda

The original design for the rice schemes in Rwanda was to vertically integrate all the processes of rice production right from production until the final product ready for utilization by the consumer. However, the decay of the rice schemes over the year has subsequently had its toll on the processing units of the schemes. Most processing units are running on unutilized excess capacity yet overhead costs of maintenance of the processing units are quite high. Some of the processing units are over 30 years old and there is a problem of sourcing the correct spare parts for the equipment when they break down. Most of the processing units do act as intermediaries between the producers and the consumers. They do purchase paddy from the farmers, mill it and sort it the sell the milled rice to consumers. Other bi products from the milling process are the broken grain, the husks and the bran. The bran is usually sold to animal feed manufacturers at about Frw 20 per KG and the milling cost ranges between Frw 45 to Frw 90 per KG. The processing of rice is made easy if the grain is well dried and uniform in size. In cases where the grain size is not uniform, high broken grain incidences are experienced and the milling recovery rate lowers.

2.9 Competitiveness of Rwanda produced rice on the World Market

Rwanda is not self sufficient in Rice, Maize, Sorghum or Beans. However, increased local production of these commodities could substitute for the existing or potential imports from either regional or international markets. As such, the 1999 FOB estimates showed that Rwanda rice went for US$ 234 per ton as compared to US$ 90 per ton for Maize and US$ 85 and US$ 280 for sorghum and beans respectively (A.W Barry, 2000).

Prices (Table 9) are shown as per online FOB price quotes for long rice grain per ton in Asian and America countries as of mid December 2002. Comparatively, Table 6 illustrates that the prices for Rice in Asian countries are very low in relation to those in Rwanda.

Table 9: Rice Quotes as of December 2002

Asia					**Americas**				
RiceOnline	Thailand	Vietnam	India	Pakistan	RiceOnline	USA South	USA California	Uruguay	Argentina
5%	$182	$182	$175	$169	4% - 5%	$208	$270	$265	$265
10%	$178	$177	$170	$165	10%	$207	$265	$260	$260
15%	$175	$173	$153	$159	15%	$204	$260	$255	$255
25%	$170	$168	$145	$153	Brown	$165	$245	$225	-
Parboiled	$190	-	$180	-	Parboiled	$260	-	$265	-

Source: RiceOnline.com

In addition to the price, it is unfortunate to note that Rice produced in Rwanda has a very high content of broken rice in excess of 50%. Whereas rice imported in Rwanda has about 15 to 18% broken rice content therefore this differential further discounts Rwanda rice on the world market. The high broken content of rice produced in Rwanda is attributed to lack of strict grading of grains as per the various varieties during processing, which results into damage of especially the longer grains that are mixed with the shorter ones. It is important to grade the rice prior to processing and to ensure that different varieties are processed separately because each has different grain qualities.

It is important to note that rice production in Rwanda is profitable to farmers even when family labour is valued at the market wage rate indicating that paddy growing in Rwanda is a profitable activity (Appendix 3).

2.9.1 Competitiveness Index for rice produced in Rwanda

The competitiveness index is one of the methods used in measuring the comparative advantage a country could have in producing a particular commodity as opposed to importing it. The method involves finding out to what extent the returns to fixed resources (non traded resources) are for a particular commodity. It is a ratio of net benefit of traded inputs to non-traded input cost. In the context of international trade, trade inputs refers to inputs that have to be imported whereas non-traded inputs refer to those inputs that are locally available. The implications for this index are that if CI > 1 then the activity is economically attractive and the higher the CI value the more attractive the enterprise. The CI is usually computed in the local currency in order to avoid the exchange rate distortions.

$$\text{Competitiveness Index} = \frac{\text{Net benefit of traded inputs}}{\text{Non-traded input cost}}$$

The mathematical formula stands as follows;

$$CI = \frac{\{P_{by} - \sum X_i P_{bxi}\}}{\sum X_j P_{dxj}}$$

Whereby;

CI = Competitiveness Index
P_{by} = Product border price (real border price of the commodity)
X_i = Traded inputs
P_{bx} = Factor border price
X_j = non traded inputs (domestic)
P_{dxj} = Factor domestic price

The assumptions made are that 1hectare yields 4 MT of paddy per annum. This converts to 2.6 MT of milled rice per hectare grown. It is also important to note that there are two growing cycles per annum. Using the figures obtained in the cost of production analysis (Table 7), the following are the numerical values for the above variables;

The border price for an MT of milled rice produced in Rwanda is Frw 200,000
The value of traded inputs used to produce a MT of milled rice is Frw 41,540
The value of domestic inputs used to produce a MT of milled rice is Frw 170,000

P_{by} = Frw 200,000
$\sum X_i P_{bxi}$ = Frw 41,540
$\sum X_j P_{dxj}$ = Frw 170,000

Therefore,

$$C I = \frac{200{,}000 - 41{,}540}{170{,}000}$$

$C I$ = **0.932**

This coefficient implies that for every unit of domestic resource factor invested in the production of rice, the benefit is 0.932 of the value of the investment. However, with minor adjustments in the domestic resource factor usage, the breakeven level of competitiveness (i.e. CI = 1) can be easily achieved. The CI > 1 do imply that it is better to produce a commodity domestically rather than importing it. The higher the CI is above 1, the more favorable it will be to engage the domestic resource factors in the production of paddy. These adjustments include reduction in usage of imported resource factors and conversely increasing the utilization of cheaper and more efficient domestic resource factors.

2.9.2 Domestic Resource Cost for rice production in Rwanda

The Competitiveness Index (C I) has an inverse relationship with the Domestic Resource Cost ratio (DRC)

$$C I = \frac{1}{DRC}.$$

The DRC value for producing Rice in Rwanda is

$$C I = \frac{1}{0.932} = \mathbf{1.07}$$

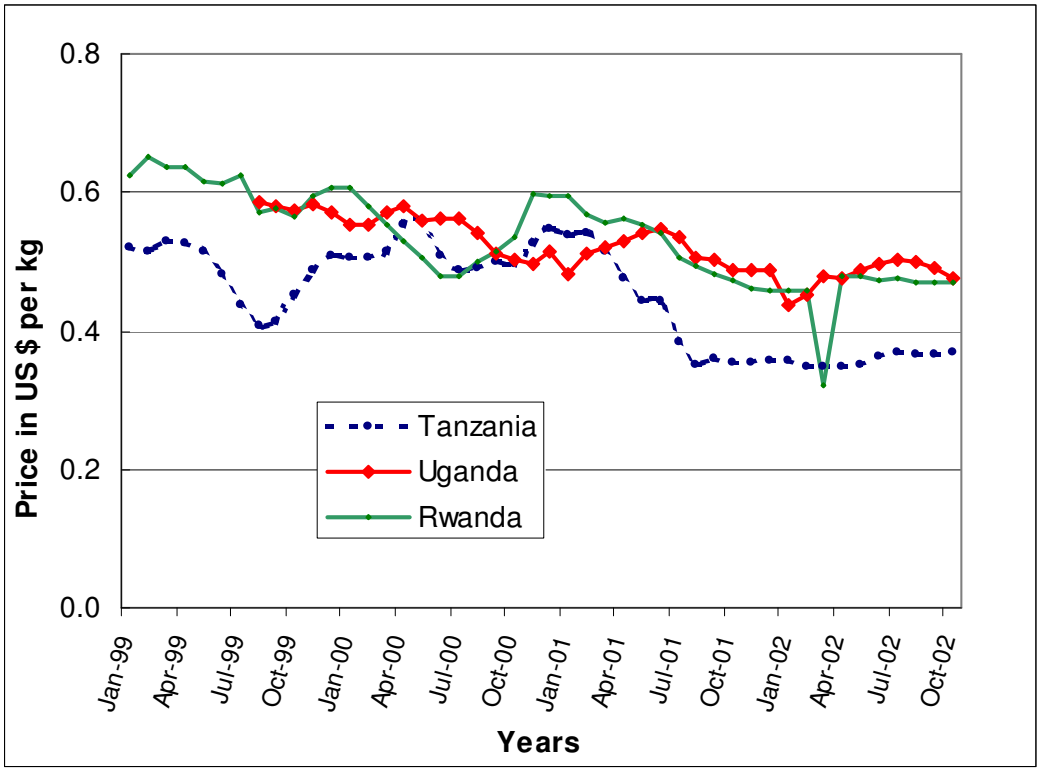
The value of the DRC below 1.0 implies that there is a comparative advantage in producing a commodity using the domestic resource factors available. The converse is true whereby when the DRC value is above 1, there isn't a comparative advantage in producing a commodity using the available resources. The higher the DRC value the less the comparative advantage.

2.10 Comparison of the price trends within the region

As shown in Figure 3, the trend of retail prices of rice in Uganda, Tanzania and Rwanda. The prices are in US dollars as a uniform currency after a conversion of the local prices using each country's exchange rate. Since changes in the exchange rate indicate changes in the value of the currency, which is closely related to the state of the economy, exchange rate figures are good alternative to the consumer price indices. Therefore Figure 3 illustrates that real retail price of rice in the region has declined over time, with Tanzania prices demonstrating a remarkable decline followed by Rwanda.

Although nominal rice prices may change in relation to changes in the value of money, overall the trend of the real price of rice in the region is likely to decrease further, dictated by externally low prices of imported varieties and through the proposed adoption of high yielding varieties in the case of Rwanda. The evidently lower prices in Tanzania during most time of the year do suggest a flow of rice from Tanzania into Rwanda.

Figure 3: Comparison of Retail Price trends of Rice in region.



Source Data: BOU, NBR, CBT, FOODNET and SISA.

Figure 3 further illustrates that Rwanda and Uganda retail prices for rice are generally comparable in value but rice in Tanzania is notably cheaper in the region. Indirectly, this figure demonstrates that the cost of rice production in the region is comparatively lower in Tanzania than in Uganda or Rwanda. This explains why rice from Tanzania is available in Rwanda markets and is likely to remain competitive unless the local production in Rwanda achieves a radical reform. The quality of rice from Tanzania is said to be generally good with aromatic, long grains.

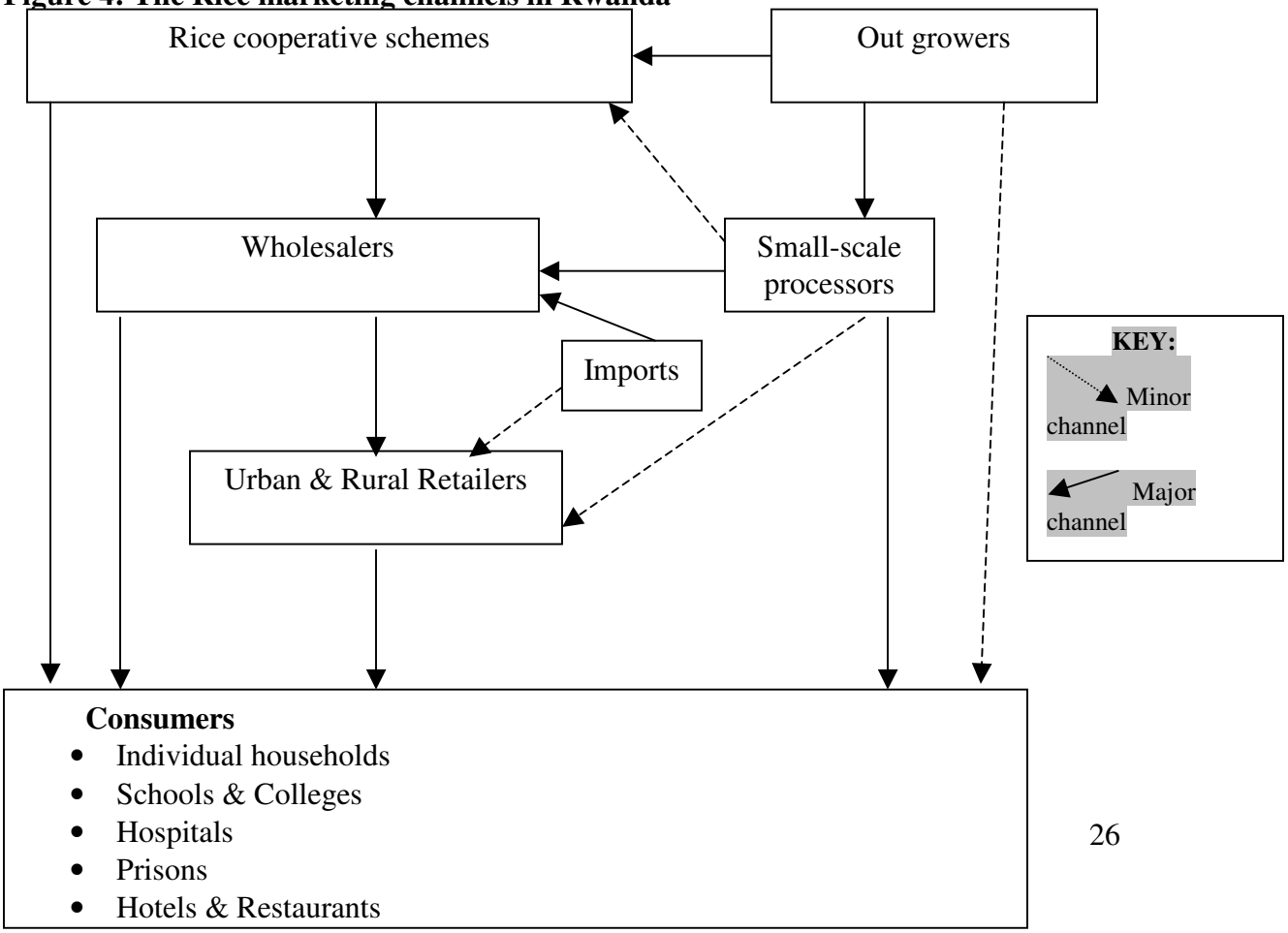
2.11 The Rice supply channels in Rwanda

In Rwanda, rice is mainly grown through the farmer cooperative schemes set up by the government. However, some of the population that is not under the membership of the cooperative scheme may also engage in rice growing. These have been referred to as out growers in Figure 4.

Rice produced under the farmer cooperative schemes is centrally processed and the final product is mainly sold directly to consumers. This is the main rice-marketing channel. Other channels involve rice from the cooperative scheme being sold to wholesalers who sell it to retailers and finally to consumers.

The rice out growers sell their produce mainly to small-scale processors. The rice is processed and then sold to retailers and consumers in the nearby area. It is a common practice for out growers to pay a small fee to the small-scale processors to process their produce, which is later consumed domestically at a household level.

Figure 4: The Rice marketing channels in Rwanda



2.12 Marketing Margins along the chain

Rice is mainly purchased at farm gate prices of US$ 150 - 200 per Ton. The prices are lowest especially during the harvest time. The milled rice is then sold to wholesalers at a price of US$ 280 – 300 per Ton. The wholesalers do sell the locally produced rice in 50Kg bags at a price of US$ 300 – 350 per Ton, depending on the availability of rice in the market. The retailers are the main buyers of rice from the wholesalers and sell out to consumers at a cost of US$ 560 – 600 per Ton. Rice bran, which is a milling bi product is disposed off at a price of US$ 20 – 40 per Ton and is mainly utilized in the making of animal feeds.

The findings from this study indicate that retailers do get the highest margins per unit sold and this ranges between US$ 0.2 and US$ 0.26. The rest of the players along the chain do get margins in the range of US$ 0.02 to 0.04 with processing fee estimated at US$ 0.04 to 0.06.

The prices offered tend to drop during the harvest period and this is usually in the months January and February and also between Late July and early September. This is due to the seasonal production of the commodity and the eagerness of every producer to sell immediately. The price of rice is highest during April and May in the off-season.

Table 10: Transaction Costs Analysis for a wholesale rice trader importer in Kigali

Item	**Cost (US$ per MT)**	**Quantity (MT)**	**Total (US$)**
Import price	350	1,000	350,000
Transport (Isaka[4]-Kigali)	55	1,000	55,000
Import Taxes	30% of CIF	1,000	121,500
CIF Kigali			**526,500**
Bonded warehouse	4% of CIF	1,000	21,060
Offload	0.89	1,000	888.89
Transport to store from bond	2.67	1,000	2,666.67
Rent of Office and Admin. Costs			3,000
Interest on letter of credit			1,333.33
Total Costs in USD			555,449
REVENUE	**Revenue (US$ per MT)**	**Quantity (MT)**	**Total**

[4] Isaka is a major inland port in Tanzania where rail line ends and from there goods travel by road

Frw 13,500per 50kg bag or (Frw 270 per KG)	587	1,000	**587,000**
Net margin (US $) (per 1000 MT traded)			**60,500**

Source: Survey data

Rice is imported into the country by wholesalers and this study established costs and margins of a particular case as shown in Table 10. Wholesalers import rice from foreign countries such as Pakistan, Vietnam, Burundi, Tanzania and Uganda. For every batch of 1000 MT of rice imported, the trader bags a profit of about US$ 60,500.

Imports of cereals into Rwanda have been steadily growing over the last 12 years from a value of about Frw 712.1 million (US$ 1.548 million) in 1990 to about Frw 4,858.8 million (US$ 10.562 million) in the year 2000. In terms of percentage of total imports for both food and non-food commodities, it rose from 2.74% in 1990 to 4.67% in the year 2000 (Statistical Abstract, 2001). Rice and wheat comprise the greatest portion of cereals imported into Rwanda. Basing on the findings from the survey, the major importers of rice into Rwanda account for about 15,000 MT of milled rice per annum. This is valued at US$ 350 per MT c.i.f. Kigali and the rice is mainly from Pakistan and Vietnam.

3.0 The Demand Analysis

3.1 World rice consumption

The world rice consumption has increased for the last three years as seen in Table 11 below. This upward trend is predicted to continue in 2001/02, when the world will consume up to 405.856 million metric tons of rice. This increase is significant, comparing to a mere 388.792 million metric tons in 1998/99. China, the world's most populous country, consumes the most rice. In general, rice consumption has increased in every country from year to year. Thailand consumes 9.9 million metric tons in 2000/01 and is predicted to increase the consumption to approximately 10 million MT in 2001/ 02. In conjunction with the world's rising consumption level, the world's rice production will also expand in order to meet this higher demand (Food market Exchange 2002[5]).

3.2 The market / product segments

The market is categorized according to the income brackets of consumers. The affluent consumers are willing to pay a premium price for the long grain, aromatic rice that is mostly imported into the country. Consumers in this category tend not to buy locally produced rice because of the high dirt content, high broken grain content and the short grain, which makes it rather cumbersome to prepare and tends to become sticky.

[5] FoodMarketExchange.com " is established as the trading hub for foodstuffs. It provides a safe, efficient and Internet-based Trading Hub (Marketplace) for buyers and sellers of food products to do business online.

Price is the major determining factor for consumers in the low-income bracket hence locally produced rice is most attractive. In some instances, rice grown in neighboring countries such as Burundi, is cheaper than that grown in Rwanda. Farmers, in such instances, prefer to sell their produce and buy cheaper rice for their own consumption. This is quite a common practice in the rice growing areas found close to the Burundi border.

The other market segment is the public institutions such as schools, hospitals, Prisons and also the entire hotel industry. These have increasingly grown in the consumption of rice due to the ease with which it can be transported, stored and cooked as compared to other food crops such as potatoes, bananas and cassava.

Table 11: World rice consumption in 1999/2000 - 2002/2003 (milled basis)

Country	1999/2000 ('000 MT)	2000/2001 ('000 MT)	2001/2002 ('000 MT)	2002/2003 ('000 MT)
China	133,763	134,356	134,595	134,800
India	82,670	75,851	82,251	84,000
Indonesia	35,400	35,877	36,358	36,790
Bangladesh	23,766	25,790	26,250	26,250
Vietnam	16,771	17,275	17,400	17,700
Thailand	9,300	9,400	9,500	9,600
Burma	9,330	9,350	9,400	9,475
Philippines	8,400	8,750	8,900	9,105
Japan	9,450	9,000	9,000	9,000
Brazil	7,956	7,956	7,958	8,000
Korea, South	4,986	5,000	5,100	5,100
United States	3,846	3,676	3,889	3,969
Egypt	2,856	3,015	3,150	3,275
Iran	3,019	3,050	3,075	3,100
EU	2,190	2,207	2,215	2,190
Korea, North	2,000	1,837	1,500	1,950
Taiwan	1,315	1,265	1,150	1,150
South Africa	531	525	550	600
Others	40,788	42,168	41,696	42,607
WORLD TOTAL	**398,337**	**396,348**	**403,937**	**408,661**

Source: *USDA, Foreign Agricultural Service (FAS), Aug 2002*

3.3 The size of Market Segments in Rwanda

The population targeted is estimated at 800,000 people, which is about 160,000 households. Given an assumption that each of these households consumes about ½ Kg of rice per day, this gets to a total consumption of about 28,000 Tons of rice per annum by

urban dwellers and institutions. The rest of the population could consume about 7,000 Tons of rice per annum resulting into a total national demand for rice in Rwanda estimated at 35,000 Tons of milled rice per annum. This would equate to 51,000 Tons of paddy per annum (MINAGRI, 2001).

With the national production estimated at about 17,600 Tons of paddy per annum, there is a national deficit of about 34,000 Tons of paddy or 23,000 Tons of milled rice per annum. It is there important to encourage and promote local production of rice so as to contribute to the balance of payment through reduction of rice imports.

3.4 Rice varieties on market and consumer preferences

In Rwanda, local retail shops and open-air markets sell both local and imported varieties of rice. However, up market retail shops such as supermarkets only sell imported and ready packed brands from India and China. Rice from India and China is ISO certified and conveniently packed in 2kg and 5kg sachets. A popular brand name of rice from India is Basmati while that from China is cock brand. Other rice imports popular in supermarkets are from Pakistan, Vietnam and Tanzania.

The main local variety that is on market in Rwanda is Kigori, which is grown on most of the rice schemes in Rwanda. Good quality varieties such as Basmati and IITA produced only in Cyangugu are highly demanded but the market is localized to the production area due to low supply.

Rice consumers in Rwanda particularly in urban areas are very keen on grain size, color, taste/flavor and cooking attributes of rice. Long white/translucent rice grains from Tanzania, Pakistan, Vietnam and India are more preferred than the local varieties in Rwanda, which are short and brown. Imported rice particularly from Pakistan, Vietnam and India is generally clean unlike local rice that has of stones and other foreign matter.

3.5 Demand and Supply projections

Using data on the size of the rural, urban and total population derived from the 1999 census results of Rwanda and 1998 crop production figures and other data (per capita consumption, annual per capita income growth and income elasticity) on maize, beans, sorghum and rice, A.W. Barry 2000, projected the 20-year demand and supply of these commodities. For 2010, Barry's projections are that Rwanda would consume 18,350 MT of rice against a national production of 6,430 tons, which gives rise to net deficit (imports) of 11,920 MT. The 2001 ministry of Agriculture (MINAGRI, 2001) report estimates that currently Rwanda requires about 35,000 tons of milled rice per annum against local production of less than 6,000 tons and by 2010 it is expected that rice would be a major staple food consumed (estimated demand 40,000 MT) by half of the total population of 11.5 million. This clearly shows that sound economic estimates based on the current socio-economic conditions in the country can greatly differ from estimates based on political will.

It is therefore difficult to predict with certainty the magnitude of rice demand in Rwanda for a period of five or ten years for now. However, it is certain is that rice production in Rwanda is to increase in the future due to the political will in an effort to improve the food security situation in the country through utilization of the abundant marshland and labor force. Funding secured from various donors has been invested in the rehabilitation of the rice schemes, research and development of the rice sub sector. These are all positive developments towards a rapid increase in rice production in the near future.

4.0 Rice sub sector investment analyses

4.1 Proposed interventions for the rice sub sector in Rwanda

The ministry of Agriculture, animal resources and forestry of Rwanda has come with an intervention strategy to develop the rice sub sector (MINAGRI, 2001). These strategies will include;

1. Improving and optimally utilizing the hydro-agricultural infrastructure
2. Improving the productivity of rice production
3. Reinforcing extension services rendered and strengthening rice producer organizations.

Water control
Since water is one of the most important elements for rice growing, strategic interventions will involve setting up better irrigation and drainage systems and infrastructure. This will be done at two levels whereby level 1 will be the water catchments point and level 2 will be the infrastructure put in place to manage the drainage of the plots. The interventions will involve;

- Rehabilitating the dams and desilters
- Rehabilitation of the hydrographic network
- Correction of the drainage network with a new topographic survey
- Setting up institutional measures to ensure permanency of works.

Productivity
Increasing productivity will not only require improvements in water control but will require to address other major constraints to production such as degenerated varieties, absence of research, insufficiency of inputs and poor application of technological alternatives. Research will emphasize

- Variety selection with preference for high yields, disease tolerance, grain quality and growth cycle of the variety
- Efforts will be made to establish the optimal irrigation needs to reduce cost of production
- Soil physico-chemical, biological and mineralogical parameters are to be studied to determine long term potential of cultivated paddy fields.
- Evaluation of pesticide use and integrated pest management against diseases, insects and weeds.
- Seed production and determination of optimal input application rates
- Improvement of processing and marketing

Extension services and producer organizations

Improved productivity will require an efficient extension service. This will facilitate increased transfer of appropriate technologies as well as application of research results. Since market forces are intended to guide the decisions of producers in order to have control on the real production costs, the producers' real control is a prerequisite to significant reduction of production costs. The government is planning to put in place a National Rice Development and Promotion Board to encourage increased production with an aim of rice becoming a staple food by 2010. The overall goal is to improve food security in Rwanda.

4.2 Implementation strategies

A four-year plan has been drafted and is currently under implementation. It involves

- To rehabilitate the existing rice growing schemes
- To Increasing area cultivated to over 30,000 Ha by the year 2010
- To rehabilitation of factories to restore the processing capacities and also improve the recovery rate from 65% to 70% and to improve competitiveness of domestically produced rice for both local and international markets.

With the successful implementation of this 4-year rehabilitation plan, it is estimated that the processing capacity will improve from 65% to 70% and with better water control and increased input utilization (200KG of NPK 17:17:17 and 100KG of Urea), yields are likely to increase by 30-50% by the fourth year of implementation. About US$ 5,644,500 is to be used to rehabilitate the existing 3,700 hectares at a unit cost of US$ 1,500 per Ha and US$ 22,548,000 used for the extension of the 7,516 hectares at a cost of US$ 3,000 per Ha. The total amount to be spent on rehabilitating and extending the existing schemes and in the coming 4 years is US$ 28,192,500.

4.3 Analysis of returns to investment in the rice sub sector of Rwanda

The supply function used to estimate the effects of agricultural research or investments into a sub sector can be represented in general form by

$$Q = q(P, W, r, Z)$$

Where Q is the quantity of the commodity produced, P is the expected output price and W is a vector of expected input prices. The variable r represents the technology related variables such as research, development and extension expenditures while variable Z is a vector of other supply-shift variables (J.M Alston et al, 1997).

The analytical tool "**D**ynamic **R**esearch **E**valu**a**tion for **M**anagement (DREAM)" is designed to evaluate the economic impacts of agricultural research & development (R&D) for a broad range of policy, marketing technology, and adoption conditions (S. Wood, 2002). The objective is to provide R&D analysts with a practical means of

generating relevant and structured information to support strategic decision-making with regard to agricultural R&D policies, priorities, and resource allocation.

It is impossible to quantify the economic impacts of all kinds of research. **DREAM** focuses primarily on the evaluation of new technologies or practices applicable at the farm level. But while the immediate impacts of R&D often arise from technology-induced changes in yield potential and production costs at the farm level, the broader economic effects also depend upon a range of biophysical, social, and market factors, for which **DREAM** requires the user to provide quantitative estimates. In this particular analysis the following premises were set based on economic coefficients and parameters drawn from national statistical abstracts and from survey findings. The total cost of rehabilitating and expanding rice schemes is US$ 28,192,500 and this is to be spent from 2000 to 2003. This total is split into rehabilitation costs which amount to US$ 5,644,500 to cover 3,700 hectares and costs for expanding cultivated area, which amounts to US$ 22,548,000 intended to open 7,516 hectares.

Study: Rice development in Rwanda
Scenario: 1
Commodity: Rice Regions: 1 Single Closed Economy - Spillover: No
Period: 20 years Base year: 2000
Discount: 5.0% Benefit: in US$1000 Quantity: in 1000 MT

SUMMARY OF INITIAL MARKET CONDITIONS

Region	Prodn	Cons	Price	Elasticity of Supply	Elasticity of Demand	Transmission Wedge	Transmission Elasticity	Exogenous Growth in Supply	Exogenous Growth in Demand.	Tax/Subsidy Supply	Tax/Subsidy Demand.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	< '000MT >		<'000 US$>	<----------pr un---------->				%/yr	%/yr	%/yr	%/yr
Rwanda	11.7	11.7	400.00	0.6	-0.8	0.00	1.00	2.50	2.50	-1.00	17.00

SUMMARY OF R&D & ADOPTION DATA

Region	K Pot.	Success Probability	Max. Adopt	K Price	K Max	Shift Type	K Var	<---Time Lags ----- Adopt ----- R&D	Adoption	at Max	Abandon	Form
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	-%-	-%-	-%-	<--'000US$--->			%/yr	-yrs-	-yrs-	-yrs-	-yrs-	
Rwanda	19.81	80.0	100.0	400.00	63.39	Sigmoid	-0.50	4	4	5	100.0	X

NB
Kmax is maximum absolute unit cost reduction (in price units). Product of Cols 2-5
Kvar is the variable unit cost reduction (%/year), if specified.
Shift type: S - Supply, D - Demand Adoption Form: L - Linear, X – Logistic
It is assumed that the entire process of rehabilitating and expanding the rice growing areas is the R&D process and the adoption is assumed to be the utilization of the revamped and new growing areas. This process is to take 4 years and thereafter, 10% annual depreciation is assumed which is US$ 203,500 in year 1 based on rehabilitation costs after a 30-year period of utilization.

RESULTS 1

Region: 1 Rwanda Price transmission (v,w): 0.00, 1.000

	Producers					Consumers					Government			
	<---no R&D--->		<------- with R&D ------>			<-- no R&D --->		<------- with R&D ------>			< Tax Rev.>		<---Research--->	
Year	Price	Quantity	Price	Quantity	Benefits	Price	Quantity	Price	Quantity	Benefits	"Prod"	"Cons"	Benefits	Costs
2000	404.0	11.7	404.0	11.7	0.0	468.0	11.7	468.0	11.7	0.0	0.0	0.0	0.0	7048.0
2001	404.0	11.9	404.0	11.9	0.0	468.0	11.9	468.0	11.9	0.0	0.0	0.0	0.0	7048.0
2002	404.0	12.2	404.0	12.2	0.0	468.0	12.2	468.0	12.2	0.0	0.0	0.0	0.0	7048.0
2003	404.0	12.5	404.0	12.5	0.0	468.0	12.5	468.0	12.5	0.0	0.0	0.0	0.0	7048.0
2004	404.0	12.9	402.7	12.9	18.6	468.0	12.9	466.7	12.9	16.2	-0.1	1.8	1.7	203.5
2005	404.0	13.2	394.1	13.4	150.9	468.0	13.2	458.1	13.4	131.1	-0.8	14.7	13.8	223.8
2006	404.0	13.5	382.1	14.0	347.8	468.0	13.5	446.1	14.0	302.2	-1.9	33.6	31.6	246.2
2007	404.0	13.9	380.4	14.4	384.7	468.0	13.9	444.4	14.4	334.2	-2.1	37.1	34.9	270.8
2008	404.0	14.2	381.3	14.7	378.4	468.0	14.2	445.3	14.7	328.8	-2.1	36.6	34.4	297.9
2009	404.0	14.6	382.2	15.1	371.7	468.0	14.6	446.2	15.1	322.9	-2.1	35.9	33.8	327.7
2010	404.0	14.9	383.2	15.4	364.4	468.0	14.9	447.2	15.4	316.6	-2.0	35.2	33.2	360.5
2011	404.0	15.3	384.1	15.8	356.5	468.0	15.3	448.1	15.8	309.7	-2.0	34.5	32.5	396.5
2012	404.0	15.7	385.0	16.2	348.0	468.0	15.7	449.0	16.2	302.4	-1.9	33.7	31.7	436.2
2013	404.0	16.1	386.3	16.6	333.3	468.0	16.1	450.3	16.6	289.6	-1.9	32.3	30.4	479.8
2014	404.0	16.5	387.5	16.9	317.7	468.0	16.5	451.5	16.9	276.0	-1.8	30.8	29.0	527.8
2015	404.0	16.9	388.7	17.3	301.1	468.0	16.9	452.7	17.3	261.6	-1.7	29.3	27.5	580.6
2016	404.0	17.3	389.9	17.7	283.6	468.0	17.3	453.9	17.7	246.4	-1.6	27.6	25.9	638.6
2017	404.0	17.8	391.2	18.1	265.0	468.0	17.8	455.2	18.1	230.2	-1.5	25.8	24.3	702.5
2018	404.0	18.2	392.4	18.6	245.4	468.0	18.2	456.4	18.6	213.2	-1.4	23.9	22.5	772.7
2019	404.0	18.7	393.6	19.0	224.7	468.0	18.7	457.6	19.0	195.2	-1.2	21.9	20.6	850.0
Present value of benefits					2578.1					2239.9			235.4	30126.4

					<----- Price--->		<---------- Production ---------->				<---------- Consumption ---------->			
Year	K Total	K Base	K Spill	K Var	NoR&D	R&D	R&D Price	change in Quantity	Value of Prodn	Benefits /VoP (%)	R&D Price	change in Quantity	Value of Consumpn	Benefits /VoC (%)
2000	0.00	0.00	0.0	0.00	400.0	400.0	0.00	0.0	4726	0.0	0.00	0.0	5475	0.0
2001	0.00	0.00	0.0	0.00	400.0	400.0	0.00	0.0	4844	0.0	0.00	0.0	5612	0.0
2002	0.00	0.00	0.0	0.00	400.0	400.0	0.00	0.0	4966	0.0	0.00	0.0	5752	0.0
2003	0.00	0.00	0.0	0.00	400.0	400.0	0.00	0.0	5090	0.0	0.00	0.0	5896	0.0
2004	2.69	3.20	0.0	-0.50	400.0	398.7	-1.25	0.0	5212	0.3	-1.25	0.0	6040	0.2
2005	21.13	25.21	0.0	-4.07	400.0	390.1	-9.82	0.2	5303	2.8	-9.82	0.2	6164	2.1
2006	47.05	56.93	0.0	-9.87	400.0	378.1	-21.87	0.4	5373	6.4	-21.87	0.4	6274	4.8
2007	50.69	63.39	0.0	-12.69	400.0	376.4	-23.57	0.5	5498	6.9	-23.57	0.5	6423	5.2
2008	48.69	63.39	0.0	-14.69	400.0	377.3	-22.64	0.5	5641	6.7	-22.64	0.5	6588	4.9
2009	46.69	63.39	0.0	-16.69	400.0	378.2	-21.71	0.5	5788	6.4	-21.71	0.5	6757	4.7
2010	44.69	63.39	0.0	-18.69	400.0	379.2	-20.78	0.5	5938	6.1	-20.78	0.5	6930	4.5
2011	42.69	63.39	0.0	-20.69	400.0	380.1	-19.85	0.5	6092	5.8	-19.85	0.5	7107	4.3
2012	40.69	63.39	0.0	-22.69	400.0	381.0	-18.92	0.4	6250	5.5	-18.92	0.4	7289	4.1
2013	38.06	62.75	0.0	-24.69	400.0	382.3	-17.69	0.4	6414	5.1	-17.69	0.4	7477	3.8
2014	35.43	62.12	0.0	-26.69	400.0	383.5	-16.47	0.4	6582	4.8	-16.47	0.4	7669	3.5
2015	32.79	61.49	0.0	-28.69	400.0	384.7	-15.24	0.4	6754	4.4	-15.24	0.4	7867	3.3
2016	30.16	60.85	0.0	-30.69	400.0	385.9	-14.02	0.4	6931	4.0	-14.02	0.4	8069	3.0
2017	27.52	60.22	0.0	-32.69	400.0	387.2	-12.79	0.3	7113	3.7	-12.79	0.3	8276	2.7
2018	24.89	59.58	0.0	-34.69	400.0	388.4	-11.57	0.3	7299	3.3	-11.57	0.3	8489	2.5
2019	22.26	58.95	0.0	-36.69	400.0	389.6	-10.34	0.3	7490	3.0	-10.34	0.3	8707	2.2

PRESENT VALUE SUMMARIES

	<--------- Present Value of R&D Benefits ---------->				<---Costs--->	<---------- Returns ---------->		
Region	Producer	Consumer	Government	Total		(B-C)	B/C	IRR
1 Rwanda	2578.1	2239.9	235.4	5053.5	30126.4	-25072.8	0.16	--.-
Total NPV Benefits	2578.1	2239.9	235.4	5053.5	30126.4	-25072.8	0.16	--.-

Table 12: Cost and Benefit summary across all regions

Year	Producer benefits (in US$ '000)	Consumer benefits (in US$ '000)	Government benefits (in US$ '000)	Total Benefits (in US$ '000)	Total Cost (in US$ '000)	Net Benefits (in US$ '000)
2000	0	0	0	0	7048	-7048
2001	0	0	0	0	7048	-7048
2002	0	0	0	0	7048	-7048
2003	0	0	0	0	7048	-7048
2004	18.6	16.2	1.7	36.5	203.5	-167
2005	150.9	131.1	13.8	295.8	223.85	71.95
2006	347.8	302.2	31.6	681.6	246.23	435.37
2007	384.7	334.2	34.9	753.8	270.86	482.95
2008	378.4	328.8	34.4	741.6	297.94	443.66
2009	371.7	322.9	33.8	728.4	327.74	400.67
2010	364.4	316.6	33.2	714.2	360.51	353.69
2011	356.5	309.7	32.5	698.7	396.56	302.14
2012	348	302.4	31.7	682.1	436.22	245.88
2013	333.3	289.6	30.4	653.3	479.84	173.46
2014	317.7	276	29	622.7	527.83	94.88
2015	301.1	261.6	27.5	590.2	580.61	9.6
2016	283.6	246.4	25.9	555.9	638.67	-82.78
2017	265	230.2	24.3	519.5	702.53	-183.04
2018	245.4	213.2	22.5	481.1	772.79	-291.7
2019	224.7	195.2	20.6	440.5	850.07	-409.58

Source: Own calculations

Fig 5: Benefits to investment in rice subsector of Rwanda

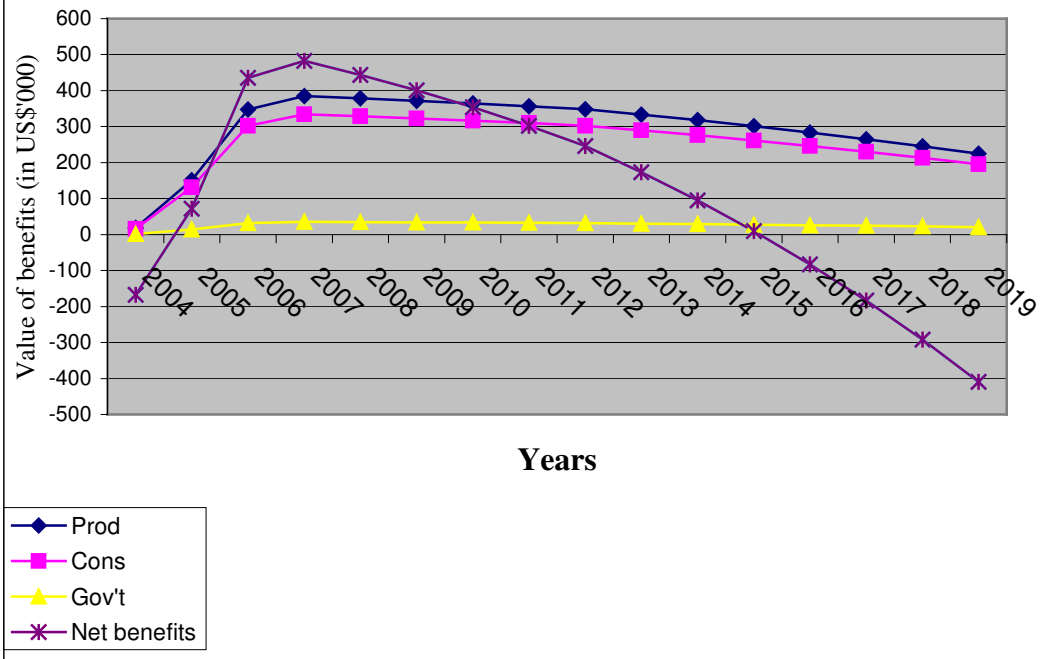
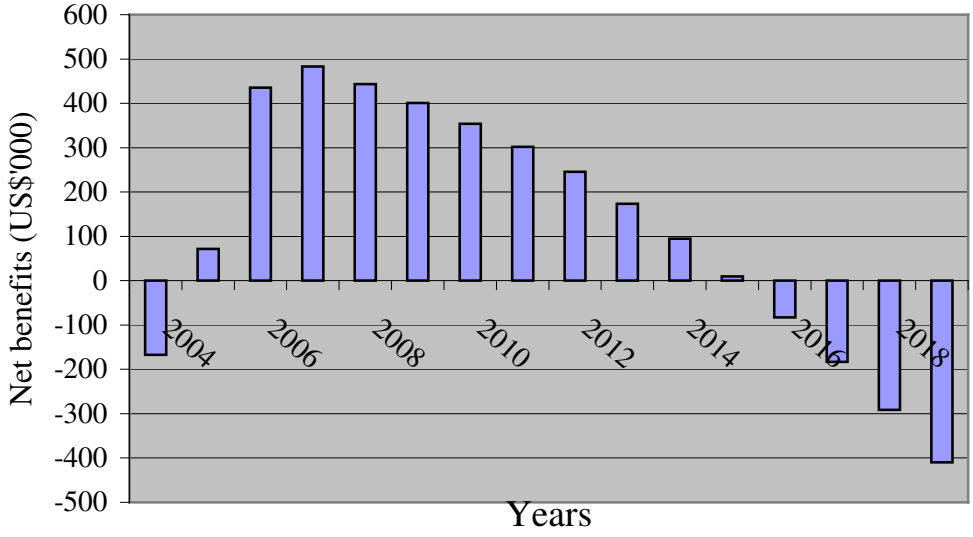


Fig 6: Rice subsector net returns to Investments in Rwanda for period 2004-2019



The above analysis shows the net benefits that are expected from an investment of a total of US$ 28,192,500, which is to be spent from the period 2000 to 2003. This money is be provided through bilateral and multilateral donors and is to be spent on the rehabilitation of 3,700 hectares of rice growing also to open up new rice growing areas covering about 7,500 hectares. The trends of the financial benefits to producers, consumers and government as a result of this investment are shown in figure 5 above. The net financial benefits of the investment are singled out in Figure 6 above and it is evident that the net benefits will rise until a peak in 2007 and then they will gradually decline until the zero level in about 2015. Beyond 2015, heavy investment will have to be made again in the sub sector.

5.0 Conclusion and the Way forward

Findings from the study seem to indicate that there is potential for growth of the domestic market for rice especially with the advantageous attributes of rice as global modernisation changes are setting in. It is also important to not that Rwanda's balance of payment and the food security position could be highly favored if what is consumed is produced locally. This is a vent of opportunities for local production of rice to be enhanced however, in order for this to happen, there ought to be a number of things in place. The current production levels are insufficient to meet the rising demand for rice as urban population growth is positive and the consumption of the commodity, especially in the urban areas, is on the increase.

The study has identified a number of strategic interventions that ought to be in place if local production and consumption of rice is to be enhance and also if the potential to export rice is ever to be exploited. They would include the following

- Research needs to identify, select and introduced the most suited varieties with the desirable attributes such as tolerance to diseases, high yielding, appropriate length of grain and aroma / flavor. These varieties ought to be selected and adapted to this environment then disseminated to the various rice producing schemes and farmers to feed into the domestic market.
- There is need to enhance the existing extension system for better service delivery to render the required technical advice to the farmers.
- Incentive for building entrepreneurial skills amongst the producers have to be made by the government in order to build the appropriate commercial management capacity right from the production level. Training could play and important role in this aspect and this could be done through NGOs and CBOs.
- It is quite important to device a sustainable system of maintaining the water / irrigation infrastructure that has been rehabilitated by the government in order to sustain local production of rice.
- Since most rice growing is done under the farmer cooperative schemes, it is important to build the management capabilities of most of the leaders and managers of these schemes. Appropriate entrepreneurial skills ought to be imparted to them to enable them manage the schemes profitable. It is crucial that a system of checks and balances is put in place to guard against mismanagement.

- The mechanisms through which inputs are supplied to the farmers ought to be stream lined for easier input access by farmers. Advice on optimal usage of inputs ought to be rendered by the extension workers. It's important to improve farmer's knowledge of fertilizer potential and how to use the inputs optimally.
- Quality standards ought to be observed right from the production level so that the processing efficiency is enhanced. The extension service is to play a key role in this aspect.

5.1 Areas for further research

It is important that similar studies are conducted in the countries within the COMESA region in order to establish the competitiveness of producing rice in the countries neighboring Rwanda. The result from this kind of research would give indications on whether Rwanda has an advantage in producing a surplus to supply the COMESA region.

It might be important to rethink about the best ways of utilizing the marshlands in Rwanda in view of the competitiveness of the various commodities that could be produced therein. It is important for a study to be conducted to come up with the actual parameters that would support decisions made on how best to utilize the marshlands in Rwanda. Alternatives could be Sugarcane, root crops or merely environment conservation.

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APPENDICES

Appendix 1

Survey Checklist

Producers	Processors	Traders
Personal Information For established firms try to get a business card, or mobile phone No. for purposes of future reference	Personal Information For established firms try to get a business card, or mobile phone No. for purposes of future reference	Personal Information For established firms try to get a business card, or mobile phone No. for purposes of future reference
Type of business How does the respondent add value along the market chain? - Does he change the form of product (processor) - Is there any vertical integration?	Type of business How does the respondent add value along the market chain? - Does he change the form of product (processor) - Is there any vertical integration?	Type of business How does the respondent add value along the market chain? Does he change the form of product or just move the product (transporter) or just store the product (wholesaler) or is he a retailer or consumer. Is there any vertical integration? Try to establish the marketing channels.
Demand -Quantity of product sold normally e.g. Per day, week, -To whom do you sell? -Are there changes in volume of sale over time? -Are there different types? -If so what is their respective demand / preference -What is the price variation as per type differences -Are there changes in prices over time? -If so what are the reasons? -Do you find problems selling your products? -If so which ones?	Demand -Quantity of product sold normally e.g. Per day, week, -To whom do you sell? -Are there changes in volume of sale over time? -Are there different types? -If so what is their respective demand / preference -What is the price variation as per type differences -Are there changes in prices over time? -If so what are the reasons? -Do you find problems selling your products? -If so which ones?	Demand -Quantity sold normally e.g. Per day, week, -To whom do you sell? -Are there changes in volume of sale over time? -Are there different types? -If so what is their respective demand / preference -What is the price variation per type -Are there changes in prices over time? -If so what are the reasons? -Do you find problems selling your products? -If so which ones?
Input Supply -From whom do you buy inputs such as seed and fertilizers? -From where do you buy? (Meeting pt.) -At what price do you buy the various types? -Does the price change over time? If so why? & How? -Do you have problems getting inputs? If so which are they?	Supply -Which are your supply areas (geographically) -From whom do you buy the raw materials? -From where do you buy? (Meeting pt.) -At what price do you buy the various types? -Does the price change over time? If so why? & How? -Do you have problems getting raw materials? If so which are they?	Supply -Which are your supply areas (geographically –districts / regional) -From whom do you buy? -From where do you buy? (Meeting pt.) -At what price do you buy the variety? -Does the price change over time? If so why? & How? -Do you have problems getting products? If so which are they?
Quality -How do you maintain quality after harvest -What is the shelf life of the products	Quality -What is the quality of products along the chain? -What is the shelf life of the products	Quality -What quality requirements do your customers have? -What is the shelf life of the products?
Storage -How much do you usually store (product)? -For how long?	Storage -How much do you usually store (product)? -For how long?	Storage -How much do you usually store? -For how long? -Do you have any storage problems? -Do you experience storage losses?
Transaction costs -What are your transaction costs in selling the commodity? (ie processing, transport, loading storage, advertising) -What is their proportion?	Transaction costs -What are your transaction costs in selling the product? (ie processing, transport, loading storage, advertising) -What is their proportion?	Transaction Cost -What are your transaction Costs? (Buying / Selling agents, brokers, loading / unloading, transport, taxes. -What is their proportion?
Grading & Sorting -Do you grade or sort? (Product) -Do better grades fetch higher prices?	Grading & Sorting -Do you grade or sort? (Product) -Do better grades fetch higher prices?	Grading & Sorting -Do you grade or sort? (By heap/size of bunch) -Do better grades fetch higher prices?
Market Information (Both raw material &	Market Information (Both raw material &	Market Information

Product) -Do you get market info? (e.g. on prices?) -If so from whom and how? -Is there a relationship between prices in different areas at a given time	Product) -Do you get market info? (e.g. on prices?) -If so from whom and how? -Is there a relationship between prices in different areas at a given time	-Do you get market info? (e.g. on prices?) -If so from whom and how? -Is there a relationship between prices in different areas at a given time
Price Formation -Who determines the price? -How is the price determined? -If firm / individual is a price taker, find out why?	**Price Formation (Both raw material & Product)** -Who determines the price? -How is the price determined? -If firm / individual is a price taker, find out why?	Price Formation -Who determines the price? -How is the price determined? -If firm / individual is a price taker, find out why?
Institutional & legal framework -Do you belong to an association? -Are there any market regulations? If so which are they and how do they affect your business?	**Institutional & legal framework** -Do you belong to an association? -Are there any market regulations? If so which are they and how do they affect your business?	Institutional & legal framework -Do you belong to an association? -Are there any market regulations? If so which are they and how do they affect your business?
Market Structure -No of sellers of product / competitors -Is there price competition -Is there non-price competition? If so how (interlocking markets)	**Market Structure** -No of sellers of product / competitors -Is there price competition -Is there non-price competition? If so how (interlocking markets)	Market Structure No of sellers -Is there price competition -Is there non-price competition? If so how (interlocking markets)
Credit availability -Are there any credit institutions -Do you use them? -What are their rates of interest?	**Credit availability** -Are there any credit institutions -Do you use them? -What are their rates of interest?	Credit availability -Are there any credit institutions -Do you use them? -What are their rates of interest?

Appendix 2

Summary of Findings from Rice Schemes and some Traders

Rice Scheme	Sources of Rice	Information relating to rice handled	Where rice is sold	Constraints and Suggested way forward
Bugarama Rice Scheme Contact: Jean Pierre Director General information: The scheme's water canal s have been rehabilitated and new varieties have been introduced. Extensionists & technicians have been trained and input supply channels have been improved	Buys rice from smaller millers in the area and also from farmers	Has 2 big mills capable of processing 1 Ton per Hour It is mostly varieties such as BR, IRON, IITA and Basmati that are grown in this area.	The processed rice is sold to traders in major towns such as Cyangugu, Gikongoro, Kigali and Bukavu in the DRC	Constraints: -Poor maintenance of the water supply infrastructure -Poor yield s due to low usage of inputs & recycling of seed -Poorly managed farmer cooperatives -Massive flooding of marshlands where rice is being grown Way Forward: -Need to introduce more Basmati variety due to its desirable qualities and its capability to fetch higher revenues

Rice Scheme	Sources of Rice	Information relating to rice handled	Where rice is sold	Constraints and Suggested way forward
Mutara Rice Scheme (CODERVAM) Contact: Uziel Uzayisenga Manager General information: Established in 1978 and handed over to private management by farmer cooperative in 1988 (CODERVAM) Has about 640 members organized into 50 groups The coop provides inputs to the members and they offer produce upon harvest Members also contribute some money towards the maintenance of the iriigation infrastructure	The cooperative obtains all the rice produced by the members within the scheme. The cooperative provides inputs to the members and some proceeds from sales minus inputs advanced The coop has 2 stores with storage capacity of 1000 tons	Has 1 big mill capable of processing 900Kg per Hour This mill is capable of sorting broken grains, bran and husks The mill has been processing about 1,100 to 1,300 Tons of paddy per annum since 1999 Paddy is purchased at Frw70 – 90 per Kg and milled rice goes for Frw135 per Kg (ex – factory) and goes for about Frw 200 per Kg on retail Rice bran is sold at Frw10-20 per Kg (Ex-factory)	The processed rice is sold to traders in major towns such as Kigali, Nyagatare and Goma in the DRC	Constraints: -Severe losses as a result of floods account for 400 tons per annum -The milling unit is quite old and causes 3% loss -Mismanagement of the coop and misappropriation of funds resulting into poor staff motivation -Excess milling & storage capacity Way Forward: -Need to train farmers on how to maintain the irrigation infrastructure -Credit from IFAD and BRD is being sought to enable farmers get stable revenue from their produce -Farmer training ought to be emphasized in order to lower costs of production

Rice Scheme	Sources of Rice	Information relating to rice handled	Where rice is sold	Constraints and Suggested way forward
CPCRB cooperative Bugarama Contact: Rukengeza Yussuf President of Coop Tel: 250-576228 Mob: 250-85-92329	The cooperative obtains all the rice produced by the members within the scheme. The cooperative provides inputs to the members and some proceeds from sales minus inputs advanced The coop provides drying places and winnowing machines to farmers at no cost The paddy is bought from the farmers at a cost of Frw70-80 per Kg	This Coop processes about 1,700 Tons of milled rice per annum	The processed rice is sold to traders in major towns such as Kigali, Gisenyi and Cyangugu Milled rice is sold at Frw100 – 120 per Kg during harvest January – April The prices rise to Frw 220 per Kg during the months of August to September	Constraints: -Perpetual lack of spare parts for the milling machines -High cost of electricity -Inadequate storage facilities -Lack of means to dispose off husk which result from processing -Tendency for farmers not to maintain separately the different rice varieties. The mixing of varieties results into high breakage while milling Way Forward: -Opening up more land for rice production -Protection of market for locally produced rice by imposing tariffs on imported rice

Rice Scheme	Sources of Rice	Information relating to rice handled	Where rice is sold	Constraints and Suggested way forward
Butare Gikonko Projet Rizicole de Butare (PRB) General Information -It was founded as a coop that is Gov't controlled. It was thru Chinese Gov;t funding. The coop provides inputs to farmers and also processes and markets their produce	Rice is produced by the farmers members and it is marketed by the coop The varieties grown are the old Kigoli varieties,	The factory has a milling capacity of 50Tons per day but it utilizes only 30% of the capacity installed. In the year 2000 it processed 1,282 Tons In the year 2001 it processed 1,181 Tons In the year 2002 it processed 1,653 Tons	It is sold mainly to the local institutions and individual household consumers.	Constraints: -Inadequate finances to maintain a steady cash flow -Under utilization of capacity resulting into excess overheads -Incompetent labour force due to permanency of employment contract

Company	Sources of Rice	Information relating to rice handled	Storage capacity	Demand
GECI Company -Company director: Callixte Kabera **General information** -Been in rice import business for 5 years. -Company has agents/offices in Tanzania (Dar-es salaam and Isaka) -Company also has its own fleet of lorries for transport (transport company)	**Imports rice from** Asian countries such as Pakistan and Vietnam from & from exporting companies & from Tanzania factories in Isaka and Dar-es salaam. Imports about 1,000Tons (i.e Pakstan = 500mt and Vietnam = 500mt) per consignment. In a year, he imports 2-3 consignments. That is 2,000 to 3,000 mt per year.	The company also buys locally from cooperatives. At present the company has contracts with CODEVAM based in Nyagatare and Gikongo PERIBE in Butare. -Before September 2002, company was paying Frw 7000 per 50kg bag for local variety called kigori. However, since September 2002, price has increased to Frw 9,500.	Company has big stores in major towns in Rwanda In Kigali, store with capacity of 1,000mt. Butare store, capacity is 150 mt Ruhengeri store, capacity is 150 mt	Major buyers are institutions (army, schools, and hospitals), wholesalers and retailers.

Appendix 3:

Farm level Incentive Indicators

Commodity	Location	Farming system	Yields	Financial profitability	Returns to labor (Frw/day)
Maize	Bugarama	Traditional / Manual	900	-21	184
Maize	Gisenyi	Improved / Manual	2000	-16	190
Maize	Gisenyi	Traditional / Manual	1300	-18	238
Maize	Mutara	Improved / Manual	1000	-21	156
Rice	Butare	Low cost irrigation	4000	34	434
Rice	Butare	Low cost irrigation	4000	34	434
Rice	Gitarama	Low cost irrigation	5000	3	413
Rice	Bugarama	High cost irrigation	4000	25	393
Rice	Rwamagana	High cost irrigation	4500	2	307
Rice	Kabuye	Low cost irrigation	4500	-34	361
Rice	Mutara	High cost irrigation	3040	-41	197
Sorghum	Byumba	Improved / Manual	2000	-7	527
Sorghum	Byumba	Traditional / Manual	1100	-9	539
Sorghum	Kibungo	Improved / Manual	2000	-10	493
Sorghum	Kibungo	Traditional / Manual	900	-20	492
Sorghum	Kigali	Improved / Manual	2000	-4	755
Sorghum	Kigali	Traditional / Manual	1000	-18	694
Dry beans	Byumba	Improved / Manual	1200	-2	584
Dry beans	Byumba	Traditional / Manual	800	-4	578
Dry beans	Kibungo	Improved / Manual	1200	17	713
Dry beans	Kibungo	Traditional / Manual	400	-75	412
Dry beans	Kigali	Improved / Manual	1200	-15	694
Dry beans	Kigali	Traditional / Manual	750	-26	679

Source: A.W. Barry, 2000

Appendix 4

Rice Production in Asia

Selected Rice-consuming and Producing countries	Rough rice						Area planted to modern Varieties (%)
	Production ('000 MT)		Area ('000 Ha)		Yield (MT/Ha)		
	1990	1999[h]	1990	1999[h]	1990	1999[h]	
Asia	**479480**	**540621**	**132328**	**138503**	**3.6**	**3.9**	**74**
Bangladesh	26778	29857	10435	10470	2.6	2.9	52
Bhutan	43	50	26	30	1.7	1.7	100
Cambodia	2500	3800	1740	1961	1.4	1.9	11
China (including Taiwan)	191615	200499	33519	31720	5.7	6.3	100[i,j]
India	111517	131200	42687	44800	2.6	2.9	73
Indonesia	45179	49534	10502	11624	4.3	4.3	77
Japan	13124	11469	2074	1788	6.3	6.4	100
Korea, DPR	3570	2343	650	580	5.5	4.0	100
Korea, Republic of	7722	7271	1244	1059	6.2	6.9	100
Lao PDR	1491	2103	650	718	2.3	2.9	2
Malaysia	1960	1934	681	674	2.9	2.9	90[l]
Myanmar	13972	17075	4760	5458	2.9	3.1	72
Nepal	3502	3710	1455	1514	2.4	2.4	36
Pakistan	4891	6900	2113	2400	2.3	2.9	42
Philippines	9885	11388	3319	3978	3.0	2.9	89
Sri Lanka	2538	2692	828	829	3.1	3.2	91
Thailand	17193	23272	8792	10000	2.0	2.3	68
Vietnam	19225	31394	6028	7648	3.2	4.1	80

Source: IRRI database, 2000

Appendix 5

Rice Production in Africa

Selected Rice-consuming and Producing countries	Rough rice						Area planted to modern Varieties (%)
	Production ('000 MT)		Area ('000 Ha)		Yield (MT/Ha)		
	1990	1999	1990	1999	1990	1999	
Africa	**12407**	**17602**	**6099**	**7842**	**2.0**	**2.2**	_
Côte d'Ivoire	660	1162	572	750	1.2	1.5	_
Egypt	3167	5816	436	655	7.3	8.9	_
Guinea	424	750	436	500	1.0	1.5	_
Liberia	185	210	200	163	0.9	1.3	_
Madagascar	2420	2637	1165	1227	2.1	2.1	_
Mali	338	589	231	330	1.5	1.8	_
Mozambique	96	200	110	182	0.9	1.1	_
Nigeria	2500	3397	1208	2050	2.1	1.7	_
Senegal	181	240	73	96	2.5	2.5	_
Sierra Leone	504	247	393	213	1.3	1.2	_
Tanzania, United Republic	740	676	385	474	1.9	1.4	_

Source: IRRI database, 2000

Appendix 6: Paddy cultivation by Area, Yields and Average Prices for 1999, 2000

Prefecture	Rice (paddy) cultivated by Area (Ha)		Rice (paddy) cultivated by quantity (MT)		Rice Yields (MT/Ha)	Average Rice price (Frw / Kg)
Year 1999	**Season A**	**Season B**	**Season A**	**Season B**		
Butare	723	526	765	613	1.103	206
Byumba	39	-	154	-	-	227
Cyangugu	683	702	1,162	1,331	1.8	190
Gikongoro	-	-	-	-	-	227
Gisenyi	-	-	-	-	-	232
Gitarama	210	45	313	275	2.306	215
Kibungo	343	160	644	170	1.618	221
Kibuye	-	-	-	-	-	235
Kigali R	363	453	824	1,179	2.455	230
Ruhengeri	-	-	-	-	-	222
Umutara	204	467	816	675	2.222	245
Total	**2,565**	**2,353**	**4,678**	**4,243**	**1.814***	**223***
Year 2000						
Butare	650	670	1,950	2,680	3.508	215
Byumba	-	-	-	-	-	231
Cyangugu	840	84	2,520	3,360	6.364	201
Gikongoro	-	-	-	-	-	228
Gisenyi	-	-	-	-	-	240
Gitarama	190	194	285	-	-	226
Kibungo	85	850	128	-	-	226
Kibuye	-	-	-	-	-	237
Kigali R	200	196	300	-	-	239
Ruhengeri	-	-	-	-	-	235
Umutara	140	176	140	-		242
Total	**2,105**	**2,170**	**5,323**	**6,040**	2.658*	**229***

Source: FAO, MINAGRI, PASAR

NB

Season A runs from September to January / February

Season B runs from March to August

* Annual average value

Appendix 7: Raw data for computing the Competitiveness Index

{(Traded inputs) x (factor border prices)}

Item	**Quantities**	**Unit cost (Frw)**	**Total Cost (Frw)**	**Total Cost (US$)**
Pesticide	0.5KG	4,000	2,000	4
Fertilizer NPK	150KG	200	30,000	60
Fertilizer (Urea)	100KG	200	20,000	40
Tools / implements	-	-	2,000	4
Total cost of Producing 2.6MT of milled rice			**54,000**	**108**

Yield is 4 MT (2.6 milled) of paddy p.a. or 2 MT (1.3 milled) per growing cycle

{Domestic inputs (Non traded)} x (Factor Prices)

Item	**Quantities**	**Unit cost (Frw)**	**Total Cost (Frw)**	**Total Cost (US$)**
Land rent	1Ha	12,500	12,500	25
Seed	70KG	120	8,400	16.8
Seed bed preparation	20	300	6,000	12
1st, 2nd, 3rd Ploughings	190 Md[6]	300	57,000	114
Planting	60 Md	300	18,000	36
Weeding	160 Md	300	48,000	96
Water channeling	30 Md	300	9,000	18
Fertilizer application	5 Md	300	1,500	3
Pesticide application	10 Md	300	3,000	6
Bird / vermin control	20 Md	300	6,000	12
Harvesting	120 Md	300	36,000	72
Transport	10 Md	300	3,000	6
Drying	30 Md	300	9,000	18
Weighing	12 Md	300	3,600	7.2
Total cost of Prodn			**221,000**	**442**

Yield is 4 MT (2.6 milled) of paddy p.a. or 2 MT (1.3 milled) per growing cycle

The border price of milled rice is Frw 200,000 per MT

[6] Units of labor: 6 hrs of work per day by 1 man