An Integrated Investment Appraisal of Paddy Irrigation
A Case of Senegal River Valley

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ABSTRACT

According to the FAOStat 2015, agriculture contributes 17 percent of the Senegalese GDP and provides 68.89 percent of the total employment of the economically active population with females accounting for 48.50 percent of that labor force. Poverty is still a challenge in Senegal with an estimated 46.7 percent of the total population living below the national poverty line.

Rice is one of the main food crops in Senegal, mostly grown by female subsistence farmers. Senegal has emerged to be one of the chief consumers of rice in West Africa and the largest importers of broken rice with approximately 70 percent of total domestic consumption imported. The project evaluated in this paper introduces paddy irrigation to increase production and introduces aromatic varieties to cater to urban preferences and reduce expensive exports.

Keywords: Paddy Production, Irrigation Farming, Cost-Benefit Analysis, Financial Analysis, Economic Analysis, Risk Analysis, Risk Management.

ÖZ

Gıda ve Tarım Örgütü (GTÖ)'nün 2015 istatistik verilerine göre tarım sektörü, Senegal GSYİH'sının yüzde 17'sine katkıda bulunuyor ve ekonomik faal nüfusun yüzde 68,89'unu oluşturuyor. Kadınlar bu işgücünün yüzde 48,50'sini oluşturuyor. Yoksulluk Senegal'de halen ciddi bir problem olmaya devam ediyor. Toplam nüfusun yüzde 46.7'si milli yoksulluk sınırının altında yaşamaktadır.

Çoğunlukla kadın geçimlik çiftçiler tarafından yetiştirilen pirinç, Senegal'deki en önemli besin ürünlerinden biridir. Senegal, Batı Afrika'daki pirincin başlıca tüketicilerinden biri ve toplam iç tüketimin yaklaşık yüzde 70'inin ithal edildiği kırık pirincin en büyük ithalatçısıdır. Bu çalışma üretimi artırmak ve böylece pahalı ihracatı azaltmak için planlanan esmer pirinç sulaması ve kentsel tercihlere hitap edecek aromatik çeşitleri artırmayı amaçlayan bir projeyi değerlendirmektedir.

Anahtar Kelimeler: Esmer Pirinç Üretimi, Sulama Tarım, Maliyet Fayda Analizi, Finansal Analiz, Ekonomik Analiz, Risk Analizi, Risk Yönetimi.

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Without mentioning names out of fear of forgetting anyone, I wish to also extend my gratitude to my colleagues for taking time out of their busy schedules to lend me a hand. Last but definitely not least, I want to thank my parents.

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LIST OF ABBREVIATIONS

ADSCR	Annual Debt Service Coverage Ratio
CAADP	Comprehensive Africa Agriculture Development Program
CBA	Cost Benefit Analysis
CFA	Communauté Financière d'Afriq
ECOWAP	Economic Community of West African States
ENPV	Economic Net Present Value
FAO	Food and Agriculture Organization of the United Nations
FNPV	Financial Net Present Value
GAIN	Global Agricultural Information Network
GDP	Gross Domestic Product
GoS	Government of Senegal
HDI	Human Development Index
IIA	Integrated Investment Appraisal
IRRI	International Rice Research Institute
LIFDC	Low-Income Food Deficit Country
MT	Metric Tons
MIRR	Modified Internal Rate of Return
NAIP	National Agricultural Investment Appraisal
NEPAD	New Partnership for Africa Development
NPV	Net Present Value
OMVS	Senegal River Development Organization
SRV	Senegal River Valley
U.S.	United States

USD	United States Dollar
WHO	World Health Organization

Chapter 1

INTRODUCTION

1.1 Background

Located in the very western section of Africa's north-western semi-arid region is Senegal, a country between Mauritania, Mali, Guinea, Guinea-Bissau and on the inside just about completely encloses The Gambia. Senegal is inhabited by a wide variety of ethnic groups with the Wolof being the largest single ethnic group at 43 percent of the total population. French is the official language, but most people also use their ethnic language. More than half Senegal's population, estimated to be 14, 5 million, (World Bank 2014), is located in coastal areas where most economic activities take place (Dennis, Niang-Diop and Nicholls 1995).

According to FAOStat 2015, agriculture contributes 17 percent of the Senegalese GDP and provides 68.89 percent of the total employment of the economically active population with females accounting for 48.50 percent of that labor force. Poverty is still a challenge in Senegal with an estimated 46.7 percent of the total population living below the national poverty line, and 38 percent live under US$1.90 per day (Groupe Consultatif, 2011). The country performed unsatisfactorily in developing its competence in the areas of health, nutrition, and education, coming 153rd out of 174 according to the 2000 United Nations Human Development Report.

In recent years, 20 percent of Senegal's economic output has been contributed by the primary sector with agriculture accounting for 10 percent of that. The sector provides

livelihood in the form of subsistence and cash income for about two-thirds of the total population with 25 percent of children U5 suffering from stunting (Feed the Future 2016). At present, Senegal is heavily reliant on the world market for its food supplies especially with rice, which makes up approximately 75 percent of total cereal imports. Senegal has not been able to attain self-sufficiency when it comes to paddy production. Domestic production accounts for 30 percent of the total domestic consumption leaving the remaining large portion to be furnished by imports (GAIN, 2013).

1.2 Importance and Objectives

Starvation and undernourishment are leading problems faced by the world`s poor and impoverished. About a third of humanity, including children, adults and the elderly within the less developed countries are known at present to be suffering from one or more of the numerous forms of malnutrition (WHO, 2000). Senegal is not immune to these problems and the challenge of feeding its growing population. The population growth rate of since 2000 has been 3 percent per year. The shortfall in domestic production of rice is due to a range of problems including unpredictable seasonal rains causing drought but also poor farming practices, lack of infrastructural development, land tenure problems as well credit difficulties. These factors constrain the growth of a more sustainable and equitable agricultural sector in the country.

Senegal relies on imports to offset its food shortages. In 2014, the estimated Senegalese milled rice consumption was 1,494,000 Metric Tons (MT), yet milled production only amounted to 380,000MT, and an estimated 1,100,000MT of rice were imported (GAIN 2015). The previous year, milled consumption was approximately 1,400,000MT while milled production and rice imports were 290,000MT and 1,100,000MT respectively (IRRI, 2015). Although production increased at a rate

higher than consumption, the problem still exists because the output cannot service the demand. The substantial import reliance makes Senegal susceptible to fluctuations in the international rice market, and global food prices may have come down from their 2008/09 peaks, but they are still relatively high making food unaffordable for many poor Senegalese households, especially those faced with high levels of indebtedness or unemployment (Seck et al., 2010).

Faced with this problem, the Government of Senegal (GoS) took various measures in an effort to match agricultural production with a growing population and increasing urbanization (Ministry of Agriculture, 2009). These measures will be discussed in the next chapter of this paper. Various stakeholders also came forward with different projects and ideas to help Senegal. One such project is the main focus of this paper. It is commendable that these persons wish to help eradicate hunger and poverty in Senegal, but it is fundamental to vet these proposed project ideas to ensure their financial and economic viability. It is equally important to make sure that any project carried out puts the Senegalese people in a better social, economic and financial place than they were before.

1.3 Method Used in the Study

1.3.1 Sources of Data

Data used in this study came from primary and secondary sources. Primary data came from a field study, and Secondary data was collected from the internet, books, articles, newspapers, journals, unpublished works as well as past presentations and case studies.

1.3.2 Study Approach

This study was conducted by means of the Cost-Benefit Analysis (CBA) for investment appraisals particularly Integrated Investment Appraisal (IIA). This type of

analysis involves evaluating a project via four main pillars Financial, Economic, Stakeholder and Risk Analysis to be precise. CBA is of assistance in preventing the implementation of bad projects and dismissal of socially and or financially good projects (Jenkins, Kuo and Harberger, 2014).

Data was analyzed through the pillars mentioned before by inserting all the relevant data into a financial model that allows one to conduct analysis and arrive at conclusions. By using a financial and economic analysis, the viability of the proposed project by is evaluated by deriving the Net Present Value (NPV). Then using the same model, values identified as being critical were derived through employing a sensitivity test to observe their movement and impact on the project outcome. The detected risky variables were then run through a Monte Carlo simulation with probability distributions to show several risk level scenarios along with their effects on the project outcome. Further discussion of the study approach is available in Chapter 3, Methodology.

1.4 Structure of the Thesis

This section, Chapter 1, is the introduction with the main purpose of giving a brief background about Senegal as well as the importance and objectives of this study. Immediately following is Chapter 2 which highlights the overview of this study by looking at the agricultural sector in Senegal with special attention to rice production and efforts by the GoS to improve paddy and milled production as part of rice self-sufficiency and poverty alleviation goals. Chapter 3 will comprise of the Project description. The Methodology used for this study, which is an extension of the preceding section on Study Approach, will be analyzed in Chapter 4.

Because this study follows IIA, succeeding sections will comprise of the pillars of analysis. Financial Analysis will be evaluated in Chapter 5. Chapter 6 will be a discussion of Economic Analysis, which will be followed by Stakeholder Analysis in Chapter 7. An important pillar, Risk Analysis, is discussed in Chapter 8. A conclusion to this study will make up Chapter 9.

Chapter 2

OVERVIEW OF THE STUDY

Senegal has emerged to be one of the chief consumers of rice in West Africa and the largest importers of broken rice with approximately 70 percent of total domestic consumption imported. Traditionally rice was grown in the Casamance region, and it was used to pay taxes and fund war endeavors during the colonial period. Due to decreasing rainfall and desertion of paddy fields because of soil salinization, there was a decrease in rain fed rice cultivation in the lowlands, which turned out to be beneficial to the uplands as they could monopolize paddy production and sales (MOA, 2009).

2.1 Rice Production in Senegal

Rice farming methods in Senegal are mainly governed by small and family-held farms. Irrigated rice farming occupied about 53,000 Ha during the 2008 crop year (off-season and rainy season) split between the Senegal River Valley (50,000 ha) and the Anambé Basin (3,000 Ha). Irrigated rice production represents 70 percent of national production. Rice yields vary between 4 and 6 MT/Ha on average.

Domestic rice production in Senegal has averaged around 200,000 MT in recent years. An estimated 85,037 hectares were under cultivation in 2006, almost exclusively by smallholder farmers, and expanding at an annual rate of 3.02 percent. The principal zones of production are in the Senegal River Valley for irrigated rice and the Casamance region for rain-fed cultivation. Yields vary significantly across regions, particularly as a result of the production system used (Ricepedia, 2015). Women are

dominant rain fed lowland farmers, and men are dominant irrigated rice farmers. Double cropping of rice, wet season, June - December and off season, February- July.

2.1.1 Senegal River Valley

The Senegal River Basin in West Africa is the focus of a comprehensive regional development project designed by USAID, known as the OMVS -IDP (Organisation pour la Mise en Valeur du Fleuve Senegal-Integrated Development Project). The Senegal River Basin is located in Guinea (9 percent of the river basin area), Mali (47 percent), Mauritania (22 percent) and Senegal (22 percent).

2.1.2 Rain-fed Production

While rain-fed rice can only be produced once per year with lower yields than irrigated rice, the vast area of the rain-fed valleys suitable for rice cultivation offers high potential for production. Only 52,149 hectares (20 percent) of the potentially cultivatable area of 255,380 hectares were cultivated in 2012. Cultivating the total potential area at optimal rain-fed yields of 3 tons/ha would produce 497,991 tons of white rice – this is equivalent to 82percent of Senegal's 2012 production deficit (MDG, 2014).

2.1.3 Constraints on Sustainable Rice Production in Senegal

The majority of Senegalese farmers grow rice for subsistence. Average parcel sizes in rain-fed regions range between 500 and 2000 m2. Farmers in rain-fed areas do not purchase agriculture inputs (e.g. certified seed, fertilizers, and herbicides). They usually prepare the land, harvest, and process the crop by hand. The smallholder's family consumes all rice produced, with no surplus to be marketed.

In the irrigated areas, most families cultivate parcels of a half hectare or less. In these areas, farmers sell the rice at harvest to repay production loans for inputs and services

such as seed, fertilizer, and mechanized tillage, harvesting, and threshing. In both the irrigated and rain-fed zones, farmers' net earnings from production in terms of white rice amount to less than the consumption requirement of the farming household.

2.2 Government Initiatives to Improve Rice Production

The GoS has been increasing investments in agriculture (more than 10 percent of GDP per year) has opened the door for stronger, resilient food security (USAID, 2015). As such, the GOS has prioritized achieving self-sufficiency in rice production as a cornerstone of its food security policies, such as the Grand Offensive for Food and Abundance (GOANA), the National Program for Rice Self-Sufficiency (PNAR), and the National Strategy for the Development of Rice Cultivation (SNDR). under the Coalition for African Rice Development (CARD), Senegal initiated the National Rice Development Strategy whose aim was producing 100,000MT of white rice by 2012.

Another initiative is The Accelerated Program for Agriculture in Senegal (PRACAS), developed by the minister of agriculture and rural equipment. It is aimed at reinforcing food security in Senegal and readjusting a trade balance deteriorated by food imports. It is also designed to help the country develop integrated and competitive sectors with high added value while preserving the socioeconomic balance and revitalizing rural economy. PRACAS has four main objectives for 2017 which include reaching self-sufficiency in rice with a production of 1.6 million tons of paddy 40 percent of which is rain-fed. This is to be achieved through focusing on seed production and yield growth; promotion of rain-fed rice farming in the Plateau and Shallows of the South as well as the intensification of irrigated rice farming in the SRV.

2.3 The Proposed Project

The United States government, through the U.S. Agency for development (USAID), launched a new project dubbed Economic Growth Project (USAID/PCE) in 2009. As far as rice is concerned, the main objective was to help SRV farmers to increase total production and yields so as to enhance their food security situation and to produce a surplus for marketing in provincial towns and cities, such as Dakar. Currently, the supply of rice in these areas is largely dominated by imports. USAID was also seeking to increase obtainability of strategic assortments of seeds through production and supply of quality certified seeds to Senegalese farmers.

Chapter 3

PROJECT DESCRIPTION

The Economic Growth Project is part of U.S. Government's interventions in Senegal to increase food security under the sponsorship of its Feed the Future initiative. The paddy production project backs the government's plans to increase food security and growth in the agricultural sector. The project integrates both poverty reduction and improved nutrition into its goals through the introduction of irrigated paddy production. The irrigated rice project also introduces aromatic varieties to generate a product that meets urban consumer preferences.

3.1 The Irrigated Paddy Production

Currently, rice cultivation is entirely commercial as opposed to subsistence farming of paddy production during the rainy season.

The whole initiative focused on the whole rice value chain from the seed producers to the millers. For this analysis, the focus will only be on the evaluating the incremental costs and benefits. By implementing this project, at least 85 percent of the farmers are expected to start producing paddy during the dry season. 12 percent of farmers are targeted for the cultivation of aromatic paddy.

Chapter 4

METHODOLOGY

4.1 Cost-Benefit Analysis

For this study, CBA was used. The Green Book defines CBA as an evaluation and monetary quantification of costs and benefits of proposed projects. Therefore, CBA involves showing as many effects of the project as possible in monetary terms, so that they can be compared in a common unit of measurement.

4.1.1 Financial Analysis

Financial analysis is about evaluating the project to see if it is financially feasible. Investors need to know if they get a positive financial return on their investment based on the used discount rate or if it is better for them to invest elsewhere. Lenders need to know if the project will generate enough cashflows to service the debt. From cash flow statements, Annual Debt Service Coverage Ratios (ADSCR's) are calculated. The banks and other lending institutions look for the to see if it is worthwhile to finance the project. As far as financial analysis is concerned, a favorable project should have a positive Financial Net Present Value (FNPV) and ADSCR's greater than one with the acceptable ranges depending on industry standards. An essential component of investment appraisal the examination of the incremental impact of the project. This means comparing the difference between the current situation net financial cashflows and net economic benefits to that of the implemented project.

4.1.2 Economic Analysis

Economic analysis is looking at the projects from the whole economy's point of view (POV). This analysis is conducted to see if there is an economic expansion, or otherwise as a result of this project. It is important to know whether it will cost the economy more if this project is undertaken or if it will be costlier to the economy, hurting a lot but helping a few, namely the project owners. Financial distortions, taxes, tariffs, subsidies, are accounted for when doing an economic analysis because financial figures are different from the real economic numbers and with economic analysis the idea is to adjust the financial figures, derive what are known as conversion factors and come up with economic figures which will be used in calculating Economic NPV, (ENPV). A positive NPV means the project makes economic sense and governments, as well as other development agencies may be more willing to fund such projects.

4.1.3 Stakeholders Analysis

Stakeholder analysis is done who are the parties benefiting or losing from should the project be carried out. Through stakeholder analysis, a clear picture of the situation is painted. This may affect the funding and starting of the project in a couple ways. If stakeholder analysis shows that project owners are benefiting at the expense of the public and/or the state, then even if it has a positive FPNV, such as project may not see the light of day. If on the other hand, political forces are at play and the project has a negative FNPV or negative ENPV but showing the state or sponsors with political ties as gaining parties from a project, such a project may be implemented. Ideally, the idea behind this is to see if poverty alleviating goals and other welfare development goals are being addressed by carrying out a project.

4.1.4 Risk Analysis

Some consider this the main pillar of IAA. Risk analysis is important because of one main reason. Uncertainty. All the figures used to make projections are not written in stone. They will most probably change, and it is very important to know the effect changes in, for example, the exchange rate, has on project outcomes namely NPV's. Sensitivity analysis is carried out for the identification of risky variables then run through the Monte Carlo simulation with probability distributions to show several risk level scenarios along with their effects on the project outcomes.

Risk analysis helps to decide which contracts need to be put in place to manage or mitigate risks and keep realized cash flows as close as possible to forecasted cash flows. With the example of exchange rate fluctuations, if the exchange rate is identified as a risky variable then hedging can be used. Another example would be interest rates. If the interest rate from a lending institution is floating, interest rate swaps can be done so that fixed interest rates are paid. There is no doubt about the importance of risk analysis because the future is simply not known and it is better to be safe than sorry, and some projects like farming projects aimed at poverty alleviation in the developing countries are too important to leave the concomitant risks unmanaged.

Chapter 5

FINANCIAL ANALYSIS

5.1 Introduction to Financial Analysis

Financial analysis of a project determines whether the project is financially feasible. It should be the foundation of any capital investment projects. It starts with the projection of quantities of production and sales then goes on to produce the financial cashflow statement of the project by considering changes to the working capital. The end result will be the expected annual financial receipts generated by the project as well as the expected annual financial expenditures incurred that is the net cashflow of the project.

As expected, the forecast cash inflows and outflows over the life of the project are a critical aspect of the financial appraisal in which consistent prices of various inputs and outputs of the project should be developed over its life. Changes in relative prices and inflation must be considered. The rate of inflation to be assumed in the base case, along with the real interest rate and the real rate of foreign exchange need to be specified and combined in a consistent fashion. This information combined with projected quantities of inputs and outputs developed in the technical and demand modules allow us to forecast annual receipts and expenditures over the life of the project in current prices (Jenkins, Kuo and Harberger, 2014).

The timing of cash receipts from sales and disbursements from purchases determines the viability of a project. Thus, the forecast of sales and purchases must be adjusted

for changes in accounts receivable and accounts payable for them to reflect cash receipts and cash expenditure, respectively. Since the project has different stakeholders who would like to ascertain the impact of the project on them, variations of financial cashflow statements can be generated to assess the commercial viability from each point of view.

5.2 Parameters and Assumptions

The following are the parameters used in building the financial model.

Price of Paddy

- The paddy price was 125 CFA per kg for non-aromatic and 150 CFA per kg for aromatic.

Paddy Production

- In the rainy season, the annual yield rates were 6,000 kg per hectare and 5,000 kg per hectare in the dry season.

- 15 percent of farmers cultivate during the rainy season with 2 percent farming aromatic paddy and the remaining 13 percent cultivating non-aromatic paddy

- In the dry season, 85 percent of farmers engage in production with 15 percent producing aromatic paddy, and 75 percent produce non-aromatic paddy.

- For the “with” scenario, it was assumed that 88 percent of farmers would cultivate non-aromatic paddy and the rest would cultivate non-aromatic paddy.

Investment Costs and Financing

- An annual amount of 350,000 Communauté Financière d'Afrique (CFA) was disbursed annually per hectare.

- The real interest was 8 percent with a risk premium of 10 percent.

- The government gave the farmers an interest rate subsidy, so farmers paid 7.5 percent throughout the life of the project.

Required Rate of Return

- The target rate of return on equity for the farmer was 12 percent real. This discount rate was chosen to represent the farmer's opportunity cost under these circumstances.

Inflation and Exchange Rates

- For the domestic Senegal inflation, World Bank projections were used and from 2017, a flat rate of 1.34 percent was assumed.

- For the US inflation rate, World Bank projections were used and from 2020, a constant rate of 2.38 percent was used.

- At the time the model was built, a real exchange rate of 575 CFA/USD was used.

5.3 Results of Financial Analysis

The results presented here are on an incremental basis. As presented in Table 1, before financing, the incremental financial net present value (FNPV) an estimated 1,018,000 CFA per hectare. After financing, this figure increased by 13 percent to 1,150,000 CFA

per hectare. This means additional income for the paddy producers which tends to be spent on food, education and other basic needs leading to the development of the country.

Table 1 shows a summary of the financial analysis. By providing funding, the FNPV increases by approximately 11 percent from USD 2.02 million to USD 2.25 million. The aggregate FNPV after financing is USD 85.65 million. This means that in the SRV, by undertaking this project, there is an additional 49,247 million CFA to be gained by paddy producers.

The discount rate of 12 percent is lower than the 37 percent FMIRR with the project. The modified internal rate of return (MIRR) was used because of some of the problems with the internal rate of return (IRR). The MIRR adds up the negative cash flows after discounting them to year zero using the external cost of capital, adds up the positive cash flows including the proceeds of reinvestment at the external reinvestment rate to the final year, and then works out what rate of return would cause the magnitude of the discounted negative cash flows at year zero to be equivalent to the future value of the positive cash flows at the final year (Kierulff, 2008). In this case, for the reinvestment rate and the safe rate the 12 percent discount rate was used. The resultant incremental MIRR was 30 percent without financing and 37 percent after financing, per hectare. Table 2 shows the financial statement from the farmer's viewpoint.

Table 1: Results of Financial Analysis

Without Project		
FNPV per Hectare without Project, CFA	**143**	*000's CFA/Ha*
FNPV per Hectare without Project, CFA	**0.25**	*000's USD/Ha*
FMIRR per Hectare without Project	**14%**	*%*
With Project		
Before Financing		
FNPV per Hectare with Project before financing, CFA	**1,161**	*000's CFA/Ha*
FNPV per Hectare with Project before financing, USD	**2.02**	*000's USD/Ha*
FMIRR per Hectare with Project before financing	**20%**	*%*
After Financing		
FNPV per Hectare with Project after financing, CFA	**1,293**	*000's CFA/Ha*
FNPV per Hectare with Project after financing, USD	**2.25**	*000's USD/Ha*
FMIRR per Hectare with Project after financing	**37%**	*%*
Incremental		
Before Financing		
Incremental FNPV per Hectare before financing, CFA	**1,018**	*000's CFA/Ha*
Incremental FNPV per Hectare before financing, USD	**1.77**	*000's USD/Ha*
Incremental FMIRR per Hectare before financing	**30%**	*%*
After Financing		
Incremental FNPV per Hectare after financing, CFA	**1,150**	*000's CFA/Ha*
Incremental FNPV per Hectare after financing, USD	**2.00**	*000's USD/Ha*
Incremental FMIRR per Hectare after financing	**37%**	*%*
Aggregate		
Before Financing		
Aggregate FNPV before financing, CFA	**43,604**	*Million CFA*
Aggregate FNPV before financing, USD	**75.83**	*Million USD*
Aggregate FMIRR before financing	**31%**	*%*
After Financing		
Aggregate FNPV after financing, CFA	**49,247**	*Million CFA*
Aggregate FNPV after financing, USD	**85.65**	*Million USD*
Aggregate FMIRR after financing	**37%**	*%*

Table 2: Financial Statement (Farmer's Point of View In 000's CFA)

With cashflow INFLOWS	**2011**	**2012**	**2014**	**2015**	**2016**	**2017**	**2018**	**2022**	**2023**	**2024**	**2025**	**2029**	**2030**
Gross Revenues from non-aromatic paddy sales	-	475	485	480	482	493	499	527	534	541	548	578	586
Gross Revenues from aromatic paddy sales	-	65	66	65	66	67	68	72	73	74	75	79	80
Total inflows, with project	**-**	**539**	**551**	**545**	**548**	**560**	**568**	**599**	**607**	**615**	**623**	**657**	**666**
OUTFLOWS													
Total cost of certified seeds	34	36	36	36	36	37	37	40	40	41	41	43	-
Total cost of Propanil	18	19	19	19	19	20	20	21	21	21	22	23	-
Total cost of Weedone	4	4	4	4	4	4	4	4	4	5	5	5	-
Total cost of Londax	7	7	7	7	7	7	7	8	8	8	8	8	-
Total cost of DAP	17	17	18	18	18	18	18	19	20	20	20	21	-
Total cost of Urea	47	48	49	49	49	50	51	53	54	55	56	59	-
Total cost of fuel	37	38	39	39	39	40	40	42	43	44	44	47	-
Total cost of sacks	18	19	20	19	19	20	20	21	22	22	22	23	-
Total rental cost of land	10	10	10	10	10	10	10	11	11	11	11	12	-
Total cost of family labor activities	14	15	15	15	15	15	16	16	17	17	17	18	-
Total cost of land preparation and offset	24	25	25	25	25	26	26	27	28	28	29	30	-
Total cost of harvesting	-	108	110	109	110	112	114	120	121	123	125	131	133
Total maintenance cost of irrigation channels	14	15	15	15	15	15	16	16	17	17	17	18	-
Total rental cost of pump	29	30	30	30	30	31	31	33	33	34	34	36	-
Total rental cost of sprayer	3	3	3	3	3	3	3	3	3	3	3	3	-
Total cost of transportation	26	27	28	28	28	28	29	30	31	31	32	33	-
Total OMVS fees	11	11	11	11	11	11	11	12	12	12	13	13	-
Total cost of small irrigation equipment	3	3	3	3	3	3	3	3	3	3	3	3	-
Total outflows, with project	**315**	**434**	**443**	**438**	**441**	**450**	**456**	**481**	**488**	**494**	**501**	**528**	**133**
Net cash flows before financing	**(315)**	**106**	**108**	**107**	**107**	**110**	**111**	**117**	**119**	**120**	**122**	**129**	**533**
Loan disbursements	350	350	350	350	350	350	350	350	350	350	350	350	-
Total loan repayment by farmers	-	376	376	376	376	376	376	376	376	376	376	376	376
Net cash flows after financing	**35**	**79**	**82**	**81**	**81**	**83**	**85**	**91**	**93**	**94**	**96**	**102**	**156**

5.4 Financial Sensitivity Analysis

Financial analysis of the project assumes that the project parameters values of project parameters change as shown by the information provided. In fact, because of the uncertainty presented by the lack of knowledge of the future, the prices of outputs and inputs are unknown. Parameters like yield rates, especially with the recent global warming and resultant changes in weather patterns, it is also less likely that projected production will exactly as predicted. This is where sensitivity testing comes in, identifying variables that affect the viability of the project the most. Sensitivity analysis also involves quantifying the extent of the variables impact. Sensitivity tests were done by altering one variable over a range of possible values while keeping all the other parameters constant. Impact was tested on the aggregate FNPV along with the annual debt service coverage ratios (ADSCRs).

Price Premium of Non-Aromatic Paddy

Table 3: Sensitivity Test for Price Premium of Non-Aromatic Paddy (Financial)

Price Premium	Paddy Production			
	Aggregate FNPV (Million USD)	ADSCR		
		2017	2023	2029
10%	54.61	1.37	1.40	1.44
15%	64.95	1.43	1.47	1.51
20%	75.30	1.48	1.53	1.58
25%	**85.65**	**1.54**	**1.59**	**1.65**
30%	95.99	1.60	1.65	1.71
35%	106.34	1.66	1.72	1.78
40%	116.69	1.71	1.78	1.85

Table 3 shows the sensitivity of the aggregate FNPV to changes in the price premium of non-aromatic paddy. By altering the parameter by 5 percent in either direction, there

is a 12 percent change in the aggregate FNPV and 4 percent change in the ADSCRs. The NPV will however be still greater than zero and the project will still be favorable. Some sources suggest 1.3 for ADSCRs in such cases and from the above results they are still greater than 1.3 in the short, medium and long run.

Price Premium of Aromatic Paddy

Table 4: Sensitivity Test for Price Premium of Aromatic Paddy (Financial)

Price Premium	Paddy Production			
	Aggregate FNPV (Million USD)	ADSCR		
		2017	2023	2029
	85.65			
35%	81.41	1.52	1.57	1.62
40%	82.82	1.52	1.57	1.63
45%	84.24	1.53	1.58	1.64
50%	**85.65**	**1.54**	**1.59**	**1.65**
55%	87.06	1.55	1.60	1.66
60%	88.47	1.56	1.61	1.66
65%	89.88	1.56	1.62	1.67

The price premium of aromatic paddy has little impact on the ADSCRs. A 5 percent change in the price premium results in a 1 percent change in the ADSCR. The same parameter change causes a 2 percent change in the aggregate FNPV. From this result, it can be concluded that the price premium for aromatic paddy is not a cause for concern as it has little impact on the project financial outcomes.

Proportion of Farmers Cultivating in the Rainy Season

As presented in table 5, if fewer farmers produce their rice in the rainy season and more participate in irrigated paddy production, the project financial returns will be more favorable.

Table 5: Sensitivity Test for Farmers Cultivating in the Rainy Season (Financial)

Farmers cultivating in rainy season	Paddy Production			
	Aggregate FNPV (Million USD)	ADSCR		
		2017	2023	2029
5%	87.27	1.55	1.60	1.66
10%	86.46	1.55	1.60	1.65
15%	**85.65**	**1.54**	**1.59**	**1.65**
20%	84.46	1.53	1.58	1.64
25%	83.65	1.53	1.58	1.63
30%	82.47	1.52	1.57	1.62
35%	81.66	1.51	1.56	1.62

Fuel Consumption During Dry Season

Table 6: Sensitivity Test for Fuel Consumption During Dry Season (Financial)

Fuel Consumption	Paddy Production			
	Aggregate FNPV (Million USD)	ADSCR		
		2017	2023	2029
129	92.40	1.57	1.63	1.69
136	90.15	1.56	1.62	1.67
143	87.90	1.55	1.60	1.66
150	**85.65**	**1.54**	**1.59**	**1.65**
158	83.07	1.53	1.58	1.63
166	80.50	1.51	1.56	1.62
174	77.92	1.50	1.55	1.60
183	75.03	1.49	1.53	1.58
192	72.13	1.47	1.52	1.57

Table 6 shows the results of the sensitivity test for fuel consumption during paddy irrigation. Considering the recent trend in fuel prices, this variable has less impact that in periods of high oil prices. A 5 percent change in fuel consumption will lead to a one percent change in both the aggregate FNPV and the ADSRCs. This shows that the financial outcomes are not very responsive to the fuel consumption and for the tested range, the FNPV is still positive, and the ADCR'S are above 1.3.

Table 7: Sensitivity Test for Paddy Yield in Dry Season (Financial)

Paddy yield - Dry Season	Paddy Production			
	Aggregate FNPV (Million USD)	ADSCR		
		2017	2023	2029
4,759	31.56	1.24	1.26	1.29
5,009	41.47	1.29	1.32	1.35
5,273	51.61	1.35	1.38	1.42
5,551	62.34	1.41	1.45	1.49
5,843	73.68	1.47	1.52	1.57
6,150	**85.65**	**1.54**	**1.59**	**1.65**
6,458	97.29	1.61	1.66	1.72

Of all the variables tested, the paddy yield in the dry season has the greatest impact, both negative and positive. A 5 percent change in the yield causes a subsequent 14 percent change in either direction of the aggregate FNPV. It results in a 4 percent change of the ADSCR.

5.5 Conclusion of Financial Analysis

The preceding section showed that financially the project is feasible with approximately USD 1,800 incremental NPV per Ha and USD 86 million aggregate. The paddy yield in the dry season and price premium on non-aromatic paddy have the greatest impact on the financial outcomes namely aggregate NPV and the ADSCRs.

Chapter 6

ECONOMIC ANALYSIS

6.1 Introduction to Economic Analysis

Project financial analysis of a project focuses on its financial attractiveness to its private investors; an economic analysis deals with the impact of the project on the entire society. Simply put, the economic analysis of a project helps determine whether the project improves the net wealth of the society or not. Thus, economic analysis is concerned with economic benefits and costs (Hill and Ingersent 1977). A project with a negative economic net present value will serve to shrink the economy rather than grow it. The economic appraisal of a project has to do with the effect of the project on the entire society and determines if the project increases the total net economic benefits according to the society as a whole (Scarborough and Kydd (1992).

6.2 Economic Parameters and Assumptions

Besides the parameters already discussed in the financial analysis, there are additional variables needed for economic analysis.

National Variables

- For Senegal, the economic cost of capital was assumed as 12 percent. No specific study was done but a study by Kuo, Jenkins, and Mphahlele where the estimation of economic opportunity cost of capital was followed.

Commodity-Specific Conversion Factors

Once the economic price of the commodity is estimated, it is important to establish the relationship between the commodity's financial and economic prices. The relationship between the economic and financial prices is called Commodity Specific Conversion Factor (CSCF). The conversion factor to convert each of the financial cashflows into the economic cost or benefit in the economic resource statement in the economic appraisal.

CSCF_i = (Economic Price)/ (Financial Price)

The economic prices for inputs and outputs are therefore obtained through multiplying the financial prices by the respective conversion factors.

For an output, if CSCF is:

- less than one, it means the project is transferring income from the economy to the project investors

- greater than one, the project is transferring income from investors the project to others in the economy, this includes consumers, lenders and the government.

Table 8 shows a summary of all the conversion factors used when building the economic resource flows. Rice, fuel, and transportation have conversion factors that are less than one meaning that the project is transferring income from the economy to the investors. The rest of the conversion factors are more than one meaning the project is transferring income from investors the project to others in Senegal's economy. For calculations of some CSCFs used in this study, please refer to the Appendix.

Table 8: Summary of Conversion Factors

Seeds (Importable Input)	1.07
Rice (Importable Output)	0.95
DAP (Importable Input)	2.10
Propanil (Importable Input)	1.07
Urea (Importable Input)	2.10
Londax (Importable Input)	1.07
Weedone (Importable Input)	1.07
Fuel (Importable Input)	0.81
Sacks (Importable Input)	1.07
Agricultural Equipment (Importable Input)	1.07
Land Preparation and Offset (Tractor-based)	1.89
CF for Transportation	0.87
CF for Labor	1.00
Rental cost	1
CF for Sample Treatment	1
CF for Government Interest rate subsidy	1

6.3 Results of Economic Analysis

The following section presents the results of the economic analysis. Table 9 shows the outcomes of the economic analysis and Table 10 shows the economic resource flow statement per hectare. with an aggregate ENPV of 31 million CFA, this project brings net economic benefits to the economy. Per hectare, the project results in an ENPV of 732,000 CFA per hectare.

Table 9: Results of Economic Analysis

Per Hectare		
ENPV per Hectare, CFA	**732**	*000's CFA/Ha*
ENPV per Hectare, USD	**1.27**	*000's USD/Ha*
EMIRR per Hectare	**30%**	*%*
Aggregate		
Aggregate ENPV, farmers, CFA	**31,334**	*Million CFA*
Aggregate ENPV, farmers, USD	**54.49**	*Million USD*
Aggregate EMIRR, farmers	**30%**	*%*

6.4 Economic Sensitivity Analysis

Just like the sensitivity testing done in financial analysis, the same is applied to the ENPV. The results of the sensitivity tests are presented below. Table 11 shows the responsiveness of the aggregate ENPV to changes in the price premium of non-aromatic paddy. The base case scenario is 25 percent price premium and USD 54 million aggregate ENPV. Changing the price premium to 30 percent results in USD 64 million aggregate ENPV. This shows that ENPV is greatly impacted by the price premium on non-aromatic paddy.

Table 10: Sensitivity Test for Price Premium of Non-Aromatic Paddy (Economic)

Price Premium	**Paddy Production**
	Aggregate ENPV (Million USD)
10%	25.26
15%	35.00
20%	44.75
25%	**54.49**
30%	64.24

For the price premium of aromatic paddy, the base scenario is 50 percent. A 5 percent change in this price premium in either direction has little impact on the ENPV as illustrated in table 12.

Table 11: Sensitivity Test for Price Premium of Aromatic Paddy (Economic)

Price Premium	**Paddy Production**
	Aggregate ENPV (Million USD)
35%	50.51
40%	51.84
45%	53.17
50%	**54.49**
55%	55.82
60%	57.15
65%	58.48

Table 13 shows the sensitivity of aggregate ENPV to changes in the proportion of farmers cultivating in the rainy season. The base scenario is 15 percent. By decreasing the number of farmers cultivating paddy in the rainy season and encouraging paddy irrigation, the ENPV increases.

Table 12: Sensitivity Test for Farmers Cultivating in the Rainy Season (Economic)

Farmers cultivating in rainy season	**Paddy Production**
	Aggregate ENPV (Million USD)
5%	56.37
10%	55.43
15%	54.49
20%	53.20
25%	52.27
30%	50.98

Table 13: Economic Resource Flow Statement (000'S CFA)

Resource Inflows	**2011**	**2012**	**2014**	**2015**	**2016**	**2017**	**2018**	**2022**	**2023**	**2024**	**2025**	**2029**	**2030**
Incremental gross revenues from non-aromatic paddy sales	-	153	153	153	153	153	153	153	153	153	153	153	153
Incremental gross revenues from aromatic paddy sales	-	103	103	103	103	103	103	103	103	103	103	103	103
Total resource inflows	-	256	256	256	256	256	256	256	256	256	256	256	256
Resource Outflows													
Incremental cost of certified seeds	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of Propanil	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of Weedone	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of Londax	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of DAP	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of Urea	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of fuel	33	33	33	33	33	33	33	33	33	33	33	33	-
Incremental cost of sacks	4	4	4	4	4	4	4	4	4	4	4	4	-
Incremental rental cost of land	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of family labor activities	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of land preparation and offset	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of harvesting	-	54	54	54	54	54	54	54	54	54	54	54	54
Incremental maintenance cost of irrigation channels	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental rental cost of pump	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental rental cost of sprayer	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental cost of transportation	4	4	4	4	4	4	4	4	4	4	4	4	-
Incremental OMVS fees	4	4	4	4	4	4	4	4	4	4	4	4	-
Incremental cost of small irrigation equipment	-	-	-	-	-	-	-	-	-	-	-	-	-
Government interest rate subsidy	-	51	39	32	39	44	41	39	38	37	37	35	35
Total resource outflows	45	150	138	131	138	143	139	137	137	136	136	134	88
Net resource flows, CFA	(45)	106	118	125	118	113	116	119	119	120	120	122	167

Table 14: Sensitivity Test for Fuel Consumption During Dry Season (Economic)

Fuel Consumption	Paddy Production
	Aggregate ENPV (Million USD)
129	59.96
136	58.14
143	56.32
150	**54.49**
158	52.41
166	50.33
174	48.25
183	45.91
192	43.56

Shifting from solely the rainy season cultivation to paddy production in both the dry and the rainy season brings an increase in the economic benefits, but it also results in an increase of fuel consumption, leading to an increase in resource outflows. This leads to a net reduction of the economic returns. The base case if 150 liters/Ha, increasing that to 192 liters/Ha results in a decrease of the ENPV from USD 54.49 million to USD 43.56 million.

Table 15: Sensitivity Test for Paddy Yield in Dry Season (Economic)

Paddy yield - Dry Season	Paddy Production
	Aggregate ENPV (Million USD)
4,759	3.58
5,009	12.92
5,273	22.46
5,551	32.56
5,843	43.23
6,150	**54.49**

In Table 15, which is the sensitivity test for paddy yield in the dry season, the base case is 6,150 kg/Ha and if it reduces to 4,759kg/Ha the aggregate ENPV will change

from USD 54.49 million to USD 3.58 million. From this test, it is evident that more needs to be done to address this issue. Ways to manage the uncertainty resulting from this parameter will be discussed in Chapter 8, Risk Analysis.

Chapter 7

STAKEHOLDER ANALYSIS

7.1 Introduction to Stakeholder Analysis

The stakeholders' analysis, also referred to as distributional analysis, asks the following question: who will benefit from the project and by how much and who will pay for the project and by how much? Both the financial and economic analyses must be finalized before the distributional impacts can be determined.

The distributional analysis links the financial analysis along with the matching externalities concerning each stakeholder. The total of these analyses throughout the several factions must sum up to the economic analysis of the overall project. Through this, it is possible to pinpoint those groups that gain and those that lose because of a project. Being able to recognize the gainers and losers of the project as well as the extend of the gain or lose if essential for the project's sustainability. The previous pillars of integrated investment appraisal (financial and economic) will make available the fundamental information for approximating precise impacts for numerous groups and parties that affect or are affected by the project (Cooper, 2004). They can be evaluated with the economic analysis to determine who gains and who loses because of a project. This is the distributional analysis, and its rationale is to see if the factions who were aimed to have benefits as a consequence of the project will, in reality, get them as well as to ensure that no specific faction is exposed to an unwarranted load because of the project. The magnitude of any load can be estimated by the NPV of the

incremental net cash flows that are each stakeholder is expected have. The impact on government is mainly externalities generated through taxes and subsidies (Mori and Mersland 2014).

It is possible to have all levels of government involved in supporting key projects. The direct fiscal impacts are observable and easily quantifiable because of the government's direct involvement in project financing. The indirect fiscal impacts are more difficult to trace and less significant in their impact on the economy. The integrated approach can quantify all fiscal impacts so that different government bodies are aware of the fiscal consequences of a project.

Table 16 summarizes what has been discussed above. Column (1) which if the financial outcome. and column (2) which is the externality should be equal to column (3) which is the economic outcome. For instance, the incremental financial of sacks is 1,060 million CFA, the externality is 72 million CFA, and the economic cost is 1,132 million CFA. The sum of the financial and externality is 1,132 million CFA which is equal to the economic cost.

Table 17 illustrates the distribution of externalities. The net externality is 12,000 CFA which was equivalent to USD 20. The tables are linked because Table 16 shows the financial, externalities and economic figures and Table 17 shows the distribution of the externalities.

Table 16: Reconciliation of Financial, Economic and Stakeholders Statement (million CFA)

		(1) Financial	(2) Externality	(3) Economic	(1) + (2) Fin. + Ext.
Benefits					
	Incremental gross revenues from non-aromatic paddy sales	**45,069**	**(2,094)**	**42,975**	**42,975**
	Incremental gross revenues from aromatic paddy sales	**30,422**	**(1,414)**	**29,008**	**29,008**
	Total benefits	**75,491**	**(3,508)**	**71,983**	**71,983**
Costs					
	Incremental cost of certified seeds	-	-	-	-
	Incremental cost of Propanil	-	-	-	-
	Incremental cost of Weedone	-	-	-	-
	Incremental cost of Londax	-	-	-	-
	Incremental cost of DAP	-	-	-	-
	Incremental cost of Urea	-	-	-	-
	Incremental cost of fuel	**12,952**	**(2,478)**	**10,474**	**10,474**
	Incremental cost of sacks	**1,060**	**72**	**1,132**	**1,132**
	Incremental rental cost of land	-	-	-	-
	Incremental cost of family labor activities	-	-	-	-
	Incremental cost of land preparation and offset	-	-	-	-
	Incremental cost of harvesting	**15,098**	-	**15,098**	**15,098**
	Incremental maintenance cost of irrigation channels	-	-	-	-
	Incremental rental cost of pump	-	-	-	-
	Incremental rental cost of sprayer	-	-	-	-
	Incremental cost of transportation	**1,514**	**(204)**	**1,310**	**1,310**
	Incremental OMVS fees	**1,262**	-	**1,262**	**1,262**
	Incremental cost of small irrigation equipment	-	-	-	-
	Government interest rate subsidy		**11,372**	**11,372**	**11,372**
	Total costs	**31,887**	**8,762**	**40,649**	**40,649**
	Net externalities, farmers, CFA	**43,604**	**(12,270)**	**31,334.23**	**31,334.23**
	Net externalities, farmers, USD	**75.83**	**(21.34)**	**54.49**	**54.49**

Table 17: Distributive Analysis

		Externality	Farmers	Government
Benefits				
	Incremental gross revenues from non-aromatic paddy sales	(2,094)		(2,061)
	Incremental gross revenues from aromatic paddy sales	(1,414)		(1,391)
	Total benefits	(3,508)	**-**	**(3,508)**
Costs				
	Incremental cost of certified seeds	-		
	Incremental cost of Propanil	-		
	Incremental cost of Weedone	-		
	Incremental cost of Londax	-		
	Incremental cost of DAP	-		
	Incremental cost of Urea	-		
	Incremental cost of fuel	(2,478)		(2,478)
	Incremental cost of sacks	72		72
	Incremental rental cost of land	-		
	Incremental cost of family labor activities	-		
	Incremental cost of land preparation and offset	-		
	Incremental cost of harvesting	-		
	Incremental maintenance cost of irrigation channels	-		
	Incremental rental cost of pump	-		
	Incremental rental cost of sprayer	-		
	Incremental cost of transportation	(204)		(204)
	Incremental OMVS fees	-		
	Incremental cost of small irrigation equipment	-		
	Government interest rate subsidy	11,372		11,372
	Total costs	8,762	**-**	**8,762**
	Net externalities, CFA		**-**	**(12,270)**
	Net externalities, USD			**(21.34)**

Chapter 8

RISK ANALYSIS

8.1 Introduction to Risk Analysis

All along, the analysis of outcomes has been centered around the project parameters being single value amounts but it is substantially improbable that the values of all the project's essential parameters will be estimated with assurance all through the duration of the project and so will the outcome of a project's net present value, debt service capacity ratio, and so forth. Thus, dealing with uncertainty and risk becomes necessary. Analysis of the nature of the risks associated with a project must be incorporated as part of an integrated project. The following chapter presents the risk analysis and management that was done when evaluating this project.

8.2 Results of Risk Analysis

It is important to analyze which parameters the financial and economic results are most sensitive to. Risk management can be done if the risky variables are known. For this section, tornado diagrams were used. Tornado diagrams are an effective way of communicating results. They provide clear identification of those parameters whose uncertainty drives the largest impact, leading to focus objectively on what is important. This helps to save time, reduce frustration and increase efficiency.[1]

[1] http://smartorg.com/tornado-diagram-resolving-conflict-and-confusion-with-objectivity-and-evidence/

Figure 1 below, shows a tornado diagram it can be observed that paddy yield of the dry season and price premium of non-aromatic paddy have the greatest impact on aggregate FNPV. This is useful because sufficient resources can be invested in making sure that the paddy yield during the irrigation period is sustained at its optimum level. The price premium of non-aromatic paddy has the second greatest impact on aggregate FNPV. There are contracts that can be signed to hedge against the risk of having the premium fall to levels that will negatively affect the project outcomes.

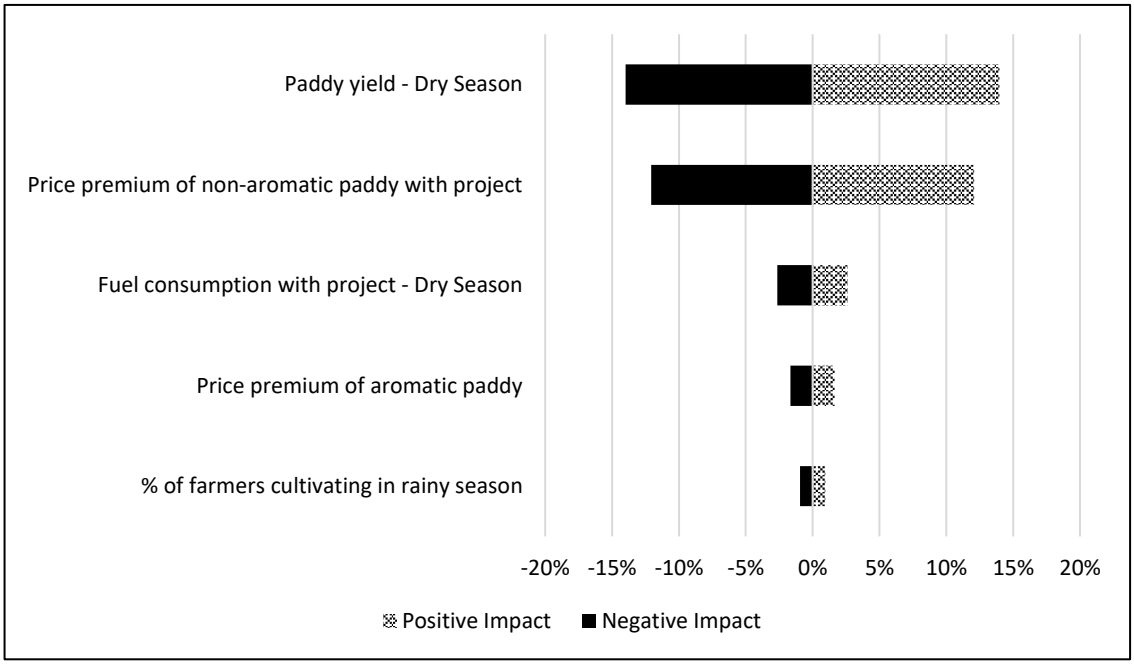

Figure 1: Impact on Aggregate FNPV by Change in Parameters

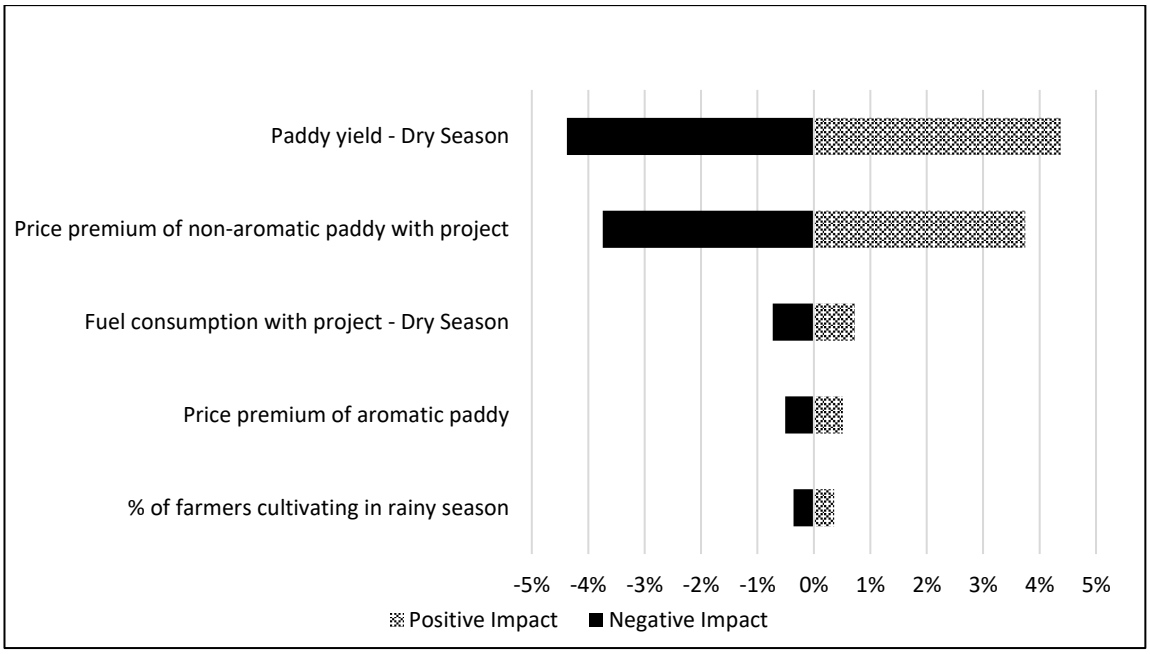

Figure 2: Impact on ADSCR by Change in Parameters

Similar to aggregate FNPV, Figure 2 shows that paddy yield in the dry season and price premium of non-aromatic paddy have the greatest impact on the farmers' ability to service their debt. (Jenkins, Kuo and Harberger, 2011). There are fundamentally only four alternatives to improve the annual debt service capacity ratios:

- loan sculpting.
- reduce the interest rate on the loan.
- reduce the amount of debt financing.
- increase the duration of the loan repayment.

Loan Sculpting

This consists of shaping the outline of debt repayment schedules in to order to optimize the ability of the project to contract debt without violating lender agreements. This is done by calculating debt obligations to ensure that principle, and interest repayments are appropriately matched to strength and pattern of the cashflows in each period. Debt

sculpting can allow a higher amount of debt to be raised thus maximizing the viability of the project.

Reduce the Interest Rate on the Loan

If it is possible to rearrange the loan conditions in such a way that ADSCRs are more positive, perhaps it will be appealing enough for the financial institutions to bankroll the project. In this project, the farmers have an interest rate subsidy. The same can be offered to the bankers.

Reduce the Amount of Debt Financing

The next alternative is where the amount of the loan is reduced. In this case, the ADSCRs increase greatly because the total of the annual payment of the borrowed amount is reduced (own funding is more), the project's capability to repay the debt is much more positive.

Increase the Duration of the Loan Repayment

If a monetary establishment is able to spread out a loan for a lengthier duration, the periodic clearance of the loan commitments will fall greatly.

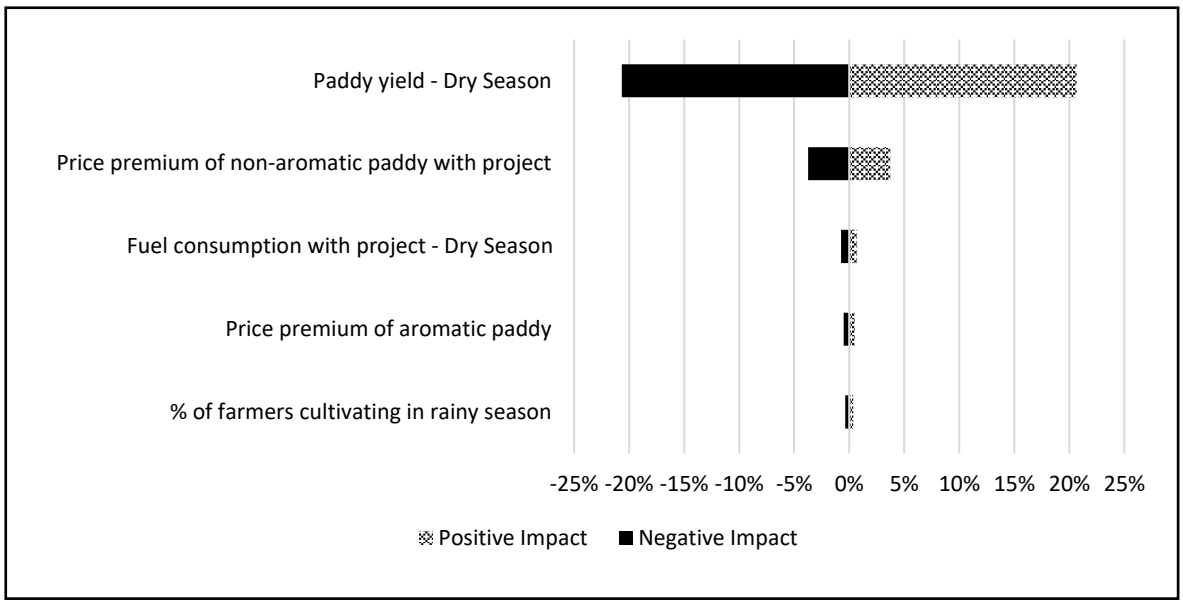

Figure 3:Impact on ENPV by Change in Parameters

Figure 3 shows an impact on ENPV by a change in parameters. From the illustration, the paddy yield in the dry season has the greatest impact on economic returns. This helps to put in place measures to keep the yield at its optimum levels.

Dealing with the Paddy Yield During Dry Season

Having proved that the yield in the dry season is a parameter that has the greatest impact on FNPV, ADSCR, and ENPV the next step is to find ways to manage this risk. Some of the ways to deal with this are the following:

- Adoption of best practice in rice cultivation
- Access to certified seeds
- Adequate equipment and GPS technologies

Chapter 9

CONCLUSION

The analysis revealed that many issues resulting in low quality local rice production in the SRV were effectively addressed buy this project. From the evaluation done, this project was expected to help the Senegalese people in terms of food security. Their goal of self-sufficiency can be met if the suggested interventions are implemented. The yield rate in the dry season, where irrigation was recommended had the highest impact on both financial and economic outcomes. It is for this reason that good agronomic practices must be encouraged among farmers to achieve and sustain high levels of production. Investment should be made in extension services so that farmers learn how to produce and manage their production levels effectively and efficiently.

The rice producers are expected to earn enough additional income to support their basic needs. This project will also contribute to the economy with expected positive economic net present values. The preference for aromatic rice varieties by urban dwellers was entirely satisfied by imports. The production of aromatic paddy will serve the urban residents and reduce the import of this fragrant rice which is more expensive.

The availability of certified seeds is a key risk factor in paddy production in Senegal. It is important to work with seed producer networks to ensure the excellent quality and sufficient quantity of this input which is critical for paddy farmers. From the seed producers, it is important to engage the other players up the value chain like the millers.

Construction of mills in the SRV will significantly reduce transport costs and ensure full utilization of the millers' capacity. synchronization among the seed producers, paddy farmers and the millers will play an important in Senegal's goal of self-sufficiency.

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APPENDIX

Calculation of Conversion Factors

Seeds (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	1.075
Import Duty on Seeds	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		1.00			1.075
Transportation Port-Local Market	2%	0.02	0.87		0.02
Price at the Local Market		1.02			1.09
Transportation Local Market-Farm Gate	2%	0.02	0.87		0.02
Price at the Farm Gate		1.04			1.11
CF for Seeds					1.07

Rice (Importable Output)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	1.075
Import Duty on Rice (CET)	12.70%	0.13			
VAT on Rice	0.00%	-			
Price at the Port		1.13			1.075
Transportation Port-Local Market	2%	0.02	0.87		0.02
Price at the Local Market		1.15			1.09
Transportation Local Market-Farm Gate	2%	0.02	0.87		0.02
Price at the Farm Gate		1.13			1.074
CF for Rice					0.95

DAP (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	1.075
Import Duty on DAP	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		1.00			1.075
Transportation Port-Local Market	2%	0.02	0.87		0.015
Price at the Local Market		1.02			1.09
Subsidy on fertilizers	50%	0.51			
Transportation Local Market-Farm Gate	2%	0.02	0.87		0.02
Price at the Farm Gate		0.53			1.11
CF for DAP					2.10

Propanil (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	1.075
Import Duty on Propanil	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		1.00			1.075
Transportation Port-Local Market	2%	0.02	0.87		0.02
Price at the Local Market		1.02			1.09
Transportation Local Market-Farm Gate	2%	0.02	0.87		0.02
Price at the Farm Gate		1.04			1.11
CF for Propanil					1.07

Urea (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	**1.075**
Import Duty on Urea	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		**1.00**			**1.075**
Transportation Port-Local Market	2%	**0.02**	0.87		**0.015**
Price at the Local Market		**1.02**			**1.09**
Subsidy on fertilizers	50%	**0.51**			
Transportation Local Market-Farm Gate	2%	**0.02**	0.87		**0.02**
Price at the Farm Gate		**0.53**			**1.11**
CF for Urea					**2.10**

Londax (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	**1.075**
Import Duty on Londax	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		**1.00**			**1.075**
Transportation Port-Local Market	2%	**0.02**	0.87		**0.02**
Price at the Local Market		**1.02**			**1.09**
Transportation Local Market-Farm Gate	2%	**0.02**	0.87		**0.02**
Price at the Farm Gate		**1.04**			**1.11**
CF for Londax					**1.07**

Weedone (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	**1.075**
Import Duty on Weedone	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		**1.00**			**1.075**
Transportation Port-Local Market	2%	**0.02**	0.87		**0.02**
Price at the Local Market		**1.02**			**1.09**
Transportation Local Market-Farm Gate	2%	**0.02**	0.87		**0.02**
Price at the Farm Gate		**1.04**			**1.11**
CF for Weedone					**1.07**

Fuel (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	**1.075**
Import Duty on Fuel	10%	**0.10**			
Excise Tax	2.5%	**0.03**			
Value Added Tax (VAT)	18%	**0.20**			
Price at the Port		**1.33**			**1.075**
Transportation Port-Local Market	2%	**0.02**	0.87		**0.02**
Price at the Local Market		**1.35**			**1.09**
CF for Fuel					**0.81**

Sacks (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	1.075
Import Duty on Sacks	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		1.00			1.075
Transportation Port-Local Market	2%	0.02	0.87		0.02
Price at the Local Market		1.02			1.09
Transportation Local Market-Farm Gate	2%	0.02	0.87		0.02
Price at the Farm Gate		1.04			1.11
CF for Sacks					1.07

Agricultural Equipment (Importable Input)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	1.075
Import Duty on Agricultural Equipment	0%	-			
VAT on Agricultural Inputs	0%	-			
Price at the Port		1.00			1.075
Transportation Port-Local Market	2%	0.02	0.87		0.02
Price at the Local Market		1.02			1.09
Transportation Local Market-Farm Gate	2%	0.02	0.87		0.02
Price at the Farm Gate		1.04			1.11
CF for Irrigation Equipment					1.07

Land Preparation and Offset (Tractor-based)		Financial Value	CF for NT Services	Value of FEP	Economic Value
CIF Price (CFA)		1.00		7.46%	**1.075**
Import Duty on Agricultural Equipment	0%	-			
VAT on Agricultural Inputs	0%	-			
Subsidy on tractors	70%	**0.70**			
Price at the Port		**0.30**			**1.075**
Transportation Port-Local Market	2%	**0.01**	0.87		**0.005**
Price at the Local Market		**0.31**			**1.079**
Transportation Local Market-Farm Gate	2%	**0.01**	0.87		**0.005**
Price at the Farm Gate		**0.31**			**1.084**
CF for Tractors					**3.49**

Components of Land Preparation	Weights	CF	Weighted CF
Cost of Tractor	40%	3.49	**1.40**
Fuel	55%	0.81	**0.44**
Labor	5%	1.00	**0.05**
CF for Land Preparation			**1.89**