Financial Benefit-Cost Analysis of Agricultural Production in Musanze District, Rwanda

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Abstract: This study considered the profitability analysis of agricultural production in Rwanda with special reference to Musanze District. Data collection was conducted through well structured questionnaire administered on 107 farmer respondents selected purposively. The method of data presentation used was descriptive statistics. The benefit-cost ratio (B-C ratio) was used to analyze the agricultural profitability in the study area. The results revealed that, in the short run, agricultural investment is a profitable business in the study area. This is reflected by the BC ratio of 1.47. The analysis also shows that all individual crops (potato, wheat, corn, tomato, onion, and cabbage) are profitable except for bean. Similarly, the results of the long run profitability analysis show that the BC ratio is 1.003102. The corresponding NPV is RwF 4,912.84; the IRR is 17.046% with the discount rate (the prevailing lending interest rate) of 16.749%. The sensitivity analysis shows that the agricultural productivity is responsive to the increase of total operating costs, the decrease in average price, the decrease in total production, as well to the increase in the discount rate. Consequently, farmers should improve their equipment and allocate rationally the inputs to improve the profitability of agricultural investments.
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1. Introduction

Generating incomes for the majority of the rural poor is one of the most important reasons that lead economists to stress increased agricultural productivity as an essential component of a successful rural development strategy (Gollin et al. 2002). Bhujel and Ghimire (2006) have estimated the production function of Hiunde rice in Morang District (Nepal). In the same way, Olujenyo (2008) has conducted a research to define the determinants of agricultural production and profitability with reference to maize production in Nigeria. In case of Rwanda, a research analysing the agricultural profitability with reference to bench terraces was conducted by Bizoza and de Graaff (2010) by using the financial benefit cost analysis.

As one of the development priorities of Rwanda, agriculture was recognised as the engine of the primary growth (Republic of Rwanda, 2004; IMF, 2008). It has been chosen as the first and strongest leverage to put the country on a sustainable development process and to fight against poverty and the investment policy in agricultural sector will contribute to change in the structures, methods, marketing and efficiency of agricultural activities with a very high impact on the revenue of the majority of the population and most of the poor, on exports and on the GDP.

The major agricultural policies adopted by the Government of Rwanda to transform and mechanize the agriculture through the development of modern agriculture include the promotion of more intensive agricultural practices through the increased use of agricultural inputs, agricultural professionalization that promotes high enterprise profitability, the promotion of soil fertility and protection, improved marketing initiatives, and the reinforcement of agricultural research and advisory including a greater role for farmer cooperatives and associations (Bingen and Munyankusi, 2002). Another government policy known as Economic Development and Poverty Reduction Strategy, EDPRS (Government of Rwanda, 2007) identifies the agricultural sector as a crucial area for a growth and calls for energetic public action in collaboration with private and nongovernmental development partners to encourage greater input use and to assist in the provision of services and their monitoring.

It is well remarkable that Rwanda authorities have made many efforts to pursue sustainable development in making strong strategies in all sectors and particularly in agricultural sector. All these efforts have improved the Rwandan economy in general and the agricultural status in particular. All undertaken strategies by the Government of Rwanda have improved the current situation of Rwandan agriculture. But the question is to know to what extent this improvement has contributed to the development of agricultural sector. In part of response to this question, the study aims at profitability analysis of the agricultural production in a sample District. Results will inform the policy where further efforts are needed

to sustain the on-going agricultural development process in Rwanda.

Making appropriate economic policies is still of current interest. In the agriculture sector, farmers do not know how profitable their cropping systems are. Another problem regards the effects of agricultural government policies on the poverty alleviation. Yet the profitability of crops planned for each region in the context of crop intensification programme still requires more explanations considering each region's specificities. Part of contribution of this study is also to give light on the benefits of crop intensification with focus to land use consolidation. The implementation of Crop Intensification Program goes together with government subsidies for the purchase of fertilizers and seeds by small holder farmers. The question remains obtaining proper exit strategy to ensure sustainability of premises already achieved as well as the overall agro-input business sustainability by involving the private sector.

This study uses the benefit-cost analysis approach to assess the profitability of agricultural investments in the short and the long runs in Musanze District, Northern Rwanda. The remainder of this paper is made of three additional sections. The second section concentrates on the overview on the concept of benefit-cost analysis as the main analytical approach. The third section describes the research methodology. And the fourth section presents results and discusses major findings. Finally, all these sections are followed by the conclusions and recommendations.

2. Benefit-Cost Analysis: A Conceptual Framework

The benefit-cost analysis is a technique used to conduct a financial analysis. It is used as a decision tool after computing all costs against benefits valued in local currency to come up with a net benefit or a net income (Gittinger, 1982). While the benefit-cost analysis as a concept was developed in 19th century, it was firstly applied in the USA for large water projects. Since then, it has been used in different fields to indicate whether the benefits of undertaken activities exceed their costs (Bizoza and de Graaff, 2010), both benefits and costs being computed in local currency. Even when the measurements of costs and benefits are complete, they might not speak for themselves until they are put in a framework. Benefit-cost analysis provides that framework. Not only can the benefit-cost analysis be used to determine economic and social cost, but also for private perspective (European Commission, 2008) as it is the case in this paper. The net present value (NPV) method and the internal rate of return (IRR) are the substitute tools of the benefit-cost analysis for analyzing profitability in the long run (European Commission, 2008).

2.l Decision Criteria: (1) Benefit-Cost Ratio

The benefit-cost ratio (BC ratio) is the present value of project benefits divided by the present value of project costs, both benefit values and cost values being computed in local currency. The BC ratio is given by the following formula:

$$BC\ ratio = \frac{\sum_{t=0}^{n}\left[R_t/(1+i)^t\right]}{\sum_{t=0}^{n}\left[C_t/(1+i)^t\right]} \text{ ------Formula (1)}$$

Where R_t stands for revenue at time t, C_t stands for the cost at time t, n stands for the number of periods or years, and i stands for the discount rate. If the B C ratio is greater than 1, the project is suitable because the benefits, measured by the present value of the total revenues (inflows), are greater than the costs, measured by the present value of the total outflows.

2.2 Decision Criteria: (2) Net Present Value (NPV)

The net present value (NPV) can be economically be interpreted as the difference between total benefits and total costs, both discounted at the appropriate discount rate. The NPV of a project is the sum of the discounted net flows of a project. The use of NPV as decision criterion means that the decision maker's objective function is the maximization of such a sum. It is a very concise performance indicator of an investment project: it represents the present amount of the net benefits (that is, benefits less costs) flow generated by the investment expressed in one single value with the same unit of measurement. The aggregation of costs and benefits occurring in different years can be carried out by weighting them.

The NPV of a project is defined as:

$$NPV = \sum_{t=0}^{n}\frac{\pi_t}{(1+i)^t} = \sum_{t=0}^{n}\frac{(R_t - C_t)}{(1+i)^t} \text{ ---Formula (2)}$$

where R_t stands for revenue at time t, C_t stands for the cost at time t, π_t stands for the profit, n stands for the number of periods or years, and i stands for the discount rate.

The NPV is a very simple and precise performance indicator. A positive NPV, NPV>0, means that the project generates a net benefit (because the sum of the weighted flows of costs and benefits is positive) and it is generally desirable either in financial terms or in economic terms.

2.3 Decision Criteria: (3) Internal Rate of Return

The economic meaning of IRR is the average

productivity of capital invested in a given investment. Alternatively, the IRR can be defined as the highest discount rate that would make a given project profitable, that is, the maximum rate which allows the sum of discounted benefits be not less than the sum of discounted costs. In other words, the IRR is the discount rate which would give a project NPV equal to zero.

$$IRR = r: NPV = \sum_{t=0}^{n} \frac{(R_t - C_t)}{(1+r)^t} = 0$$ ----Formula (3)

where R_t stands for revenue at time t, C_t stands for the cost at time t, π_t stands for the profit, n stands for the number of periods or years, and r stands for the internal rate of return. A project is qualified as profitable if the IRR is greater than the discount rate.

3. Research Methodology

3.1 Presentation of the study area

Musanze District is one of the five Districts of the Northern Province. It has a surface of 530.4 km^2 of which 60 km^2 for the Volcano National Park and 28 km^2 of the Ruhondo Lake. Musanze District is surrounded by Uganda in North and by the Democratic Republic of Congo (D.R.C), the Volcano National Park, in the South by Gakenke District, in the East by the Burera District, and in the West by Nyabihu District. Musanze District faces tropical climate of highlands with has mean temperature of 20ºC. Generally with enough rain the whole year, the precipitations vary between 1,400 mm and 1,800 mm.

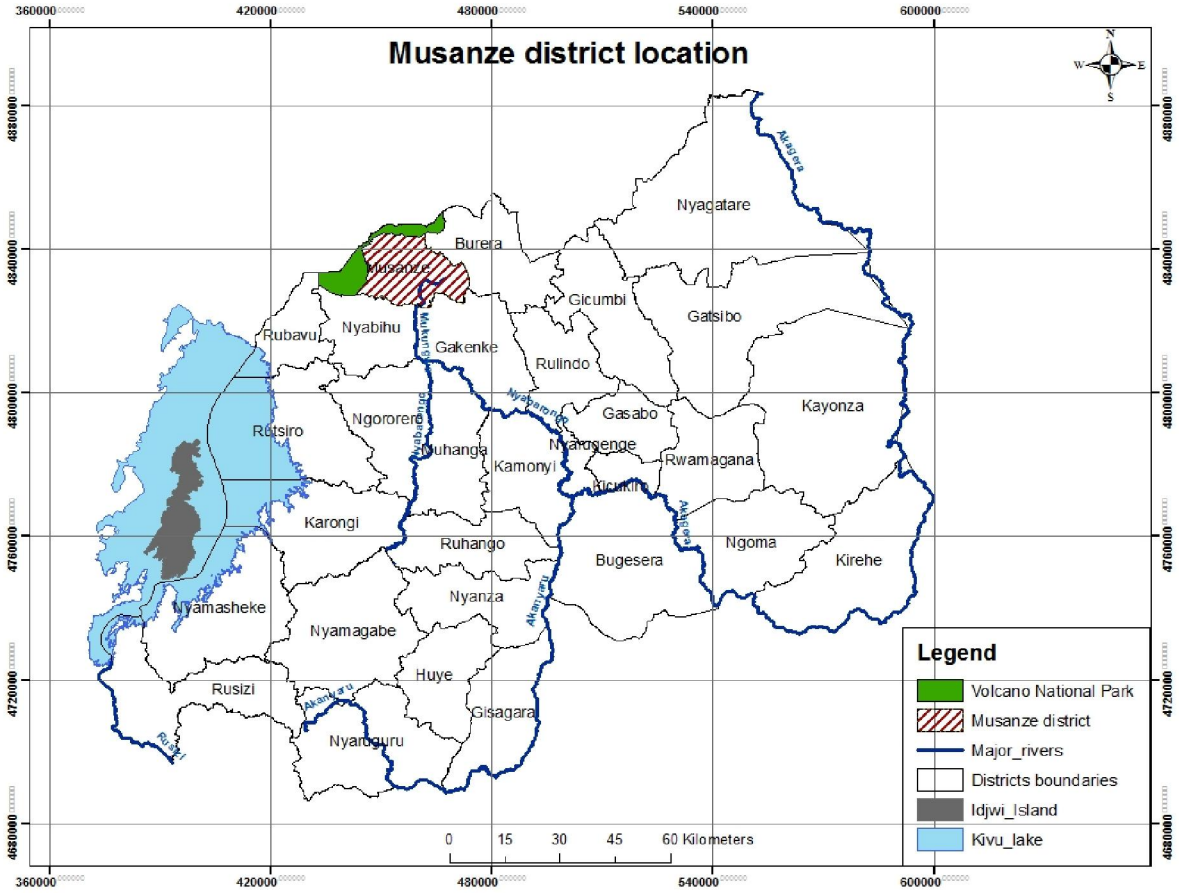

Figure 1: Location of Musanze District on the map of Rwanda

Two main and two small seasons characterize the study area namely the rainy and the dry seasons: from June to mid-September, we have the great dry season; from January to mid-March, the small dry season; from mid-March to the end of May, the great rainy season; and from mid-September to the end of December, the small rainy season.

In terms of physical characteristics of the study area, the soil of Musanze District is dominated by volcanic soil which is essentially fertile. The main crops of Musanze District are Irish potato, bean, corn and wheat. The horticulture experiences a slow

development, limited to vegetables and fruits (District de Musanze, 2007).

3.2 Data Collection Method

For the intention of data collection, a field survey was conducted in Musanze District during August and September 2012 from a purpose sample of 107 farmers' organizations assisted by the Programme DERN in Musanze District. Besides the field survey, the documentary method was used in collecting data. This method involves information delivery by studying carefully studying written documents, or visual information from various sources called documents. These documents include textbooks, newspapers, articles, speeches, advertisements, pictures, and many others. In this research, the documentary method has been used to deal with primary data which concern primarily the literature review.

3.3 Descriptive statistics

The data collected for the purpose of this research have been summarized in tables both in real terms and in money value. The tables comprising data include the mean, the median, the maximum, the minimum, the standard deviation, the skewness, the kurtosis, the Jarque Bera and its probability as well as the number of observations for each variable. Tables have been dressed globally for all variables both in real terms and money value. In addition, individual tables for bean, Irish potato, corn and wheat in money value have been dressed.

4. Results and Discussion

4.1 Presentation of Results

The following table describes the agricultural production in Musanze District. It presents the socioeconomic characteristics of main crops produced in the study area. This table shows that, on the land of 18.01 ares, the production is RwF 185,905 worth, and it costs RwF 6,649 for equipment, RwF 39,140 for labour, RwF 16,019 for land, RwF 28,464 for fertilizers, RwF 48,408 for seeds, and RwF 10,626 for pesticides.

Table 1: Description of crop production in RwF in Musanze District

	Y	K	L	LD	F	S	P
Mean	185,905.3	6,848.598	39,139.72	16,018.69	28,463.87	48,407.99	10,626.24
Median	116,400.0	3,000.000	25,500.00	12,000.00	19,720.00	24,500.00	4,000.000
Maximum	1,200,000.	51,000.00	170,000.0	80,000.00	233,950.0	450,000.0	184,000.0
Minimum	7,500.000	0.000000	4250.000	3000.000	1000.000	100.0000	0.000000
Std. Dev.	235,228.4	11,360.22	38,283.55	12,154.26	35,018.29	71,806.90	22,360.21
Skewness	2.947173	2.514302	2.010700	2.669577	3.737338	3.054826	4.953687
Kurtosis	12.34640	8.688639	6.416958	12.00963	19.34468	14.53104	35.64035
Jarque-Bera	544.3558	257.0117	124.1523	488.9902	1,440.128	759.2220	5,187.487
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	107	107	107	107	107	107	107

Source: Field survey, August and September 2012 (Summarized by using EViews)

In the table 1 above, the socioeconomic characteristics of the crops grown in Musanze District have been presented. The socioeconomic characteristics of potato production in Musanze District show that the production is RwF 251,739, and its cost is RwF 11,270 for equipment, RwF 30,078 for labour, RwF 17,526 for land, RwF 39,178 for fertilizers, RwF 83,226 for seeds, and RwF 16872 for pesticides.

For the bean, the production on average is RwF 75,853, and its cost is RwF 5,856 for equipment, RwF 46,838 for labour, RwF 14,276 for land, RwF 14,572 for fertilizers, RwF 7,054 for seeds, and RwF 10,102 for pesticides. Similarly, the same characteristics show that the production of corn on average is RwF 190,417, and its cost is RwF 8,171 for equipment, RwF 76,075 for labour, RwF 15,000 for land, RwF 22,548 for fertilizers, RwF 12,821 for seeds, and RwF 6,795 for pesticides.

Yet these characteristics show that the production of wheat on average is RwF 97,500, and its cost is RwF 5,924 for equipment, RwF 24,083 for labour, RwF 13,500 for land, RwF 12,861 for fertilizers, RwF 7,408 for seeds, and RwF 13,757 for pesticides.

As for the tomato, the production is RwF 225,000, and its cost is RwF 2,500 for equipment, RwF 25,500 for labour, RwF 15,000 for land, RwF 13,916 for fertilizers, RwF 29,280 for seeds and RwF 47,500 for pesticides. For the cabbage, the production of cabbage is RwF 80,000, and its cost is RwF 3,600 for equipment, RwF 17,000 for labour, RwF 10,000 for land, RwF 20,000 for fertilizers, RwF 100 for seeds and RwF 160 for pesticides. Yet for the onion, the production of onion is RwF 168,000, and its cost is RwF 15,300 for labour, RwF 15,000 for land, RwF 8,219 for fertilizers, and RwF 3,500 for seeds.

4.2 Short run profitability analysis of agricultural production in Musanze District

As the short run profitability analysis is concerned, the indicators contained in the table 2 below summarize the results. For individual crops, the results show that the BR ratios are 1.50, 0.97, 1.68, 1.61, 1.94, 6.22, and 2.10 for potato, bean, wheat, corn, tomato, onion and cabbage respectively. At collective level, the BC ratio is 1.47. All these results show that agricultural investments are profitable in the short run in the study area, except for the bean.

Even though crop production is profitable, it is better to analyse the cost components in order to know the importance of each of them.

Table 2: Profitability analysis of crop production in Musanze District (per are)

Items	Potato	Bean	Wheat	Corn	Tomato	Onion	Cabbage	All crops
Revenue								
Total revenue	**15,294**	**4,065**	**8,729**	**6,260**	**56,250**	**67,200**	**8,000**	**10,317**
Variable costs								
Labour expenses	1,827	2,510	2,156	2,501	6,375	6,120	1,700	2,172
Fertilizers	2,380	781	1,151	741	3,479	3,288	2,000	1,580
Seeds	4,996	378	663	421	7,320	1,400	100	2,686
Pesticide expenses	1,025	541	1,232	223	11,875	0	16	590
Total variable costs	**10,228**	**4,210**	**5,202**	**3,886**	**29,049**	**10,808**	**3,816**	**7,028**
Gross Margin	**5,066**	**(145)**	**3,527**	**2,374**	**27,201**	**56,392**	**4,184**	**3,289**
Depreciation	228	105	177	90	208	0	120	127
Rent	1,065	765	1,209	493	3,750	6,000	1,000	889
Total Fixed Costs	**1,293**	**870**	**1,386**	**583**	**3,958**	**6,000**	**1,120**	**1,016**
Net farm income	**3,773**	**(1,015)**	**2,141**	**1,791**	**23,243**	**50,392**	**3,064**	**2,273**
B C ratio	**1.50**	**0.97**	**1.68**	**1.61**	**1.94**	**6.22**	**2.10**	**1.47**

Source: Computation of the gross margin and BC ratio by using Microsoft Excel

The cost components of crop production are given by the figure 2 below. This figure shows that, from the most to the least important, seeds covers 36% of TVC, labour 29%, fertilizers 22%, pesticides and equipment cover respectively 8 and 5% of TVC. If the farmer happens to reduce the big components of TVC, seed expenses by producing them themselves, this will increase the GM. The same result should be achieved if the farmers master the labour expenses or the fertilizer expenses.

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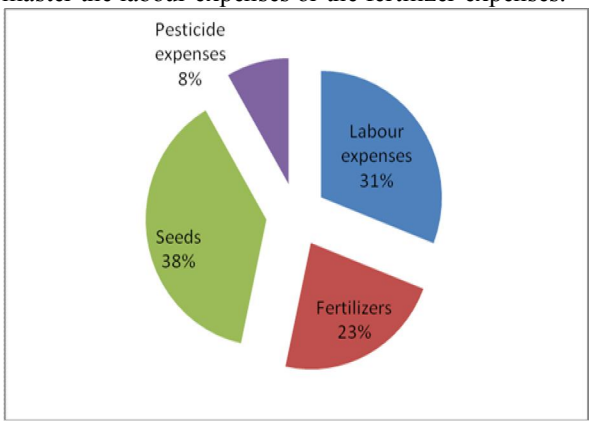

Figure 2: Variable costs incurred in agricultural production in Musanze District

Through the profitability analysis of crop production here above conducted, considering their BC ratios that are greater than 1, it has been shown that potato production, corn production, wheat production, tomato production, onion production and cabbage production are all profitable.

In contrast, the bean production was qualified unprofitable as its BC ratio is less than 1. For the purpose of profit improvement, costs should be mastered, since there is inverse relationship between profitability and costs: the less the cost, the more the profit, and the higher the cost, the lower the profit. This justifies the cost composition analysis of different crops grown in Musanze District.

Now that the profitability of main crops grown in Musanze District has been analysed, it is better to do so for different crops individually.

The profitability analysis of Irish potato is summarized in the table 14 below. This table shows that the GM is positive and the BC ratio equal to 1.50 is greater than 1, which implies that the potato production is profitable. The calculations also show that the return to labour is RwF 2,356 (given the requirement of 2.15 units of labour per are) which is greater than the daily minimum wage of RwF 700 paid to the worker in Musanze District.

Table 3: Profitability analysis of Irish potato production in Musanze District

Items	Revenue/ Costs in RwF per are	Percentage
Revenue		
Total revenue	**15,294**	
Variable costs		
Labour expenses	1,827	17.86
Fertilizers	2,380	23.27
Seeds	4,996	48.85
Pesticide expenses	1,025	10.02
Total variable costs	**10,228**	**100.00**
Gross Margin	**5,066**	
Depreciation	228	
Rent	1,065	
Total Fixed Costs	1,293	
Net farm income	**4,001**	

Source: Computation of the gross margin of potato by using Microsoft Excel

The profitability analysis of bean production is shortly presented in the table 15 below. This table shows that the GM is negative and the BC ratio equal to 0.966 is less than 1, which implies that the bean production is not profitable. Considering the requirement of around 3 (that is 2.95) units of labour per are, the calculations also show that the return to labour is RwF - 49 which is strictly less than the daily minimum wage of RwF 700 paid to the worker in Musanze District.

Table 4: Profitability analysis of bean production in Musanze District

Items	Revenue/Costs in RwF per are	Percentage
Revenue		
Total revenue	**4,065**	
Variable costs		
Labour expenses	2,510	59.62
Fertilizers	781	18.55
Seeds	378	8.98
Pesticide expenses	541	12.85
Total variable costs	**4,210**	100.00
Gross Margin	**(145)**	
Depreciation	105	
Rent	765	
Total Fixed Costs	870	
Net farm income	**(1,015)**	

Source: Computation of the gross margin of bean by using Microsoft Excel

The profitability of wheat production in Musanze District is described in the table 16 here below presented. This table shows that the GM is RwF 3,527 and the BC ratio is 1.68, which implies that wheat production is profitable. The calculations also show that the return to labour is RwF 1,391 (given the requirement of 2.54 units of labour per are) which is greater than the daily minimum wage of 700 RwF paid to the worker in Musanze District.

Table 5: Profitability analysis of wheat production in Rwanda

Items	Revenue/Costs in RwF per are	Percentage
Revenue		
Total revenue	**8,729**	
Variable costs		
Labour expenses	2,156	41.45
Fertilizers	1,151	22.13
Seeds	663	12.75
Pesticide expenses	1,232	23.68
Total variable costs	**5,202**	**100.00**
Gross Margin	**3,527**	
Depreciation	177	
Rent	1,209	
Total Fixed Costs	1,386	
Net farm income	**2,141**	

Source: Computation of the gross margin of wheat by using Microsoft Excel

The table 6 presented below summarizes shortly the profitability analysis of corn production in Musanze District. The table here above shows that the GM of corn is RwF 2,374 and the computed BC ratio is 1.61. Both indicators show that corn is profitable. The calculations also show that the return to labour is RwF 807 (considering that it requires 2.94 units of labour per are) which is greater than the daily minimum wage of 700 RwF paid to the worker in Musanze.

Table 6: Profitability analysis of corn production in Musanze District

Items	Revenue/Costs in RwF per are	Percentage
Revenue		
Total revenue	**6,260**	
Variable costs		
Labour expenses	2,501	64.36
Fertilizers	741	19.07
Seeds	421	10.83
Pesticide expenses	223	5.74
Total variable costs	**3,886**	**100.00**
Gross Margin	**2,374**	
Depreciation	90	
Rent	493	
Total Fixed Costs	583	
Net farm income	**1,791**	

Source: Computation of the gross margin of corn by using Microsoft Excel

The profitability analysis of tomato production in Musanze District is presented in the table 18. This table shows that the GM of tomato is RwF 27,201 and the computed BC ratio is 1.936, which implies that tomato production is profitable in Musanze District. The calculations also show that the return to labour is RwF 3,627 (given the requirement of 7.50 labour units per are) which is greater than the daily minimum wage of RwF 700 paid to the worker in Musanze District.

The profitability of onion production in Musanze District is shown in the table 19 below. This table shows that the GM of onion is RwF 56,392 and the computed BC ratio is 6.22, which implies that onion production is highly profitable in Musanze District. The calculations also show that the return to labour is RwF 7,832 (which is greater than the daily minimum wage of RwF 700 paid to the worker in Musanze District.

Table 7: Profitability analysis of onion production in Musanze District

Items	Revenue/Costs in RwF per are	Percentage
Revenue		
Total revenue	**67,200**	
Variable costs		
Labour expenses	6,120	56.62
Fertilizers	3,288	30.42
Seeds	1,400	12.95
Pesticide expenses	0	0.00
Total variable costs	**10,808**	**100.00**
Gross Margin	**56,392**	
Depreciation	0	
Rent	6,000	
Total Fixed Costs	6,000	
Net farm income	**50,392**	

Source: Computation of the gross margin of onion by using Microsoft Excel

Cabbage is also among the crops grown in Musanze District. Its profitability is analysed briefly by using the table below. It is shown in this table that the GM of cabbage is RwF 4,184 and the computed BC ratio is 2.10, which implies that cabbage production is profitable in Musanze District. The calculations also show that the return to labour is RwF 2,092 which is greater than the daily minimum wage of RwF 700 paid to the worker in Musanze District.

Through the profitability analysis of crop production here above conducted, considering their BC ratios that are greater than 1, it has been shown that potato production, corn production, wheat production, tomato production, onion production and cabbage production are all profitable. In contrast, the bean production was qualified unprofitable as its BC ratio is less than 1. For the purpose of profit improvement, costs should be mastered, since there is inverse relationship between profitability and costs: the less the cost, the more the profit, and the higher the cost, the lower the profit. This justifies the cost composition analysis of different crops grown in Musanze District.

4.3 Long-run profitability analysis of agricultural production in Musanze District

Besides the short run profitability analysis contained in the previous section, the long run profitability analysis was undertaken. The period of ten years was fixed. The investments include the land cost and the equipment costs. The average land cost was estimated at RwF 412,593. Another element of investment is equipments which was estimated at RwF 9,903. As the equipment is not used for one year, the annual depreciation amount was calculated by fixing the duration of the agricultural equipments to 3 years on average. The corresponding annual depreciation amount was RwF 3,301, and the equipments are replaced each three-year period.

About the revenues, the average agricultural production was RwF 185,905 per season. This comes to RwF 371,810 per year (two seasons). Assuming the same production capacity alongside the ten year period, the annual production is fixed to RwF 371,810. Concerning the costs, the average amount for a season is RwF 39,140, RwF 1,651, RwF 28,464, RwF 48,408, and RwF 16,970 for labour, depreciation, fertilizers, seeds, and pesticides respectively. This comes to the annual total of RwF 78,280, RwF 3,301, RwF 56,928, RwF 96,816, and RwF 33,940 for labour, depreciation, fertilizers, seeds, and pesticides respectively. These totals are also assumed to prevail alongside the ten-year period.

The discount rate was chosen by averaging the monthly lending rates for the period from January to October 2012 as they were published by the National Bank of Rwanda (www.bnr.rw/statistics.aspx, accessed on October 23, 2012 at 10:11 a.m). The discount rate used in this research is then 16.749%.

In these conditions, the discounted revenues amount to RwF 1,588,812.73 and the discounted costs totalize RwF 1,583,899.88. Therefore, the BC ratio is 1.003102. The corresponding NPV is RwF 4,912.84. The IRR of such an investment is 17.046%. These results show that agricultural investments are profitable in the long run in the study area.

4.4 Sensitivity analysis

The profitability analysis showed that agricultural investments are profitable both in the short run and in the long run in the study area. But it is better to say something about its sustainability. It is why the sensitivity analysis was conducted.

Firstly, assuming this a 10% increase in total operating costs, the long run profitability of agricultural production is questionable. The main problem is here about the capacity of farmers to meet

themselves their costs and maintain their activities profitable. Under such circumstances, the results of this study show that the BC ratio is 0.94 and the NPV is negative, NPV= - 99 366.34. The IRR is 10.4% which is lower than the discount rate of 16.749%. These results show that the agricultural production is sensitive to the change in total operating costs. Therefore, if the total operating costs increase by 10%, the agricultural investments in the study area are not profitable.

Secondly, considering a decrease of the average price by 10%, the sensitivity analysis shows that the total revenues decrease by 10%. The results show that agricultural investment in the study area is unprofitable since the BC ratio comes to 0.903, VAN of – 153,969.88, the discount rate of 16.749% and the IRR of 6.372%. The table 24 below gives the details on the calculations of these indicators.

Thirdly, the sensitivity analysis of the decrease in total production shows the similar results as in case of the decrease in the average price. That is, if both the average price and the total production decrease by 10%, the BC ratio comes to 0.903, VAN of – 153,969.88, the discount rate of 16.749% and the IRR of 6.372%.

Lastly, a 10% increase in lending interest rate makes ipso facto the discount rate to increase in the same proportion. That is, if the discount rate increases from 16.749 to 18.424%, the BC ratio comes to 0.99, VAN to – 21,696.84, the discount rate to 18.424% and the IRR amounts to 17.0458%.

In all four cases of sensitivity analysis, the BC ratios are less than 1, the NPVs are negative, and the IRRs are less than the corresponding discount rates. But by importance, the agricultural profitability is mostly sensitive to both the decrease in the average price and the decrease in the total production. After the decrease in both the average price and the total production come the increase in total operating costs and the increase in the lending interest rate respectively.

5. Conclusions and Policy Recommendations

This paper examined the profitability of agricultural production in Musanze District. Data were collected through a field survey conducted in Musanze District during August and September 2012 from a purposive sample of 107 farmers' organizations assisted by the Programme DERN. The benefit-cost ratio was computed to estimate the profitability of potato, bean, wheat, corn, onion, tomato and cabbage, individually and collectively, in the study area.

The agricultural production is generally profitable in the study area as it is reflected in the BC ratio of 1.47. The individual profitability analysis of potato, wheat, corn, onion, tomato and cabbage has shown that the corresponding BC ratios are 1.50, 1.68, 1.61, 6.22, 1.50 and 2.10 respectively. It is remarkable that all BC ratios are greater than 1. Considering these indicators, all individual crops (potato, wheat, corn, tomato, onion, and cabbage) are profitable in the short run except for bean for which the BC ratio is 0.96 as it is reflected by the results.

In the long run, the results of the profitability analysis show that the discounted revenues amount to RwF 1,588,812.73 and the discounted costs totalize RwF 1,583,899.88. The BC ratio is 1.003102, the corresponding NPV is RwF 4,912.84, and the corresponding IRR is 17.046%. The ordering shows that, by importance, the agricultural profitability is mostly sensitive to both the decrease in the average price and the decrease in the total production. After the decrease in both the average price and the total production come the increase in total operating costs and the increase in the lending interest rate respectively.

For further increase in agricultural production and profitability improvements, some recommendations have been formulated: farmers and farmers' organizations should improve their equipment by adopting modern agricultural tools and new technological methods and farmers should reallocate rationally the inputs so as to attain the least-cost input combination. The government should guarantee access to extension services and market to farmers. Yet the farmers should record all their operations by adopting the use of crop cards for getting reliable information necessary to the computation of the farmer's profitability.

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