Cost and benefit analysis of cropping systems for sorghum and maize production under the Africa RISING project in Mali

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Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

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Introduction

Several on-farm trials are being conducted in southern Mali with the active participation of farmers with the objective of developing agricultural technologies attractive to farmers. The objective of this report is to provide the results of cost-benefit analysis of selected technologies promoted by Africa RISING in southern Mali. Specially, we perform a comparative analysis of costs and benefits of crop trials implemented in the intervention villages in Bougouni and Koutiala districts for sorghum and maize production.

Analysis methodology

This section is composed of two parts. A first part focuses on the sampling procedure and the second part discusses the method used to the cost and benefit analysis.

Sampling procedure and data collection

Cost and benefit analysis of technologies promoted by the project uses household survey data. The survey has been carried out in the project intervention villages in Bougouni and Koutiala districts over the first quarterly 2016, and has involved smallholder farmers who applied the technologies promoted by the project in their field during the cropping seasons 2014 and 2015. The survey is focused on the technologies for sorghum and maize production. A total of 82 sorghum farmers and 56 maize farmers have been interviewed. The collected data included use of inputs (seed, manure, and fertilizer), workforce, labour, production level, market transactions.

For the maize production, the two factors were the production without contour bonds and with contour bonds. In the two cases, there is the application of compost (average 5 tons per hectare during the labour period), DAP (average 200 kg per hectare about 10 to 15 days after planting and after rain), and urea (average 100 kg per hectare about 25 to 30 days after planting and after rain). For the sorghum production, four types of treatments have been surveyed including farmer practice (control treatment), treatment with only manure, treatment with only chemical fertilizer, and treatment with manure and fertilizer combined. The quantity of manure recommended is 4 to 6 tons per hectare, and chemical fertilizer (urea and cereal complex) is 50 kg per hectare.

Cost and benefit analysis

We assess the net benefits using the partial budget analysis. Definitions of some terms and the methods of calculations are described as follows:

- Average yield: the yield is the quantity of output produced per unit area. Yield is expressed in kg/ha. The experimental grain yield was adjusted by 10% to approximate the yield that farmers can obtain on their farms. The scaling down is necessary to prevent overestimation of the returns that farmers are likely to obtain from a treatment.
- Output prices: we used farm gate prices to compute returns. The farm gate price of the output is the value (price) farmers receive or can receive for their harvested crops. In other words, it is the price farmers received at the end of the production process.
- Gross return: the gross return is the product of the farm gate price of the output and the adjusted yield. Farm gate prices have been derived from monthly field surveys conducted by the local partners in the intervention villages of Africa RISING.
- Total variable input costs: the total variable input cost is the sum of all variable input costs and varies from one treatment to another. These are farm gate costs of the variable inputs for each of the treatments. Inputs used for the analysis include: seed, labour, compost, urea, complex NPK, pesticide, harvest bags, and workforce.

- Net return: net return is the difference between the gross return and the total variable input cost.
- Marginal rate of return: is the percent change of net returns as a result of the introduction of the technology. It is the ratio of increased benefits to increased costs which is put in a percentage form.

Results

Cost and benefit analysis of maize production

The results derived from cost-benefit analysis are provided for the production without contour bonds and the production with contour bonds at household level (see table 1 below). The results show that the two cropping systems are benefit for the small holder farmer of maize in Southern Mali. The maize production with contour bonds has generated a net benefit estimated to about FCAF 500,000 per hectare with the input costs estimated to almost FCFA 123,000. The inputs include compost, seeds, labour, urea, DAP, pesticides, workforce, and harvest bags. The production without contour bonds has generated a net benefit estimated to about FCFA 295,000 per hectare with the input cost of FCFA 103,000. The net benefit generated by the production with contour bonds is about 60% higher than that generated without contour bonds. In summary, the maize production with contour bonds has a potential of grain yield and economically benefit for the smallholder farmers of maize.

Cost and benefit analysis of sorghum production

The results derived from cost-benefit analysis of sorghum production are provided for four cropping systems including farmer practice (control treatment – T1), treatment with manure only (T2), treatment with chemical fertilizer only (T3), and treatment with manure and chemical fertilizer combined (T4). The results show that the net benefits are positive for the four cropping systems. For the dominance analysis, the treatments are arranged in ascending order of magnitude of the total variable input and corresponding net benefit. Treatments T1 and T3 are dominated by treatments T2 and T4. Then, treatments T1 and T3 are excluded from analysis. The marginal rate of return for changing from treatment T2 to treatment T4 is 59%. Then, an investment of FCFA 1 in application of T4 provides an additional gain of FCFA 0.59. In summary, the application of manure and chemical fertilizer (e.g. urea, cereal complex or DAP) for the sorghum production is most beneficial economically for smallholder farmers in Southern Mali.

Table 1: Cost-benefit analysis for maize production without and with contour bonds

	Treatments	
	Without Contour Bonds	With Contour Bonds
Yields(kg/ha)		
Grain	2753	3718
Residues	3800	5792
Sales (kg/ha)		
Grain	1764	2788
Residues	3800	5792
Adjusted sales (kg/ha)		
Grain	1587,6	2509,2
Residues	3420	5212,8
Sale price (FCFA/kg)		

Grain	175	175
Residues	35	35
Benefice brute (CFCA)	397530	621558
Input costs (FCFA)		
Compost	17750	17750
Seeds	9845	9845
Harvest bags	2674	3145
Urea	25295	25295
Labour	8342	8482
DAP	13760	13760
Pesticide	2505	2422
Workforce	22500	42000
Total of costs (FCFA)	102671	122699
Net benefit (FCFA)	294859	498859

Table 2: Cost-benefit analysis for sorghum production under application of manure and chemical fertilizer

	Treatments			
	Farmer Practice	Manure treatment	Fertilizer treatment	Manure and fertilizer treatment
Yields (kg/ha)				
Grain	883	1076	1308	1511
Residues	1050	1245	1550	1610
Sales (kg/ha)				
Grain	218	336	375	525
Residues	1050	1245	1550	1610
Adjusted sales (kg/ha)				
Grain	196,2	302,4	337,5	472,5
Residues	945	1120,5	1395	1449
Sale price (FCFA/kg)				
Grain	125	125	125	125
Residues	30	30	30	30
Gross margin(CFCA)	52875	71415	84037,5	102532,5
Inputs (FCFA)				
Compost	0	3735	0	3500
Seeds	2400	2400	2400	2400
Harvest bags	1750	2500	3000	3450
Urea	0	0	17500	17500
labour	2123	2200	2500	2750

Workforce	3600	4700	5100	5500
Total of costs (FCFA)	9873	15535	30500	35100
Net benefit (FCFA)	43002	55880	53537,5	67432,5
Change in net benefits between two treatments		12878	-2342,5	13895
Change in total variable input costs between two treatments		5662	14965	4600

Conclusion

This report performs a cost-benefit analysis of cropping systems for sorghum and maize production under the Africa RSING project in Southern Mali particularly in Bougouni and Koutiala districts using the survey data and the partial budget method. The survey was conducted over the first quarterly 2016 and covered the selected technologies for sorghum and maize production. The results showed that the maize production with contour bonds has a potential of grain yields and generated a net benefit estimated to 60% higher compared to the production without contour bonds. Regarding the sorghum production, the cropping system combining manure and chemical fertilizer (T4) is most beneficial economically for smallholder farmers. Indeed, an investment of FCFA 1 in application of T4 provides an additional gain of FCFA 0.59. If farmers have the choice between these treatments, it would be benefit for them to choose manure and fertilizer treatment for sorghum production, and treatment with contour bound for maize production. However, efforts should be made to facilitate the availability of fertilizers at a good price for the smallholder farmers, and capacity building for the implementation of contour bounds in the fields.