Cost Benefit Analysis of Mali's Sorghum and Millet Value Chains

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Development Discussion Paper: 2017-03

ABSTRACT

This paper presents the findings of the CBA of Mali's work with the sorghum and millet value chains (VCs). The analysis looks at evaluating the recent Feed the Future (FtF) activities implemented under the Africa RISING' large-scale diffusion of technologies for sorghum and millet systems (ARDT_SMS). It is seen that ARDT_SMS project has produced positive economic returns, with an ERR of 24 percent and an ENPV of USD 14.33 million. The annual income of the millet farmers has increased from 27 to 126 USD/ha. In the sorghum VC the annual income of farmers has increased from 50.0 USD/ha to 115.0 USD/ha. Another important finding of the analysis is that significant fiscal savings due to reduced subsidy on fertilizers can be attributed to the project. The annual fiscal savings for the GoM from reduced subsidy requirement are estimated at 816,011 USD. The PV over project life amounts to 6.8 mill USD. Moreover, positive environmental impacts can be attributed to the project due to the reduced fertilizer consumption.

Acknowledgements

USAID's "Learning, Evaluation, and Analysis Project" (LEAP II) financed this study. Cambridge Resources International Inc., worked under a subcontract to International Development Group. Contract Number: AID-OAA-I-12-00042/AID-OAA-TO-14-00046.The contribution and assistance of Karim Sanogo, and Stephanie Schmidt is greatly appreciated. The report benefited greatly from the valuable assistance of John Nzungize (ICRISAT), Aminata Coulibaly (CRS) and other implementing partners including CMDT - Sikasso, CMDT - Koutiala, MALIMARK, IER, AOPP, EUCORD, AKF and SOGEA. The team is extremely grateful for the support provided by USAID, including Yacouba Santara and David Yanggen (Director – Office of Economic Growth) for their overall guidance. Special thanks are given to the farmers and other stakeholders in the Sikasso and Mopti regions, who generously gave their time to help the team collect needed data and related information.

Key words: cost-benefit analysis, investment appraisal, stakeholder analysis, Sorghum and Millet value chain, marketing, Mali.

JEL: D13, D31, D61, D62, E23, H42

List of Acronyms

AKF	Aga Khan Foundation
AOPP	Association des Organisations Professionnelles Paysannes
CBA	Cost Benefit Analysis
CMDT	Compagnie Malienne pour le Développement des Textiles
CRS	Catholic Relief Services
DRA	Direction Régionale de l'Agriculture
ENPV	Economic Net Present Value
EUCORD	European Cooperative for Rural Development
FEP	Foreign Exchange Premium
FNPV	Financial Net Present Value
FtF	Feed the Future
GoM	Government of Mali
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IER	Institut d'Economie Rurale
IIA	Integrated Investment Appraisal
IRR	Internal Rate of Return
MALIMARK	Mali Agricultural Market Trust
MERR	Modified Economic Rate of Return
MIRR	Modified Internal Rate of Return
MT	Metric Tone
NPV	Net Present Value
SOGEA	Société Générale d'Agrochimie
USAID	United States Agency for International Development
USD	United States Dollar
VC	Value Chain

Executive Summary

USAID has been supporting development of agriculture and improvements in food security in many countries in sub-Saharan Africa through technical assistance under its Feed the Future (FtF) program. In an effort to evaluate these programs, USAID has recently begun a process of conducting cost benefit analyses (CBAs) of the various activities currently in process or already completed. In order to support this process, USAID Washington requested IDG under its LEAP (Learning Evaluation and Analysis Project) II to conduct several of these CBA activities. This report presents the findings of the CBA of USAID/Mali's work with the sorghum and millet value chains (VCs). The analysis looks at evaluating the recent FtF activities implemented under the Africa RISING' large-scale diffusion of technologies for sorghum and millet systems (ARDT_SMS).

USAID/Mali's Africa RISING' large-scale diffusion of technologies for sorghum and millet systems (ARDT_SMS) falls within a larger portfolio of U.S. Government interventions in Mali to improve food security, under the Feed the Future initiative. The project commenced in 2014 and will be completed in 2017. The ARDT_SMS project was implemented in line with Government of Mali (GoM) development strategies toward achieving the food security of small farmers and national self-sufficiency in sorghum and millet production. The ARDT_SMS aims to increase production and incomes for sorghum and pearl millet farmers.

The ARDT_SMS project is focused in two regions of the country, Sikasso (sorghum VC) and Mopti (millet VC). The two main activities of the ARDT_SMS projects are:

1. Establishment of the farmers' field schools to enhance farmers' knowledge of new sorghum and millet production technologies;
2. Establishment of demonstration plots to promote productive technologies by showing farmers potential productivity that can be achieve;

The phase II of the ARDT_SMS project will aim to increase access to improved inputs such as certified seeds, fertilizers, and fungicides. The phase II of the project, however, is out of scope of this CBA.

The production technologies promoted by the project allow farmers to increase yield of millet by 30%. In addition, the project introduced the intercropping of millet with cowpeas, allowing farmers not only to increase millet yield but also to harvest two crops. As a result, the annual income of the millet farmers has increased from 27 to 126 USD/ha.

Production of sorghum in the Sikasso region has been gradually declining during last 10 years. Promotion of cotton and maize production by the government and donors can partially explain this trend. However, the analysis also revealed that existing production technology results on marginal financial benefits (FNPV 292 USD/ha), which explains the phenomena. The production technologies introduced by the project allow farmers to increase sorghum yield by 60%. As in the millet VC, the project introduced intercropping of sorghum with cowpeas. The annual income of farmers increased from 50.0 USD/ha to 115.0 USD/ha.

Despite the potential of new production technologies to improve the households' income, limited attention of the ARDT_SMS project on other than productivity related issues, such as market access, access to micro credits, and etc. raises the major concern. The analysis, therefore, assumes that only 50% of the targeted households will adopt the production practices introduced by the ARDT_SMS project. Under this assumption the project has produced positive financial and economic returns, with an ERR of 24 percent and an ENPV of USD 14.33 million.

Table 1. Summary Impact Figures

	ERR*	ENPV**
Impact Mali Country Perspective	**N/A**	**USD 23.80 mill**
Present Value of USAID Investment		USD 9.47 mill
Impact USAID Perspective	**24 %**	**USD 14.33 mill**

*Economic Rate of Return
**Economic Net Present Value

Another important finding of the analysis is that significant fiscal savings due to reduced subsidy on fertilizers can be attributed to the project. Maize production is dominant in Sikasso region; therefore, the CBA assumes that 60% of area affected by the project will shift from maize to improved sorghum. In contrast to maize, sorghum cultivation requires lower fertilizers and other chemicals application. In addition, currently sorghum producers are not able to benefit from the 50 percent price subsidy on fertilizers. The annual fiscal savings for the GoM from reduced subsidy requirement are estimated at 816,011 USD. The PV over project life amounts to 6.8 mill USD. Moreover, positive environmental impacts can be attributed to the project due to the reduced fertilizer consumption.

The analysis makes four key recommendations:

1. **GoM subsidy on fertilizers:** The GoM provides 50% subsidy on chemical fertilizer (Sikasso region) used for production of cotton, maize and rice. Significant number of project beneficiaries is expected to shift from cotton and maize production to the improved sorghum production, therefore, releasing fiscal pressure. It is recommended to include sorghum into the list of crops that can obtain subsidies on fertilizers. Such a measure will allow farmers to increase annual income from 115 to 134 USD/ha. This additional financial incentive will boost the scaling up dissemination of the production technologies.

2. **Access to hybrid and improved seed varieties** has to be insured to enable success of the project. The problem of cultural reluctance of farmers to purchase seeds for their production should be addressed by the project[1]. Currently project provides free sorghum and millet seeds to attendants of field schools and farmers have limited exposure to purchasing seeds directly from the market. With phase II, the project is expecting to improve access to high quality seeds by increasing seed production. Farmers, however, have only one farm period to begin purchasing seeds directly from the market before the anticipated project end date. This is a very short period for addressing any problems that may arise in this process and can potentially threaten sustainable access to new seed varieties.

3. **Coordination challenges at the implementing partner level**. Coordination of activities between current project implementing partners is fairly weak, resulting in a "silo approach" to project implementation in certain areas, which can reduce efficiency and overall impact of project. In the 2014-15 farm year, there were instances of the same farmer receiving ARDT_SMS project training from two different implementing partners and with two different methodologies in the Sikasso region. This risk can be managed by introducing consultative platforms for partners working in the same region and at the lead implementing partner (ICRISAT) level.

4. **Leveraging synergies with other projects carrying out similar work in the Sikasso and Mopti regions.** Adoption of new technologies requires a certain level of commitment by farmers to change current production practices. This commitment

1 Farmers rarely obtain seeds from other family members, neighbors, or the market. As suggested by other studies, selling seed is a "taboo".

can only be obtained when farmers have access to all required inputs, access to credit and access to markets to sell their production. Limited attention of the ARDT_SMS project on other than productivity related issues raises the major concern.

Introduction

Project Description

The United States Agency for International Development (USAID) has requested a cost-benefit analysis (CBA) of USAID/Mali's Africa RISING large-scale diffusion of technologies for sorghum and millet systems (ARDT_SMS), implemented over the 2014-17 period. The project is being implemented within specific Feed the Future (FtF) intervention areas in the Mopti (millet VC) and Sikasso (sorghum VC) regions of Mali.

The ARDT_SMS project's overall goal is to increase incomes for sorghum and pearl millet farmers by raising the productivity and profitability of these two cereals. Project activities are guided by two specific objectives. First, to enhance male and female farmers' knowledge of new sorghum and millet production technologies. Second, to facilitate male and female farmers' access to the improved seeds, fertilizers, and fungicides.

FtF's Mali has selected sorghum and millet VC as priority VCs due to high per capita consumption of the crops. In addition, both of the crops have a good level tolerance for local climatic conditions (irregular rainfall and low soil fertility).

The ARDT-SMS project designs strategies and technologies to ensure success for those who are often margin to the sorghum and millet value chains, most of the times, women and children. Increased productivity under the activities of the ARDT_SMS project, therefore, creates more opportunities to directly impact the livelihoods of the rural poor, particularly women and children. This is consistent with the Government of Mali's (GoM) increasing focus on cereal production and the resilience of vulnerable households.

The CBA was conducted on the basis of data and information collected through interviews with ARDT_SMS implementing partners, beneficiary farmers and other stakeholders in the VCs. A comprehensive literature review was conducted to verify the collected information and fulfil data gaps. A detailed list of the stakeholders interviewed is provided in Annex A.

Description of Interventions

The focus of the ARDT_SMS project is on the diffusion of technologies of proven efficacy for enhancing sorghum and pearl millet production systems under the environmental and socio-economic realities of Malian farmers. The major agro-ecological and production system differences in the Mopti and Sikasso regions as well as the presence and capabilities

of different implementing partners led to the development of two different approaches for the Sikasso and Mopti regions. Interventions in Mopti are focused on productivity of the millet crop, while those in Sikasso target the sorghum crop.

Catholic Relief Services (CRS), Direction Régionale de l'Agriculture (DRA)-Mopti (Ministry of Agriculture) and Aga Khan Foundation (AKF) are the lead implementing partners in the Mopti region with support from other partners, such as International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Société Générale d'Agrochimie (SOGEA), Institut d'Economie Rurale (IER), and input dealers and farm seed producer organizations. Specific technologies being diffused to improve productivity of the millet crop in Mopti include:

- Introduction of improved varieties and hybrids of millet.
- Seed treatment for controlling early season insect pests and diseases using fungicides
- Introduction of intercropping of millet with cowpea
- *Weed* management and micro dose application of fertilizers
- Biological Control of the millet head miner

Compagnie Malienne pour le Développement des Textiles (CMDT)-Koutiala, CMDT-Sikasso, CRS and DRA-Sikasso are the main implementing partners in the Sikasso region, with an active participation of other partners, such as AOPP, MALIMARK, EUCORD, ICRISAT and IER. The specific technologies used to improve the sorghum crop are similar to the activities in millet VC with the exception that biological control of head miner is not applicable in the sorghum VC.

Methodology

The Integrated Investment Appraisal (IIA) model offers a means of evaluating both the financial and the socio-economic effectiveness of an investment project, estimating its impact from various perspectives. IIA is the only single-model approach to quantify the impact of every project-related transaction, from the private investor to tax revenues, fiscal expenditure, consumers, and the environment. The methodology is used in project evaluations by major development banks, donor agencies, and public investment units.

Alternative forms of impact analysis entail discrete financial analyses and assessments of economic impact, which are often carried out by independent analysts at different stages of

project development, and which therefore rarely provide an opportunity for experts to adjust and improve project design.

The IIA of USAID's ARDT_SMS project begins with an evaluation of the profitability of the investment (financial module). This analysis is conducted on an incremental basis to determine the net incremental impact of the project on various stakeholders, including project beneficiaries, and to test the project's financial sustainability. The socio-economic assessment (economic module) builds on the financial module, greatly reducing the time and resources normally required for such studies. The economic module is based on the principles of applied welfare economics,[2] according to which socio-economic benefits are assigned monetary values and assessed using typical investment project efficiency indicators, such as economic net present value (ENPV), analogous to financial net present value (FNPV), and economic rate of return (ERR), analogous to internal rate of return (IRR).

Model Description

The analysis is applied to a 20-year evaluation period, 2014-34, and compares "with-project" and "without-project" scenarios on an incremental basis, with real financial and economic discount rates set at 12 percent.[3] The model is constructed on an annual basis with a base year of 2015 and results are expressed in 2015 prices. The model first derives nominal cash flows, which are then discounted using corresponding price indexes to derive real cash-flow statements. The analysis uses World Bank inflation and exchange rate data.

Cereal production costs are usually expressed on a per-hectare basis. As a result, the farm models were constructed on a per-hectare basis. The CBA model starts with an analysis of millet and sorghum production, comparing the profitability of production in the "without-project" and "with-project" scenarios. The "without-project" scenario for millet producers is assumed to be local millet production, while the "without-project" scenario for sorghum producers is assumed to be the combination of maize and local sorghum production with the share of 60% and 40%, respectively[4]. Impact of a change in this assumption is presented in the Sensitivity Analysis section of this report.

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[2] See "Three Basic Postulates for Applied Welfare Economics", A. Harberger, 1971.

[3] USAID set the 12% rate for both the economic and financial model.

[4] This assumption is based on the field observations in Sikasso region.

Farmer cash-flow profiles provide the basis for subsequent economic, stakeholder, and risk analysis of millet and sorghum farming activities. The Monitoring and Evaluation indicators on the total land surface affected by ARDT_SMS project is used to derive an aggregate economic resource flow statement. The baseline analysis assumes that the project would be able to achieve only 50% of the M&E target. The rationale for this assumption is discussed in details in Sensitivity and Risk Analysis section. USAID investment cost is then compared with the net incremental economic benefits of the ARDT_SMS project to derive the net present value (NPV) of the USAID investment.

Financial Analysis

Primary data for the financial analysis was collected during a data collection trip in December 2015. Consultations with agricultural experts and implementers of the ARDT_SMS project, as well as a literature review, were used to analyze and adjust the data. A set of farm budgets for the "without-project" and "with-project" scenarios was prepared (see Annexes C to G). The farm budgets were prepared based on mean values, excluding statistical outliers from the analysis.

A summary of the incremental financial analysis of the ARDT_SMS project is presented in Table 2 (below). The adoption of new production methods promoted by the ARDT_SMS project is expected to result in positive financial returns for sorghum and millet farmers.

Table 2. Incremental Financial Analysis (USD).

ARDT_SMS Beneficiaries	FNPV/Ha	IRR	Total FNPV
Millet producers	592.49	31%	12.67 mill
Sorghum Producers	325.40	34%	6.96 mill
Total			**19.63 mill**

In the millet VC, annual income of farmers has increased from 27.38 USD/ha to 125.53 USD/ha, a more than 450 percent increase to farmers. This translates into incremental FNPV of USD592 per hectare. The total incremental FNPV[5] from the millet farmers' perspective is USD12.7 million, assuming an adoption rate of 50% for the new millet varieties. The incremental IRR is 31 percent.

In the sorghum VC, the analysis uses a counterfactual crop for sorghum, assuming farmers allocate 60% of their land to growing maize and 40% to growing local sorghum varieties. Under this assumption the annual income of farmers has increased from 49.52 USD/ha to 115.15 USD/ha, a 233 percent increase. The FNPV per hectare is USD721.55 for "with-project", compared to USD396.15 in the "without-project" scenario. The incremental FNPV is USD325.40 per hectare and IRR is 34%. The total incremental FNPV[6] from the sorghum farmers' perspective is USD6.96 million.

Currently maize producing farmers in Sikasso region benefit from the 50% subsidy on fertilizers. The improved sorghum production technologies introduced by the project are financially more profitable for farmers then maize production[7]. Given current dominance of the maize production in the region, the analysis assumes that 60% of area affected by the project will shift from maize to improved sorghum. Sorghum producers, however, are not able to benefit from the 50 percent price subsidy that is available for other crops through CMDT. If the GoM will provide equivalent subsidy on fertilizers for sorghum the incremental FNPV per hectare will increase to USD482.0. The annual income will become 133.87 USD/ha, rising from 115.15 USD/ha with no subsidy.

Benefits of ARDT_SMS Project Interventions

Dissemination of knowledge on improved production practices has resulted a number of benefits in the sorghum and millet VCs. Figure 1 presents the main benefits of the project activities.

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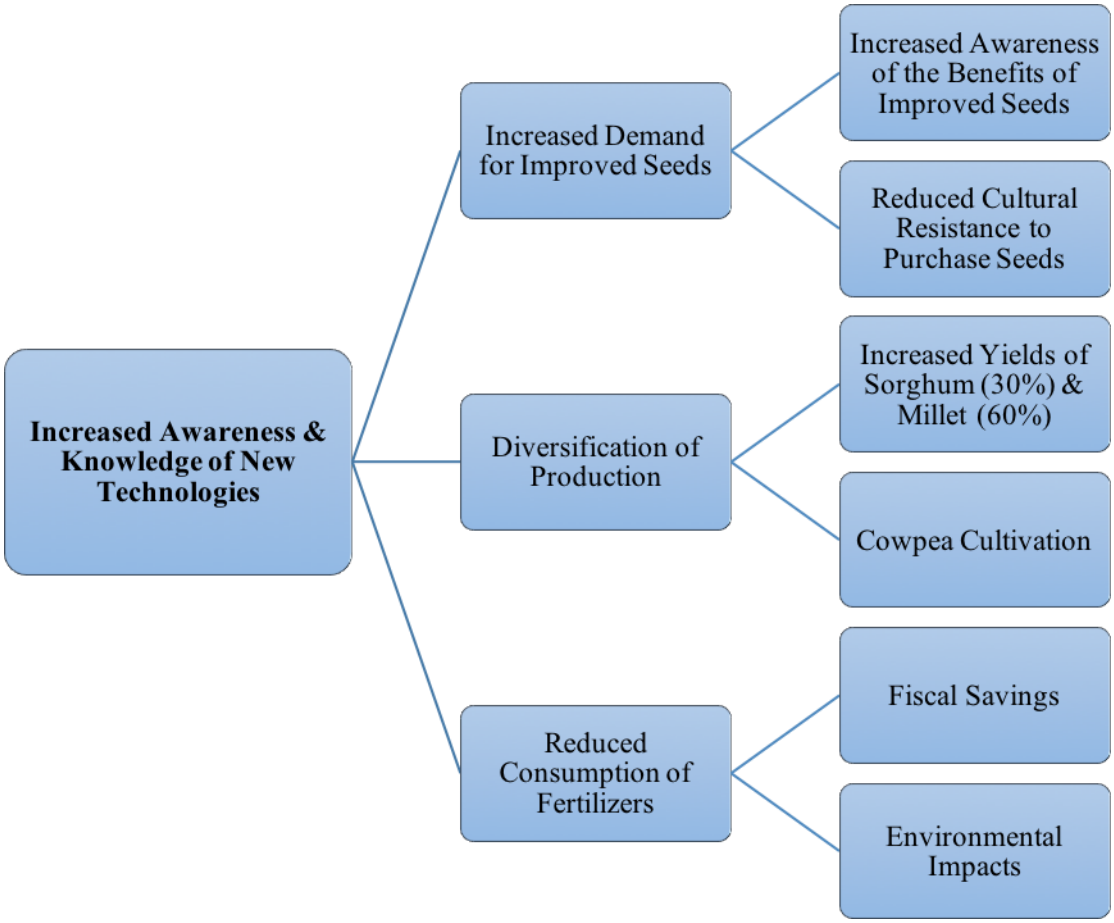
[5] Total number of hectares affected by the project is assumed to be 21,382.

[6] Total number of hectares affected by the project is assumed to be 21,382.

[7] FNPV for maize production find out to be 465 USD/ha comparing to 722 USD/ha for improved sorghum.

Figure 1. Benefits of Productivity Improvement Interventions.



Increase in Yields

The project interventions have resulted increase in average yields of millet and sorghum. Millet yields have increased from 0.93 MT/ha to 1.2 MT/ha. Average sorghum yield has increased from 1.0 MT/ha to 1.6 MT/ha. The provision of seeds, seed treatment and mineral fertilizer facilitated the immediate application of new production methods in a peer-to-peer learning environment.

Increased Demand for Improved Seeds

Phase I of project implementation has been successful in generating interest among farmers in the different improved seed varieties being diffused. Farmers that completed training programs were convinced of the benefits of the use of improved inputs. This in turn helped to reduce the cultural reluctance to purchase any types of seeds. During farmer interviews, however, access to larger quantities of improved seed varieties beyond the life of project was frequently cited as a constraint to long term adoption of new technologies.

As the project enters phase II of implementation, with emphasis on training new seed producers, it is clear that some level of excess demand for these new seed varieties has already been established through successful awareness and knowledge improvement interventions. This increases the likelihood of having sufficient demand when additional improved seed varieties enter the market.

Benefits of Intercropping

The project introduced intercropping of sorghum and millet with cowpeas. Cowpeas can efficiently be intercropped with sorghum and millet with limited reduction in the yields of the main crop. In the millet VC, the value of cowpeas harvest is estimated at 54.5 USD/ha. This corresponds to 55% of the total increase in the annual income of millet producing farmers.

In case of the sorghum VC the net benefit from cultivating cowpea is 72.6 USD/ha. This is higher then the estimated total increase in the annual income of 65.0 USD/ha, indicating that without intercropping farmers have no incentive to switch from maize production to improved sorghum production.

Reduced consumption of fertilizers

Maize production is dominant in Sikasso region; therefore, the CBA assumes that 60% of area affected by the project will shift from maize to improved sorghum. In contrast to maize, sorghum cultivation requires less fertilizers and other chemicals. In addition, currently sorghum producers are not able to benefit from the 50 percent price subsidy on fertilizers. The annual fiscal savings for the GoM from reduced subsidy requirement are estimated at 816,011 USD. The PV over project life amounts to 6.8 mill USD. Moreover, positive environmental impacts can be attributed to the project due to the reduced fertilizer consumption.

Incremental Costs to the Millet Farmers

Total costs for millet farmers have increased by 58 USD/ha. This moderate increase in the cost seems to be reasonable, however, given low purchasing power of the farmers, access to microfinance still remains the issue. The major cost contributors are improved seeds and labor. Table 3 presents the summary of farm level expenditures. For more detailed breakdown of costs and benefits at the farm level, please see the farm budget for local and improved millet provided in the Annexes C and D.

Table 3. Farm Level Expenditures (Millet, USD/ha)

Cost	Without Project (Local Millet)	With Project (Improved Millet)	Incremental
Seeds	2.6	22.6	20
Labor	117.9	136.7	18.8
Other costs	102.5	121.7	19.2
Total	**223.0**	**281.0**	**58.0**

Incremental Costs to the Sorghum Farmers

Total costs for sorghum farmers have increased by 32.5 USD/ha. As in the millet VC, the major cost contributors are improved seeds and labor. It should be noted that significant direct cost savings result from reduced consumption of fertilizers and herbicides. Table 4 presents the summary of farm level expenditures.

Table 4. Farm Level Expenditures (Sorghum, USD/ha)

Cost	"Without-project" (Maize & Local Sorghum)	"With-project" (Improved Sorghum)	Incremental Costs
Seeds	4.7	36.5	31.8
Fertilizer	77.9	39.8	(38.1)
Herbicide & Fungicide	21.0	15.1	(5.9)
Labor	174.6	219.6	45
Other costs	13.3	13.0	(0.3)
Total	**291.5**	**324**	**32.5**

Economic Analysis

The financial analysis outlined above forms the basis for an economic assessment of ARDT_SMS investments. Economic analysis examines the incremental costs and benefits of project activities in terms of their broader impact on the society. Economic analysis takes into account various distortions that are present in the economy. Market prices frequently do not correspond to the actual value of resources produced and consumed in the course of a given activity, due to distortions such as taxes and subsidies.

The GoM exempts all chemical products and agricultural equipment from value added tax (VAT), and it subsidies fertilizers destined for maize in the Sikasso region, and fertilizers destined for millet plots in Mopti region.

The analysis treats cowpeas, maize, sorghum and millet as importable project outputs. The conversion factor[8] for maize, sorghum, millet and cowpeas is estimated at 0.84.

The following distortions exist:

- the foreign exchange premium (FEP), which is estimated at 7.02% for Mali,[9]
- VAT and import duty on imported agricultural products (respectively 18% and 7.5%).

Mali exports mixed mineral and chemical fertilizers, exporting principally to China, India and Burkina Faso. As a result, fertilizers are treated as exportable inputs. The only distortion on non-subsidized fertilizers is the foreign exchange premium (FEP). For subsidized fertilizers, conversion factor arrives at 2.04 while fertilizers with no subsidy have 1.07 as a conversion factor.

The analysis presented here uses commodity-specific conversion factors to adjust cash flows and derive net resource flows from millet and sorghum producers. The net resource flows are then scaled up, according to the acreage of land surface affected by ARDT_SMS activities, to capture total net economic benefit.[10]

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[8] Conversion factors are constructed for transforming financial prices into corresponding economic values.

[9] Kuo, 2014

[10] See Annex B for a complete set of conversion factors used in the analysis.

The following tables present a summary of the incremental economic analysis from Mali's and USAID perspectives.

Table 5. Incremental Economic Analysis of ARDT Project.

ARDT Beneficiaries	ENPV/Ha (USD)	ERR	Total ENPV (USD millions)
Millet producers	393.42	28%	8.41
Sorghum Producers	704.47	N/A	15.39
TOTAL ENPV (Mali Perspective)			**23.80**
PV of USAID Investment			9.47
ENPV USAID Perspective			**14.33**
MRR USAID Perspective			**24%**

USAID investment in the millet and sorghum VCs amounts to USD 11 million (50% in the millet VC and 50% in the sorghum VC) in nominal terms. The PV of this cost is USD 9.47 million, which is deducted from the PV of net economic benefits from Mali's perspective to calculate the ENPV of the ARDT project from the USAID perspective.[11] The ENPV from USAID prospective is USD 14.33 mill using 12 percent economic opportunity cost of capital. The ERR is 24 percent.

[11] The PV and NPVs are expressed as of 2014, the year the ARDT project commenced.

Stakeholder Analysis

The social analysis of the project estimates the distribution of income changes caused by the project. This distributive analysis includes the reconciliation of financial, economic, and distributional appraisals, as well as identifying project impacts on principal objectives of the society concerned. There are four main stakeholders associated with the ARDT project:

1. Sorghum producers (Sikasso region)
2. Millet producers (Mopti region)
3. Government of Mali
4. USAID

The financial gains to sorghum producers and to millet producers are reported as the corresponding FNPV in the financial analysis section. The cost of USAID investments is nominal at USD11 million over the life of the ARDT project. This translates into a PV at 12% of USD9.47 million.

Government Net Externalities are FEP savings from reduced cereal imports, but also fiscal losses through taxes (VAT and import duties) and direct costs through fertilizer subsidies for the millet value chain.

The following table presents the results of distributive analysis.

Table 6. Distributive Analysis (USD millions)

Stakeholder	PV of Gains/Losses
Sorghum producers	6.96
Millet producers	12.67
USAID Investment	(9.47)
Government of Mali – Total	4.18
Government Net Externalities- Millet VC	*(4.26)*
Government Net Externalities- Sorghum VC	*8.43*
Total	**USD 14.33 mill**

Sensitivity and Risk Analysis

The sensitivity analysis tests the impact of changes to the main assumptions and parameters of the analysis on the deterministic returns of ARDT_SMS project interventions. The sensitivity analysis was conducted on key variables. While some variables are presented below, more sensitivity tables are in the Excel model that accompanies this report. The sensitivity analysis was conducted on a number of variables including:

1. Change in the adoption rates of the hectares under improved technologies for both millet and sorghum;
2. Change in the yields in the "with-project" scenario;
3. Change in the price of fertilizers;
4. Change in the yields in the "without-project" scenario;

Table 7. Impact of change in adoption rates on ENPV from USAID's perspective (Million USD)

		Adoption rate (Millet)						
		10%	20%	30%	50%	60%	80%	100%
Adoption rate (Sorghum)	10%	(4.71)	(3.03)	(1.34)	2.02	3.70	7.07	10.43
	20%	(1.63)	0.05	1.73	5.10	6.78	10.15	13.51
	30%	1.45	3.13	4.81	8.18	9.86	13.22	16.59
	50%	7.60	9.29	10.97	**14.33**	16.02	19.38	22.74
	60%	10.68	12.36	14.05	17.41	19.09	22.46	25.82
	80%	16.84	18.52	20.20	23.57	25.25	28.61	31.98
	100%	22.99	24.68	26.36	29.72	31.41	34.77	38.14

The baseline scenario assumes 50% adoption rate for both millet and sorghum VCs. An impact of simultaneous changes in the adoption rate in each of the VCs is presented above. The project return reaches its maximum of USD 38.14 million if the adoption rate in both VCs is 100%. An adoption rate of 20% is the breakeven point for the ENPV from USAID's perspective. The adoption rate, therefore, has to be closely monitored by the M&E unit of the project.

Table 8. Yield of improved millet (Kg/Ha)

		Aggregate Incremental FNPV (Million USD)	Incremental ENPV (Million USD)	
		Millet	Economy	USAID
977	5%	4.12	1.23	(3.51)
1,023	10%	5.44	2.33	(2.40)
1,070	15%	7.13	3.75	(0.98)
1,116	20%	9.04	5.36	0.63
1,200	29%	**12.67**	**8.41**	**3.68**

The baseline analysis assumes a 30% increase in yield of millet if farmers use improved millet seeds and suggested production technologies. If increase in the yield of millet only reaches 18%, total ENPV from USAID's perspective for millet farmers will become negative. Financial NPV will also drop to USD 8.30 million.

Table 9. Yield of cowpeas in the millet VC (Kg/Ha)

		Incremental FNPV (Million USD)	Incremental ENPV for millet (Million USD)	
		Millet	Economy	USAID
160	-20%	10.07	6.22	1.49
170	-15%	10.72	6.77	2.04
180	-10%	11.37	7.32	2.58
190	-5%	12.02	7.86	3.13
200	0%	**12.67**	**8.41**	**3.68**

Farmers are intercropping cowpeas with improved sorghum. Economic NPV from USAID's perspective for millet farmers may drop by 30% if the yields of cowpea seeds drop by 10%.

Table 10. Yield of improved sorghum (Kg/Ha)

		Incremental FNPV (Million USD)	Incremental ENPV (Million USD)	
		Sorghum	Economy	USAID
1,300	30%	(3.40)	6.66	1.92
1,400	40%	0.06	9.57	4.83
1,500	50%	3.51	12.48	7.74
1,550	55%	5.23	13.94	9.20
1,600	**60%**	**6.96**	**15.39**	**10.66**

The financial and economic returns are highly sensitive to the change in the yield of improved sorghum, indicating that it should be closely monitored. The baseline assumption is that project beneficiaries will experience a 60% increase in the yield of sorghum. Financial NPV will turn into negative if this increase drops by one third to 40%. This will cause the production of improved sorghum to become financially unfeasible for the farmers. It should be noted that there is significant subsidy on fertilizers used for maize cultivation. In addition, quantity of fertilizers required for maize is significantly above the quantity demanded by sorghum. Although the FNPV becomes negative if the increase in sorghum yield drops, the ENPV still remains positive due to the significant savings of fiscal resources.

Table 11. Yield of cowpea residues (Bundle/Ha)

		Incremental FNPV (Million USD)	Incremental ENPV for sorghum farms (Million USD)	
		Sorghum	Economy	USAID
640	-20%	**3.62**	**12.58**	**7.84**
680	-15%	**4.46**	**13.28**	**8.55**
720	-10%	**5.29**	**13.98**	**9.25**
760	-5%	**6.12**	**14.69**	**9.95**
800	0%	6.96	15.39	10.66

Farmers intercrop cowpea with improved sorghum. In case of sorghum VC, the value of residues from cowpeas used to feed cattle is the main benefit. The analysis assumes that 800

bundles of residues can be harvested per hectare. Decrease in the quantity of cowpeas produced can negatively affect both FNPV and ENPV to the extent that 10% decrease in the yield can result in 24% decrease in the financial NPV and 13.2% decrease in the economic NPV from USAID's perspective.

Table 12. Change in price of fertilizers

	Incremental FNPV (Million USD)		Incremental ENPV (Million USD)	
	Millet	**Sorghum**	**Economy**	**USAID**
0%	**12.67**	**6.96**	**23.80**	**14.33**
10%	12.53	7.17	24.66	15.19
20%	12.39	7.39	25.51	16.04
30%	12.26	7.61	26.37	16.90
40%	12.12	7.82	27.22	17.75
50%	11.98	8.04	28.08	18.61

In case of the millet VC, incremental costs of fertilizers are positive since more fertilizer is needed with improved millet. As a result, the increase in fertilizer costs has a negative influence on FNPV for millet farmers. Sorghum farmers experience the opposite. They become better off with an increase in price of fertilizers since the incremental cost of fertilizers is negative and it acts as a cost saving for those farmers. Economic NPV from USAID perspective increases overall with increases in the price of fertilizers.

Table 13. Change in the yields in the without-project scenario

	Aggregate Incremental FNPV (Million USD)		Aggregate Incremental ENPV (Million USD)	
	Millet	**Sorghum**	**Economy**	**USAID**
0%	15.18	10.31	28.75	19.28
1%	**12.67**	**6.96**	**23.80**	**14.33**
2%	10.30	4.63	19.85	10.38
3%	8.91	3.03	17.32	7.85
4%	8.05	1.92	15.65	6.18
5%	7.46	1.15	14.50	5.03

The growth in the yields in the "without" project scenario is assumed to be 1% as a base scenario in this analysis. This assumption stresses financial and economic returns by assuming that base line productivity level will gradually increase in time. Higher growth rates will decrease financial and economic returns of ARDT_SMS project. However, it is important to note that an improvement in the yields in "without" project always comes with an incremental cost, which was not taken into account in this analysis.

Conclusions and Recommendations

ARDT_SMS project has produced positive economic returns, with an ERR of 24 percent and an ENPV of USD 14.33 million. The annual income of the millet farmers has increased from 27 to 126 USD/ha. In the sorghum VC the annual income of farmers has increased from 50.0 USD/ha to 115.0 USD/ha.

Another important finding of the analysis is that significant fiscal savings due to reduced subsidy on fertilizers can be attributed to the project. Maize production is dominant in Sikasso region; therefore, the CBA assumes that 60% of area affected by the project will shift from maize to improved sorghum. In contrast to maize, sorghum cultivation requires lower fertilizers and other chemicals application. In addition, currently sorghum producers are not able to benefit from the 50 percent price subsidy on fertilizers. The annual fiscal savings for

the GoM from reduced subsidy requirement are estimated at 816,011 USD. The PV over project life amounts to 6.8 mill USD. Moreover, positive environmental impacts can be attributed to the project due to the reduced fertilizer consumption.

The analysis makes four key recommendations:

1. **GoM subsidy on fertilizers:** The GoM provides 50% subsidy on chemical fertilizer (Sikasso region) used for production of cotton, maize and rice. Significant number of project beneficiaries is expected to shift from cotton and maize production to the improved sorghum production, therefore, releasing fiscal pressure. It is recommended to include sorghum into the list of crops that can obtain subsidies on fertilizers. Such a measure will allow farmers to increase annual income from 115 to 134 USD/ha. This additional financial incentive will boost the scaling up dissemination of the production technologies.

2. **Access to hybrid and improved seed varieties** has to be insured to enable success of the project. The problem of cultural reluctance of farmers to purchase seeds for their production should be addressed by the project[12]. Currently project provides free sorghum and millet seeds to attendants of field schools and farmers have limited exposure to purchasing seeds directly from the market. With phase II, the project is expecting to improve access to high quality seeds by increasing seed production. Farmers, however, have only one farm period to begin purchasing seeds directly from the market before the anticipated project end date. This is a very short period for addressing any problems that may arise in this process and can potentially threaten sustainable access to new seed varieties.

3. **Coordination challenges at the implementing partner level**. Coordination of activities between current project implementing partners is fairly weak, resulting in a "silo approach" to project implementation in certain areas, which can reduce efficiency and overall impact of project. In the 2014-15 farm year, there were instances of the same farmer receiving ARDT_SMS project training from two different implementing partners and with two different methodologies in the Sikasso

12 Farmers rarely obtain seeds from other family members, neighbors, or the market. As suggested by other studies, selling seed is a "taboo".

region. This risk can be managed by introducing consultative platforms for partners working in the same region and at the lead implementing partner (ICRISAT) level.

4. **Leveraging synergies with other projects carrying out similar work in the Sikasso and Mopti regions.** Adoption of new technologies requires a certain level of commitment by farmers to change current production practices. This commitment can only be obtained when farmers have access to all required inputs, access to credit and access to markets to sell their production. Limited attention of the ARDT_SMS project on other than productivity related issues raises the major concern.

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Annex A – List of Interviewed Stakeholders

Date	Location	Stakeholders
City of Bamako (December 1 – 4, 2015)		
Tuesday, December 1, 2015	ACI 2000	USAID In brief – David Yanggen (Director, Office of Economic Growth) & colleagues
Tuesday, December 1, 2015	Samanko	ICRISAT – John Nzungize (Principal Scientist)
Wednesday, December 2, 2015	MALIMARK/AC2000	MALIMARK – Tangara Aminata Coulibaly (National Director) & colleague
Wednesday, December 2, 2015	Rue Mohamed V	IER – Abdoul Karim Traoré (Director of Research) & colleague
Thursday, December 3, 2015	ACI 2000	CRS – Ousmane Maiga (Deputy Head of Programs)
Thursday, December 3, 2015	Immeuble Niangado (adjacent CICB)	AKF - Karim Sissoko (Regional Rural Development) & colleague
Friday, December 4, 2015	Avenue de l'OUA Faladié	SOGEA – Nonon Diarra (Director General)
Friday, December 4, 2015	Hamdallaye ACI 2000	EUCORD – Karamoko Sako (National Coordinator) & colleague
Sikasso Region (December 6 – 14, 2015)		
Sunday, December 6, 2015	Bougouni	Farmer's Cooperative (ARDT Beneficiaries) – Sidiki Sangare & colleagues
Monday, December 7, 2015	Sikasso	CMDT Sikasso – Abdul Maiga (Head of Research) & colleagues
Monday, December 7, 2015	Sikasso	AOPP – Oumar Sanogo (Coordinator, Sikasso Office) & colleagues

Date	Location	Stakeholders
Monday, December 7, 2015	Sikasso	CRS – Aminata Coulibaly (Head of Program – ARDT) / DRA – Mr. Yaya (Head of Division & CRS POC) & colleagues
Tuesday, December 8, 2015	Sikasso Commune: N'tobougou	N'tobougou Farmers' Cooperative (8 farmers present)
Tuesday, December 8, 2015	Sikasso Commune: Tabacoro	Tabacoro Women's Cooperative (5 farmers present)
Tuesday, December 8, 2015	Kaboïla Commune: Nayerebougou	Nayerebougou Farmers' Cooperative (7 farmers present)
Tuesday, December 8, 2015	Kaboïla Commune: Badabala	Badabala Farmer Group (11 farmers present)
Wednesday, December 9, 2015	Zégoua Commune: Nassoulou	Nassoulou Farmers' Cooperative (8 farmers present)
Wednesday, December 9, 2015	Zégoua Commune: Katele	Katele Farmers' Cooperative (8 farmers present)
Wednesday, December 9, 2015	Kadiolo Commune: Gninasso	Gninasso Farmers' Cooperative (7 farmers present)
Wednesday, December 9, 2015	Kadiolo Commune: Sama	Sama Farmers' Cooperative (8 farmers present)
Thursday, December 10, 2015	Kouoro Commune: Makono	Makono Farmers' Cooperative (5 farmers present)
Thursday, December 10, 2015	Kouoro Commune: Sougoula	Sougoula Farmers' Cooperative (4 farmers present)
Thursday,	Gongasso Commune:	Tabakoro Farmers' Cooperative (5 farmers

Date	Location	Stakeholders
December 10, 2015	Tabakoro	present)
Thursday, December 10, 2015	Gongasso Commune: N'tibougou	N'tibougou Farmers' Cooperative (4 farmers present)
Friday, December 11, 2015	Koutiala	CMDT Koutiala – Brema Diara (Head of Agriculture Production Division) & colleagues
Friday, December 11, 2015	Sinsina Commune: Napossela	Napossela Farmers' Cooperative (4 farmers present)
Friday, December 11, 2015	Koutiala Commune: Bagnan	Bagnan Farmers' Cooperative (3 farmers present)
Saturday, December 12, 2015	Zangasso Commune: Zangasso	Zangasso Farmers' Cooperative (7 farmers present)
Saturday, December 12, 2015	Koutiala Commune: N'tosso	N'tosso Farmers' Cooperative (6 farmers present)
Monday, December 14, 2015	Klela Commune: Zerelani	Zerelani Farmers' Cooperative (6 farmers present)
Monday, December 14, 2015	Klela Commune: N'jirikoro	N'jirikoro Farmers' Cooperative (5 farmers present)
Monday, December 14, 2015	Sikasso	UNRIA – Souleymane Dambele (President for Sikasso Region) & colleagues

Date	Location	Stakeholders
City of Bamako (December 15 – 18, 2015)		
Tuesday, December 15, 2015	Samanko	ICRISAT – John Nzungize (Principal Scientist)
Wednesday, December 16, 2015	Hamdallaye ACI 2000	Kafo Jigenew – Ibrahima Keita (Deputy Director) & colleague
Wednesday, December 16, 2015	Hamdallaye ACI 2000	BNDA – Bassirou Diarra (Head, SME Services)
Wednesday, December 16, 2015	Sogoniko	TOGUNA Agro-Industries – Hamat Macina (Internal Controls / SMQ)
Wednesday, December 16, 2015	Kalaban Coura	AOPP – Oumar Coumaré (Coordinator, ARDT Project)
Thursday, December 17, 2015	Niamakoro Cité UNICEF	CVC Project – Willem Van Campen (Chief of Party) & colleagues
Thursday, December 17, 2015	ACI 2000	USAID Outbrief – David Yanggen (Director, Office of Economic Growth) & colleagues
Friday, December 18, 2015	Badalabougou	WFP – Ali Abdul Salim (Project Coordinator) and Nouhou Cissé (M&E Officer)
Mopti Region by phone (December 16 – 18, 2015)		

Date	Location	Stakeholders
Wednesday, December 16, 2015	Dourou Commune: Kourou-Tangui	Boureima Issa SAGARA (ARDT project farmer)
Friday, December 18, 2015	Sio Commune: Kalamani	Jean BORE (ARDT project farmer)
Friday, December 18, 2015	Koporona Commune: Kountagoro	El Hadj Oumar TOGO (ARDT project farmer)

Annex B – List of Commodity Specific Conversion Factors

Seeds (importable input)	0.85
Maize, sorghum, millet, and cowpeas (importable output)	0.84
Fertilizer for millet and maize (exportable input)	2.04
Fertilizer for other crops (exportable input)	1.07
Fungicide and herbicide (importable input)	0.98
Sacks (importable input)	0.75
Agricultural equipment (importable input)	0.98
Labor	1.00
Cowpea’s residues	1.00
Organic manure	1.00

Annex C – Indicative Local Millet Farm Budgets

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Millet (Kg/Ha)	930	155	144,150
Total Revenues			**144,150**
Costs			
Cost of Inputs			
Seeds (recycled) – millet	8	190	1,520
Fertilizer – organic manure	2,500	3	7,500
Fertilizer – cereal complex	25	220	5.500
Fertilizer – urea	25	220	5,500
Fungicide – local product	2	500	1,000
Total cost of Inputs			**21,020**
Cost of Labor			
Cleaning plots	6	1,250	7,500
Sowing	12	1,250	15,000
Weeding	20	1,250	25,000
Application of chemical fertilizer	1	1,250	1,250
Application of organic manure	40	750	30,000
Harvesting millet	10	1,250	12,500
Threshing and winnowing	10	1,250	12,500
Total cost of labor			**103,750**
Other Costs			
Sacks	9	75	675
Transportation	9	300	2,700
Total other costs			**3,375**
Total Costs			**128,145**
Net Income			**16,005**

Annex D – Indicative Improved Millet Farm Budgets

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Millet (Kg/Ha)	1,200	155	186,000
Cowpeas (Kg/Ha)	200	234	46,800
Cowpeas residues (Bundle/Ha)	35	75	2,625
Total Revenues			**235,425**
Costs			
Cost of Inputs			
Seeds (improved) – millet	4	1,250	5,000
Seeds (improved) – cowpeas	8	1,000	8,000
Fertilizer – organic manure	2,500	3	7,500
Fertilizer – cereal complex	35	220	7,700
Fertilizer – urea	35	220	7,700
Fungicide – Apron star	1	1,200	1,200
Total cost of Inputs			**37,100**
Cost of Labor			
Cleaning plots	6	1,250	7,500
Sowing	16	1,250	20,000
Weeding	10	1,250	12,500
Application of chemical fertilizer	6	1,250	7,500
Application of organic manure	40	750	30,000
Harvesting millet	13	1,250	16,250
Harvesting cowpeas	8	1,250	10,000
Threshing and winnowing	13	1,250	16,250
Total cost of labor			**120,000**
Other Costs			
Sacks	12	75	900
Transportation	12	300	3,600
Total other costs			**4,500**
Total Costs			**161,600**
Net Income			**73,825**

Annex E – Indicative Maize Farm Budgets

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Maize (Kg/Ha)	2,400	103	247,200
Total Revenues			**247,200**
Costs			
Cost of Inputs			
Seeds (recycled) – maize	25	150	3,750
Fertilizer – organic manure	5,000	5	25,000
Fertilizer – cereal complex	100	233	23,300
Fertilizer – urea	100	233	23,300
Herbicide – preemergence	3	4,650	13,950
Fungicide – Apron star	1	1,210	1,210
Total cost of Inputs			
Cost of Labor			
Cleaning plots	5	1,250	6,250
Application of chemical fertilizer	2	1,250	2,500
Application of herbicide	1	1,250	1,250
Application of organic manure	5	1,250	6,250
Harvesting maize	15	1,250	18,750
Removing husks and winnowing	25	1,250	31,250
Transportation	5	1,250	6,250
Total cost of labor			**72,500**
Other Equipment			
Herbicide pump	0.2	12,500	2,500
Total cost of equipment			**2,500**
Price for Services			
Soil plowing cost	1	20,000	20,000
Sowing cost	1	5,000	5,000
Weeding cost	1	12,500	12,500
Mounding cost	1	10,000	10,000
Total cost of services			**47,500**
Other Costs			
Sacks	24	75	1,800
Total other costs			**1,800**
Total Costs			**125,510**
Net Income			**121,690**

Annex F – Indicative Local Sorghum Farm Budgets

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Sorghum (Kg/Ha)	1,000	120	120,000
Total Revenues			**120,000**
Costs			
Cost of Inputs			
Seeds (recycled) – sorghum	8	150	1,200
Fertilizer – cereal complex	20	233	4,660
Herbicide – total	2	3,750	7,500
Total cost of Inputs			**13,360**
Cost of Labor			
Cleaning plots	5	1,250	6,250
Sowing	5	1,250	6,250
Application of chemical fertilizer	0.25	1,250	313
Application of herbicide	1	1,250	1,250
Harvesting sorghum	10	1,250	12,500
Threshing and winnowing	10	1,250	12,500
Transportation	2	1,250	2,500
Total cost of labor			**41,563**
Other Equipment			
Herbicide pump	0.2	12,500	2,500
Total cost of equipment			**2,500**
Price for Services			
Soil plowing cost	1	10,000	10,000
Weeding cost	1	25,000	25,000
Mounding cost	1	10,000	10,000
Total cost of services			**45,000**
Other Costs			
Sacks	10	75	750
Total other costs			**750**
Total Costs			**103,173**
Net Income			**16,827**

Annex G – Indicative Improved Sorghum Farm Budgets

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Sorghum (Kg/Ha)	1,600	120	192,000
Cowpeas residues (Bundle/Ha)	800	75	60,000
Total Revenues			**252,000**
Costs			
Cost of Inputs			
Seeds – sorghum	6	1,500	9,000
Seeds – cowpeas	8	1,500	12,000
Fertilizer – cereal complex	35	440	15,400
Fertilizer – urea	17	440	7,480
Herbicide – total	2	3,750	7,500
Fungicide – Apron star	1	1,210	1,210
Total cost of Inputs			**52,590**
Cost of Labor			
Cleaning plots	5	1,250	6,250
Sowing	8	1,250	10,000
Application of chemical fertilizer	8	1,250	10,000
Application of herbicide	1	1,250	1,250
Harvesting sorghum	8	1,250	10,000
Threshing and winnowing	12	1,250	15,000
Transportation	4	1,250	5,000
Total cost of labor			**57,500**
Other Equipment			
Herbicide pump	0.2	12,500	2,500
Total cost of equipment			**2,500**
Price for Services			
Soil plowing cost	1	20,000	20,000
Weeding cost	1	37,500	37,500
Mounding cost	1	11,250	11,250
Total cost of services			**68,750**
Other Costs			
Sacks	16	75	1,200
Total other costs			**1,200**
Total Costs			**110,090**
Net Income			**141,910**

Annex H – Sources of Inputs

General Inputs	
Input	**Source**
Periodical replacement of herbicide pump (Cell F56)	□ Interviews with farmers
Number of hectares under improved technologies, M&E targets (Cell I66 to L66)	□ M&E data of the project
Share of different regions (Cell F67 to F68)	□ Assumption
Cost of labor (Cell F71 to F72)	□ Interviews with farmers
Local Millet Production (Without Project)	
Input	**Source**
In-house consumption (Cell F84)	□ Interviews with farmers □ FAO Recommendation
Millet sold (Cell F85 to F86)	□ Function of the yield and in-house consumption
Initial yield of local millet (Cell F89)	□ Interviews with farmers
Price of millet (Cell F90 to F91)	□ Interviews with farmers □ CRS
Weighted average price of millet (Cell F92)	□ Function of prices and weights
Input requirements (Cell F99 to F105)	□ Interviews with farmers □ CRS
Cost of inputs (Cell F108 to F114)	□ Interviews with farmers □ CRS
Labor requirement (Cell F120 to F127)	□ Interviews with farmers □ CRS
Number of sacks required (Cell F129)	□ Function of yield
Price of sacks (Cell F130)	□ Interviews with farmers
Transportation fee (Cell F131)	□ Interviews with farmers
Improved Millet Production (With Project)	
Input	**Source**

In-house consumption (Cell F139)	□ Interviews with farmers □ FAO Recommendation
Millet sold (Cell F140 to F141)	□ Function of the yield and in-house consumption
% change in yield of millet (Cell F142)	□ Interviews with farmers
yield of improved millet (Cell F143)	□ Function of % change in yield
Price of millet (Cell F144 to F145)	□ Interviews with farmers □ CRS
Weighted average price of millet (Cell F146)	□ Function of prices and weights
In-house consumption (Cell F148)	□ Interviews with farmers □ CRS
yield of cowpeas (Cell F140)	□ Interviews with farmers
Price of cowpeas (Cell F151 to F152 and F153)	□ Interviews with farmers □ CRS
Residue of cowpeas (Cell F154)	□ Interviews with farmers
Input requirements (Cell F157 to F163)	□ Interviews with farmers □ CRS
Cost of inputs (Cell F166 to F167)	□ Interviews with farmers
Labor requirement (Cell F178 to F185)	□ Interviews with farmers □ CRS
Number of sacks required (Cell F187)	□ Function of yield
Price of sacks (Cell F188)	□ Interviews with farmers
Transportation fee (Cell F189)	□ Interviews with farmers
Maize Production (Without Project)	
Input	**Source**
Share of maize/sorghum (Cell I96 to I97)	□ Assumption based on field visit and DRA statistics
In-house consumption (Cell F204)	□ Interviews with farmers □ FAO Recommendation
Maize sold (Cell F205 to F206)	□ Function of the yield and in-house consumption
Yield growth rate (Cell F207)	□ Assumption

Maximum yield achievable (Cell F208)	□ Assumption
Initial yield of maize (Cell F209)	□ Interviews with farmers □ CRS □ CMDT □ DRA
Price of maize (Cell F210 to F211)	□ Interviews with farmers □ CRS
Weighted average price of millet (Cell F212)	□ Function of prices and weights
Input requirements (Cell F219 to F226)	□ Interviews with farmers □ CRS □ CMDT
Cost of inputs (Cell F229 to F236)	□ Interviews with farmers □ Interviews with agro dealers □ UNRIA and Malimark
Labor requirement (Cell F241 to F249)	□ Interviews with farmers □ CRS
Herbicide pump (Cell F251)	□ Interviews with farmers
Pumps required (Cell F252)	□ Interviews with farmers □ CMDT
Price of services (Cell F254 to F257)	□ Interviews with farmers
Number of sacks required (Cell F259)	□ Function of yield
Price of sacks (Cell F260)	□ Interviews with farmers
Local Sorghum Production (Without Project)	
Input	**Source**
In-house consumption (Cell F273)	□ Interviews with farmers □ FAO Recommendation
Sorghum sold (Cell F274 to F275)	□ Function of the yield and in-house consumption
Initial yield of local sorghum (Cell F278)	□ Interviews with farmers □ CRS □ CMDT □ DRA
Price of sorghum (Cell F279 to F280)	□ Interviews with farmers □ CRS
Weighted average price of millet (Cell	□ Function of prices and weights

F281)	
Input requirements (Cell F288 to F295)	□ Interviews with farmers □ CRS □ CMDT
Cost of inputs (Cell F298 to F305)	□ Interviews with farmers □ Interviews with agro dealers □ UNRIA and Mali mark
Labor requirement (Cell F310 to F318)	□ Interviews with farmers □ CRS
Herbicide pump (Cell F320)	□ Interviews with farmers
Pumps required (Cell F321)	□ Interviews with farmers □ CMDT
Price of services (Cell F323 to F326)	□ Interviews with farmers
Price of sacks (Cell F328)	□ Interviews with farmers
Improved Sorghum Production (With Project)	
Input	**Source**
In-house consumption (Cell F337)	□ Interviews with farmers □ FAO Recommendation
Sorghum sold (Cell F338 to F339)	□ Function of the yield and in-house consumption
yield of improved sorghum (Cell F341)	□ Interviews with farmers □ CRS □ CMDT
Price of sorghum (Cell F342 to F343)	□ Interviews with farmers □ CRS
Weighted average price of millet (Cell F344)	□ Function of prices and weights
Residues of cowpeas (Cell F349)	□ Interviews with farmers □ CRS
Input requirements (Cell F352 to F359)	□ Interviews with farmers □ CRS □ CMDT
Price of fertilizers (Cell F362 to F363)	□ Interviews with farmers □ CRS □ Interviews with agro dealers □ UNRIA and Mali mark

Cost of inputs (Cell F366 to F368 and F371 to F373)	□ Interviews with farmers □ Interviews with agro dealers □ UNRIA and Mali mark
Price of Fertilizers (Cell F369 to F370)	□ Function of subsidy switch (Cell F359) □ Interviews with agro dealers □ UNRIA and Mali mark
Labor requirement (Cell F378 to F386)	□ Interviews with farmers □ CRS
Herbicide pump (Cell F388)	□ Interviews with farmers
Pumps required (Cell F389)	□ Interviews with farmers □ CMDT
Price of services (Cell F391 to F394)	□ Interviews with farmers
Price of sacks (Cell F396)	□ Interviews with farmers
Macroeconomic Indicators	
Input	**Source**
US inflation rate (Cell F399)	□ IMF
Price index – US (Cell F400)	□ Function of US inflation
Mali inflation rate (Cell F401)	□ IMF
Price index – Mali (Cell F402)	□ Function of Mali inflation
Relative Price Index (Cell F403)	□ Function of US and Mali price index
Official nominal exchange rate (Cell I404 to J404)	□ World Bank (http://data.worldbank.org/indicator/PA.NUS.FCRF)
Real exchange rate (Cell F405)	□ 2015 is the base year and therefore the nominal exchange rate is equal to real exchange rate.
Nominal exchange rate (Row 407)	□ Function of real exchange rate and relative price index
Discount rate (Cell F408)	□ USAID guidelines
EOCK (Cell F409)	□ USAID guidelines
USAID investment cost (Cell I412 to L412)	□ M&E data of the project
Share of regions from the budget (Cell F411)	□ Assumption