USAID
FROM THE AMERICAN PEOPLE

PHOTO CREDT: PRIMROSE BASIKITI, CRI

COST-BENEFIT ANALYSIS OF USAID RESILIENCE IN THE SAHEL INITIATIVE

Final Report

(DELETE THIS BLANK PAGE AFTER CREATING PDF. IT'S HERE TO MAKE FACING PAGES, AND LEFT/RIGHT PAGE NUMBERS SEQUENCE CORRECTLY IN WORD. BE CAREFUL TO NOT DELETE THIS SECTION BREAK EITHER, UNTIL AFTER YOU HAVE GENERATED A FINAL PDF. IT WILL THROW OFF THE LEFT/RIGHT PAGE LAYOUT.)

LEARNING, EVALUATION AND ANALYSIS PROJECT-II (LEAP-II)

Cost-Benefit Analysis of USAID Resilience in the Sahel (RISE) Initiative

Final Report

September 28, 2018

Contract Number: AID-I-12-00042/AID-OAA-TO-14-00046

This report was prepared by International Development Group (IDG) with Subcontractor Cambridge Resource International (CRI) with the following contributors: Mikhail Miklyaev, Brian Matanhire, Primrose Basikiti, Shahryar Afra, Mostafa Shahee, Elly Preotle, and Carlo Abuyuan.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CET	Common External Tariff
CF	Conservation Farming
CNFA	Cultivating New Frontiers in Agriculture
CSCF	Commodity Specific Conversion Factor
DSCR	Debt Service Coverage Ratio
ECOWAS	Economic Community of West African States
ENPV	Economic Net Present Value
ERR	Economic Rate of Return
FEP	Foreign Exchange Premium
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
GoB	The government of The Republic of Burkina Faso
GoN	The government of The Republic of Niger
HH	Household
IIA	Integrated Investment Appraisal
NCBA-CLUSA	National Cooperative Business Association - Cooperative League of the United States of America
PICS	Purdue Improved Cowpea Bags
PV	Present Value
REGIS-AG	Resilience and Economic Growth in the Sahel - Accelerated Growth
REGIS-ER	Resilience and Economic Growth in the Sahel - Enhanced Resilience
RISE	Resilience in the Sahel Enhanced
SLC	Sustainable Livelihoods Component
USAID	United States Agency for International Development
VC	Value Chain
WCS	Warrantage Credit Scheme

1. EXECUTIVE SUMMARY

1.1 PROGRAM DESCRIPTION

The Resilience in the Sahel Enhanced (RISE) Initiative is a multisector program aimed at increasing the resilience of vulnerable households (HHs) in the Sahel region who face climatic, conflict-induced, environmental, and economic shocks that adversely affect their livelihoods.[1] The Cost Benefit Analysis (CBA) focuses on two five-year USAID RISE projects in Burkina Faso and Niger: Resilience and Economic Growth in the Sahel - Enhanced Resilience (REGIS-ER) implemented by NCBA-CLUSA, and Resilience and Economic Growth in the Sahel – Accelerated Growth (REGIS-AG), implemented by CNFA. In Burkina Faso, both projects cover the Est, Centre Nord, and Sahel regions, and in Niger, the geographic areas covered include the Zinder, Maradi, and Tillaberi regions. REGIS-ER aims to boost crop and livestock production, while REGIS-AG works to strengthen the horizontal and vertical market linkages necessary for farmers to effectively produce and market their crops and increase their incomes, what the projects call the "Push & Pull" strategy.

The CBA evaluates the projects' interventions implemented in agriculture, poultry, and small ruminant value chains (VCs). A short description of the interventions, investment costs, and the number of beneficiaries in each VC is provided below:

Agriculture VC: For agricultural VC interventions, REGIS-AG's beneficiaries in Burkina Faso and Niger are 41,224 and 61,254 farmers respectively. These numbers include beneficiaries from other VCs that were not covered by the CBA.

The CBA assessed the "Sustainable Livelihoods Component" of REGIS-ER with a focus on Conservation Farming (CF). CF encompasses the use of an assortment of climate-adapted farming practices to intensify agricultural productivity in the cowpea, millet, and sorghum VCs, with the objective of increasing HH's income and access to food. CF was introduced to 58,670 farmers in Burkina Faso and 24,280 farmers in Niger.

The CBA assessed REGIS-AG's interventions in the cowpea VC (the project did not work in the millet and sorghum VCs). REGIS-AG reached 21,700 and 23,322 beneficiaries in the cowpea value chain in Burkina Faso and Niger, respectively. The project links farmers to credit through the warrantage credit scheme (WCS). This intervention allows farmers to store their surplus and sell it during the peak-price season, therefore, generating additional income. This intervention is the only REGIS-AG intervention covered by the CBA.

Poultry VC: The CBA of the poultry VC analyzes the following:

1. **REGIS-ER Poultry Habbanayé Intervention** in which productive chickens are gifted to women from vulnerable HHs. The women are then expected to transfer the first offspring to other

[1] Resilience is, "The ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth" (USAID, 2012)

vulnerable HHs. This intervention reached 13,157 and 13,801 beneficiaries in Burkina Faso and Niger, respectively.

2. **Chicken vs. Guinea-fowl Rearing** USAID hypothesizes that chicken rearing is a high-risk high-reward activity as compared to guinea-fowl rearing which is a lower-risk lower-reward activity. The CBA scope of work requests that an analysis be conducted to test this hypothesis. Accordingly, the CBA team conducted a comparative CBA of chicken versus guinea-fowl rearing for farmers in Burkina Faso and Niger. It should be noted that REGIS-ER and REGIS-AG did not work in the guinea-fowl VC.

Small Ruminant VC: The CBA of the small ruminant VC analyzes the following:

1. **REGIS-ER Goats Habbanayé Intervention** in which productive goats are gifted to women from vulnerable HHs. Similar to poultry Habbanayé, beneficiaries are expected to transfer the first offspring to other vulnerable HHs. This intervention reached 5,926 and 11,155 beneficiaries in Burkina Faso and Niger, respectively.
2. **Goats vs. Sheep Rearing:** The CBA team conducted a comparative CBA of rearing goats versus sheep in Burkina Faso and Niger to identify which of these two inventions is more lucrative and should be prioritized.
3. **Sheep Fattening:** The CBA seeks to evaluate if the intensive inputs required for sheep fattening translate into improved profit margins for farmers.

1.2 CBA OUTCOMES

1.2.1 OVERALL PROGRAM OUTCOMES FROM DIFFERENT PERSPECTIVES

TABLE 1. CBA FROM DIFFERENT PERSPECTIVES

		Incremental Aggregate Returns					
		Overall Project Returns		Returns - Burkina Faso		Returns - Niger	
RISE Initiative Activity	Number of Beneficiaries	ENPV M'US$	ERR %	ENPV M'US$	ERR %	ENPV M'US$	ERR %
REGIS-ER	110,807	32.44	29.7%	19.06	30.3%	13.39	29.0%
REGIS-AG	45,022	-7.38	-11.3%	-3.15	-8.9%	-4.22	-13.7%
USAID	155,829	25.07	27.2%	15.91	28.5%	9.16	24.6%

RETURNS TO USAID

Given that REGIS-ER and REGIS-AG are two independent projects which fall under the purview of the of USAID's RISE Initiative, the results from the CBA establish that in aggregate, the projects' interventions in both Burkina Faso and Niger produce a positive outcome from USAID's perspective, as shown in Table 1. Overall, given a total cost with present value (PV) of US$ 20.59 million, the two projects combined generate an economic net present value (ENPV) of US$ 25.07 million and an economic rate of return (ERR) of 27.2%, which is greater than USAID's benchmark discount rate of 12%. USAID's outcomes from the individual country's perspective given a PV of investment costs of US$ 9.79 million and US$ 10.80 million in Burkina Faso and Niger respectively, are as follows: in Burkina Faso the ENPV accruing to USAID is US$ 15.91 million and the ERR is 28.5%, whereas in Niger the ENPV is US$ 9.16 million and the ERR is 24.6%.

RETURNS TO REGIS-ER

From an individual project perspective, the results presented in Table 1 show that the overall outcome of REGIS-ER's interventions in both Burkina Faso and Niger is positive. REGIS-ER in PV terms has invested US$ 11.18 million, weighed against the benefits accruing to the project's beneficiaries. The results show that the project generates in aggregate an ENPV of US$ 32.44 million and ERR of 29.7%.

Disaggregated by country, REGIS-ER's interventions generate a positive return in both Burkina Faso and Niger. The PV of investment costs in Burkina Faso is US$ 5.46 million and US$ 5.72 million in Niger. Taking into account the benefits created in each country, REGIS-ER's outcomes translate to an ENPV of US$ 19.06 million and ERR of 30.3% in Burkina Faso. Whereas, in Niger, the ENPV from REGIS-ER's perspective is US$ 13.39 million and the ERR is 28.90%.

RETURNS TO REGIS-AG

The scope of the CBA with respect to REGIS-AG only covered the WCS in the cowpea VC due to the reasons mentioned in the preceding sections. The overall aggregate outcomes of REGIS-AG's WCS intervention were found to be negative. REGIS-AG's investment cost in the cowpea VC alone is higher than the REGIS-ER's total investment cost in all three agriculture VCs (cowpea, millet, and sorghum) resulting in negative returns due to high costs per REGIS-AG beneficiary. The total PV of REGIS-AG's investment in both Burkina Faso and Niger is equivalent to US$ 9.41 million. The overall returns accruing to REGIS-AG given the aggregate benefits to its beneficiaries were ENPV US$ -7.38 million and an ERR of -11.3%.

The PV of REGIS-AG's investment costs is US$ 4.33 million in Burkina Faso and US$ 5.08 million in Niger.[2] The economic benefits generated by the REGIS-AG's interventions in the cowpea VC are not sufficient to justify these costs. The ENPV and ERR from REGIS-AG's perspective in Burkina Faso are US$ -3.15 million and -10.49% respectively. In Niger the ENPV is US$ - 4.22 million and the ERR is -13.72%.

1.2.2 REGIS-ER OUTCOMES

Table 2 presents the returns accruing to REGIS-ER and in each country on a VC basis. Overall, the agriculture VC generates the highest returns on investment when compared to the poultry and small ruminant VCs. The total PV of investment costs in the agriculture, poultry, and small ruminant VCs in both Burkina Faso and Niger are US$ 4.60 million, US$ 2.75 million, and US$ 3.83 million, respectively. The net benefits generated by REGIS-ER's agriculture interventions result in an ENPV of US$ 20.49 million from REGIS-ER's perspective, whereas the net benefits resulting from the interventions in the poultry and small ruminant VCs result in ENPVs of US$ 7.35 million and US$ 4.60 million to REGIS-ER respectively.

[2] To assess REGIS-AG's interventions in the cowpea VC, the team used of estimates that are based on distributing the total aggregate cost over the total number of project beneficiaries to determine the cost per beneficiary. The beneficiary costs and the number of beneficiaries in each VC were then used to estimate the total costs in each VC per annum.

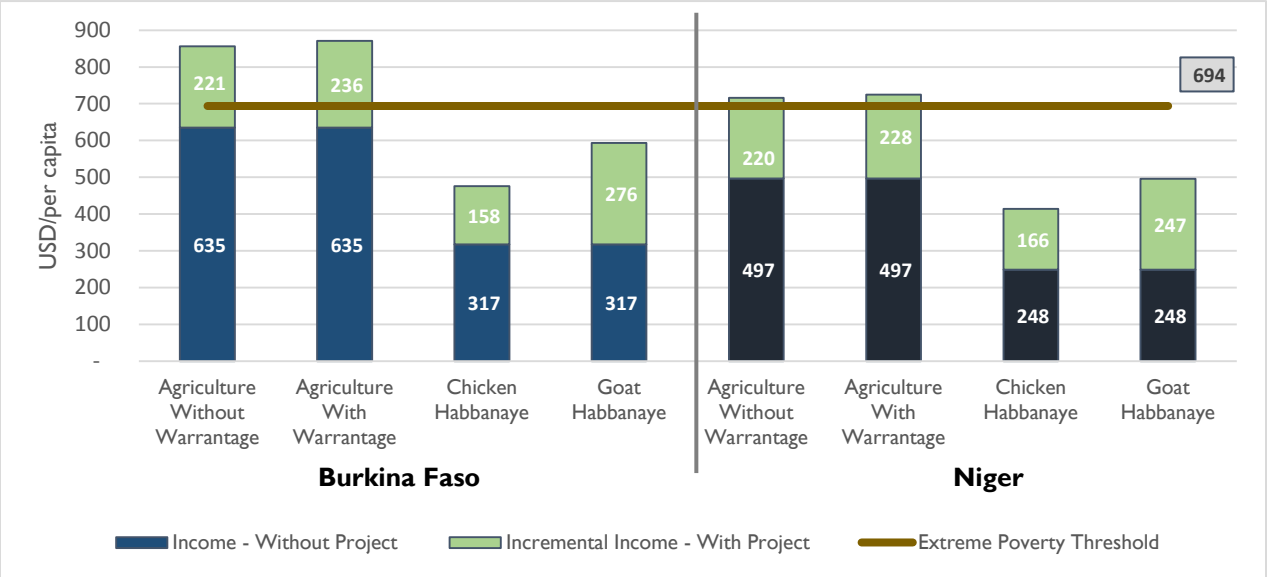
TABLE 2. OVERALL OUTCOMES REGIS-ER

	Incremental Aggregate Returns - REGIS-ER					
	Overall Project Returns		Project Returns Burkina Faso		Project Returns Niger	
Value Chain	ENPV M' US$	ERR %	ENPV M' US$	ERR %	ENPV M' US$	ERR %
Agriculture (cowpea, millet & sorghum	20.49	29.50%	13.92	30.27%	6.57	28.10%
Poultry (chicken)	7.35	38.48%	3.42	38.54%	3.93	38.43%
Small Ruminant (goat)	4.60	21.39%	1.71	21.81%	2.88	20.73%

IMPACTS OF THE PROJECTS' INTERVENTIONS ON POVERTY ALLEVIATION

One of the main objectives REGIS-ER and REGIS-AG is to increase the incomes of the projects' beneficiaries. This objective is tied to the overall objective of the RISE Initiative, which is to lift the recipients of USG's assistance out of extreme poverty. Given an extreme poverty threshold of US$ 694 per capita, in which case it is assumed that an individual spends on average US$ 1.90 daily over the course of a year, Figure 1 illustrates how REGIS-ER's CF and goat and chicken Habbanayé interventions, and REGIS-AG's WCS are expected to contribute to alleviating poverty through the agriculture, chicken, and goat VCs.[3]

FIGURE 1. PER CAPITA INCOME VS. POVERTY THRESHOLD



[3] Extreme poverty often refers to living on less than $1.90 per day. (USAID, September 2015). https://www.usaid.gov/ending-extreme-poverty

The per capita income in the agriculture VC without REGIS-ER interventions presented in Figure 1 as the "income – without project" was derived by taking the land owned by the HH[4] and apportioning it to each individual within the HH.[5] Hence the analysis assumes that each individual's income within a HH is generated from around 0.45 hectares. It should be noted that the income accruing to each individual is only from the cultivation of crops and does not take into account other sources of income such as livestock rearing, among others. The per capita income from the agriculture VC was adjusted to take into account these missing sources of income that together with agricultural income comprise the total income per capita. The adjustment was made by applying the share of income generated from other sources to the agricultural income, in order to provide a more accurate estimate of the total per capita income "without the project."[6] Though the share of income from agriculture for rural HHs in Burkina Faso is 75.8% according to the World Bank, the analysis assumes that it is 65% with 10.8% being apportioned to the rearing of livestock as the percentage share reported by the World Bank (75.8%), which includes both crop and livestock production.[7] This analysis assumes that the share of income from other sources is 24.2%. Data on income shares for rural HHs in Niger could not be found. Therfore, the income share assumptions for Burkina Faso were utlized for Niger. Once the total per capita income was estimated, it was then converted from local currency to its US$ PPP adjusted equivalent.[8]

The PPP adjusted per capita income from agriculture was used as the basis for estimating the chicken and goat livestock farmers per capita incomes in the "without project" scenario. Since the Habbanayé chicken and goat interventions target the most vulnerable HHs who own very little in terms of land or assets such as livestock, the analysis assumes that the per capita income of this group of beneficiaries is around 50% of that estimated for the agriculture VC. In the agriculture VC, the analysis shows that given "without project" per capita incomes of US$ 635 in Burkina Faso and US$ 497 in Niger and incremental per capita incomes of US$ 221 in Burkina Faso and US$ 220 in Niger from CF interventions only, REGIS-ER's beneficiaries will be lifted out of extreme poverty. It is estimated that the beneficiaries will be 23% and 3% above the poverty threshold in Burkina Faso and Niger, respectively. Taking into account REGIS-AG's WCS intervention in the agriculture VC, Figure 1 illustrates that the incremental per capita incomes of the beneficiaries will be much higher. In Burkina Faso, the incremental per capita income from the benefits from warrantage is estimated at US$ 236, whereas in Niger it is anticipated to be around US$ 228. As a result, the beneficiaries will surpass the poverty threshold by a ratio of 26% in Burkina Faso and 4% in Niger.

---

[4] The analysis assumes an impoverished HH in Burkina Faso owns roughly 3 hectares (reference: Property Rights and Resource Governance, Burkina Faso, USAID Country Profile) whereas in Niger the HH land holding is assumed to be 2.91 hectares (reference: http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/).

[5] The average size of a household in Burkina Faso as of 2010 is estimated at 6.8 (reference: Households Demand for Staple Cereal Commodities and Analysis of the Evolution of Staple Cereals' Prices in Burkina Faso, T.M. Traore & D. Fields (2017). The average household size is slightly smaller in Niger at 6.7 as of 2013 (reference: UNICEF Niger Situation Report, November 2013).

[6] The per capita income from agriculture is adjusted by using the following formula:

$$\text{Total per capita income} = \frac{\text{Income from agriculture without project}}{\%\text{ share of income from agriculture}}$$

[7] Burkina Faso: Poverty, Vulnerability, and Income Source (World Bank, June 2016)

[8] PPP conversion factors were obtained from the World Bank: https://data.worldbank.org/indicator/PA.NUS.PRVT.PP?locations=BF-NE

The beneficiaries of chicken Habbanayé are expected to realize increases in their incomes. In Burkina Faso, the per capita income in the chicken VC is expected to increase by 50% from US$ 317 "without the project" to US$ 475 "with the project". In Niger, the per capita incomes are projected to increase by 67% from US$ 248 to US$ 414. Though the chicken Habbanayé beneficiaries' incomes will increase, the incremental incomes from chicken rearing alone will unlikely be sufficient to lift them out of extreme poverty. Estimates show that the poverty gap for chicken Habbanayé beneficiaries will be about 31% in Burkina Faso and 40% in Niger.

For goat Habbanayé in Burkina Faso, the beneficiaries' per capita incomes are projected to increase by 87%. The per capita income "without the project" and the incremental income "with the project" were estimated at US$ 317 and US$ 276, respectively. The Nigerien goat Habbanayé beneficiaries' per capita incomes will double from the "without project" scenario of US$ 248 to US$ 495. Though significant gains are expected to accrue to the goat Habbanayé beneficiaries, these incremental gains alone are unlikely to be adequate to lift them out of extreme poverty.

1.4.1 AGRICULTURE VC CONCLUSIONS AND RECOMMENDATIONS

Integrating Purdue Improved Crop Storage (PICS) bags outside of the cowpea VC should be explored. Though spoilage occurs with all three crops, farmers use PICS bags for only cowpeas, and only in rare instances did we find that farmers use PICS bags to store millet and sorghum. An analysis on the use of PICS bags shows that the benefits far outweigh the cost of purchasing the bags. The Benefit-Cost Ratios (BCRs) show that farmers in all three VCs would benefit from the adoption of PICS bags. In Burkina Faso, the BCRs are estimated at 7.35, 6.70 and 4.48, and in Niger, at 7.26, 13.68 and 5.11, for the cowpea, millet, and sorghum VCs respectively. This analysis highlights that the cost of PICS bags is not the only constraint to farmers using them. Three factors that may impede the use of PICS bags in the millet and sorghum VCs include:

a) A lack of knowledge of the benefits PICS bags;
b) In a situation when farmers have a cash constraint allowing them to buy only a few PICS bags, it is rational that they use them for cowpeas only as the BCR is higher both for Burkina Faso and Niger.
c) In a situation where access to PICS bags is limited or access to storage facilities is a constraint. For example, one of the female farmers interviewed stated that this year she could not benefit from Warrantage since the storage facility did not have adequate space to accommodate harvests from all farmers and priority was given to disadvantaged households.

The projects should explore why millet and sorghum farmers are not using PICS bags and what measures can be taken for them to adopt these practices.

Improve access to inputs. Some targeted areas are remote and lack access to input markets, which makes it difficult and expensive for farmers to purchase recommended inputs such as fertilizers. As a result, some farmers cannot fully apply the recommended set of inputs, which negatively impacts the benefits of CF with regards to increased crop productivity. Though REGIS-ER has promoted Community-Based Solution Providers (CBSPs) to fill this gap, work should continue and be scaled up if possible.

Diversify household livelihoods. Burkina Faso and Niger have only one cropping season over the course of the year. In order to lift agricultural HHs out of extreme poverty and increase their resilience, HHs need to diversify their livelihoods. Farming HHs should be trained and encouraged to engage in alternative income generating activities during the agricultural off-season. Though REGIS-AG has conducted training in the processing of cowpeas into various products such as snacks, flour, couscous, and baby foods, future projects should explore scaling up capacity building in processing. Adding value to the raw cowpeas would increase farmers' incomes and provide a source of income other than that from crop cultivation.

Consider future regional economic trade. Both Burkina Faso and Niger export significant amounts of their cowpeas in the West African region. However, the primary destination for Burkinabe and Nigerien cowpea is Nigeria. Nigeria, which is the largest consumer of cowpeas in Africa, has in the past had to import cowpeas to supplement its huge demand. However, the country's production is growing and is nearing self-sufficiency. Burkina Faso and Niger's cowpea export markets may need to be diversified to include other regional and international destinations. Though countries like Ghana, Benin, Togo, and Mali can absorb the output from Burkina Faso and Niger, their demand for the crop is not as strong as Nigeria's. It should be noted that there is a need to conduct a study on the comparative advantage of Burkinabe and Nigerian cowpeas versus other producers in the regional export market before any measures are taken to promote the crop.

1.4.2 POULTRY VC CONCLUSIONS AND RECOMMENDATIONS

HABBANAYÉ INTERVENTION

The study revealed that chicken rearing supported by the REGIS-ER Habbanayé intervention earned USAID a 38.48% return on investment. The ENPV in Niger is US$ 5.34 million and US$ 4.76 million in Burkina Faso.

CHICKEN VS. GUINEA FOWL REARING

The comparative CBA showed that with an investment of US$ 70 for chicken (which is enough to purchase parent stock of chicken of 10 layers and one cockerel) and US$ 151 for guinea fowls (which is enough to purchase 8 guinea hens and 4 cockerels), guinea fowl rearing is more profitable in both Burkina Faso and Niger with annualized incomes of US$ 249 and US$ 267, respectively.

The sensitivity analysis revealed increasing the parent stock for both chickens and guinea fowls under prevailing conditions had no significant impact on the financial returns that would accrue to the farmers. From the results of the study, it is concluded that low egg production, egg losses, cost and availability of feed, general mismanagement, and low selling prices are the key factors contributing to low returns from chicken rearing. The analysis revealed that at any incremental scale, guinea fowl rearing is more profitable than chicken rearing.

While guinea fowl rearing is more profitable than chicken rearing, it requires higher investment costs. In addition, while Habbanayé chicken targeted women from poor households, the CBA team observed that guinea fowl rearing was mostly done by men.

The following recommendations are made:

1. Formalization of Habbanayé groups

a. The development of poultry rearing faces many challenges, including:
    i. Reducing animal mortality by building the beneficiaries' technical capacity as well as increasing the adoption rate for good animal husbandry practices; and
    ii. Access to finance to provide adapted shelter and ensure food and health.
b. Resolving these challenges will require the organization and cooperation of different actors. Supporting the women's groups involved in Habbanayé to organize into cooperatives should be considered. This initiative could benefit from the current momentum of the Government of Burkina Faso and its development partners in establishing cooperatives in accordance with the Organization for the Harmonization of Business Law in Africa (OHADA) uniform act.

2. To address high mortality rates in poultry:
    a. In addition to the village poultry volunteers (VVV) and private veterinarians, the projects should promote the use of state livestock services to improve the monitoring of pastoralists practices, including the improvement of habitat and caring for young animals (chicks).
3. To address the low egg production:
    a. Educate farmers on the benefits of proper and nutritious low-cost feeding to avoid diet imbalances and boost egg production; and
    b. Link farmers to low-cost feed producers.
4. To address egg losses:
    a. Encourage farmers to set up laying nests for their chicken and provide training on how to build low-cost nests.
5. At the institutional level, increase collaboration with state technical services
    a. Since state technical services are long-term structures, establishing relationships with them is essential to ensure sustainability and the projects should work to develop a collaborative framework.

1.4.3 SMALL RUMINANT VC CONCLUSIONS AND RECOMMENDATIONS

HABBANAYÉ INTERVENTION

The results indicate that the benefits of the Habbanayé intervention outweigh the costs from USAID's perspective. One of the frequent complaints about the Habbanayé intervention is that farmers do not transfer the first offspring to other vulnerable households. While it may be both challenging and costly to monitor the transfer, this should not prevent USAID from investing in Habbanayé, as the economic returns presented in this study are estimated assuming no transfers are carried out. Therefore, the Habbanayé intervention when coupled with the animal husbandry training is an efficient way to assist the most vulnerable households.

Expanding Habbanayé goat will require:

- Improving farmers' capacity to produce affordable feed. To produce enough feed during the rainy season, farmers need to cut and keep hay to feed animals throughout the dry season (hay should be cut before blooming which results in the better preservation of crop residues).
- Support farmers to improve animal prophylaxis (proper shelter, balanced feeding, adhering to the vaccination calendar, early detection of disease, and preventing animal divagation).
- Improvement in goat breeding and reducing the risk of consanguinity.

It is also recommended not to include sheep in Habbanayé. The analysis revealed that:

- A smaller number of beneficiaries can benefit as the required investment cost is three times higher in the sheep VC as compared to the goats VC. In other words, the economic returns from USAID's perspective will be higher if the same amount of funds is invested in the goats VC.
- The high price of sheep creates an incentive for vulnerable households to immediately sell the animals to meet cash needs. As a result, there may be a higher dropout rate of beneficiaries as compared to the goats Habbanayé.

GOATS VERSUS SHEEP REARING

The analysis revealed that while both goat and sheep rearing is financially and economically feasible, goat rearing results in higher financial returns due the lower investment cost requirements. Sheep rearing, in turn, generates higher annual income when compared to goats. Also, farmers that are engaged in sheep rearing have the opportunity to profit from sheep fattening which generates additional income. It is recommended to advise farmers to invest their annual proceeds from the sale of crops into goat farming. Once farmers reach a financial position where they can afford the purchase of the first sheep herd, they should diversify into sheep rearing as well.

The only difference between goats/sheep rearing and Habbanayé from the farmers' perspective is the source of funding for the initial herd purchase. Therefore, most of the observations and conclusions of the Habbanayé analysis are also directly applicable to the goats and sheep rearing.

SHEEP FATTENING

Sheep fattening allows farmers to obtain a profit margin of about US$ 25/year assuming they fatten one animal twice a year. However, the sheep fattening intervention may not be appropriate for the most vulnerable beneficiaries since vulnerable households have competing cash needs and may find it financially challenging to feed sheep over a six-month period.

Field visits revealed that farmers that engage in the sheep fattening are not necessarily the same farmers that rear small ruminants. Sheep fattening is done by women as the investment of cowpea proceeds after the harvest or by those able to identify the commercial opportunity (high demand for lamb during festivals) and with the technical knowledge required to fatten sheep. Supporting sheep fattening will help farmers diversify their diversification, mitigate inflation, and create assets. The marginal cost of adding sheep fattening to other training conducted by REGIS-ER and REGIS-AG is likely minimal and should be explored.

2. INTRODUCTION

The Sahel is a region in the northern part of the African continent and is the ecoclimatic and biogeographic zone in which Burkina Faso and Niger lie. Its semi-arid climate has changed rapidly over the past few decades. According to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), 98% of the region's farming activities are rain-fed.[9] Due to higher temperatures, shifting rain patterns, and increased incidents of droughts, there has been a significant decline in water resources, which are of great importance in sustaining the agro-pastoral livelihoods of communities in the region. Farming and livestock rearing activities account for around about 87% of the regional workforce. Climatic changes pose a significant threat to the livelihoods of the majority of its populace, who subsist on agriculture and pastoralism as their predominant source(s) of food and income.

As a result of these extreme climatic changes, agro-pastoral households (HHs) face chronic poverty, food insecurity, malnutrition, and violent extremism. It has become increasingly difficult for HHs to recover from climatic and environmental shocks due to their increased frequency.

In response to these challenges, USAID is implementing the Resilience in the Sahel Enhanced (RISE) Initiative. The RISE is a multisector program whose main goal is to increase the resilience of vulnerable HHs in the Sahel to climatic, environmental, as well as economic shocks.[10]

This report presents the financial, economic, and stakeholder impacts of the Cost Benefit Analysis (CBA) of the RISE Initiative. The CBA focuses on two five-year USAID RISE projects in Burkina Faso and Niger: Resilience and Economic Growth in the Sahel - Enhanced Resilience (REGIS-ER) implemented by NCBA-CLUSA and Resilience and Economic Growth in the Sahel – Accelerated Growth (REGIS-AG), implemented by CNFA. In Burkina Faso, both projects cover the Est, Centre Nord and Sahel regions, and in Niger, the geographic areas covered include the Zinder, Maradi, and Tillaberi regions.

2.1 DESCRIPTION OF PROJECTS' INTERVENTIONS

The interventions introduced and implemented by REGIS-ER and REGIS-AG are outlined in this section. With respect to REGIS-ER, this CBA evaluates the interventions undertaken in the agriculture, poultry and small ruminant VCs. For REGIS-AG interventions, only the cowpea VC was assessed.

2.1.1 REGIS-ER INTERVENTIONS

This CBA evaluates REGIS-ER's Sustainable Livelihoods Component (SLC). The SLC aims to enhance the resilience of agriculture and animal production in the face of recurrent climatic and environmental shocks, with the objectives of diversifying economic opportunities and intensifying agriculture and animal

[9] https://reliefweb.int/sites/reliefweb.int/files/resources/Sahel%20Info%20Sheet%20Jan%202016.pdf

[10] Resilience is, "The ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth" (USAID, 2012)

production. The interventions implemented by REGIS-ER in the agriculture, poultry, and small ruminant VCs under the SLC are described below.

AGRICULTURE VALUE CHAIN INTERVENTIONS

REGIS-ER utilizes Conservation Farming (CF) Practices to increase agricultural production. CF is a climate adapted farming method that allows for the intensification of the agricultural output in the context of harsh climatic conditions and land degradation. CF promotes the efficient use of the limited factors of production including most water resources which have become increasingly scarce due to variable rainfall patterns and frequent drought spells. CF encourages the conservation and regeneration of the environment to foster sustainable agriculture.

TABLE 3. CONSERVATION FARMING TECHNIQUES

	Technique	Premise
1	Water entrapment using physical enclosures such as zai, furrows, demi lunes and stone bounds	Limited water resources need to be concentrated where they are most required. Using physical enclosures allows rainwater to be trapped in the field, increasing water infiltration and curbing runoff and water soil erosion.
2	Use of Improved Inputs	a. Certified early maturing seed varieties help farmers to cope with variable rainfall patterns and short rainy seasons. b. The use of compost with the aid of fertilizers enriches the soil and promotes fertility
3	Mulching	Mulching results in soil moisture retention; it also limits water and wind erosion of the soil. Furthermore, mulching has the added benefit of promoting a conducive environment for plant germination as well as enriching the soil.
4	Crop Rotation	Crop rotation reduces the risks of losses due to diseases and or parasites.
5	Post-Harvest Management	Conservation of cereals and grains using PICS bags
6	Farmer Managed Natural Regeneration (FMNR)	The management and regeneration of flora such as trees and shrubs help to boost soil productivity as these plants increase the amount of organic matter and minerals in the soil. They also mitigate wind soil erosion and the evaporation of soil moisture.

Model farmers were trained to utilize CF farming techniques, which are outlined in Table 3, to demonstrate the advantages of CF practices over traditional farming methods. The model farmers were required to train other farmers alongside REGIS-ER staff, within the project's producer organizations (POs), to expedite the dissemination of CF techniques. CF was introduced to 58,670 and 24,280 cowpea, millet, and sorghum farmers in Burkina Faso and Niger, respectively.

POULTRY VALUE CHAIN INTERVENTIONS

REGIS-ER's activities to enhance resilience in the poultry value chain are summarized below:

1. **Habbanayé:** The Fulani pastoralists in West Africa are accustomed to a practice called Habbanayé, whereby wealthier households lend female ruminants to a poorer friend or family member who keeps the offspring of the borrowed animals to build their own stock. This practice was adopted by the project and women from impoverished HHs are given ten hens and one cockerel (men are not included in this program).
2. **Village poultry volunteers training:** Volunteers were trained and provided medical kits in preparation for the SLC poultry-raising activity, in response to high poultry mortality and morbidity.

3. **Vaccination campaigns** were carried out to fight key diseases affecting poultry such as Newcastle.
4. **Trade fairs:** The project organized poultry trade fairs in collaboration with REGIS-AG and the local government.

SMALL RUMINANT VALUE CHAIN INTERVENTIONS

Similar to Habbanayé chicken, REGIS-ER also implemented goat Habbanayé targeting women from vulnerable households. The project gifted each beneficiary in Burkina Faso five goats (one buck and four does). In Niger each recipient received four goats (one buck and three does). The recipients of the Habbanayé goats were only women. The goat Habbanayé hands down the offspring from one generation of beneficiaries to the next. REGIS-ER also supported sheep fattening activities and animal health campaigns.

2.1.2 REGIS-AG INTERVENTIONS

The main objective of REGIS-AG's interventions was to strengthen both the vertical and horizontal market linkages to increase access to input and output markets within the agriculture and livestock VCs. Within the agriculture VC, REGIS-AG only targeted cowpeas since it is a high-value cash crop. The interventions implemented by REGIS-AG are listed below. It should be noted that the CBA assessed one out of the three interventions, the Warrantage Credit Scheme (WCS). The reasons why the other interventions were not evaluated are outlined in the description of each intervention.

1. **Access to Finance:** Cowpea farmers were linked to input financing from Micro-Finance Institutions (MFIs) by employing WCS. Farmers are given credit with MFIs using crop produce stored in a warehouse as collateral. The farmers store their cowpeas at the end of the harvest and sell them during the dry season when crop prices are significantly higher. The farmers then use the crop sales to pay off their loans. WCS requires farmers to invest in PICS bags to minimize post-harvest losses and maintain the quality of cowpeas during the five to six-month storage period.

2. **Capacity Building and Literacy Training:** Cowpea farmers were educated on quality control measures improve the marketability of their produce. This included training on the use of various packing and presentation techniques. Although this capacity building was a major component of REGIS-AG's interventions, it was excluded from the CBA. To properly assess the benefits and costs of this intervention would require baseline and final impact assessment studies. These studies were not available at the time the CBA was conducted.

3. **Intensified Marketing**: REGIS-AG assisted farmers gain access to markets through agricultural fairs and meetings with other actors in the VC. The fairs were essential in linking cowpea farmers to individual and commercial off-takers. Farmers were also connected to women who process cowpeas into various local delicacies, providing new avenues to sell their produce. However, the positive impact of the linkages created in output markets can only be observed from the reduction in the cost of accessing the market or a higher price of the produce (cowpea). During the field visits the team failed to obtain any evidence of such an impact. Therefore, this intervention was excluded from the CBA.

3. METHODOLOGY

3.1 METHODOLOGY

The Integrated Investment Appraisal (IIA) methodology was used to conduct the CBA of REGIS-ER's and REGIS-AG's interventions in Burkina Faso and Niger. IIA is a holistic method of CBA that allows for an integrated analysis of the project(s) from a number of different perspectives. Using the various tools of IIA (financial, economic, stakeholder, sensitivity, and risk analysis), this CBA identifies and quantifies the benefits and impacts of REGIS-ER and REGIS-AG from the following perspectives:

i. **Project Beneficiaries:** agro-pastoral HHs involved in the agriculture, poultry, and small ruminant VCs.
ii. **Project Sponsor:** USAID which funded REGIS-ER and REGIS-AG.
iii. **Other Project Stakeholders:** The fiscal impacts on the Governments of Burkina Faso and Niger.

Utilizing the framework of IIA, the CBA measured the costs of undertaking REGIS-ER's and REGIS-AG's interventions as well as the resulting financial and economic benefits, while simultaneously allocating these costs, benefits and impacts to the appropriate stakeholders. The CBA was carried out on an incremental basis. The incremental benefits and impacts of the projects' interventions are obtained by finding the difference between the financial and economic outcomes under the traditional farming practices (also referred to as the "without project" scenario) and the financial and economic outcomes that are expected due to the adoption of best farming practices ("with project" scenario).

Incremental analysis determines the benefits of the projects' interventions as it reveals the additional net benefits/costs created as a result of adopting the prescribed interventions. Positive incremental financial and economic returns are synonymous with additional net benefits, whereas negative incremental financial and economic returns indicate that the interventions lead to additional net costs rather than benefits. Incremental benefits are measured at the HH and aggregate levels.

3.2 MODEL DESCRIPTION

Microsoft Excel was utilized to construct a model that compares the annual cash/resource flows in the "without project" and the "with project" scenarios. These two cash/resource flows ("without" and "with" project) were used to develop the annual incremental cash/resource flow.[11] The financial, economic, stakeholder, sensitivity, and risk analysis were undertaken using the annual incremental cash/resource flows. The analysis covers a ten-year period from 2014 to 2023. 2014 is the base year (the period in which the projects commenced), and 2024 is used as a liquidation period.

The model is utilized to derive nominal cash flows, which are subsequently converted to real cash/resource flows through the use of price indices developed using World Bank inflation and exchange

[11] In the context of IIA, cash flows look at the financial benefits and costs of the project. Whereas, resource flows consider the economic benefits and costs.

rate data. The real incremental cash/resource flows were then used to compute various outcomes such as financial and economic net present value (FNPV and ENPV), financial internal rate of return (FIRR) and the economic rate of return (ERR), by discounting the incremental cash and resource flows using a real financial and economic discount rate of 12%. The difference between incremental cash and resource flows were utilized to identify and quantify the fiscal externalities accruing to the Governments of Burkina Faso (GoB) and Niger (GoN). The incremental cash flows were used to assess the incomes accruing to agriculture, poultry, and small ruminant HHs as a direct result of adopting the projects' interventions.

3.3 COMPONENTS AND STRUCTURE OF THE CBA

3.3.1. CBA COMPONENTS

The CBA consists of two main components. Which are outlined below:

1. **CBA Component 1:** The first component entails the evaluation of REGIS-ER's interventions across the agriculture, poultry, and small ruminant VCs in Burkina Faso and Niger.

2. **CBA Component 2:** The second component assesses REGIS-AG's interventions in the agriculture VC, both in Burkina Faso and Niger.

The CBA also includes three sub-components which address specific questions posed by the USAID Sahel Regional Office. These three subcomponents are outlined below:

i. **CBA Sub-component 1:** A comparative analysis of Goat Vs. Sheep Rearing in Burkina Faso and Niger is conducted, with the objective of assessing which of the two business cases (goat or sheep rearing) is more lucrative and merits prioritization of USAID investment.

ii. **CBA Sub-component 2:** An analysis is conducted to determine if the intensive inputs required for Sheep Fattening either in Burkina Faso or Niger translate into increased profit margins for farmers.

iii. **CBA Sub-component 3:** A comparative analysis of Chicken Vs. Guinea Fowl Rearing in Burkina Faso and Niger is conducted to assess which of the two business cases (chicken or guinea fowl rearing) provides the right balance between risk and reward from the farmers' perspective and warrants the prioritization of USAID investment.

3.3.2. STRUCTURE OF EACH COMPONENT

Each component of the CBA is structured in a similar fashion, consisting of four sections: financial, economic, stakeholder, and sensitivity and risk analysis. This approach taken in each of the four analysis sections and applied across all the components of the CBA is detailed below. Each of the subsequent sections only presents the results obtained from the CBA.

FINANCIAL ANALYSIS

Financial analysis was conducted based on the comparison of traditional farming practices versus project prescribed (best farming) practices which were tailored specifically for each VC: crops, poultry, and small ruminants. The comparison of traditional farming practices versus best farming practices was utilized to identify and quantify the financial costs and benefits associated with each of these farming practices. Farm budgets were constructed through the collection of field data, literature review, and consultations with the projects' beneficiaries in each VC as well as agricultural experts. The farm budgets were used to estimate the financial returns that farmers can attain from each of these farming practices as well as the incremental financial impacts of farmers adopting the best farming practices introduced by projects.

ECONOMIC ANALYSIS

Unlike financial analysis, which evaluates the costs and benefits accruing to a subset of individuals in society, economic analysis takes a more holistic approach. It evaluates the broader costs and benefits accruing to society as a whole. Economic analysis goes beyond assessing the impact of best farming practices on HHs' financial wellbeing – it assesses how best farming practices impact the economic growth of the countries in which the projects operate.

Economic analysis also differs from financial analysis in how resources are valued. Financial analysis uses market prices in the valuation of inputs and outputs. Market prices do not always reflect the true value of resources due to the presence of various market distortions such as trade tariffs, taxes, and subsidies. When undertaking economic analysis, these distortions are removed as they do not represent real costs in the use of production inputs or the consumption of outputs.

The farm budgets utilized to conduct financial analysis were adjusted to their economic equivalents through the use of commodity specific conversion factors (CSCFs), which eliminate the various market distortions from the prices of inputs and outputs. The adjusted farm budgets were then used to estimate the economic impact(s) on each of the two countries where best farming practices were introduced. Furthermore, they were utilized to measure the economic returns accruing to the projects as a result of the implementation of their interventions to assist agro-pastoral HHs in Burkina Faso and Niger.

STAKEHOLDER ANALYSIS

Given that economic analysis encompasses a broad view of the economy/society as a whole, the actors that will benefit either positively or negatively from the project, directly or indirectly, need to be identified. Stakeholder analysis is used to identify which of the actors in the economy stand to gain or lose as a result of various impacts created by the projects' interventions in the agriculture, poultry, and small ruminant VCs. These impacts are known as externalities. The projects' externalities are derived by taking the difference between the aggregate incremental resource flow and the aggregate incremental cash flow statements. The aggregate incremental resource flow statement represents the overall benefits to the economy as a whole, while the aggregate incremental cash flow statement estimates the net financial benefits to the projects' intended beneficiaries. In both Burkina Faso and Niger, the projects' externalities accrue to only one stakeholder, the Governments of the countries, which arise due to the trade tariffs, taxes and subsidies imposed on various project inputs and outputs. Additionally, externalities are created due to gains and losses in the foreign exchange premium (FEP). All these distortions translate to fiscal impacts that can be assessed from the estimated incremental tax flows to the GoB and the GoN.

SENSITIVITY ANALYSIS

The primary objective of sensitivity analysis is to test the base case results by changing various project data inputs and assumptions over a given range to see how the project's financial, economic, and stakeholder outcomes respond to these changes. Sensitivity analysis, therefore, allows for the identification of the critical variables that have the greatest positive or negative impact on the project's outcomes.

4. CBA OF REGIS-ER

4.1 FINANCIAL ANALYSIS

Aggregate financial results, which show the total financial benefits accruing to all REGIS-ER beneficiaries, were measured based on the incremental net cash flow amassed as a result of farmers adopting REGIS-ER's interventions in the agriculture, poultry, and small ruminant VCs. The aggregate incremental net cash flow is derived from the difference between the aggregate cash flow from best farming practices and the aggregate cash flow from traditional farming practices on an annual basis. The annual aggregate incremental net cash flow was projected over a period of ten years and discounted using a real discount rate of 12% to derive the financial net present value (FNPV) and the financial internal rate of return (ERR) from the perspectives of Burkina Faso and Niger.

The results of the financial analysis are presented from two perspectives: 1) the aggregate perspective of all the HHs that benefited from the best farming practices, and 2) the income profiles of HH beneficiaries across all VCs.

4.1.1 FINANCIAL RETURNS

The aggregate financial returns accruing to REGIS-ER beneficiaries in the agriculture, poultry, and small ruminant VCs as a result of the adoption of the interventions introduced in each VC are presented in Table 4.

In the agriculture VC, the financial returns that farmers get per hectare are positive. The incremental FNPV per hectare is US$ 483.78 and US$ 501.70 in Burkina Faso and Niger, respectively. This indicates that CF is a profitable method of cultivating crops and farmers will continue to reap the benefits of CF over the years to come. Given that the total number of beneficiaries reached by REGIS-ER's CF intervention is estimated at 58,670 and 24,280 farmers in Burkina Faso and Niger respectively, the incremental aggregate FNPV in Burkina Faso is US$ 14.24 million and US$ 7.89 million in Niger, which translates to a financial rate of return of 32.24% in Burkina Faso and 33.21% in Niger.

TABLE 4. INCREMENTAL AGGREGATE VALUE CHAIN FINANCIAL RETURNS

	Burkina Faso			Niger		
Value Chain	**No. of Beneficiaries**	**FNPV (M' US$)**	**FIRR (%)**	**No. of Beneficiaries**	**FNPV (M' US$)**	**FIRR (%)**
Agriculture (cowpea, millet & sorghum)	58,670	14.24	32.24%	24,280	7.89	33.21%
Chicken	13,157	4.98	50.25%	13,801	5.52	48.12%
Goat	5,926	4.40	40.03%	11,155	7.05	35.29%

The financial analysis of REGIS-ER's Habbanayé chicken intervention revealed that the FNPV accruing to each adopting beneficiary is US$ 215 and US$ 745 in Burkina Faso and Niger, respectively. The total number of beneficiaries of the Habbanayé chicken intervention in Burkina Faso is 13,157 and in Niger, 13,801. Taking all of the beneficiaries into account, it is expected that the incremental aggregate FNPV will be US$ 4.98 million and US$ 5.52 million in Burkina Faso and Niger, respectively, while the financial rate of return will be 50.25% in Burkina Faso and 48.12% in Niger. The very high rate of return of the

Habbanayé interventions is driven by the investment cost for initial herd, which is met by USAID, as animals are gifted to the beneficiaries.

In the case of REGIS-ER's Habbanayé goat intervention, farmers rearing goats are anticipated to continue to reap positive financial gains well into the foreseeable future. The FNPV per beneficiary is estimated at US$ 948 and US$ 804 in Burkina Faso and Niger, respectively. As the project is expected to reach 5,926 beneficiaries in Burkina Faso and around 11,155 in Niger, the aggregate FNPV is US$ 4.40 million and US$ 7.05 million in Burkina Faso and Niger respectively. The financial rate of return is 40.03% in Burkina Faso and 35.29% in Niger.

4.1.2 HOUSEHOLD INCOME AND PRODUCTION COST PROFILES

One of the main objectives of REGIS-ER's interventions is to increase HH's incomes derived from agro-based and livestock rearing activities that farmers engage in to provide food and generate income. This section presents the HH income profiles within each VC as well as the incurred costs.

AGRICULTURE HOUSEHOLD INCOME PROFILE

The agricultural HH income profile presented in this section shows how farmers' incomes are expected to increase as a direct result of the adoption of CF practices. The impacts of CF on crop productivity and food security are outlined in Annex A1, A2, and A3.

Agricultural HHs' livelihoods are not based on the cultivation of a single crop but rather on the cultivation of multiple crops that meet the HHs' food and monetary requirements. While the crop VCs addressed by REGIS-ER can be evaluated on an individual basis, when it comes to measuring farmers' incomes, it is preferable to measure farmers' income based on the basket of goods they produce. In this case, the HH food basket consists of three crops: cowpea, millet, and sorghum. This HH food basket was used to estimate farmers' net income, farm employment income, and HH income for the cases of traditional farming and CF. The estimates are shown in Figure 3.

When cultivating these three crops, farmers can feed their households as well as sell any excess produce that is not required for consumption. The crop residuals from cowpea, millet, and sorghum have great value since they are utilized as animal fodder or sold in the marketplace at a reasonable price. Hence farmers' incomes are based on both the production of crop grains and crop residuals, taking into account cost production.

Farmers' incomes in Burkina Faso and Niger differ due to three main factors that have a significant bearing on income: crop yields, the market price of grains and residuals, and post-harvest losses. These are quite different between the two countries. In general, crop yields and their market prices are higher in Burkina Faso as compared to Niger, whereas the price of crop residuals is lower in Burkina Faso, in comparison to Niger. There are slight differences in post-harvest losses between the two countries. However, the data collected show that Niger has a lower post-harvest loss rate than Burkina Faso.

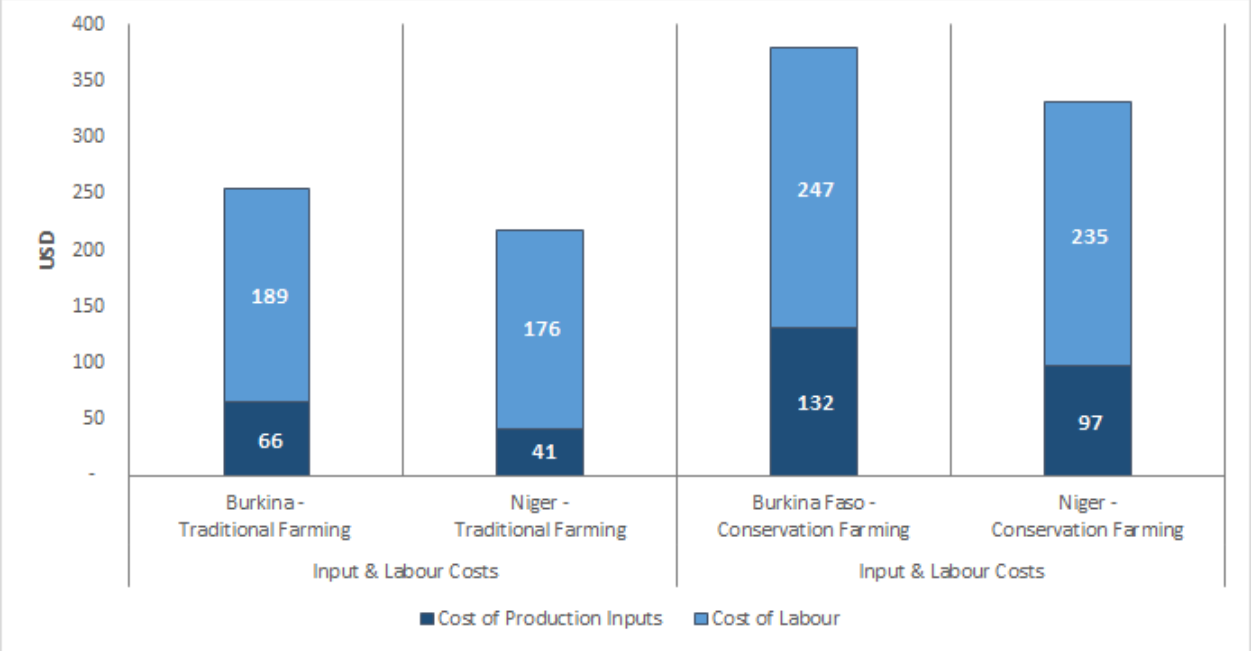
The impacts of these critical factors are exhibited in the difference between the farmers' net income, farm employment income, as well as HH income. This study defines net income as income net of all costs including family labor. The household income in turn is defined as total of the net income and employment income, therefore, assuming that all farm labor is family labor. As illustrated in Figure 3, the

net income, farm employment income and HH income in Niger are on average 35% and 13% lower as compared to Burkina Faso in the case of traditional farming practices and CF practices respectively.

AGRICULTURE PRODUCTION COST PROFILE

The cultivation of crops either using traditional farming methods or CF techniques entails two explicit costs, the cost of production inputs such as seeds, fertilizers, pesticides, etc., and the cost of labor. This section of the financial analysis compares the production costs of traditional farming methods versus CF and assesses the incremental cost impact on farmers who adopt CF practices. Figure 3 summarizes the total production costs for both the traditional and CF scenarios. The summary also disaggregates these costs between the cost of production inputs and the cost of labor. With respect to Burkina Faso, the total production cost incurred by farmers under the traditional farming practice was equivalent to US$ 255 per hectare per annum. This total production cost was composed of US$ 66 of input costs and US$ 189 of labor costs. Because CF promotes the use of improved inputs such as certified and early maturing seeds, fertilizers, and compost, the cost of production inputs will double to US$ 132 per hectare. CF is more labor intensive as compared to traditional farming. Hence the cost of labor is also set to increase by 30.69% to US$ 247 per hectare. The total production cost incurred by farmers adopting CF is US$ 379 per hectare per annum (an increase of 48.63%). The incremental cost of adopting CF is US$ 124 per hectare per annum. In the case of Niger, the total production cost of cultivating the HH food basket under the traditional farming practices is US$ 217 per hectare per annum. This total production cost consists of US$ 41 of input costs and US$ 176 of labor costs. As a result of the use of improved inputs and more intensive labor activities in the case of CF, the costs of inputs and labor are set to increase by 136.59% and 33.53% respectively. This translates to input costs of US$ 97 per hectare and labour costs of US$ 235 per hectare.

FIGURE 2. AGRICULTURE PRODUCTION COSTS WITHOUT AND WITH CF (US$/HA)



The total production cost incurred by farmers adopting CF is US$ 332 per hectare per annum (an increase of 53%). The incremental cost of adopting CF is equal to US$ 115 per hectare per annum. CF is

more resource demanding as it results in the increased cost of production as indicated by the positive incremental production costs in both countries.

Increased production costs, however, do not negate its benefits as the increase in crop productivity under CF results in increased revenue for farmers. This revenue is more than sufficient to cover the increases in the cost of production and still leaves farmers with a reasonable return as illustrated in the proceeding section (farmers' income and financial returns).

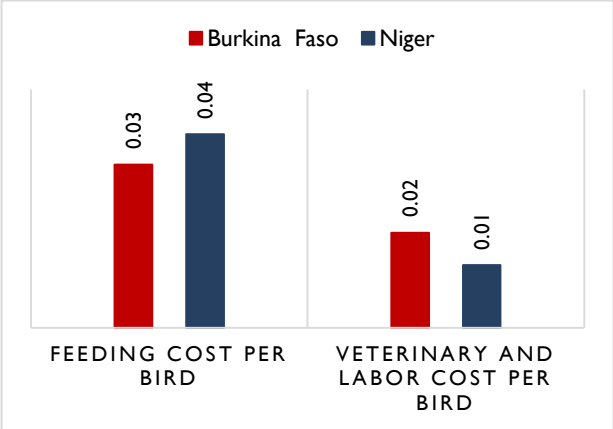
POULTRY HOUSEHOLD INCOME PROFILE

From the parent stock of 11 chickens, the CBA revealed that the annualized income[12] from chicken rearing is US$ 124 in Burkina Faso and US$ 134 in Niger. This annualized income is comprised of chicken, egg, and manure sales. Most farmers do not sell organic matter as they use it on their land, primarily in parcels where women produce vegetables. The value of manure was therefore estimated based on the information provided by the few farmers who sell it. The farmers mostly use eggs for hatching, with consumption and sale of eggs being sporadic.

In both countries, chicken productivity was low, as evidenced by low egg production and high mortality rates. The Habbanayé beneficiaries cited heat stress and lack of adaptation of the parent stock given that hens are supplied through public tenders and gathered from various regions, not necessarily similar to the origin conditions. Wildcats also contribute to high mortality rates. During field visits, it was observed that there was inadequate protection of the birds against severe weather and periodic chicken feed shortages.

Although positive, the annualized incomes from chicken VC are lower than can potentially be achieved. The hen productivity under the poultry kit is far below the minimum that a farmer can achieve under similar chicken rearing conditions. Existing studies report that the annual egg production per hen ranges from 20 to 100 eggs under three to four clutches per year, with a hatching rate averaging 83%, under the village chicken production systems. It was observed that a hen clutches three times a year (once during the rainy seasons, two times during the dry season), lays 12 eggs in each clutch and hatches ten chicks during the rainy seasons, and only six chicks during the dry season. Therefore, without any egg losses and a hatching rate of 100%, a hen is expected to produce only 22 chicks per year. Farmers prefer not to keep large flocks due to feeding challenges. However, the study showed that a bigger flock translates to higher returns.

FIGURE 3. WEEKLY CHICKEN PRODUCTION COSTS (US$)



POULTRY PRODUCTION COST PROFILE

The cost of chicken rearing is similar in both Niger

[12] Annualized income is the average income over the 10 years of the evaluation period expressed in dollars of 2014.

and Burkina Faso. It was observed that chickens in Burkina Faso were fed approximately 25% less than chickens in Niger. The farmers cited the cost and availability of feed as reasons for this difference. Due to government support, veterinary costs are less in Niger than in Burkina Faso. Because of bigger flock sizes, the amount of time spent looking after the chickens on per bird basis is also less in Niger. Figure 4 summarizes the weekly production costs of chicken rearing in both countries.

SMALL RUMINANT HOUSEHOLD INCOME PROFILE

Goat Habbanayé beneficiaries' income was from sales or household consumption of goats and use of manure on the fields. The milk from goats is rarely if ever collected and left for kids feeding. Hence, the value of milk was not included as a benefit in this study. The financial analysis indicates that Nigerien goat farmers' incomes are 10% less than those of Burkinabe farmers. Annualized farmers' incomes in Burkina Faso were estimated at US$ 213, whereas in Niger they are US$ 193. This 10% difference in the incomes of goat farmers in the two countries can be attributed to two factors. The first is the difference in the initial herd size per beneficiary in Burkina Faso and Niger in which each beneficiary in Burkina Faso received five goats (one buck and four does), and whereas in Niger they received four goats (one buck and three does). The second factor is the lower average litter size in Niger as compared to Burkina Faso. In Niger, each doe on average delivers 1.30 kids, whereas in Burkina Faso the kidding rate is 1.45 kids per delivery.

SMALL RUMINANT REARING COST PROFILE

The annual total cost of rearing goats is composed of primarily of three items: feeding costs, veterinary costs, and labor costs. In Burkina Faso, the annual feeding, veterinary, and labor costs are US$ 16.86, US$ 1.60 and US$ 5.44 per head respectively. Hence the total annual cost of rearing one goat in Burkina Faso is US$ 23.90.

In Niger, the total annual cost of rearing a goat is US$ 22.24. Broken down by cost item, a goat farmer in Niger is likely to incur feeding costs of US $13.54, veterinary costs of US$1.18 and labor costs of US$ 7.52 per goat per annum.

Farmers bear the cost of feeding the animals mostly during the dry seasons (on average 90 days per annum), as free grazing is the main source of food for goats during the rainy season.

4.2 ECONOMIC ANALYSIS

The results of the economic analysis are presented from two perspectives: the first is the individual country perspective and the second perspective looks at the economic returns accruing to REGIS-ER. The difference between the two is USAID costs.

4.2.1 ECONOMIC RETURNS – INDIVIDUAL COUNTRY PERSPECTIVE

TABLE 5. ECONOMIC IMPACTS OF REGIS-ER INTERVENTIONS FROM AN INDIVIDUAL COUNTRY PERSPECTIVE

	Incremental Aggregate Economic Returns Individual Country Perspective	
	ENPV (M' US$)	ERR (%)
Burkina Faso	24.52	36.00%
Niger	19.10	36.92%

Economic returns from the individual country's perspectives were measured based on the aggregate incremental net resource flow amassed by each country as result of farmers adopting REGIS-ER's interventions in the agriculture, poultry, and small ruminant VCs. The aggregate incremental net resource flow is derived from the difference between the aggregate resource flow from best farming practices and the aggregate resource flow from traditional farming practices on an annual basis. The annual aggregate incremental net resource flow was projected over a period of ten years and discounted using a real discount rate of 12% to derive the ENPV and the ERR from the individual perspective of Burkina Faso and Niger. The results of the expected economic impact of CF in Burkina Faso and Niger are presented in Table 5.

Table 6 clearly shows that in both Burkina Faso and Niger, there will be positive economic growth as a result of agriculture, poultry, and small ruminant farmers adopting REGIS's interventions. Over a ten-year period, REGIS-ER interventions are expected to contribute an additional US$ 24.52 million to the economy of Burkina Faso. In Niger the interventions are anticipated to add around US$ 19.10 million to the nation's economy.

TABLE 6. ECONOMIC IMPACTS OF REGIS-ER INTERVENTIONS IN EACH VALUE CHAIN

	Incremental Aggregate Economic Returns Individual Country - Value Chain Perspective			
	Burkina Faso		Niger	
Value Chain	ENPV (Million US$)	FIRR (%)	ENPV (Million US$)	FIRR (%)
Agriculture (cowpea, millet & sorghum)	16.52	33.92%	8.57	33.24%
Poultry (Chicken)	4.76	54.76%	5.34	52.97%
Small Ruminant (Goat)	3.23	34.52%	5.19	31.17%

Table 6 presents the value each of REGIS-ER's investments to specific VCs contributing to the overall economic growth of Burkina Faso and Niger. The agriculture VC is expected to add US$ 16.52 million to the economy of Burkina Faso and US$ 8.57 million to the economy of Niger. Due to the interventions implemented in the poultry VC, the economy of Burkina Faso is expected to benefit by US$ 4.76 million, and Niger's benefits from this VC are anticipated to be around US$ 5.34 million. Additionally, the small ruminant VC is projected to make additions of US$ 3.23 million and US$ 5.19 million to the economies of Burkina Faso and Niger respectively.

4.2.2 ECONOMIC RETURNS – REGIS-ER PERSPECTIVE

Economic returns from REGIS-ER's perspective were measured based on the aggregate incremental net resource flow amassed by each country as result of REGIS-ER's interventions. The total aggregate costs incurred to implement REGIS-ER interventions across the agriculture, poultry, and small ruminant VCs in Burkina Faso and Niger were taken into account to derive the aggregate incremental net resource

flow accruing to REGIS-ER. The results of the estimated economic returns to REGIS-ER are presented in Table 7.

TABLE 7. OVERALL ECONOMIC RETURNS TO REGIS-ER

	Incremental Economic Returns REGIS's Perspective (Million US$)					
	REGIS-ER (Burkina Faso)		REGIS-ER (Niger)		REGIS-ER (Burkina Faso & Niger)	
Total Incremental PV of Net Resource Flow	24.52		19.10		43.62	
PV of REGIS-ER Investment Costs	5.46		5.72		11.18	
	ENPV	ERR	ENPV	ERR	ENPV	ERR
REGIS-ER Returns	**19.06**	**30.25%**	**13.39**	**28.90%**	**32.44**	**29.66%**

Table 7 indicates that in both Burkina Faso and Niger, given that REGIS-ER invested US$ 5.46 million and US$ 5.72 million respectively, there will be positive returns to REGIS-. With respect to Burkina Faso, the incremental ENPV is US$ 19.06 million, and in Niger, it is US$ 13.39 million. The ERR is 30.25% in Burkina Faso and 28.90% in Niger. On a collective basis, the overall incremental ENPV estimated to accrue to REGIS-ER, given an aggregate total investment cost of US$ 11.18 million, is US$ 32.44 million, and the ERR is 29.66%.

The returns accruing to REGIS-ER are further disaggregated to show the specific returns that are expected in each VC, given the interventions' investment costs, as well as the benefits generated in each VC, are different. Table 10 presents the economic returns to REGIS-ER on a VC basis.

TABLE 8. VALUE CHAIN ECONOMIC RETURNS TO REGIS-ER

	Incremental Economic Returns REGIS's Perspective (M' US$)					
	Agriculture VC		Chicken VC		Goat VC	
	Burkina Faso	Niger	Burkina Faso	Niger	Burkina Faso	Niger
Total Incremental PV of Net Resource Flow	16.52	8.57	4.76	5.34	3.23	5.19
PV of REGIS-ER investment Costs	2.60	2.00	1.34	1.41	1.52	2.31
ENPV	**13.92**	**6.57**	**3.42**	**3.93**	**1.71**	**2.88**
ERR	**30.27%**	**28.10%**	**38.54%**	**38.43%**	**21.81%**	**20.73%**

The CBA of REGIS-ER's CF intervention revealed that given a PV of investment costs of US$ 2.60 million in Burkina Faso and US$ 2 million in Niger, the project would reap positive returns in both countries. As shown in Table 8, REGIS-ER's ENPV was estimated at US$ 13.92 million and its ERR at 30.27% in Burkina Faso, while in Niger the ENPV is expected to be around US$ 6.57 million with an ERR of 28.10%.

The CBA of Habbanayé poultry in Burkina Faso and Niger revealed that REGIS-ER's intervention in the VC will generate a positive return on investment. In PV terms, REGIS-ER invested US$ 1.34 million in Burkina Faso and US$ 1.41 million in Niger. The results of the analysis show that in Burkina Faso and Niger, REGIS-ER will have a return on investment of 38.54% and 38.43%, respectively. The ENPV in Niger is US$ 3.93 million while in Burkina Faso is US$ 3.42 million.

The CBA of Habbanayé goats in both Burkina Faso and Niger, also reveals that the resulting returns on investment will be positive from REGIS-ER's perspective. Having invested US$ 1.52 million and US$ 2.31 million in PV terms in Burkina Faso and Niger respectively, REGIS-ER is expected to attain an ENPV of US$ 1.71 million and an ERR of 21.81% in Burkina Faso. Whereas in Niger, the ENPV will be US$ 2.88 million and an ERR of 20.73%.

4.3 STAKEHOLDER ANALYSIS

4.3.1 AGRICULTURE VALUE CHAIN'S FISCAL IMPACTS

INCREMENTAL FISCAL IMPACTS OF CF: BURKINA FASO

Out of the three crops grown in the HH food basket under CF, only cowpeas are exported. Production has increased in recent years, resulting in cowpea transitioning from a food security crop to a cash crop, while millet and sorghum which remain vital to food security, have to be imported to augment domestic demand. Around 33% of domestic cowpea production is exported to regional markets in Nigeria, Ghana and Mali, with the major export destination being Nigeria. Actual export quantities are unknown as data on the trade of cowpea is scant.

TABLE 9. PRESENT VALUES OF INCREMENTAL FISCAL IMPACTS OF CF IN BURKINA FASO

	Incremental Fiscal Impacts (Million US$)
Value Chain	**Burkina Faso**
Cowpea	2.41
Millet	-0.04
Sorghum	-0.09
Total Impact on Government's Tax Revenue	**2.29**

According to the latest available data on trade tariffs, the GoB does not impose either export duties or VAT on all exports except for livestock and its related products. The import duty on millet and sorghum is 5% according to the Common External Tariff (CET) of the Economic Community of West African States (ECOWAS) of which both Burkina Faso and Niger are both members. Hence the same import duty applies to Niger.

Taking into account the tariff structure outlined above, the results shown in Table 9 indicate that as crop productivity increases as a result of CF, foreign exchange earnings and indirect taxes will increase due to the utilization of these forex earnings. As a result, the GoB's tax revenue is estimated to increase by US$ 2.41 million over a 10-year period due to increased cowpea exports. The GoB's tax revenue from import duties levied on millet and sorghum imports will decline as the incremental domestic production will substitute some of the country's imports of these two staple crops. It is estimated that the tax revenues from millet and sorghum will decrease by US$ 0.04 million and US$ 0.09 million, respectively. However, the overall fiscal impact will be positive due to the gains in the tax revenues on cowpeas outstripping the losses in the millet and sorghum VCs. The overall fiscal impact is US$ 2.29 million.

INCREMENTAL FISCAL IMPACTS OF CF: NIGER

According to ICRISAT, Niger is one of the biggest exporters of cowpea in the world and its main export destination is Nigeria. However, the country also exports cowpeas to Ghana, Benin and Togo. Data on trade statistics could not be found to verify this claim. Similar to Burkina Faso, the country also imports millet and sorghum to supplement domestic production of these two staple crops. The literature review conducted on the trade tariff structure showed no evidence of export tariffs. Niger is subject to the CET as it is a member of ECOWAS, which means that both millet and sorghum imports incur an import tariff of 5%. The GoN currently supports domestic farmers in the cowpea, millet and sorghum VCs through a subsidy of 20.6% on a variety of fertilizers such as NPK, which farmers adopting CF use to boost soil fertility.

TABLE 10. PRESENT VALUES OF INCREMENTAL FISCAL IMPACTS OF CF IN NIGER

	Incremental Fiscal Impacts (M'US$)	
Value Chain	**Niger with subsidy**	**Niger without subsidy**
Cowpea	1.25	1.54
Millet	-0.39	-0.03
Sorghum	-0.16	0.00
Total Impact on Government's Tax Revenue	**0.69**	**1.51**

Given the prevailing tax structure outlined above, Table 10 presents the resulting incremental fiscal impacts that the GoN is anticipated to encounter as a result of farmers' adoption of CF. Table 10 presents two scenarios, the first considers the current situation where the GoN subsidizes NPK fertilizers and the second scenario assumes there is no subsidy given on fertilizers. In the case of scenario 2 (no subsidy on fertilizers), incremental indirect taxes from the utilization of increased forex earnings from increased crop exports due to increased crop productivity would be higher than in scenario 1. This incremental tax revenue is estimated at US$ 1.54 million. The differential tax revenue between the two scenarios is US$ 0.29 million. Scenario 2 shows that without a subsidy on fertilizers, the GoN would face a much lower tax revenue loss in the millet and sorghum VCs. The tax revenue lost in the millet VC in the case of the second scenario is US$ 0.03 million, which means the GoN will abate an incremental tax revenue loss equal to US$ 0.36 million. As for sorghum, the tax revenue loss would be negligible. Hence the GoN would be able to abate an incremental tax revenue loss equal to US$ 0.16 when compared to scenario 1. In scenario 2, the overall fiscal impact will be more positive as compared to scenario 1 and is estimated to be around US$ 1.51 million.

These two scenarios highlight that the GoN bears an extra fiscal burden due to the subsidy on fertilizers. As crop productivity increases, the GoN spends more fiscal resource on the extra fertilizers that farmers need to produce cowpea, millet and sorghum. This incremental expenditure amounts to US$ 0.29 million, US$ 0.36 million and US$ 0.16 million in the cowpea, millet and sorghum VCs, respectively. If the GoN ceased to subsidize fertilizers, it could shave off US$ 0.81 million from its budgetary expenditures on agriculture. However, this may come at the cost of farmers being less able to afford fertilizers.

4.3.2 POULTRY VALUE CHAIN'S FISCAL IMPACTS

TABLE 11: EXTERNALITIES FROM POULTRY

Burkina Faso (M'US$)			Niger (M'US$)		
	FEP	Other Distortions		FEP	Other Distortions
Total benefits	0.73	-1.56	Total benefits	0.84	-1.80
Total costs	2.85	-3.46	Total costs	3.63	-4.41
Net benefits	-2.12	1.90	Net benefits	-2.79	2.61
Total externalities		-0.22	Total externalities		-0.18

Table 11 shows a breakdown of the present value of the project's fiscal impacts generated from foreign exchange externalities gained or lost through the expansion of exports or imports and the availability of the foreign exchange as well as other distortions such as import tariffs. The net negative externalities are also a result of import tariff revenues lost due to the import substitution effects of the project. The study revealed that the government externalities in Burkina Faso amounted to negative US$ 0.22 million and negative US$ 0.18 million in Niger.

4.3.3 SMALL RUMINANT VALUE CHAIN'S FISCAL IMPACTS

TABLE 12. GOAT REARING EXTERNALITIES

Goats Rearing	Total Externalities (M'US$)	FEP (M'US$)	Other Externalities (M'US$)
Burkina Faso	-1.17	0.12	-1.36
Niger	-1.86	0.21	-2.02

The fiscal impacts arising from the Habbanayé goat intervention can be attributed to the distortions created through the foreign exchange premium, import tariffs and value-added tax as well as income tax. These distortions result in both positive and negative externalities which accrue as gain or losses to the Governments of Burkina Faso and Niger. In Burkina Faso and Niger, the import duties imposed on livestock, animal feed, and salt blocks are 20%, 10%, and 5%, respectively. In addition, FEP was estimated at 5%. However, the standard VAT rates for Burkina Faso are 18% while it stands at 19% for Niger. In both countries, the VAT only applies to salt blocks and vaccines. The results of these distortions are shown in Table 12.

4.4 SENSITIVITY ANALYSIS

The results presented in the financial, economic and stakeholder analyses are the deterministic base case analysis outputs. They are subject to change given various endogenous and exogenous factors that can cause the project's outcomes to differ from those obtained in the base case scenario. This section presents the sensitivity and risk analysis results of the agriculture, poultry, and small ruminant VCs.

4.4.1 AGRICULTURE SENSITIVITY

Four of the projects' variables were found to have a significant impact on the economic returns to REGIS-ER, namely the expected yields, the market prices of crops, the adoption rate and post-harvest losses. With respect to farmers' incomes, only the expected yields, market prices of crops, and post-harvest losses have the greatest impact. The results of the sensitivity analysis are shown in Table 13.

TABLE 13. REGIS-ER AGRICULTURE SENSITIVITY ANALYSIS RESULTS

			Sensitivity of Output Variables to Changes in Project Key Variables			
			Incremental Returns REGIS-ER % Change		HH Income % Change	
Project Key Variable	Base Case Project Key Variable Assumptions	Sensitivity Test Range	REGIS-ER Base Case Aggregate ENPV (20.50 M'US$)	REGIS-ER Base Case Aggregate ERR (29.50%)	Burkina Faso Base Case HH Income per Ha (456 US$)	Niger Base Case HH Income per Ha (400 US$)
Deviation In Expected Yield	0.00%	(-25%) - (+30%)	(-72%) - (+87%)	(-34%) - (+23%)	(-32%) - (+37%)	(-31%) - (+37%)
Deviation in Market Price	0.00%	(-30%) - (+40%)	(-77%) - (+103%)	(-38%) - (+26%)	(-34%) - (+46%)	(-29%) - (+39%)
Adoption Rate	80.00%	(+50%) - (+100%)	(-69%) - (+137%)	(-32%) - (+33%)	N/A	N/A
Deviation in the Price of Production Inputs	0.00%	(-20%) - (+20%)	(-18%) - (+18%)	(-10%) - (+10%)	(-6%) - (+6%)	(-5%) - (+5%)
Deviation in Price of Labor	0.00%	(-20%) - (+20%)	(-16%) - (+16%)	(-7%) - (+7%)	N/A	N/A
Post-Harvest Losses	VC Specific*	(-10%) - (+20%)	(-69%) - (+137%)	(-32%) - (+33%)	(-13%) - (+26%)	(-11%) - (+22%)

EXPECTED YIELDS: A positive or negative deviation in the yields of cowpea, millet, and sorghum results in enormous changes in the returns accruing to REGIS-ER. Variations in yield also have a significant impact on HHs' net incomes. If yields observed for the case of CF were to decline by 25%, the ENPV from REGIS-ER's perspective would decrease by 72%, while the HH net incomes in Burkina Faso and Niger would decrease at a moderate rate of 32% and 31% respectively.

MARKET PRICES: The prices of cowpea, millet, and sorghum are volatile in both Burkina Faso and Niger. Prices follow a regular trend, low during and after the harvesting period and they increase significantly during the dry and planting seasons when grain stores are low, and demand is high. Hence, crop prices are one of the most critical variables as the sensitivity analysis highlights. An average decline of 30% in the market prices of cowpea, millet, and sorghum, would result in REGIS-ER's ENPV dropping by 77%, while HH incomes in Burkina Faso and Niger will decline by 34% and 29% respectively.

ADOPTION RATE: The number of farmers adopting CF has a significant impact on the returns accruing to REGIS-ER given its investment in undertaking CF interventions in Burkina Faso and Niger. If 50% of farmers who benefited from CF were to abandon the new farming practices, REGIS-ER's ENPV would decrease by 69%.

POST-HARVEST LOSSES: One of REGIS-ER's interventions is aimed at decreasing post-harvest losses through the use of PICS bags. If farmers do not adopt post-harvest management practices through the use of PICS bags, post-harvest losses will continue to be as high as pre-CF figures. If CF post-harvest losses were to increase by 20% for example, REGIS-ER's ENPV would decline by 69%, while HH income would decline by 13% and 11% in Burkina Faso and Niger respectively.

4.4.1 POULTRY SENSITIVITY

For the project to achieve and exceed the results presented in the financial and economic analysis, a number of variables need to be closely monitored by REGIS-ER. These variables are presented in Table 14 and 15 for Burkina Faso and Niger, respectively.

Burkina Faso

1. **Eggs laid per clutch.** The sensitivity analysis shows that a 10% increase in the number of eggs laid per each laying period could increase the base case income from US$ 124 to US$ 162. Since the number of eggs laid is mostly affected by improper nutrition, laying chickens require a balanced diet to sustain maximum egg production over time. Inadequate nutrition can cause hens to stop laying and insufficient levels of energy, protein or calcium can cause a drop in egg production. A 10% increase will result in positive returns from REGIS-ER's perspective, from US$ 3.42 million to US$ 4.97 million. If egg production decreases by 10%, both FNPV and ENPV from Burkina Faso's perspective will decrease by 33%.

TABLE 14. SENSITIVITY ANALYSIS ON CHICKEN OUTCOMES (BURKINA FASO)

		Project Outcomes			
		Aggregate FNPV	ENPV Burkina Faso	ENPV REGIS-ER	Farmer's income
	Sensitivity Factor	(million US$)			(US$)
	Base Case Scenario Results	**4.98**	**4.76**	**3.42**	**124**
Eggs laid per clutch	-10%	3.47	3.32	1.98	89
	+10%	6.60	6.31	4.97	162
Average egg loss	-10%	5.06	4.84	3.50	126
	+10%	4.50	4.30	2.96	113
Chick mortality	-10%	6.23	5.96	4.62	153
	+10%	1.27	1.20	-0.14	34

2. **Chick mortality**. The analysis showed that a decrease in the weekly chick mortality rate has significant impacts on the project outcomes. If the base case chick mortality rate increases by 10%, FNPV and ENPV from Burkina Faso's perspective will decrease by 75%, farmers' annualized income will decrease by 72%, and the ENPV from USAID's perspective will be negative.

3. **Average egg loss.** Because the chickens are free range, they may hide their eggs instead of laying nests. From field observations, in most cases it was observed that farmers did not have proper nests for their hens. This can result in egg losses due to predators such as snakes and shell breakage, which were estimated at 15%. If this figure increases by 10%, the ENPV from REGIS-ER's perspective will decrease to US$ 2.96 million while annualized farmers' income will decrease to US$ 113.

Assuming that 2/3 of the egg losses can be attributed to the absence of hen houses, the analysis attempts to estimate expected profitability of hens houses construction. If the average egg loss decreases from 15% to 10%, the present value of financial gains due to reduced losses over 10 years is US$ 151. The present value of the cost of hen house construction is US$ 35 assuming 5 years life for a hen house. Therefore, the net gains are US$ 116. It is therefore recommended to train farmers on how to construct hen houses.

Niger

TABLE 15. SENSITIVITY ANALYSIS ON CHICKEN OUTCOMES (NIGER)

		Project Outcomes			
	Sensitivity Factor	Aggregate FNPV	ENPV Niger	ENPV USAID	Farmer's income
		(million US$)			(US$)
	Base Case Scenario Results	5.52	5.34	3.93	131
Eggs laid per clutch	- 10%	3.98	3.86	2.45	95
	+10%	6.79	6.56	5.15	159
Average egg loss	- 10%	5.61	5.43	4.02	133
	+10%	5.08	4.92	3.51	121
Weekly chick mortality	- 10%	6.70	6.47	5.06	157
	+10%	4.45	4.31	2.90	106

1. **Eggs laid per clutch.** The sensitivity analysis showed that a 10% decrease in the number of eggs laid per each laying period would decrease the base case income from US$ 131 to US$ 95. It will also decrease the ENPV from REGIS-ER's perspective from US$ 3.93 million to US$ 2.45 million.
2. **Average egg loss.** If egg losses increase by 10%, the farmer's annual income will decrease to US$ 121 from US$ 131, the ENPV from Niger's perspective will fall from US$ 5.34 million to US$ 4.31 million, and FNPV will decrease by 8% from US$ 5.52 million.
3. **Weekly chick mortality.** The sensitivity analysis revealed that if the number of chicks dying per week reduced by 10%, the farmers' annual income would increase by 32% and REGIS-ER returns by 44%. The ENPV from Niger's perspective would increase by 32% while FNPV would increase by 21%.

For the project to break even, the adoption rate needs to be at least 18.5% in Niger and 69.6% in Burkina Faso. For the base case, a 70% adoption rate was assumed. During field visits, it was observed that for some women the chickens died after receiving them, or they sold them before they could start rearing. The 30% dropout rate accounts for these cases.

4.4.1 SMALL RUMINANTS SENSITIVITY

For REGIS-ER to achieve the outcomes presented in the financial and economic analysis, some variables need to be closely monitored by the project. The average litter size and mortality rates are the main parameters that affect the project's outcomes. Table 16 demonstrates how improvement in these parameters might improve the viability of the project both from the financial and economic perspective.

TABLE 16. SENSITIVITY ANALYSIS OF REGIS-ER GOATS HABBANAYÉ

		Burkina Faso		Niger	
		Farmers' Annual Income	ENPV REGIS-ER Perspective	Farmers' Annual Income	ENPV REGIS-ER Perspective
Sensitivity Factor	Base Case Scenario	US$ 213	US$ 1.71 mill	US$ 193	US$ 2.88 mill
Average Litter Size	-10%	US$ 178	US$ 0.89 mill	US$ 164	US$ 1.62 mill
	0%	Base case value: 1.45		Base case value: 1.3	
	+10%	US$ 245	US$ 2.49 mill	US$ 220	US$ 4.09 mill
Average Mortality Rate	-10%	US$ 222	US$ 1.96 mill	US$ 202	US$ 3.31 mill
	0%	Base case value: 9.5%		Base case value: 9.5%	
	+10%	US$ 203	US$ 1.48 mill	US$ 183	US$ 2.46 mill

Average Litter Size significantly affects the financial and economic performance of REGIS-ER's Habbanayé intervention. A 10% decrease in the average litter size results in a decline of the ENPV from REGIS-ER's perspective by 45.6% and 42.0% in Burkina Faso and Niger, respectively. With respect to farmers' incomes, a 10% decrease in the litter size will lead to a 16% reduction in the annual income of farmers in Burkina Faso and a 15% reduction in Niger. The litter size is affected by many factors including diet, husbandry practices, shelter conditions, breed etc. REGIS-ER should closely monitor these factors.

Average Mortality Rate has a moderate impact on the financial and economic outcomes of the Habbanayé intervention. If the mortality rate were to increase by 10%, farmers' incomes in Burkina Faso and Niger would contract by 5% in Both Burkina Faso and Niger. On the other hand, the ENPV of REGIS-ER would decrease by 14% in Burkina Faso and 15% in Niger.

5. CBA OF REGIS-AG

Given that crop productivity greatly increases as a result of CF, farmers will have sufficient food to feed their HHs and will be left with excess crops that they can sell in order to meet other needs. In the cowpea value chain, for example, it is estimated that farmers' HHs will consume around 8% and 7% of their total production per annum in Burkina Faso and Niger, respectively. Hence farmers will have around 92-93% of their production that they can sell. Taking into consideration that cowpea is a cash crop and an exportable product, it is highly likely that farmers will sell the excess cowpea as a means to generate an income.

The warrantage credit system (WCS) was used by REGIS-AG as a means to market farmers' surplus cowpeas as well as a means to access financing for inputs amongst other operational needs. This section presents the results of the financial, economic, and stakeholder assessment of the WCS.

5.1 FINANCIAL ANALYSIS

5.1.1 FINANCIAL RETURNS

Table 17 shows that farmers will reap positive long-term financial benefits from adopting the WCS. On an individual basis, each cowpea farmer in Burkina Faso is expected to attain an FNPV of US$ 60.32 per Ha, whereas in Niger the FNPV per Ha is US$ 33.39. The total number of beneficiaries in the cowpea VC in Burkina Faso and Niger is equal to 41,224 and 61,254. Given the total number of farmers reached by REGIS-AG, it is anticipated that the aggregate financial benefits accruing to farmers as a result of the WCS will be US$ 0.92 million and US$ 0.61 million in Burkina Faso and Niger, respectively.

TABLE 17. INCREMENTAL FINANCIAL RETURNS

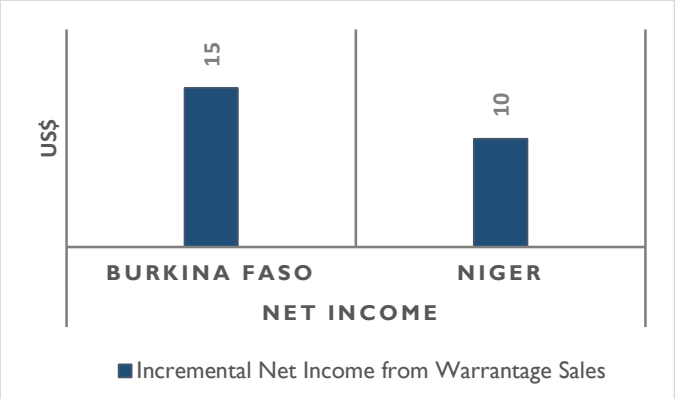
	Estimated Number of Beneficiaries reached by REGIS-AG who Cultivate Cowpea	FNPV (US$/Ha)	Aggregate FNPV (M'US$)
Burkina Faso	41,224	60.32	0.92
Niger	61,254	33.39	0.61

5.1.2 HOUSEHOLD INCOME AND DEBT REPAYMENT PROFILES

5.1.2.1 HOUSEHOLD INCOME PROFILE

The WCS allows farmers to profit from higher crop prices that prevail in the dry season as compared to the low prices during and after the harvesting period. Prices tend to be higher during the dry season as supply is low and demand is high. Financial analysis shows that farmers who engage in the WCS will obtain additional incomes due to the price differential that exists between selling their produce during and right after the harvesting period as opposed to waiting five to six months down the line when prices are much higher. Estimates indicate that farmers who engage in the WCS will augment their incomes by roughly US$ 15 and US$ 10 per hectare per annum, in Burkina Faso and Niger respectively, as shown in Figure 5. With the additional income from the price differential augmenting those from CF, the total HH incomes for cowpea farmers in Burkina Faso should equal to US$ 471 and US$ 410 in Niger.

FIGURE 4. ADDITIONAL HH INCOME FROM WARRANTAGE

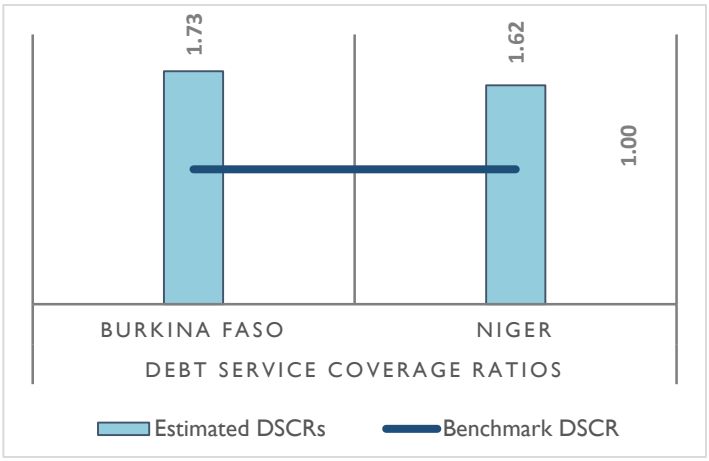


It should be noted that crop price differentials also exist in the millet and sorghum value chains. Farmers do not necessarily have to employ the WCS to profit from the price margins that result from the timing of crop sales. Farmers can simply store the portion of their cowpea, millet, and or sorghum once harvested and wait to sell it during the dry season when prices are at their peak. This, however, requires that farmers employ the use of PICS bags so as to limit post-harvest losses and optimize the gains from the price margins.

DEBT REPAYMENT PROFILE

Cowpea farmers who utilize the WCS to obtain financing for their operational needs such as inputs incur a financing cost. An assessment of the farmers' ability to pay back the loan principal received from MFIs, as well as the interest charged against the loan reveals that given the revenue accruing to farmers from selling their cowpeas at significantly higher prices, farmers have sufficient cash flows to cover their debt obligations (loan principal and interest). With a benchmark debt service coverage ratio (DSCR) of one, which shows that the net cash flow accruing to farmers is equal to their debt obligations, Figure 6 highlights that the DCSRs of cowpea farmers in both Burkina Faso and Niger surpasses this benchmark considerably. The DSCR of cowpea farmers in Burkina Faso is 0.73 times higher than the benchmark, while in Niger it is 0.62 higher than the benchmark. The DSCRs of 1.73 and 1.62 in Burkina Faso and Niger respectively, illustrate the strength of cowpea farmers' net cash flows in terms of meeting debt obligations as the analysis shows. The net cash flow of cowpea farmers in Burkina Faso is 0.73 times greater than their debt obligations, and in Niger, it is 0.62 times greater.

FIGURE 5. WCS DEBT SERVICE COVERAGE RATIOS



5.2 ECONOMIC ANALYSIS

The results of the economic analysis are presented from two perspectives: the first is the individual country perspective and the second perspective looks at the economic returns accruing to REGIS-ER.

5.2.1 ECONOMIC RETURNS – INDIVIDUAL COUNTRY PERSPECTIVE

TABLE 18. ECONOMIC GAINS FROM WCS

	Aggregate ENPV M' US$
Burkina Faso	1.18
Niger	0.86

The WCS is expected to have a positive impact in terms of growing the economies of both Burkina Faso and Niger. The incremental economic benefits accruing to the economies of Burkina Faso and Niger as a result of cowpea farmers adopting the WCS are shown in Table 18. Overall, the economy of Burkina Faso is anticipated to increase by around US$ 1.08 million and that of Niger by roughly US$ 0.86 million.

5.2.1 ECONOMIC RETURNS – REGIS-AG'S PERSPECTIVE

The economic returns from REGIS-AG are presented in Table 19. The present value of REGIS-AG's investment cost in both Burkina Faso and Niger for all its interventions, which are outlined in section 2.1.2 of this report, is equal to US$ 9.41 million. Weighed against the benefits that were estimated to accrue from these interventions, which are US$ 2.04 million, the overall returns to REGIS-AG were found to be negative. The ENPV was found to be US$ -7.38 million while the ERR is -11.29%.

TABLE 19. ECONOMIC RETURNS TO REGIS-AG FROM WCS

	Incremental Economic Returns REGIS-AG's Perspective (Million US$)					
	REGIS-AG (Burkina Faso)		REGIS-AG (Niger)		REGIS-AG (Burkina Faso & Niger)	
Total Incremental PV of Net Resource Flow	1.18		0.86		2.04	
PV of REGIS-AG Investment Costs	4.33		5.08		9.41	
	ENPV	ERR	ENPV	ERR	ENPV	ERR
REGIS-AG Returns in each Country	**-3.15**	**-8.89%**	**-4.22**	**-13.72%**	**-7.38**	**-11.29%**

Disaggregated by country, the returns to REGIS-AG were also found to be negative, both in Burkina Faso and Niger. Given a present value of investment costs of US$ 4.33 million and incremental benefits of US$ 1.18 million, REGIS-AG's ENPV is estimated to be US$ 3.15 million whereas the ERR is -8.89%. In Niger, the present value of REGIS-AG's investment costs is US$ 5.08 million, while the projected benefits are equal to US$ 0.86 million, which translates to an ENPV of -4.22 million and an ERR of -13.72 million.

The negative returns from REGIS-AG's perspective do not necessarily stem from the fact that its interventions did not make a positive impact on its beneficiaries. Two points that should be kept in mind when looking at these returns:

1. Out of REGIS-AG's three main interventions in the cowpea VC namely, access to finance (WCS), capacity building and literacy training, and intensified marketing, only the first of these interventions (WCS) translated into tangible benefits that could be monetized and included in the CBA. For reasons as to why the benefits accruing from the other two interventions were not analyzed, please refer to section 2.1.2 of this report.

2. The costs provided by REGIS-AG were total aggregate costs for all its interventions across the agriculture, poultry, and small ruminant VCs. The CBA team failed to obtain disaggregated costs from REGIS-AG, despite several attempts to acquire this information. To assess REGIS-AG's interventions in the cowpea VC, the team used estimates based on distributing the total aggregate cost over the total number of project beneficiaries to find the cost per beneficiary. The beneficiary costs and the number of beneficiaries in each VC were then used to estimate the total costs in each VC per annum. The estimated total annual costs in the cowpea VC could not be further broken down by the specific interventions carried out by REGIS-AG to allow for a more precise estimation of the costs versus the benefits accruing from each specific intervention. This is due to a lack of information on how REGIS-AG distributes its budget. Hence the cost estimates used to evaluate the returns to REGIS-AG from the WCS may not accurately depict the actual returns to be realized by the project.

5.4. SENSITIVITY ANALYSIS

Four of the projects' variables were found to have a moderate to significant impact on the economic returns of REGIS-AG: the expected yields, the market prices of crops, the adoption rate, and post-harvest losses. With respect to farmers' incomes, the expected yields, market prices of crops, and post-harvest losses have the greatest impact. The results of the sensitivity analysis are shown in Table 20.

TABLE 20. REGIS-AG AGRICULTURE SENSITIVITY ANALYSIS RESULTS

			Sensitivity of Output Variables to Changes in Project Key Variables			
			Incremental Aggregate Returns REGIS-AG % Change		Net Income % Change	
Project Key Variable	Base Case Project Key Variable Assumptions	Sensitivity Test Range	Aggregate ENPV (-7.38 M' US$)	Aggregate ERR (11.29%)	Burkina Faso Base Case Net Income per Ha (15 US$)	Niger Base Case Net Income per Ha (10 US$)
Deviation In Expected Yield	0.00%	(-30%) - (+30%)	(-8%) - (+14%)	(-30%) - (+39%)	(-50%) - (+50%)	(-50%) - (+50%)
Deviation in Market Price	0.00%	(-30%) - (+40%)	(-8%) - (+11%)	(-31%) - (+32%)	(-30%) - (+40%)	(-30%) - (+40%)
Adoption Rate	80.00%	(+50%) - (+100%)	(-10%) - (+7%)	(-40%) - (+21%)	N/A	N/A
Post-Harvest Losses	10%	(-10%) - (+35%)	(-8%) - (+14%)	(-30%) - (+39%)	(-50%) - (+50%)	(-50%) - (+50%)

EXPECTED YIELDS: A deviation in the yields of cowpea will cause the results obtained in the base case to vary. A 30% decline in the yield of cowpea will result in the ENPV of REGIS-AG to decrease by 8% and farmers' net incomes in Burkina Faso and Niger decreasing by 50%.

MARKET PRICES: A 30% decline in the price of cowpea will result in REGIS-AG's ENPV decreasing by 8%, and farmers' net incomes in both Burkina Faso and Niger decreasing by 30%.

ADOPTION RATE: The number of farmers adopting WCS has a small effect on the returns to REGIS-AG. If 50% of farmers who benefited from WCS were to abandon it, REGIS-AG's ENPV would decrease by 10%, and its ERR would decrease by 40%. This is due to the high cost per beneficiary.

POST-HARVEST LOSSES: One of the requirements of the WCS is that farmers store their cowpeas in PICS bags. If farmers do not use PICS bags, their post-harvest losses are likely to be very high. If losses are 35% as a result of farmers not using PICS bags, farmers' incomes in both Burkina Faso and Niger are expected to decline by 50%. Post-harvest-losses only have a slight impact on REGIS-AG's returns. At a post-harvest loss rate of 35%, REGIS-AG's ENPV would decrease by 8% and it ERR would decline by 30%.

6. COMPARATIVE CBA OF GOAT VS SHEEP REARING

6.1 FINANCIAL ANALYSIS

The results of the financial analysis of goat versus sheep rearing are presented in Table 21 for both Burkina Faso and Niger from the perspective of beneficiaries. Both sheep and goat rearing result in positive financial returns in both countries. This is illustrated by the positive FNPVs as well as FIRRs that are significantly higher than the 12% discount rate used in the analysis.

TABLE 21. FINANCIAL ANALYSIS RESULTS OF GOATS VS. SHEEP REARING

Value Chain Burkina Faso	FNPV per Beneficiary (US$)	FIRR per Beneficiary (%)
Goats Rearing	725	41.4%
Sheep Rearing	656	29.5%
Value Chain Niger	**FNPV per Beneficiary**	**FIRR per Beneficiary**
Goats Rearing	619	36.5%
Sheep Rearing	617	27.9%

In Burkina Faso, the results show that a farmer is better off rearing goats than sheep, as the FNPV per goat beneficiary is US$ 725 as opposed to US$ 656 for sheep rearing. Hence a goat rearing farmer earns around US$ 69 more than a sheep farmer. The FIRR attained from goat rearing is 11.9% higher than that for sheep rearing clearly showing that there is a greater return on investment for farmers rearing goats compared to sheep rearing in Burkina Faso.

The same narrative holds in Niger as a farmer is better off rearing goats than sheep. As the results show, by rearing goats a farmer can attain an FNPV of US$ 619 which is US$ 2 higher than that attained from sheep rearing (US$ 617). However, the difference between sheep and goat rearing in Niger is marginal.

The CBA assumes that a farmer makes an investment of US$ 199.50 in the goat VC with the price for goats is the same in both countries. This amount is sufficient to purchase four does and one buck. The alternative is to purchase four ewes and one ram at a cost of US$ 547.3 in Burkina Faso. In Niger the farmer will need to invest US$ 556 in sheep rearing due to the higher price of the animals. The analysis also took into consideration the price differential between the goats and sheeps as well as difference in feeding and other costs, reproduction performance, mortality rates, etc. USAID will be able to reach almost three times more beneficiaries in the goat VC compared to the sheep VC with a given budget, due to the lower investment cost per beneficiary required.

The results indicate that in Niger the annualized income per farmer attainable from sheep rearing is US$ 256 while the annualized income from goat rearing is US$193. Likewise, in Burkina Faso, the annualized income from sheep rearing is US$ 258 and US$ 213 in the case of goat rearing. As the figures show, in both Burkina Faso and Niger, sheep rearing generates 18% and 25% more income than goat rearing, respectively. This is mainly because sheep in both countries sell at a price that is around 40% more than the price of goats. These higher incomes, however, are because the annualized income does not capture the difference in the investment cost.

6.2 SENSITIVITY ANALYSIS

Sensitivity analysis of goat rearing versus sheep rearing was conducted and the results are presented in Table 22 and Table 23 for Burkina Faso and Niger, respectively.

TABLE 22. SENSITIVITY ANALYSIS OF GOAT VS. SHEEP REARING IN BURKINA FASO

		Goat		Sheep	
		Farmer's Annual income	ENPV Per Household	Farmer's Annual income	ENPV Per Household
Sensitivity Factor	**Base Case Scenario**	US$ 213	US$ 521	US$ 258	US$ 452
Average Litter Size	-10%	US$ 178	US$ 344	US$ 227	US$ 293
	0%	Base case value: 1.45		Base case value: 1.40	
	+10%	US$ 245	US$ 687	US$ 284	US$ 590
Average Mortality Rate	-10%	US$ 222	US$ 573	US$ 268	US$ 508
	0%	Base case value: 9.5%		Base case value: 11.4%	
	+10%	US$ 203	US$ 470	US$ 247	US$ 394

This analysis shows that while Burkinabe farmers in sheep VCs are better off compared to goat VCs, they are both susceptible to changes in average litter size of the animals. A 10 percent decrease in the average litter size of goat and sheep from the base case values (1.45 and 1.40), can decrease the farmers' income to US$ 178 (a 16.4% decrease) and US$ 227 (a 12.0% decrease) respectively. The average mortality rates are also a critical risk-factor in livestock value chains. A 10 percent increase in the average annual mortality rates (goat's and sheep's value chains), from the base case values (9.5% and 11.4%), will cause the farmers' income to drop to US$ 203 (a 4.7% decrease) and US$ 247 (a 4.3% decrease) accordingly. The above results show the importance of closely monitoring the average current litter size and mortality rates of the livestock.

TABLE 23. SENSITIVITY ANALYSIS OF GOAT VS. SHEEP REARING IN NIGER

		Goat		Sheep	
		Farmer's Annual income	ENPV Per Household	Farmer's Annual income	ENPV Per Household
Sensitivity Factor	**Base Case Scenario**	US$ 193	US$ 448	US$ 256	US$ 404
Average Litter Size	-10%	US$ 164	US$ 304	US$ 225	US$ 240
	0%	Base case value: 1.30		Base case value: 1.40	
	+10%	US$ 220	US$ 586	US$ 283	US$ 545
Average Mortality Rate	-10%	US$ 202	US$ 497	US$ 267	US$ 461
	0%	Base case value: 9.5%		Base case value: 11.4%	
	+10%	US$ 183	US$ 399	US$ 245	US$ 344

This analysis shows that while Nigerien farmers in the sheep VC are better off by US$ 63 compared to the goat VC, they are both sensitive to changes in the average litter size of the animals. A 10 percent decrease in the average litter size of goat and sheep, from the base case values (1.30 and 1.40), can decrease the farmers' income to US$ 164 (a 15.0% decrease) and US$ 225 (a 12.1% decrease) respectively. Average mortality rates are also a key risk-factor. A 10 percent increase in the average annual mortality rates (goat's and sheep's VCs), from the base case values (9.5% and 11.4%), will cause a decrease in the farmers' income to US$ 183 (a 5.2% decrease) and US$ 245 (a 4.3% decrease) respectively.

7. CBA SHEEP FATTENING

7.1 FINANCIAL ANALYSIS & ECONOMIC ANALYSIS

The CBA evaluates whether the intensive inputs required for fattening sheep translate to improved profit margins for farmers. The analysis was only conducted for Burkina Faso, but the results can be extrapolated to gauge the impact of the use of intensive inputs in fattening sheep in Niger as well. The field visits revealed that sheep have a great significance in the religious and cultural customs of the region. Sheep fattening is therefore undertaken with the aim of meeting the demand that arises from religious ceremonies.

TABLE 24. SHEEP FATTENING COSTS AND REVENUES (US$ 2018 PRICES/HEAD)

Costs	
Cost of 6-month Lamb	53
Feeding Costs and Other Costs	60.3
Total Cost (1)	113.3
Revenues	
Price of Ramp	132.4
Mortality Rates	2.5%
Revenue (2)	129.1
Profit (2-1)	15.8
Number of Cycles per Annum	2
Number of Animals Fattened per Cycle	1
Annual Profit	31.6

Farmers typically purchase a six-month-old ram and fatten it for a period of six months. On average two fattening cycles are conducted per annum. The results of CBA in Burkina Faso indicate that sheep fattening generates an FNPV of US$ 226.50 and an ENPV of US$ 124. The annual profit accruing to farmers based on the simple calculations shown in Table 24 is equal to US$ 31.60. This calculation, however, excludes extra income generating activities such as selling manure. The results of the model show that when the revenue from the sales of manure is included in the analysis, farmers' profits are US$ 36. The profit margin reported here takes into account an adjustment of a 2.5% probability of the livestock dying. The prevailing average mortality rate for sheep across all age categories is 11%. The fattening activity assessment, however, assumes a 2.5% mortality rate. Mortalities among fattened animals are generally very low. This is due to better husbandry practices on chosen animals for this specific purpose. Animals are carefully selected and well fed comparatively, while health care provided is also better. Profitability of this activity and price premium of such fattened animals are the main driver for this improved care.

Table 25. Sensitivity Analysis of Sheep Fattening

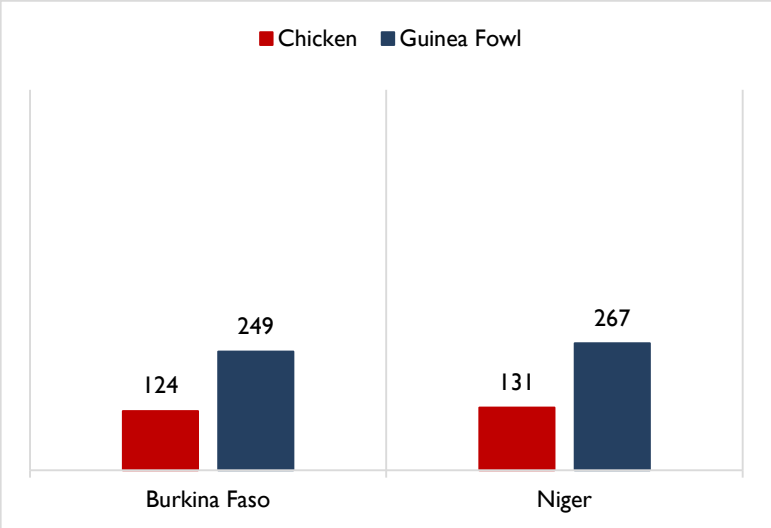
		Sheep Fattening	
		Farmer's Annual income	ENPV Per Household
Sensitivity Factor	Base Case Scenario	US$ 35.9	US$ 124
Mortality Rate	-10%	US$ 36.5	US$ 127
	0%	Base case value: 5.0%	
	+10%	**US$ 35.3**	**US$ 121**

8. COMPARATIVE CBA OF CHICKEN VS GUINEA FOWL REARING

The parameters used for the guinea fowl CBA were obtained from farmers dwelling in proximity to Habbanayé chicken beneficiaries. This means that both the farmers and their birds were exposed to the similar environmental and economic conditions, making the analysis as unbiased as possible. The estimated results presented show the benefits that will accrue to the farmers, the country, and USAID from chicken activities versus what would accrue to the farmers for guinea fowl rearing instead.

8.1 FINANCIAL ANALYSIS

FIGURE 6. ANNUALIZED INCOME OF CHICKEN VS. GUINEA FOWL REARING



When comparing chicken versus guinea fowl rearing, the CBA assumes that US$ 70 is used to purchase parent stock of chicken of 10 layers and one cockerel. The alternative is to buy eight guinea hens, and four cockerels for guinea fowl that total US$ 151.

From this parent stock, the comparative CBA revealed that guinea fowl rearing is more profitable than chicken rearing in both Burkina Faso and Niger. The annualized income from guinea fowl rearing in both countries is almost twice that from chicken rearing.

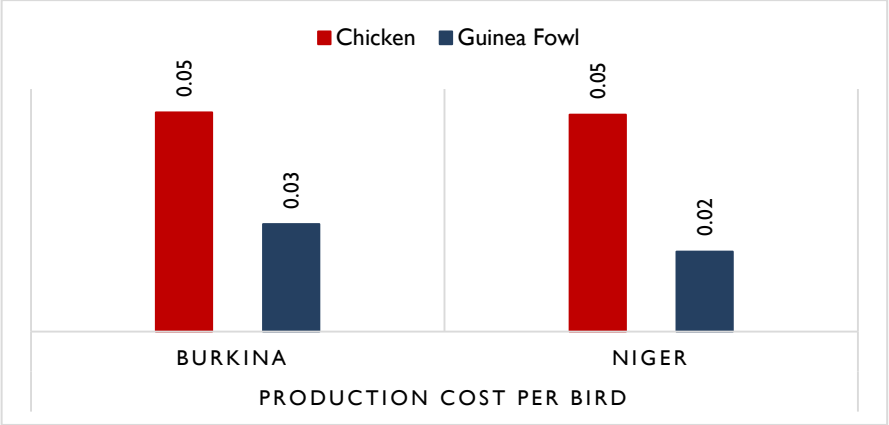
The income from guinea fowl rearing in Burkina Faso is US$ 249, and it peaks at US$ 272 four years after the project has started. The expected annualized income from guinea fowl rearing in Niger is US$ 267 and peaks to US$ 290 in the project's fourth year.

When comparing guinea fowls to chicken, a number of factors were considered. The advantages of guinea fowl include:

a) **Egg production**: guinea hens lay eggs from June to September, compared to chicken hens that only produce eggs three times a year (once during the rainy season and twice during the dry season). Guinea hens, therefore, lay more eggs than chicken hens. However, the average observed hatching rate for chicken eggs was 83% compared to only 25% for guinea fowl eggs. The low guinea fowl hatching rate is because guinea hens do not sit on their eggs long enough and chicken hens must be used for the remainder of the 27 days. However, farmers do not have enough chickens to sit on guinea eggs.
b) **Selling prices**: guinea fowls sell for almost double compared to chicken. Guinea fowl eggs are also more expensive than chicken eggs, at US$ 0.18 vs. US$ 0.09. Egg off-take is high for guinea fowls as field studies showed that the main objective for farmers was to sell fertilized eggs to potential guinea fowl rearers.

c) **Low feeding and labour costs**: Guinea fowls are natural scavengers, and therefore, at maturity, they are able to meet their own dietary needs. In this regard, farmers mostly feed the keets but provide only water for the whole flock. As a result, less time and money is spent during guinea fowl rearing. Figure 7 summarizes the weekly production of costs guinea fowl versus chicken rearing.

FIGURE 7. WEEKLY PRODUCTION COSTS OF CHICKEN VS. GUINEA FOWL REARING



d) **Resistance to diseases**: At the adult stage, guinea fowls are resistant to common poultry diseases compared to chickens. Hence the adult mortality rate is lower in guinea fowls than chicken.

However, guinea fowl rearing is not without its disadvantages:

a) Guinea fowl eggs are sold more than chicken eggs. Farmers tend to sell a higher proportion of guinea fowl eggs laid, leaving only a few for hatching. This means that the chicken flock will grow faster than a guinea fowl flock. In Niger and Burkina Faso, the guinea fowl egg off-take is 55% and 68% respectively, compared to only 2% chicken for eggs in both countries. The price of guinea fowl eggs is a higher than chicken eggs, and this provides motivation for farmers to sell.
b) The other challenge is high keet mortality and morbidity up to 8 weeks, which was estimated to be 1.82 times higher than chick mortality. The susceptibility of the keets to unpleasant weather conditions, diseases, and poor mothering by the guinea fowls leads to high keet mortality. Many farmers use chickens to hatch guinea fowl eggs, as the female guinea fowl often leaves its nesting place only after a few keets hatch.
c) Another critical factor is the high price of the guinea fowl parent stock. During field visits, the team discovered that on the local market, a male/female pair of guinea fowls costs US$ 12.57 and while a pair of chickens cost US$ 6.73. The high price prevents farmers to enter the VC. In addition, an optimal ratio for chicken is 1 cockerel to 10 or even more hens. For guinea fowl, this ratio is 1 to 1 at its optimal level. The analysis here is based on the ratio of 1 guinea fowl cockerel to 2 hens.

Another factor to consider is while Habbanayé chicken targeted women from poor households, guinea fowls would require a different approach. It was observed that guinea fowl rearing was mostly done by men. Women cited several reasons including not being able to distinguish their eggs and birds from others as the main reason why they preferred to stay away from guinea fowl rearing.

8.2 SENSITIVITY ANALYSIS

Guinea Fowls

Egg production and hatchability. The sensitivity analysis revealed that increasing the egg production by 10% could increase the annualized income to US$ 271 in Burkina Faso and US$ 286 in Niger. This is on average a 14% increase from the base case annualized income in both countries. However, the increase in egg production will not happen overnight. The birds need proper nutrition and a balanced diet which needs to be maintained a sufficient amount of time for sustainable egg production. During field visits, it was observed that the hatching rate of guinea eggs was over three times lower than that of chicken eggs (25% vs 83%). If the guinea fowl hatching rate can be increased by only 10%, farmers' expected annualized incomes in Burkina Faso and Niger will be US$ 258 and US$ 276, respectively. If the hatching rate of guinea eggs is raised to the same level as chickens (83%), then the annualized incomes will be US$ 678 in Niger (154%) and US$ 591 in Burkina Faso (137%). To maximize the fertility and hatchability of guinea fowl eggs, the male/female sex ratio will need to be maintained at an optimal level of 1:1, which may not be feasible in a rural setting. Also, because of the guinea hens' inability to sit on their eggs for the whole duration of the incubation period, farmers will have to use chickens to hatch guinea fowl eggs. Additionally, there are other biological reasons that will keep fertile egg production rates lower in guinea fowls than in chickens.

TABLE 26. SENSITIVITY ANALYSIS OF RISKY VARIABLES ON FARMERS' ANNUALIZED GUINEA FOWL INCOME

		Annualized Income	Annualized Income
	Sensitivity Factor	Burkina Faso	Niger
Base Case Scenario		**249**	**267**
Eggs laid per clutch	-10%	215	227
	+10%	271	286
Hatching rate	-10%	227	237
	+10%	258	276
Average egg loss	-10%	249	276
	+10%	227	235
Egg off-take	-20%	318	344
	+20%	176	169
Keet mortality rate	-10%	259	269
	+10%	227	244

Another variable that has an impact on the results is egg off-take. In both countries, guinea fowl egg sales are significantly higher with a market value two times that of chicken eggs. Selling a sizeable proportion of guinea fowl eggs means farmers compromise flock growth. By leaving more eggs to hatch, the annualized income from guinea fowl may decidedly change. Currently, the guinea fowl egg off-take is 68% in Burkina Faso and 55% in Niger. If this is reduced to 50% in Burkina Faso and 45% in Niger, the expected annualized farmers' incomes will increase by approximately 29% in both countries.

Guinea Fowls versus Chickens

1. **Optimal parent stock size**. The results of this sensitivity analysis, summarized in Table 28, show that the parent stock that farmers use to commence their rearing activities has no significant impact on the financial returns that will accrue to the farmers. In Burkina Faso, the analysis shows that for chicken rearing, increasing the parent stock size will only increase costs and will not significantly impact farmers' annualized incomes. Increasing the parent stock to 23 chickens will increase the cost from US$ 70 to US$147. However, farmer's annualized income will only increase from US$ 124 to US$ 137. Such returns do not justify the increased investment. For Niger, increasing the parent stock to 23 increases the cost of parent stock by 110% and will increase farmer's annualized income by 12%. For guinea fowl, the results are similar. With a base case cost of US$ 151, increasing the number of parent stock to 23 increases the cost per beneficiary by 92% in both Burkina Faso and Niger but the expected annualized income from guinea fowl rearing in both countries would only increase by an average of 6.5%.

TABLE 27: SENSITIVITY ANALYSIS OF OPTIMAL PARENT STOCK SIZE

	Burkina Faso				Niger			
	Chicken		Guinea fowl		Chicken		Guinea fowl	
	Annualized income (US$)	Cost (US$)	Annualized income (US$)	Cost (US$)	Annualized income (US$)	Cost (US$)	Annualized income (US$)	Cost (US$)
Base Case	**124**	**70**	**249**	**151**	**131**	**70**	**267**	**151**
13	128	83	253	163	135	83	270	163
14	128	90	254	176	135	90	271	176
15	131	96	255	189	138	96	273	189
16	131	102	257	201	139	102	274	201
17	132	109	257	214	140	109	274	214
18	133	115	260	226	141	115	277	226
19	135	121	261	239	142	121	279	239
20	136	127	261	251	144	127	279	251
21	136	134	263	264	145	134	281	264
22	137	140	266	276	146	140	283	276
23	137	147	266	289	147	147	283	289

2. **Optimal number of hens in the flock.** The field visits revealed that farmers preferred to keep small flock sizes mainly because large flocks equate to higher feeding and veterinary costs and more time out of their day dedicated to tending to the birds. However, by keeping a maximum of 13 chicken hens or 15 guinea hens, farmers are not operating at a maximum scale. As summarized in Table 28, if farmers first grow their flock and operate at a larger scale, they will potentially realize higher profits. The sensitivity analysis revealed that at any incremental scale, guinea fowl rearing will still be more profitable than chicken rearing. The issue of space will limit how many birds a farmer keeps. The project can support farmers with chicken feed, train farmers to make their own feed, or link them to low-cost feed producers. Guinea fowls' scavenging nature makes them more cost effective than chickens in terms of feeding.

TABLE 28: SENSITIVITY ANALYSIS OF OPTIMAL NUMBER OF HENS IN FLOCK

	Burkina Faso		Niger	
	Chicken	Guinea fowl	Chicken	Guinea fowl
	Annualized income	Annualized income	Annualized income	Annualized income
Base Case	**124**	**249**	**131**	**267**
16	181	256	184	273
17	199	270	201	286
18	217	298	228	314
19	216	304	238	327
20	220	317	257	332
21	224	346	271	359
22	227	352	277	372
23	230	364	280	399

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 AGRICULTURE CONCLUSIONS AND RECOMMENDATIONS

Integrating PICS bags outside of cowpea VC should be explored. Though spoilage occurs with all three crops, farmers only make use of PICS bags for cowpeas. Only in rare instances did the CBA team find that farmers used PICS bags to store millet and sorghum. The analysis shows that the benefits of PICS bags far outweigh their cost. Given that PICS bags reduce post-harvest losses the Benefit-Cost Ratios (BCRs) show that farmers in all three VCs would benefit from the adoption of PICS bags. In Burkina Faso, the BCRs are estimated at 7.35, 6.70 and 4.48, and in Niger, they are equivalent to 7.26, 13.68 and 5.11, for the cowpea, millet, and sorghum VCs respectively. The analysis revealed that the cost of PICS bags is not the only constraint to their use. Other factors explaining the limited use of PICS bags in the millet and sorghum VCs are:

a) A lack of knowledge of the benefits of using PICS bags;
b) If farmers have a cash constraint allowing them to buy few PICS bags, the bags are normally used for only cowpeas since the BCR is higher both for Burkina Faso and Niger; and
c) In a situation where access to PICS bags is limited or access to storage facilities is a constraint. For example, one of the female farmers interviewed stated that this year she could not benefit from Warrantage since the storage facility did not have adequate space to accommodate harvests from all farmers and priority was given to disadvantaged households.

The projects should explore why millet and sorghum farmers are not using PICS bags and what measures can be taken for them to adopt these practices.

Improve access to inputs. Some targeted areas are remote and lack access to input markets, which makes it difficult and expensive for farmers to purchase recommended inputs such as fertilizers. As a result, some farmers cannot fully apply the recommended set of inputs, which negatively impacts the benefits of CF with regards to increased crop productivity. Though REGIS-ER has promoted Community-Based Solution Providers (CBSPs) to fill this gap, work should continue and be scaled up if possible.

Diversify household livelihoods. Burkina Faso and Niger have only one cropping season over the course of the year. In order to lift agricultural HHs out of extreme poverty and increase their resilience, HHs need to diversify their livelihoods. Farming HHs should be trained and encouraged to engage in alternative income generating activities during the agricultural off-season. Though REGIS-AG has conducted training in the processing of cowpeas into various products such as snacks, flour, couscous, and baby foods, future projects should explore scaling up capacity building in processing. Adding value to the raw cowpeas would increase farmers' incomes and provide a source of income other than that from crop cultivation.

Consider future regional economic trade. Both Burkina Faso and Niger export significant amounts of their cowpeas in the West African region. However, the primary destination for Burkinabe and Nigerien cowpea is Nigeria. Nigeria, which is the largest consumer of cowpeas in Africa, has in the past had to import cowpeas to supplement its huge demand. However, the country's production is growing and is nearing self-sufficiency. Burkina Faso and Niger's cowpea export markets may need to be diversified to

include other regional and international destinations. Though countries like Ghana, Benin, Togo, and Mali can absorb the output from Burkina Faso and Niger, their demand for the crop is not as strong as Nigeria's. It should be noted that there is a need to conduct a study on the comparative advantage of Burkinabe and Nigerian cowpeas versus other producers in the regional export market before any measures are taken to promote the crop.

9.2 POULTRY CONCLUSIONS AND RECOMMENDATIONS

The study revealed that chicken rearing supported by the REGIS-ER Habbanayé intervention earned USAID a 38.48% return on its investment. The ENPV in Niger is US$ 5.34 million and US$ 4.76 million in Burkina Faso.

The comparative CBA showed that with an investment of US$ 70 for chicken, which is enough to purchase parent stock of chicken of 10 layers and one cockerel and US$ 151 for 8 guinea hens and four cockerels, guinea fowl rearing is more profitable in both Burkina Faso and Niger with annualized incomes of US$ 249 and US$ 267, respectively.

The sensitivity analysis revealed increasing the parent stock for both chickens and guinea fowls under prevailing conditions had no significant impact on the financial returns that would accrue to the farmers. The key factors contributing to low returns from chicken rearing include low egg production, egg losses, cost and availability of feed, general mismanagement, and low selling prices. The analysis revealed that at any incremental scale, guinea fowl rearing is more profitable than chicken rearing. However, guinea fowl rearing also requires higher investment costs. In addition, while Habbanayé chicken targeted women from poor households, Habbanayé guinea fowls would target men as it was observed that guinea fowl rearing was mostly done by men. The following recommendations are made:

1. Formalization of Habbanayé groups
    a. The development of poultry rearing faces many challenges, including:
        i. Reducing animal mortality by building the beneficiaries' technical capacity as well as increasing the adoption rate for good animal husbandry practices; and
        ii. Access to finance to provide adapted shelter and ensure food and health.
    b. Resolving these challenges will require the organization and cooperation of different actors. Supporting the women's groups involved in Habbanayé to organize into cooperatives should be considered. This initiative could benefit from the current momentum of the Government of Burkina Faso and its development partners in establishing cooperatives in accordance with the Organization for the Harmonization of Business Law in Africa (OHADA) uniform act.
2. To address high mortality rates in poultry:
    a. In addition to the village poultry volunteers (VVV) and private veterinarians, the projects should promote the use of state livestock services to improve the monitoring of pastoralists practices, including the improvement of habitat and caring for young animals (chicks).
3. To address the low egg production:
    a. Educate farmers on the benefits of proper and nutritious low-cost feeding to avoid diet imbalances and boost egg production; and
    b. Link farmers to low-cost feed producers.
4. To address egg losses:
    a. Encourage farmers to set up laying nests for their chicken and provide training on how to build low-cost nests.

5. At the institutional level, increase collaboration with state technical services
    a. Since state technical services are long-term structures, establishing relationships with them is essential to ensure sustainability and the projects should work to develop a collaborative framework.

9.3 SMALL RUMINANTS CONCLUSIONS AND RECOMMENDATIONS

HABBANAYÉ INTERVENTION

The results indicate that the benefits of the Habbanayé intervention outweigh the costs from USAID's perspective. One of the frequent complaints about the Habbanayé intervention is that farmers do not transfer the first offspring to other vulnerable households. While it may be both challenging and costly to monitor the transfer, this should not prevent USAID from investing in Habbanayé, as the economic returns presented in this study are estimated assuming no transfers are carried out. Therefore, the Habbanayé intervention when coupled with the animal husbandry training is an efficient way to assist the most vulnerable households.

Expanding Habbanayé goat will require:

- Improving farmers' capacity to produce affordable feed. To produce enough feed during the rainy season, farmers need to cut and keep hay to feed animals throughout the dry season (hay should be cut before blooming which results in the better preservation of crop residues).
- Support farmers to improve animal prophylaxis (proper shelter, balanced feeding, adhering to the vaccination calendar, early detection of disease, and preventing animal divagation).
- Improvement in goat breeding and reducing the risk of consanguinity.

It is also recommended not to include sheep in Habbanayé. The analysis revealed that:

- A smaller number of beneficiaries can benefit as the required investment cost is three times higher in the sheep VC as compared to the goats VC. In other words, the economic returns from USAID's perspective will be higher if the same amount of funds is invested in the goats VC.
- The high price of sheep creates an incentive for vulnerable households to immediately sell the animals to meet cash needs. As a result, there may be a higher dropout rate of beneficiaries as compared to the goats Habbanayé.

GOATS VERSUS SHEEP REARING

The analysis revealed that while both goat and sheep rearing is financially and economically feasible, goat rearing results in higher financial returns due the lower investment cost requirements. Sheep rearing, in turn, generates higher annual income when compared to goats. Also, farmers that are engaged in sheep rearing have the opportunity to profit from sheep fattening which generates additional income. It is recommended to advise farmers to invest their annual proceeds from the sale of crops into goat farming. Once farmers reach a financial position where they can afford the purchase of the first sheep herd, they should diversify into sheep rearing as well.

The only difference between goats/sheep rearing and Habbanayé from the farmers' perspective is the source of funding for the initial herd purchase. Therefore, most of the observations and conclusions of the Habbanayé analysis are also directly applicable to the goats and sheep rearing.

SHEEP FATTENING

Sheep fattening allows farmers to obtain a profit margin of about US$ 25/year assuming they fatten one animal twice a year. However, the sheep fattening intervention may not be appropriate for the most vulnerable beneficiaries since vulnerable households have competing cash needs and may find it financially challenging to feed sheep over a six-month period.

Field visits revealed that farmers that engage in the sheep fattening are not necessarily the same farmers that rear small ruminants. Sheep fattening is done by women as the investment of cowpea proceeds after the harvest or by those able to identify the commercial opportunity (high demand for lamb during festivals) and with the technical knowledge required to fatten sheep. Supporting sheep fattening will help farmers diversify their diversification, mitigate inflation, and create assets. The marginal cost of adding sheep fattening to other training conducted by REGIS-ER and REGIS-AG is likely minimal and should be explored.

ANNEXES

A. BENEFITS OF CONSERVATION FARMING

A.1. BACKGROUND

Climatic changes (soaring temperatures, increasingly variable rainfall patterns, and the increased occurrence of droughts and floods) experienced in the Sahel region over the last couple of decades have had a pronounced effect on the productivity of crops and the food security of the region's population. Both Burkina Faso and Niger have experienced variations in their climatic conditions. According to a document produced in collaboration between the NAIP, ICAR, and TNAU, climatic conditions are one of the factors that have the greatest impact on crop productivity.[13] This document states that approximately 50% of the resulting crop yield is attributable to the influence of the climatic factors such as water, temperature, humidity, solar radiation, wind velocity and atmospheric gases, under which the crop is grown.[14]

Given that 98% of the agricultural activity in the Sahel region is rain-fed and since rainfall and temperature patterns have changed in the recent past, these two factors were identified as being the major influence in the variability of crop yields.[15]

A.1.1 DISPARITY IN CROP PRODUCTIVITY

Data collected for the CBA in Burkina Faso and Niger shows a significant difference in the productivity of cowpea, millet, and sorghum between these two countries. The data show that crop yields in Niger are markedly lower than those in Burkina Faso for both the "without" and the "with" project scenarios, as illustrated in Table 30. Over a 3-year period without the project, the yields of cowpea, millet, and sorghum are 26%, 27%, and 38% lower, respectively, in Niger as compared to Burkina Faso. Control data sourced from FAO show the same trend over a 10-year period. The percentage differences are significantly higher, which is due to the difference in yield statistics as well as the analysis period.[16] With the project, the same trend of lower yields in Niger persists. However, the difference in yields between the two countries crop VCs narrows considerably for the cowpea and millet VCs, while the sorghum VC results in only a narrow change in productivity.

[13] NAIP stands for the National Agricultural Innovation Project, ICAR stands for the Indian Council of Agricultural Research and TNAU stands for the Tamil Nadu Agricultural University.
[14] http://eagri.org/eagri50/AGRO101/lec09.pdf
[15] https://reliefweb.int/sites/reliefweb.int/files/resources/Sahel%20Info%20Sheet%20Jan%202016.pdf

[16]

TABLE 29. YIELD COMPARISON

	Average Crop Yields (KG/Ha)								
	Cowpea			Millet			Sorghum		
Country	Burkina Faso	Niger	% Difference	Burkina Faso	Niger	% Difference	Burkina Faso	Niger	% Difference
FAO (2006 - 2015)	478.57	279.53	-70.49%	822.83	472.13	-74.28%	1016.01	384.18	-164.46%
Without Project (2015 - 2017)	527.81	419.07	- 25.95%	666.42	523.88	- 27.21%	731.88	532.03	- 37.56%
With Project (2015 - 2017)	922.71	842.00	- 9.59%	1,094.92	992.73	- 10.29%	1,227.40	907.09	- 35.31%

DISPARITY IN CLIMATIC CONDITIONS

Every crop has its unique requirements regarding temperature and water. The optimal temperature and water level that a crop requires for development and growth vary throughout the cropping cycle (from seed germination to grain filling).

TEMPERATURE

Cowpeas require temperatures between 20 – 30 Degrees Celsius to maximize productivity.[17] Sorghum and millet have a higher tolerance for hotter temperatures. The optimal growth temperatures for sorghum are between 20 – 36 Degrees Celsius. Temperatures above 36 Degrees Celsius result in a decrease of grain filling and thus lead to lower yields. Millet is significantly more tolerant to extreme temperatures than most cereal crops. Millet's optimal growth temperature is in the range of 20 – 40 Degrees Celsius.[18] The species of millet grown in Burkina Faso and Niger and the rest of the Sahel region is the pearl millet variant. Pearl millet can fill grains and produce an acceptable yield even at temperatures greater than 42 Degrees Celsius, making it highly adaptable to extreme temperatures.[19]

Table 31 shows how the historical average temperatures in Burkina Faso, Niger, and the Sahel region compare against the optimum requirements for the three crop VCs.

[17] Department of Agriculture, Forestry and Fisheries, RSA. (2011), Production Guidelines for Cowpeas

[18] Pascal, P.V.Vara & Staggenborg, Scott. (2010) Growth and Production of Sorghum and Millets

[19] ICRISAT, "Clue to Pearl Millet Heat Tolerance May Help Fight Climate Chaos", www.icrisat.org/clue-to-pearl- millets-heat-tolerance-may-help-fight-climate-chaos/

The temperatures in Burkina Faso more or less fall within the required range for the cowpea VC. In Niger, temperatures are slightly higher and tend on average to be higher than the acceptable range for the optimal growth and development of cowpeas. Both countries, however, tend to have temperatures that are higher than the required range for cowpeas during certain periods of the cropping cycle, as indicated by the maximum average temperature recorded during the cropping season over a 10-year period. The temperatures in Burkina Faso and Niger meet the requirements for the optimal growth of both sorghum and millet as the maximum average temperatures recorded over a 10-year period do not exceed the upper limit of each crops' optimal temperature range.

TABLE 30. COMPARISON OF TEMPERATURES

	Temperature Range During the Sowing and Growing Period of the Cropping Season in the Sahel Region (Average Temp 2006 - 2015)		
	Average	**Average Minimum**	**Average Maximum**
Burkina Faso	29.19	26.17	33.51
Niger	31.90	29.68	34.79
Sahel Region	30.43	24.99	35.16

RAINFALL

For optimal growth and yield, cowpeas require between 400 – 700 mm of rainfall during the cropping season.[20] Similar to cowpeas, sorghum requires water during its development and growth cycle, 400 – 600 mm. In contrast to cowpeas and sorghum, pearl millet is more drought resistant and can be grown in areas with rainfall ranging between 125 – 600 mm, making it more suitable for areas with low seasonal and annual rainfall.

Figure 8 shows how rainfall patterns over a 10-year period compare with the amount of rainfall required for the optimal development and growth of cowpeas. Cowpeas in Burkina Faso are receiving more than the minimum required rainfall. In Niger, the situation is reversed with cowpea receiving insufficient rainfall. On average over the 10-year period, the rainfall received in Burkina Faso was 20% lower than the optimal requirement. In Niger, it was 43% below the minimum amount required, a clear indication that cowpeas in Niger are water deprived.

[20] Department of Agriculture, Forestry and Fisheries, RSA. (2011), Production Guidelines for Cowpeas

FIGURE 8. COMPARISON OF THE RAINFALL REQUIREMENT OF COWPEA VS. RAINFALL RECEIVED

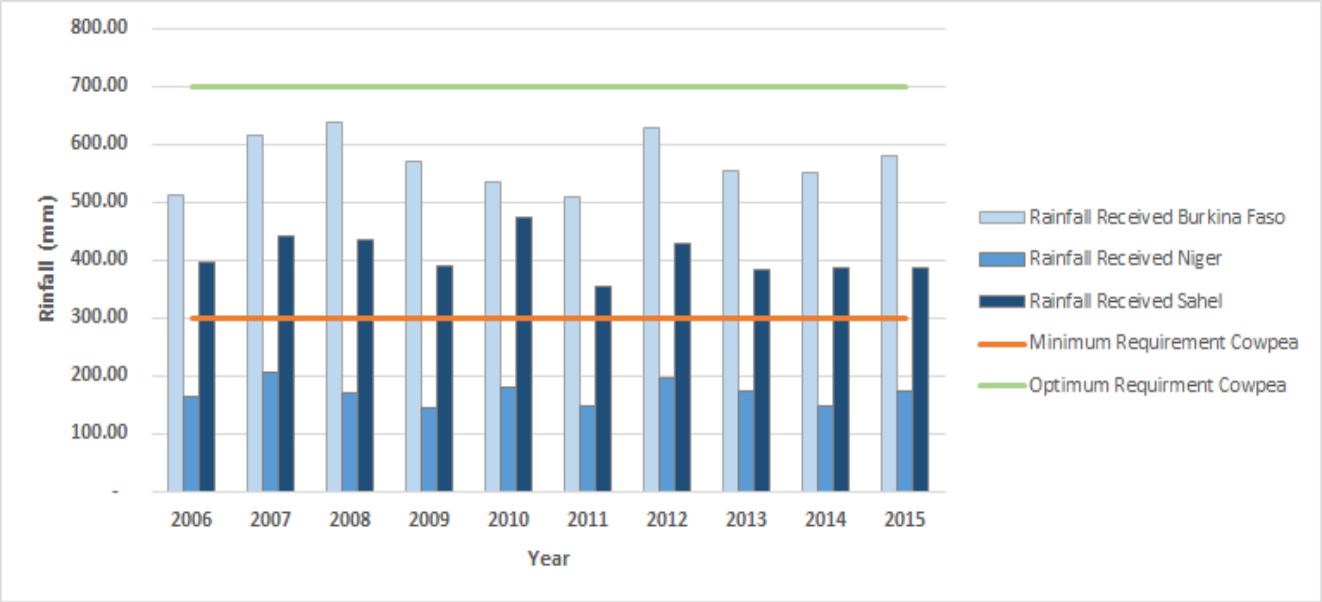


Figure 9 shows how rainfall patterns over a 10-year period compare with the amount of rainfall required for the optimal development and growth of sorghum. Sorghum in Burkina Faso receives more than the minimum required rainfall. However, in Niger the situation is reversed, with sorghum receiving insufficient rainfall. On average over the 10-year period, the rainfall in Burkina Faso was only 5% lower than the optimal requirement. In Niger, it was 57% below the minimum amount required, which is a clear indication that sorghum in Niger is water deprived.

FIGURE 9. COMPARISON OF THE RAINFALL REQUIREMENTS OF SORGHUM VS. RAINFALL RECEIVED

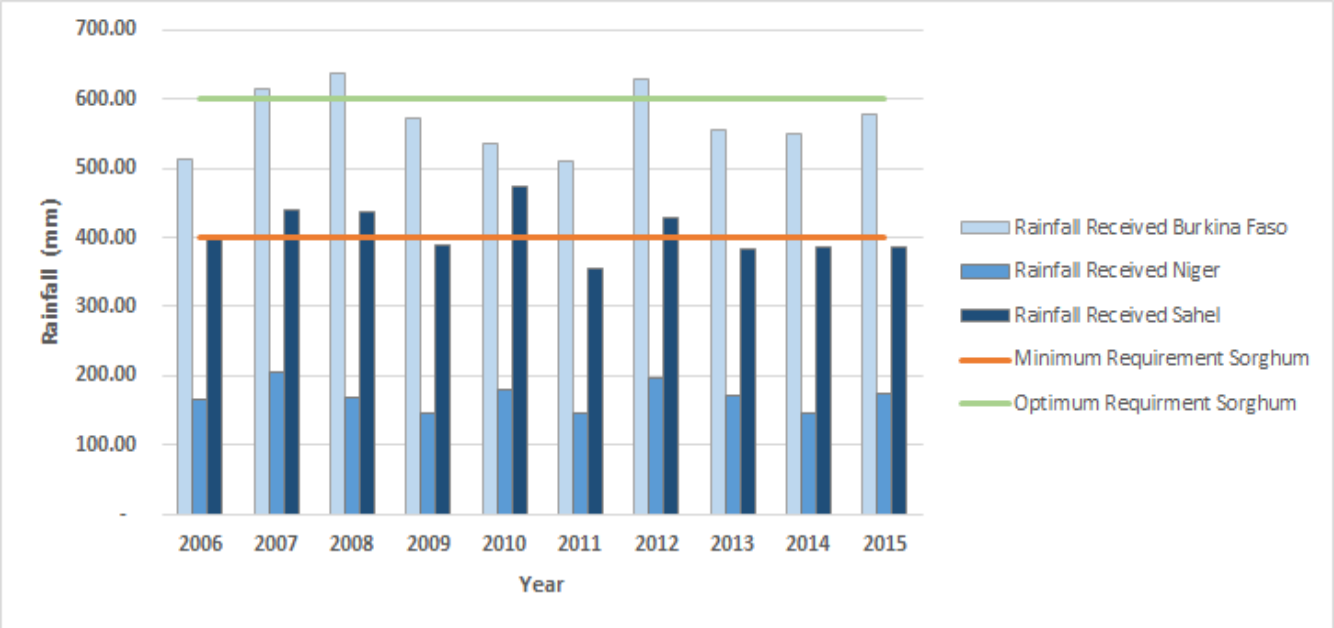
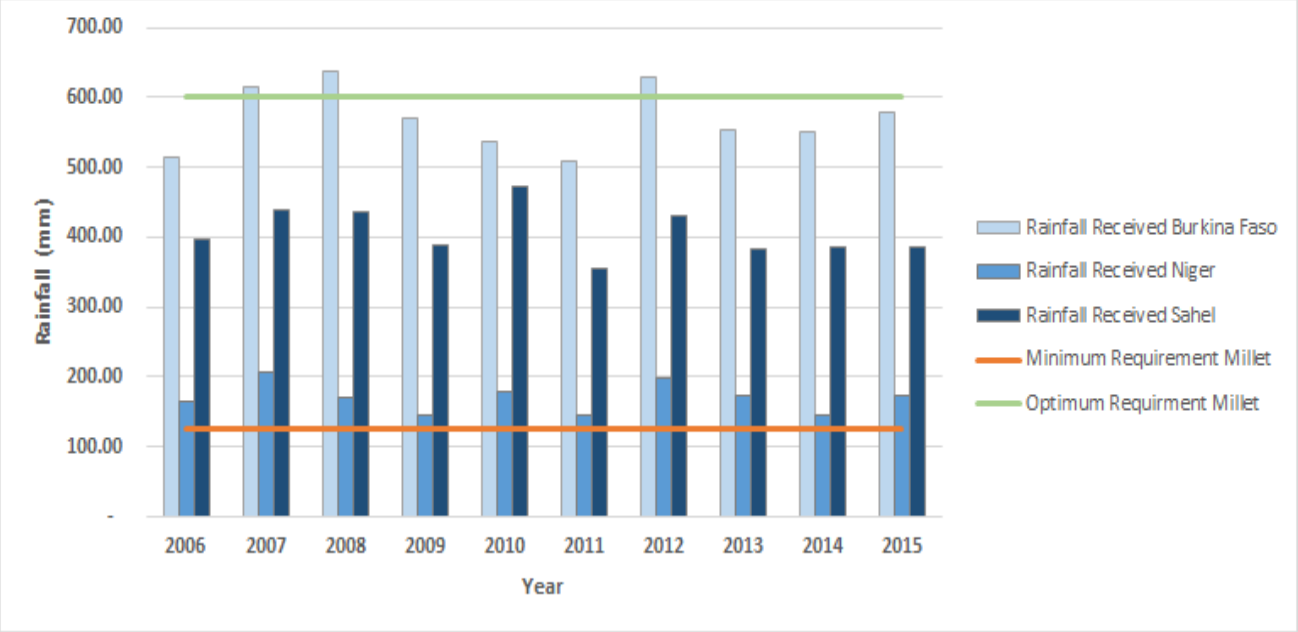


Figure 10 shows how rainfall patterns over a 10-year period compare with the amount of rainfall required for the optimal development and growth of millet. Millet in Burkina Faso receives more than the minimum required rainfall. Unlike the cowpea and sorghum VCs, the millet VC in Niger receives sufficient rainfall. On average over a 10-year period, the rainfall received in Burkina Faso was only 5% lower than the optimal requirement. In Niger it was 36% above the minimum threshold and 72% below the optimal threshold, a clear indication of how millet in Niger does receive enough rainfall, but not enough to maximize productivity of the crop.

FIGURE 10. COMPARISON OF THE RAINFALL REQUIREMENTS OF MILLET VS. RAINFALL RECEIVED



A.2. IMPACTS OF CF ON CROP PRODUCTIVITY

REGIS-ER introduced farmers to conservation farming techniques that aimed at efficiently using limited factors of production, most importantly water resources which have become increasingly scarce due to variable rainfall patterns and frequent drought spells. To trap rainwater within the farmland and to ensure that it infiltrates into the soil rather than runoff, farmers were encouraged to use physical water entrapment methods such as Zai, furrows, demilunes, and stone bounds.

Data collected over the period 2014 to 2017, with respect to farm yields for cowpea, millet, and sorghum, appear to support the effectiveness of these water entrapment methods, taking into account all other factors of production such as soil fertility and nutrition. The project also addressed these factors through the promotion fertilizers and compost. Table 32 illustrates how crop yields have increased due to the project's interventions and how water entrapment techniques are possibly helping farmers to tackle adverse weather conditions such as low and variable rainfall as well as droughts.

TABLE 31. IMPACTS OF CF ON CROP PRODUCTIVITY

	Burkina Faso			Niger			% Difference in Crop Productivity between countries Without Project	% Difference in Crop Productivity between countries With Project
	Without Project (Kg/Ha)	With Project (Kg/Ha)	% Change in Crop Productivity	Without Project (Kg/Ha)	With Project (Kg/Ha)	% Change in Crop Productivity		
Cowpea	527.81	922.71	74.82%	419.07	842.00	100.92%	-25.95%	-9.59%
Millet	666.42	1,094.92	64.30%	523.88	992.73	89.49%	-27.21%	-10.29%
Sorghum	731.88	1,227.40	67.71%	532.03	907.09	70.50%	-37.56%	-35.31%

The difference in yields in the cowpea, millet and sorghum VCs between Burkina Faso and Niger have decreased by a large margin due to the introduction of CF techniques by REGIS-ER. Though Burkina Faso still has higher yields than Niger even with the project, the difference in crop productivity is less pronounced. Cowpea, millet and sorghum yields in Niger have increased by 100.92%, 89.49%, and 70.50% respectively. This outstrips the productivity gains achieved in Burkina Faso which stand at 74.82%, 64.30% and 67.71% for cowpeas, millet, and sorghum respectively. The yield differential between the two countries reduces considerably, with the cowpea and millet VCs with the biggest changes.

A.3. IMPACTS OF CF ON FOOD SECURITY

The second major objective of REGIS-ER is to ensure food availability through improved and intensified crop production. Figures 11 and 12 compare the food security status of agriculture HHs, both without and with CF practices in Burkina Faso and Niger.

In Burkina Faso, the average HH is composed of 6.8 persons and owns on average 3 hectares of farmland. Given that the CBA was conducted on a per hectare basis, this means that 2.27 persons within the HH are able to subsist of off the crops that are planted on a hectare of land. Using the data that are currently available on household consumption patterns, it was estimated that per hectare of land the consumption of cowpea, millet, and sorghum would be approximately equal to 18 kg, 134 kg, and 131 kg per annum, respectively. In Niger the average HH is composed of 6.7 persons and owns around 2.91 hectares of land. HH consumption patterns per hectare in Niger were estimated to be around 18 kg, 332 kg, and 88 kg per annum for cowpea, millet and sorghum respectively.

These estimates of consumption levels per hectare were weighed against HH crop production per hectare in the case of without and with CF. The results shown in Figure 11 indicate that for all crop VCs in Burkina Faso, consumption is lower than production, both with and without CF. In fact, CF greatly increases food security especially in the case of cereals which are staple crops.

FIGURE 11. AGRICULTURE VC HOUSEHOLDS' FOOD SECURITY PROFILE - BURKINA FASO

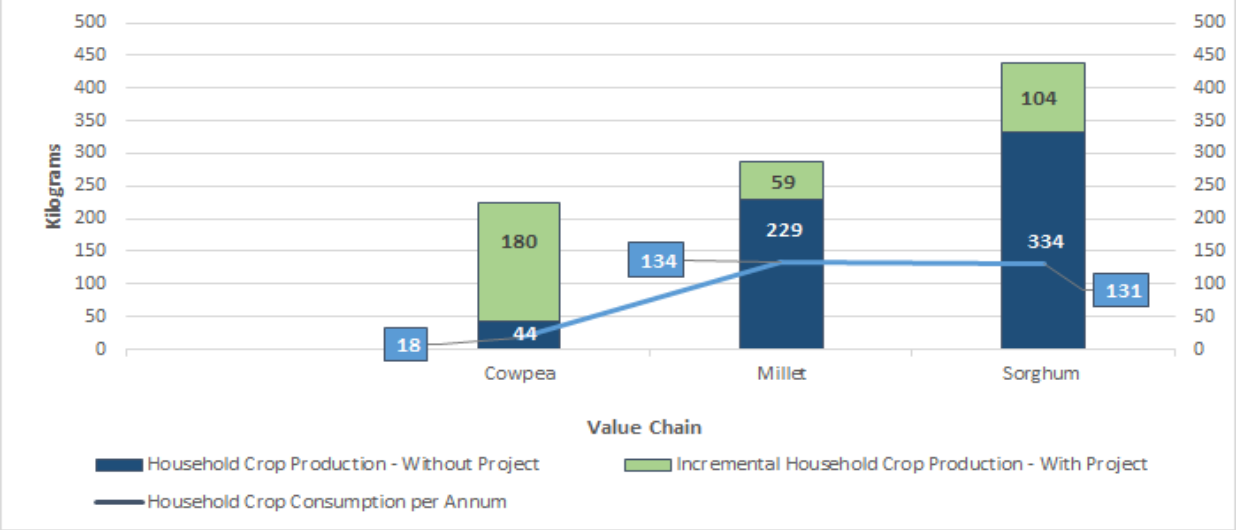
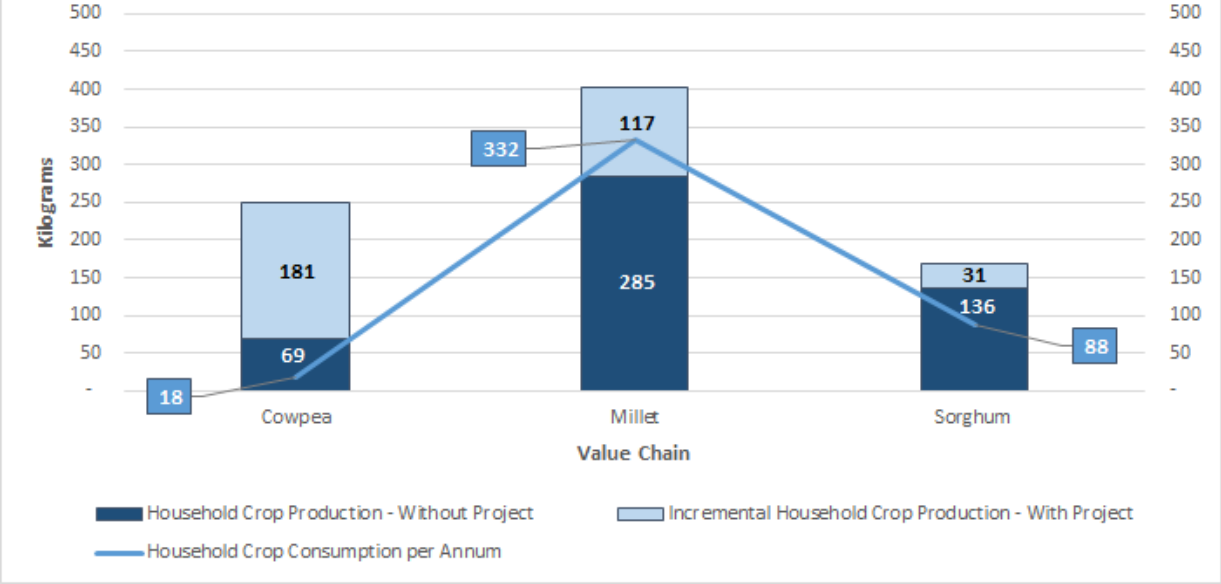


FIGURE 12. AGRICULTURE VC HOUSEHOLDS' FOOD SECURITY PROFILE - NIGER



In the case of Niger, the analysis reveals that with respect to cowpea and sorghum, HH consumption is significantly lower than production in both without and with CF. However, for millet the results indicate that without CF, HH production of the crop is 86% of consumption requirements. Millet is of great importance in Niger as compared to Burkina Faso as the population has a pronounced preference for millet as opposed to sorghum. This is highlighted by Nigerians consumption of millet which is 2.47 times higher than that of Burkinabes. Additionally, Nigerians tend to consume less sorghum compared to their Burkinabe neighbors, as their consumption is 0.67 times that of Burkinabes. The availability of millet to HHs in Niger is improved in the case of CF. Figure 12 shows that production per hectare increases to 1.21 times the required consumption, indicating increased food security in this important VC.