Building climate resilience of vulnerable agricultural livelihoods in southern Zimbabwe

Economic Analysis

A. Introduction

1. With increasing climate risks, water is the key limiting factor for agricultural productivity and adaptation to climate change. In addition to decreasing rainfall, annual rainfall in AER V is increasingly variable, characterized by erratic and unpredictable rains (short, sharp, isolated storms), rather than being evenly distributed. The majority of farmland in southern Zimbabwe – the provinces of Manicaland, Masvingo and Matabeleland South – falls within Agro-Ecological Regions (AERs) IV and V, which have the lowest agricultural potential in terms of rainfall, temperature and length of growing season. The effects of climate-induced droughts, heightened by the 2015/2016 El Niño, continue to reveal that despite current baseline investments, Zimbabwe's agricultural sector remains highly vulnerable and exposed to increasing climate risks.
2. To effectively adapt to climate change, smallholder farmers require:

    I. irrigation based on climate-proofed system designs, as well as the efficient operation and maintenance of irrigation infrastructure and efficient, planned and climate risk-informed water management on both irrigated and rain fed lands;

    II. climate-resilient cropping systems and livestock and resource management practices crucial to enhancing crop/livestock productivity for both rain-fed and irrigated systems, as well as access to market linkages and partnerships to sustain adaptation to climate change, motivating farmers to diversify production, adopt practices that reduce their climate vulnerability, and maintain irrigation infrastructure and equipment;

III. climate information, and weather forecasting, and its understanding and application, along with weather and agricultural advisories, that allow smallholders to make climate-informed planning and management decisions for on-going adaptation to climate change.

3. Each of these interventions are geared towards strengthening resilience of agricultural livelihoods of vulnerable communities, particularly women, in southern Zimbabwe in the face of increasing climate risks and impacts.
4. The economic feasibility of the project was determined using funds flow from small-scale farmers who will benefit from the project. Financial and gross margin analyses were conducted to assess the financial returns of the project's interventions for the project's beneficiaries.
5. Economic cost-benefit analysis was carried out to assess the impact of the project on society's welfare. The analysis of the project was carried out in accordance with the Guidelines for the Economic Analysis of Projects of United Nations Development Program (UNDP 2015). The economic desirability of the investments was determined by computing the economic internal rate of return (EIRR) and economic net present value (NPV) and comparing the EIRR with the assumed 10% discount rate (as recommended in UNDP 2015).
6. Discounted fund flows period varies by intervention between 15 and 25 years. We assume that after the useful life of each intervention, the benefits become zero. The analysis is based on discussions at the project sites and data from different agencies in the country. The climate information and climate resilient cropping outputs of the projects are assumed to have a lifespan of 15 years while the irrigation component have a lifespan of 25 years.

B. Identifying the Costs and benefits of project intervention

7. For calculating benefits with the project, statistics from Agritex (Agribusiness & Marketing) in Zimbabwe were used. Representative farm level data provides the financial gross margin analysis of the farm. This is presented in Table 2 below for tomatoes production. For this analysis, local market prices are used when applicable. In many of the estimated values, explicitly modeling prices of the commodities were not necessary.

8. The economic valuation of the benefit of irrigation relies on the following components:

   i) The total hectares that will be covered by irrigation investment with this project is 1,786. This is also used for the basis of other interventions in the project.

Irrigation Location	Hectares
Mzingwane River Basin	151
Runde River Basin	939
Save River Basin	696
Total intended command area	**1,786**

   ii) We assume that without irrigation, farmers will only plant in one season while farmers with irrigation can plant in at least two seasons (dry and wet seasons) and some can potentially plant more than twice with irrigation access.

   iii) We assume that crops such as Sugar Beans and tomatoes will be planted on the land in the dry season.

9. The benefits of irrigation for agriculture in this area is two-folds:
   a. Improved productivity in the rainy season due to irrigation facility for production in that season – not directly valued for this analysis due to lack of data to estimate the benefit also presents a conservative estimate of the benefit of the project given that irrigation access during the raining season can help supplement increased rainfall variability.
   b. Production in at least two seasons instead of one with the project is assumed to be conservative.

10. For output 2 of this project, the benefits we focus on is the farmer field school. We use estimate from Davis et al (2012) to provide evidence on economic and production impact of a farmer field school (FFS) project in East Africa. FFSs were shown to have positive impact on production and income among women, low-literacy, and medium land size farmers with the middle land area terciles showing significant increase in agricultural income for all countries combined (24%). The farmers in this project will be small and medium scale farmers with similar characteristics as the medium scale farmers in Davis et al (2012) given the experience of the

farmers in the country on irrigation user groups and potential for contract farming.[1]

11. Based on similar projects and the O&M related to the EWS systems, the expected lifetime of the project is assumed to be 15 years. The benefits we focus on for the EWS is the value to farmers of improved climate advisory services. We assume that climate forecast will lead to increased productivity and yield for the farmers in the region. In a study of smallholder farmers in four villages in Zimbabwe, Patt et al. (2005) observed that for farmers that participated in training on the uncertainty that surrounds climate forecasting, farmers who reported changing management based on forecast information experienced a 19% yield benefit in 2003/04, and a 9% benefit averaged across years, relative to farmers who did not respond to forecast information. Studies with extended interactions between farmers and institutions that provide EWS information have been shown to have reasonably high rates of use and benefits (Hansen, 2011). Roncoli *et al.* (2009) states that farmers reported higher yields based on participatory EWS information received and they were better prepared for the planting season. For this study, we assume a 5% increase in the revenue of farmers to be conservative given that not all farmers will benefit from a one on one training like the Patt et al experiment.

Other significant benefits not quantified:

12. Other benefits not quantified include the potential impacts of innovation platforms, that may be scaled out through farmer field schools? The DR&SS case study on the CIAT-PABRA-DR&SS bean platform in Chimanimani indicated that farmers may both benefit from improved prices (based on market access and collective engagement with market actors) as well as increased production. See p. 60 in CSA package sub assessment. Farmer field schools also has the benefit of facilitating improved market linkages. E.g. examples of increased livestock prices and contract farming relationships.
13. While the impact estimates capture total benefits of the farmer field schools, potential impacts like this can lead to higher benefits than the conservative estimate used in the analysis.

[1] There are different reported benefits of FFS. The values used in the economic analysis are studies from impact evaluation studies with characteristics comparable to the project sites.

C. Methodology and Parameter Assumptions

14. The economic analysis is based on the following additional assumptions about the project and economic conditions:

- Benefits generally won't accrue the first two years of the project. Because of the soft nature of some of the interventions, benefits can accrue starting from the third year. We however stagger the benefits based on the budget rollout (Table 1). That is, by year 3, only 63% of the benefits would have been realized and the full benefit is not realized until year 7. This provides a highly conservative estimate of the benefits and economics appraisal.

Table 1: Cumulative Percentage of budget expenditure from year 3.

Year 3	Year 4	Year 5	Year 6	Year 7
63%	76%	85%	95%	100%

- Financial gross income for Sugar Beans and Tomatoes were converted to economic values at a conversion factor of 1 while the financial costs were converted to economics costs using the following factors based on similar studies in the country:[2]
  i. Labor – 0.40
  ii. All other inputs – 1.62

Season	Crop	Gross Income	Conversion Factor	Gross economic value	Variable Cost	Variable Economic cost	Net economic value
Winter	Sugar Beans	4,350	1.00	4,350	1,949	2,631	1,719
	Tomatoes	15,000	1.00	15,000	6,428	6,428	8,572
	Average	**9,675**	**1**	**9,675**	**4,189**	**4,530**	**5,145**

[2] The economic conversion factor is the ratio of the economic price (shadow price) to the financial price. In some countries, central planning agencies produce economic conversion factors for various commodities. The factors shown in the CRIDF economic analysis are based on estimates by the Department of Agricultural Technical and Extension Services (AGRITEX) in the Ministry of Agriculture, Lands and Rural Resettlement, and the FAO Sub-Regional Office for East and Southern Africa.

D.Costs and Benefits

15. The total cost of the project amounts to USD 47.82 million including cofinancing by the government of Zimbabwe. This excludes the operating and maintenance costs for the interventions over the lifetime of the project.
16. The cost benefit analysis shows that with a 10 percent discount rate, the discounted net present value of the project is valued at about 27 million USD. The economic internal rate of return is 20%, which exceeds 10%.
17. Though the internal rate of return is 20% for the base case, there are other benefits not captured in this analysis. For example, based on the interventions in this proposal – specifically output 1 and 2, it is reasonable to assume that in the future without the project scenario, expected net revenues will reduce because of climate change, and that the project will prevent all or some of that projected climate change impact on agricultural productivity.[3] The implication of not capturing the increase in the differences with or without the project in the face of climate change is that benefits estimated in this analysis provides a lower bound on the value of the project.
18. Three sensitivity test cases were examined: (i) total cost increased by 20%; and (ii) total benefits decreased by 20%; and (iii) total cost increased by 20% and total benefits simultaneously decreased by 20%. In all cases, the project remains economically feasible and EIRR remains above the minimum threshold. Results are presented below.

Table 2: Net present value (million USD) and Economic Internal Rate of Return (EIRR)

	NPV	EIRR
Base case	$27.18M	20%
Cost +20%	$18.91M	16%
Benefits – 20%	$13.47M	15%
Cost +20% and benefit -20%	$5.20M	12%

[3] Abidoye and Odusola (2015) showed that climate change impact on Zimbabwe is higher than average impact on other African countries. Multiple studies including Adhikari et al (2015) indicated that East Africa could lose as much as 40% of its maize production by the end of the 21st century" (p.116-17).

Reference:

1. Abidoye, B. O., & Odusola, A. F. (2015). Climate change and economic growth in Africa: an econometric analysis. *Journal of African Economies*, *24*(2), 277-301.

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5. Roncoli, C., Jost, C., Kirshen, P., Sanon, M., Ingram, K. T., Woodin, M., Somé, L., Ouattara, F., Sanfo, B. J., Sia, C., Yaka, P. and Hoogenboom, G. (2009). From accessing to assessing forecasts: an end-to-end study of participatory climate forecast dissemination in Burkina Faso (West Africa). *Climatic Change* 92: 433–460.