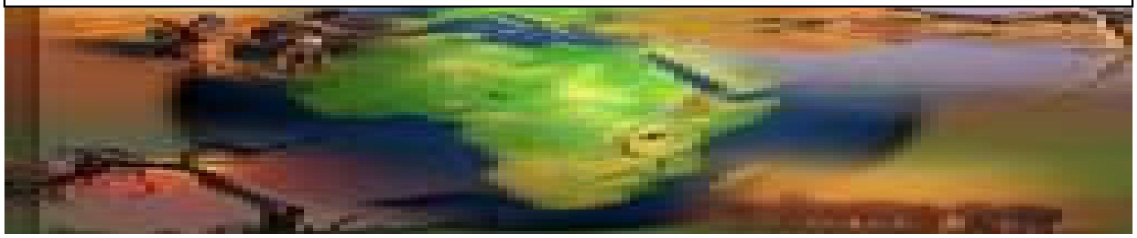
**CLIMATE CHANGE AND AFRICAN AGRICULTURE**
*Policy Note No. 11, August 2006, CEEPA*



## The economic impacts of climate change on agriculture in Zimbabwe[1]

This study uses a cross-sectional approach to measure the relationship between net revenue from agriculture and climate in Zimbabwe by correlating variations in key climate attributes and corresponding variations in net revenue observed across the country. The data for the analysis is based on 700 cross-sectional farm household surveys conducted in a number of provinces and selected districts across the country.

Cross-sectional observations across different climates can reveal the climate sensitivity of agriculture. The advantage of this empirical approach is that it does not only capture the direct effect of climate on productivity but also reflects farmers' adaptation to local climate. This farmer behavior is important as it mitigates problems associated with deviations from optimal environmental conditions. Analyses that do not include adaptation (such as the early agronomic studies) overestimate the damages associated with any deviation from the optimum. However, while the Ricardian model takes into account the costs associated with various adaptation alternatives, it suffers some limitations.

### The value of agriculture in Zimbabwe

Agriculture and the smallholder farming sector dominate Zimbabwe's economy. Agriculture provides employment and livelihoods for about 70% of the population, including 30% of formal employment, and accounts for about 40 to 50% of the country's total export revenues. About three-quarters of Zimbabwe's population live in the rural smallholder farming sector and depend on agriculture for their livelihoods. In addition, the agricultural sector contributes about 17% to the country's GDP.

Net revenue is defined as gross revenue less fertilizer and pesticide costs, cost of hired labor (valued at the median market wage rate), cost of transport, packaging and marketing costs, storage costs and post-harvest losses. Valuation of both crops and inputs was based on median prices per district. Household labor was excluded from the definition of net farm revenue as it resulted in many households having negative net farm revenues.

[1] This Policy Note is prepared by M De Wit based on Mano & Nhemachena (2006), Assessment of the economic impacts of climate change on agriculture in Zimbabwe: A Ricardian approach, *CEEPA Discussion Paper No. 11, CEEPA, University of Pretoria.*

**Table 1: Net farm revenue across provinces in Zimbabwe (US$/ha)**

| Province | Mean net farm revenue | Range |
|---|---|---|
| Manicaland | 281.31 | 2094.95 |
| Mashonaland Central | 915.23 | 5036.57 |
| Mashonaland East | 499.93 | 2769.09 |
| Mashonaland West | 240.23 | 1879.34 |
| Masvingo | 231.71 | 2744.46 |
| Midlands | 375.13 | 2665.44 |
| Total sample | 355.89 | 5859.27 |

Table 1 shows great variability in net farm revenue within provinces and across the whole sample, indicating that net revenue may be influenced by differences in climatic conditions in the various agro-climatic zones in each province. The empirical analysis therefore tried to find the climatic, soil, socio-economic and hydrological variables that would help explain this variability.

The soil variables that were included in the model were generally significant in explaining variability mainly in net revenues across households. Among the socio-economic variables, more years of education and increased access to extension services are associated with improved farming information that is important for agricultural productivity. The results also show that small farms are more productive on a per hectare basis than large ones. Other important factors that have significant effects on net farm revenues include access to capital, a high livestock index and access to irrigation. Livestock, particularly cattle, are an important asset in the farming system and can do well in a dry climate. There is a further positive relationship between net farm revenues and runoff as an additional source of water for farms with irrigation and all farms and a negative relationship for dryland farms.

## Sensitivity to temperature and precipitation

An increase in summer temperature by 1°C would reduce net farm revenues by about $86 per hectare for all farms and about $98 for dryland farms and $76 for farms with irrigation. Increases in the spring temperature also decrease net farm revenues. However, increases in winter and autumn temperatures are beneficial to crops and increase net farm revenues by about $34 per hectare for all farms and about $45 for dryland farms and $69 for farms with irrigation.

An increase in precipitation has positive effects on net farm revenues, particularly for summer and spring. An increase of one millimeter in summer precipitation would result in an increase in net farm revenues of about $39, $31 and $25 per hectare for all farms, dryland farms and farms with irrigation respectively. Net farm revenues are highly sensitive to changes in climate and the elasticities are relatively high for both summer temperature and precipitation.

## Agriculture and climate change

A 2.5°C increase in temperature would result in a decrease in net farm revenues by US$0.4 billion (31% decrease) for all farms but an increase in net revenue for farms with irrigation by US$0.02? billion (3% increase). A 7% decrease in precipitation would result in a decrease in net farm revenue by US$0.3 billion for all farms (27% decrease) (Table 2).

**Table 2: Climate change impacts from uniform climate scenarios**

| | All farms | Dryland | Irrigated |
|---|---|---|---|
| **+2.5°C increase in temperature** | | | |
| ΔNet revenue (US$ per ha) | -109.93 | -117.42 | 96.61 |
| | (-31%) | (-17%) | (3%) |
| ΔTotal net revenue (billions US$) | -0.368 | -0.373 | 0.017 |
| **7% reduction in rainfall** | | | |
| ΔNet revenue (US$ per ha) | -99.18 | -112.35 | -53.82 |
| | (-27%) | (-16%) | (-2%) |
| ΔTotal net revenue (billions US$) | -0.332 | -0.357 | -0.009 |

Mean temperature and rainfall has been predicted by three models, CGM2, HadCM3 and PCM, for the years 2050 and 2100. By 2100 CGM2 and HadCM3 predict a 4°C and PCM a 2°C increase in temperature in Zimbabwe. Rainfall predictions show that the CGM2 model predicts an average decrease of 10%, the HadCM3 model an average decrease of 17% and the PCM model an average decrease of 21% for the year 2100. The scenarios show negative effects on farm net revenues for further increases in temperature, particularly for all farms and dryland farms. Further increases in temperature would be detrimental to agricultural production in the country for the years 2050 and 2100. The CGM2, HadCM3 and PCM scenarios predict that by 2100 net farm revenues will decrease by US$0.8, US$ 1.3 billion and US$ 1.4 billion across all farms, dryland farms and farms with irrigation respectively.

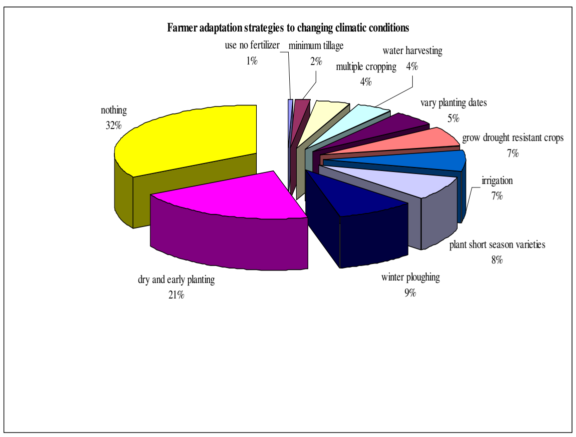
Further reductions in precipitation and increases in temperature in the country would make farming no longer viable, so if farmers are to continue to farm there is an urgent need for the government and private institutions to develop ways of helping them adapt to these future negative climatic conditions.

## Farmer strategies to adapt to climate change

About 68% of the farmers in the study indicated that they do at least something in response to changing climate, which shows they are aware of the changing climatic conditions (Figure 1).

The adaptation strategy most commonly used (about 21%) is dry and early planting. Farmers therefore need seed varieties that can stay in the soil for some time before the rains come, as well as early maturing varieties. Winter plowing is very important as it helps conserve moisture, especially when it is done soon after the winter rains. Farmers also plant short season and drought resistant crop varieties and practice multiple cropping that includes changing crop mixes.

**Figure 1: Farmer response strategies to climate change**




## Conclusions and policy implications

Climatic variables (temperature and precipitation) have significant effects on net farm revenues in Zimbabwe. Net revenues are negatively affected by increases in temperature and decreases in precipitation. The results showed that farms with irrigation are more resistant to changes in climate, indicating that irrigation is an important adaptation option for reducing the impacts of further changes in climate. More years of education and increased access to extension services are associated with the improved farming information that is important for agricultural productivity

Net farm performances for smallholder farms can be increased through providing training for farmers and helping them acquire more livestock. There is a further need to provide easy access to both input and output markets. And because irrigation and livestock significantly affect net farm performances in the country, these two factors can be a useful channel for boosting farmer adaptation strategies and improving net farm revenues in the smallholder farming sector in the face of changing climatic conditions.

*The agricultural sector in sub-Saharan Africa is predicted to be especially vulnerable to climate change because this region already endures high heat and low precipitation, provides the livelihoods of large segments of the population, and relies on relatively basic technologies, which limit its capacity to adapt. This series of Policy Notes reports on the methods and results of the first continent-wide study of this kind assessing how the economic well-being of African farming communities is currently affected by climate, predicts how future climate change effects may unfold under various possible global warming scenarios, and evaluates the roles adaptation to climate change could play. The study is based on collaborative research efforts conducted in 11 countries: Burkina Faso, Cameroon, Egypt, Ethiopia, Ghana, Kenya, Niger, Senegal, South Africa, Zambia and Zimbabwe. The sampled districts used as the unit of analysis cover all key agro-climatic zones and farming systems in Africa. This is the first analysis of climate impacts and adaptation in Africa on such a scale and the first in the world to combine cross-country, spatially referenced survey and climatic data for conducting an analysis that uses economic impact assessment methods, river-basin hydrological modeling and crop growth simulation techniques.*

All the reports produced under this GEF/WB/CEEPA funded project, *Regional Climate, Water and Agriculture: Impacts on and Adaptation of Agro-ecological Systems in Africa*, are found on CEEPA e-Library at its website link (www.ceepa.co.za/discussionp2006.html) and can also be accessed directly through the project link (www.ceepa.co.za/Climange_Change/project.html)

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