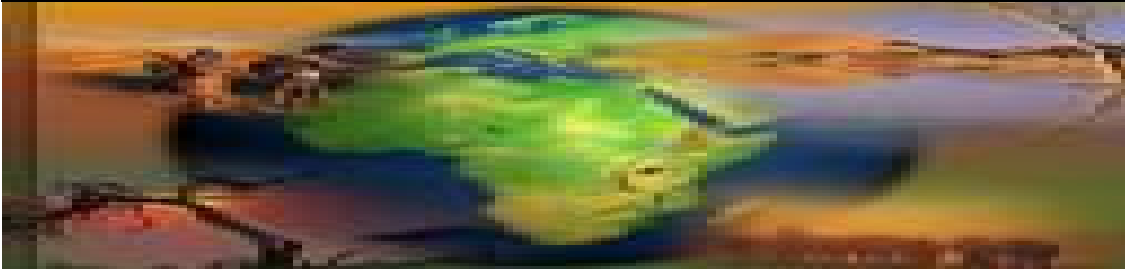


## CLIMATE CHANGE AND AFRICAN AGRICULTURE

*Policy Note No. 10, August 2006, CEEPA*



### **How farmers perceive and adapt to climate change in Africa<sup>1</sup>**

This study investigates the ability of farmers in Africa to detect climate change and assesses how they have adapted to whatever climate change they believe has occurred. It attempts to answer the following questions in particular: Do farmers perceive climate change to have occurred already and if so have they begun to adapt? What kinds of adaptations have they made to climate change? What, if any, is the role of government in overcoming barriers to adaptation? Over 9500 farmers were interviewed about their perceptions of climate change, the adaptations they make, and what they perceive as barriers to adaptation. More specifically, they were asked to describe verbally any long-term changes in temperature and precipitation, as well as any measures

---

<sup>1</sup> This Policy Note is prepared by M de Wit based on Maddison (2006), *The perception of and adaptation to climate change in Africa, CEEPA Discussion Paper No. 10, CEEPA, University of Pretoria.*

they had taken to adapt to whatever changes they had seen. The study uses data on farmers' perceptions of climate change and lists of adaptations and perceived barriers to adaptation, linked to farmer characteristics and other spatially referenced data. It is very important to identify these barriers to adaptation, particularly if they are amenable to public policy.

### **Agricultural adaptation to climate change**

A key question is the manner in which farmers update their expectations of the climate in response to unusual weather patterns. No evidence was found that farmers plan on the basis of climatic norms but rather that a higher weight is given to more recent years. Learning about the most appropriate crops and best production techniques could take a variety of forms, such as learning by doing, learning by copying or learning from instruction. The costs of transition hinge on the efficacy of these mechanisms, but all of them imply delays. Learning by doing requires time-consuming and potentially costly experimentation, learning by copying requires that someone take the initial first step, and learning from instruction requires an instructor.

## Evidence on the adoption of new technologies in agriculture

The literature generally has four themes concerning adoption of new technologies: that it is linked to resource scarcity or price changes; that it is affected by capital or savings constraints; that the rate of adoption is affected by learning costs; and that technology adoption and risk aversion are linked.

Farm size, tenure status, education, access to extension services, market access and credit availability are major determinants of the speed of adoption. The ultimate ceiling of adoption is determined by agro-climatic conditions, topographical features and the availability of water.

Considerable time lags were also observed between the existence of a technology and the time at which farmers become aware of it.

The experience of agriculture in Africa in adopting technologies associated with the green revolution does not engender confidence. The rate at which these have

been adopted has been very slow in some areas and it is not clear why adoption of new technologies for reasons of climate change should fare any better

## Perception of climate change in Africa

The literature on adaptations also makes it clear that perception is a necessary prerequisite for adaptation. The preliminary evidence from a number of African countries described above reveals that large numbers of agriculturalists already perceive that the climate has become hotter and the rains less predictable and shorter in duration.

Farmer perceptions of climate change by country are presented in Table 1. The data indicate that across the ten countries studied significant numbers of farmers believed average temperatures had increased. In six out of the ten countries the majority of farmers believed rainfall levels had decreased. A sizeable minority also believed they had witnessed a change in the timing of the rains.

**Table 1: Perceptions of climate change by country (% of respondents)**

Perception	BF	Cam	Egy	Eth	Gha	Ken	Nig	Sen	SA	Zam
Increased temperatures	29	22	74	14	62	62	50	69	59	32
Decreased temperatures	1	4	1	63	1	9	10	2	1	4
Altered temperature range	0	28	11	0	2	.28	20	0	13	5
Other temperature change	11	9	0	0	7	1	6	0	0	14
No change in temperature	0	29	12	3	14	42	13	0	22	32
Increased precipitation	5	11	5	10	3	9	13	1	1	9
Decreased precipitation	42	25	53	9	57	70	60	84	54	26
Change in timing of rains	30	18	7	58	38	30	2	85	17	25
Change in frequency of droughts	9	n.a.	0	8	3	100	9	84	7	10
Other changes in precipitation	4	11	0	0	6	0	5	0	1	14
No change in precipitation	19	27	32	4	4	27	5	0	23	13

It appears that the more experience farmers have, the more likely they are to claim that temperatures have increased and the less likely to claim there has been no change. The results for precipitation are very similar: once again the experienced farmer is less likely to cling to the view that there has been no change. Also significant is distance to market, although whether the market in question is the place where the farmer buys inputs or sells outputs seems to make a critical difference. Subsistence farmers are far more likely to notice climate than other kinds of farmers. Based on data in Niger and Ghana, there is a strong indication that neighboring farmers are more likely to share the same climate change perception. For comparison with the perceptions of those farmers who believe the climate has become hotter and drier, Table 2 shows the actual annual change in temperatures and precipitations as recorded by weather monitoring stations.

This analysis indicate that Burkina Faso, Cameroon, Egypt, Ethiopia, Ghana and Zambia have indeed experienced significantly higher temperatures and that Burkina Faso, Ghana, Niger, Senegal and Zambia have experienced a significantly drier climate. Large numbers of farmers in these countries are therefore justified in stating that the climate has become hotter and drier. In a number of countries (Kenya, Niger, Senegal and South Africa) large numbers of farmers stated that the climate was becoming hotter, despite there being no evidence for such a change in the meteorological data. Likewise there is no evidence that precipitation has changed over Egypt, Kenya and South Africa although large numbers of farmers claimed that the

### climate has become drier. **Adaptation to climate change in Africa**

In so far as adaptations are dependent on customs, institutions and policies, one might expect to see differences between countries in the extent of adaptation. It turns out that these differences are indeed profound. In all countries apart from Cameroon and South Africa the planting of different varieties of the same crop is considered to be one of the most important adaptations. Different planting dates are also considered an important adaptation in Egypt, Kenya and Senegal. Adopting a shorter growing season is universally practiced in Senegal but is elsewhere almost irrelevant. In Egypt the majority of respondents have moved towards non-farming activities. In Egypt, Kenya and South Africa significant numbers of farmers have adapted by increased use of irrigation. In Burkina Faso, Kenya and Niger there is increasing use of water conservation techniques. Soil conservation techniques are increasingly practiced in Burkina Faso, Kenya, Senegal and Niger. There is also increasing use of shading and sheltering techniques in Burkina Faso, Niger and Senegal, where they have been adopted by approximately one third of respondents. Increased use of weather insurance is almost exclusive to Egypt. Prayer and ritual offerings are made in Senegal and Niger. There are, however, several countries in which almost a third or more of respondents report no change in agricultural practices. These include Burkina Faso, Cameroon, Ghana, South Africa and Zambia. By contrast, every Egyptian and every Ethiopian respondent claimed to have made at least one adaptation.

**Table 2: National trends in temperature and precipitation**

Country	Data refer to 1978–2000			Data refer to 1948–2001
	Change in min temp (°C)	Change in max temp (°C)	Change in precip (mm)	Change in precipitation (mm)
Burkina Faso	+0.16*	0.00	-4.12	-3.92**
Cameroon	+0.31*	+0.02	+7.48	-4.30
Egypt	+0.25**	+0.04	-1.63	+0.06
Ethiopia	+0.63**	-0.03	+9.12	-0.39
Ghana	+0.29**	+0.02	-11.27**	-3.66**
Kenya	+0.12	+0.02	+4.20	+3.01
Niger	0.00	-0.01	-0.16	-1.19**
Senegal	+0.11	+0.01	-1.79	-5.97**
South Africa	+0.02	0.00	+0.19	+0.19
Zambia	0.15**	+0.10*	-16.49**	-2.21*

*Zimbabwe was excluded from this analysis as survey data on this component was unusable.*

*Notes:* Data are taken from ARTES. Coefficients refer to change per annum.

\*\* significant at 1% level \* significant at 5% level

It further appears that changes in temperature and precipitation cause changes in crop selection, changes in the use of shading and sheltering, and changes in soil conservation. In addition, changes in precipitation are also met by changes in planting dates, a shorter growing season, and increased use of water conservation techniques.

The baseline climate itself can be expected to affect the probability of particular adaptations being made. There were significant numbers of farmers who did not adapt in each type of climate (categorized as hot and cool, dry and wet, areas with high and low runoff) but adaptations were far more frequent in hot climates and wet climates. These differences are even more marked in those regions where it is both hot and dry, and those where it is cool and wet.

### **Perceived barriers to adaptation by country**

The analysis of adaptation by country revealed some important differences in the extent and prevalence of different adaptation measures (Table 3). The barriers to adaptation seem higher in Cameroon, Egypt and Ethiopia than elsewhere. A large number felt that lack of credit or savings represented a barrier to adaptation. This was felt most acutely in Kenya and Niger. Lack of access to water was anticipated to be a major problem in adaptation, but in fact was not perceived to be a barrier except in Ethiopia, Kenya and Senegal. Lack of access to appropriate seed, lack of security of property rights and lack of market access were hardly mentioned except in Ethiopia. Few farmers perceived lack of information about the weather or long-term climate change to be a barrier to adaptation, except in Cameroon, Kenya and Zambia.

Likewise, few believed they lacked knowledge about the appropriate adaptations. In Ethiopia a quarter of respondents felt that they lacked

information about climate change.

Barriers	BF	Cam	Egy	Eth	Gha	Ken	Nig	Sen	SA	Zam
Lack of information about weather	0	12	7	0	2	14	7	0	3	18
Lack of information about climate change	0	5	0	28	2	3	8	0	2	16
Lack of knowledge about adaptations	12	5	0	28	2	31	4	0	5	1
Lack of credit or savings	20	34	0	31	16	73	56	1	25	28
Rationing of inputs other than water	0	0	0	27	2	5	0	0	0	12
No access to water	0	4	0	15	2	14	4	19	2	0
Lack of appropriate seed	0	0	0	18	3	8	0	0	0	2
Adaptation not cost effective	0	8	0	18	4	6	0	0	7	0
Insecure property rights	0	5	0	9	0	5	0	0	0	0
Lack of market access or transport problems	0	2	0	0	0	5	3	0	0	1
Other	20	n.a.	0	5	20	100	17	44	2	33
No barriers to adaptation	63	6	6	12	50	15	18	44	56	25

**Table 3: Perceived barriers to adaptation by country (% of respondents)**

### Factors influencing adaptation

The adaptation process is driven by a number of factors. Firstly, it is apparent that more experienced farmers are more likely to record an adaptation measure. Free extension advice about either livestock or crop production also strongly increases the probability of the farmer adapting. Greater distance to the market where outputs are sold diminishes the probability of adaptation. The level of education (measured in years) also greatly increases the probability of adaptation. Being head of the household also increases the probability that the farmer can adapt, perhaps because he or she is in control of household resources. There is no evidence that gender influences the probability of adaptation.

It appears that larger farms are more likely to adapt to climate change. This is

consistent with the idea that adaptation has a fixed cost element, implying that information gathering is less worthwhile for small farmers. Tenurial arrangements are not important, apart from where land is borrowed, possibly because these farmers might lose their land. Land that is already marginal in the sense of having high temperatures or low rainfall apparently compels farmers to adapt to whatever changes in climate they witness.

### Conclusions and policy implications

It is unlikely that farmers know immediately the best response to climate change when such agricultural practices as it requires are outside the range of their experience. There is a significant amount of evidence detailing the slow uptake of technological adaptations in agriculture during the green revolution, especially in Africa.

From the present study a number of findings emerge that resonate with the earlier literature. These relate to the importance of extension services and proximity to the market in determining whether individual farmers respond to the perception of a changed climate. Together these highlight the importance of accounting for alternative channels of learning. One of the main way in which farmers learn what adaptations are appropriate is from observing their neighbors. Perhaps the single most important finding from this study is that whereas it is farming experience that determines whether or not farmers perceive climate change, it is education that largely determines whether or not they adapt to it.

In terms of policy implications it appears that improved farmer education would do most to hasten adaptation. The provision of free extension advice may also play a role in promoting adaptation. In so far as distance to the selling market

is a significant determinant of whether a farmer adapts to climate change, it may be that improved transport links would improve adaptation, although the precise mechanism underlying this is unclear. Better roads may allow farmers to switch from subsistence farming to cash crops, or facilitate the exchange of ideas through more regular trips to the market. There are many country specific differences in the propensity of individuals to adapt, and further analysis would be required to understand underlying factors. Adaptation, however, is something undertaken only by those who perceive climate change. The perception of climate change appears to hinge on farmer experience and the availability of free extension advice specifically related to climate change. But although the policy options for promoting an increased awareness of climate change may be limited, this study indicates that the perception of climate change is already high.

*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](http://www.ceepa.co.za/discussionp2006.html)) and can also be accessed directly through the project link ([www.ceepa.co.za/Climange\\_Change/project.html](http://www.ceepa.co.za/Climange_Change/project.html))

**Centre for Environmental Economics and Policy in Africa (CEEPA)**, University of Pretoria, Room 2-7, Agricultural Annex, 0002 PRETORIA, South Africa. Tel: +27 (0)12 420 4105, Fax: +27 (0)12 420 4958, Web address: [www.ceepa.co.za](http://www.ceepa.co.za)

Core funding from the GEF and supplementary funding from TFESSD, Finnish TF, NOAA-OPG, and CEEPA in support of this project's activities are all gratefully acknowledged. The project was coordinated by CEEPA and managed in the World Bank by the Agricultural and Rural Development Department and World Bank Institute.



**THE WORLD BANK**

The findings, interpretations, and conclusions expressed herein are those of the author(s) and do not necessarily reflect the views of the Board of Executive Directors of the World Bank or the governments they represent. The World Bank does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of the World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.