Economic Impacts of Climate change on farmers in Nioro du Rip, Senegal : An integrated assessment

Hathie[1], I , Amikuzuno[2], J., MaCarthy[3], D.S., Diancoumba[3], M., Freduah[3], B.S., Adiku[3], S.G.K., Agali[4], A., Lizaso[5], J., Fatondji[6], D., Adams[7], M., Tigana[8], L., Koomson[3], E., Traore[6], P.C.S., Traore[4], S., Diarra[9], D.Z. Naab[10], J.B., Sarr[4], B., N'diaye[11], O., Sanon[8], M.

1. Background and objectives

•Climate change is projected to aggravate the challenges already faced by Sub-Saharan Africa's (SSA) smallholder farmers.

•Changes in rainfall levels and distribution, in addition to a rise in temperature are expected to negatively affect the growing conditions and thus the potential yields of many crops in SSA.

•In Senegal, climate change increases the uncertainty of the onset of the rainy season, and the total amount and distribution of the rains (Sene et al., 2006). Recent studies have also suggested possible future decline in rainfall and an increase in air temperature (Funk et al., 2012).

•These projected changes in climate and the subsequent impact on yields would certainly aggravate the food security status and poverty levels of smallholders whose livelihoods are dependent on agriculture.

•The objective of this study is to examine these economic impacts of future climate on the livelihood of farm populations in the Nioro area of Senegal.

2. Study area

• Agriculture in the study area is dominated by millet and peanuts grown in annual rotation. Maize is also cultivated but to a lesser extent.

•Fallow durations tends to disappear under population pressure. Use of manure for cereals farming is limited to the homestead. Very few farmers apply mineral fertilizer. As a result, average yield of cereals and peanut are low.

•Livestock plays a significant role in the functioning of the overall system through its forward and backward linkages with the cropping system.

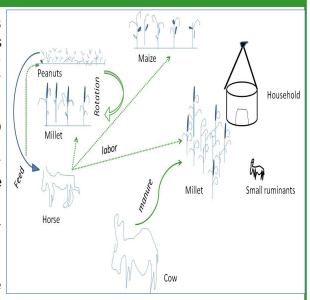

Fig 1. Current production system, Nioro Senegal

3. Methods

The TOA-MD model is used to assess the economic impacts of climate change on a population of heterogeneous farms based on key variables such as mean net farm returns, per capita income, and poverty. It enables the assessment of the level of gains and losses from climate change. Inputs for the TOA-MD derive from household survey data, such as farm size, household size, cropping and livestock activities, yields and prices of these activities, cost of production, and non-agric income. In the case of Nioro, the crops cultivated were millet, peanuts and maize.

To implement the integrated assessment, the TOA-MD also receives input from two crop simulation models (APSIM and DSSAT) for three crops (millet, maize and peanut) under (i) the current climate (1980-2009) (ii) the future climate (2040-2069). Future yield simulations were projected by five GCMs (E, I, K, O, R). The aim of this study is to determine the sensitivity of current agricultural production systems to climate change, assuming no adaptation.

4. Results

•The projected incomes by four out of five GCMs indicate future losses to farms (Table 1).

•Only GCM E, under DSSAT, predicts more gainers than losers from climate change, with net gains amounting about 7% of mean net farm income. In the case of APSIM, there are between 59 and 72% of losers while net mean income losses are estimated between 5 and 13%.

Table 1. Percent gainers and losers under the various GCMs.

Strata	Climate scenario	DSSAT		APSIM	
		Gainers (%)	Net Loss (%)	Gainers (%)	Net Loss (%)
Non maize farms	GCM E	58.55	-7.14	29.73	12.02
maize farms		59.47	-7.16	34.24	8.36
All farmers		59.02	-7.15	32.05	9.94
Non maize farms	GCM I	48.47	0.91	37.08	7.64
maize farms		32.84	9.33	45.47	2.40
All farmers		40.44	5.70	41.39	4.66
Non maize farms	GCM K	24.68	15.59	28.20	14.06
maize farms		7.01	30.38	27.76	12.42
All farmers		15.61	24.01	27.97	13.13
Non maize farms	GCM O	35.11	11.46	37.02	9.90
maize farms		26.99	16.35	41.34	6.37
All farmers		30.94	14.24	39.24	7.89
Non maize farms	GCM R	24.80	15.35	31.15	12.11
maize farms		13.50	26.99	30.57	10.59
All farmers		19.00	21.97	30.85	11.25

•The results of the DSSAT crop model showed higher variability (Fig. 3) with 41 to 84 % of losses (i.e. -7% to 24% of mean net farm income).

5. Results

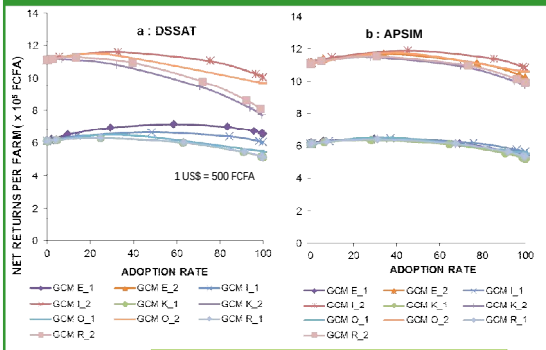

Fig 3. Change in mean net farms returns (3a. DSSAT; 3b. APSIM)

6. Results

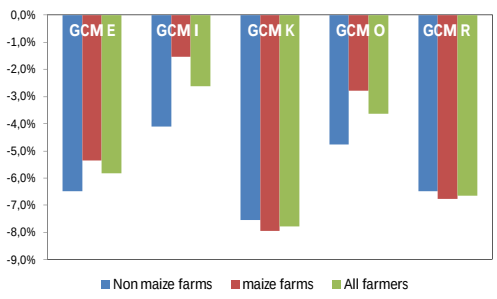

Fig 4. Percent Change in per capita income without adaptation (APSIM)

7. Results

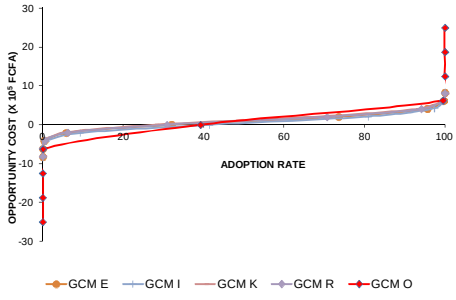

Fig 5. Percent gainers from Climate Change

8. Discussions

Due to the lower future yields simulated by DSSAT and APSIM, it appears that most economic indicators would decline under climate change with a higher impact on maize based farms (stratum 2) than non-maize based farms (stratum 1). Whereas APSIM seems to project less variability in net returns irrespective of stratum (Fig 3b), DSSAT shows considerable variations in net returns (Fig 3a). At 60% adoption rate of stratum 2, DSSAT shows net returns ranging from 10 to 12 x 10^5 FCFA. In the case of APSIM, net returns were about 11 x 10^5 FCFA for the same adoption rate. this latter stratum, with APSIM, all GCMs seem to produce the same level of outcome (Fig. 3). Decrease in mean net farm income varies between 8 and 12% for stratum 1 while it drops between 2 and 12% for stratum 2.

The same patterns are observed when looking at the impact of climate change on per capita income. Of all the GCMs, R and K display the greatest negative (Fig. 4). With APSIM, net losses per farm amount to $200 on average with a minimum of $76 and a maximum of $365.

Not all farms lose with the advent of climate change. As is apparent in Fig. 5, there is a minority of farms that made gains. With APSIM, it varies between 28 and 41, depending on the climate scenario.

9. Conclusions

This study has shown that farmers in Nioro du Rip, Senegal, would experience declines in their net farm returns and per capita income if no adaptation strategies are implemented. Although few farms would benefit from climate change impact, the overall picture is somewhat gloomy. It is therefore worthwhile to investigate the impact of adaptations strategies that could minimize these adverse effects.

10. Acknowledgments

Funding for this study was provided by DFID through the AgMIP project.

1. *IPAR, Senegal :* Initiative Prospective Agricole et Rurale; *2. UDS, Ghana : University of development studies;* 3. University of Ghana; *4. AGHRYMET, Niger:* Centre National d'Agro-Hydro-Météorologie du Niger; *5. Technical University of Madrid, Spain; 6. ICRISAT Mali :* International Crops Research Institute for the Semi-Arid Tropics; 7. CIRAD : Centre de Coopération Internationale en Recherche Agronomique pour le Développement ; *8. INERA, B. Faso :* Institut de l'Environnement et de Recherches Agricoles; *9. METEO Mali; 10. SARI, Ghana:* Savanna Agricultural Research Institute.; 11.*ACACIM, Senegal :* Agence Nationale de l'Aviation Civile et de la Météorologie;