How climate change awareness influences agronomic practices and Biochar adoption

POLICY BRIEF

October 2019

Figure 1A. *Small scale biochar production using homemade stove and*

Figure 1B; *Large scale biochar production in a bioenergy plant*

Key messages

- Farmers perceive that climate change variables have either decreased or increased, findings corroborated by meteorological data
- Agronomic practices are mainly conventional cultivation, use of chemical fertilizers and pesticides.
- Farmers adopt biochar for increase of agricultural output and those who don't adopt biochar lack of information/ awareness about biochar

Introduction

Agricultural production is a complex interaction between human and natural environment, making agriculture both significantly responsible and vulnerable to climate change. Agriculture is the mainstay of most rural economies in many developing countries, including China (National Bureau of Statistics of China, 2010). Due to high demand for food, agricultural production has shifted from traditional organic agricultural practices, to adopting high yielding, use of chemical farm inputs and agricultural technologies. This has however been at the expense of the environment, with use of some of the farm inputs and technologies negatively affecting the environment.

On one side, agriculture is vulnerable to climatic variation because of its dependence on temperature and patterns of rainfall. On the other hand, agriculture directly and indirectly contributes to global greenhouse gases (GHGs) emissions in CO2equivalents from fossil-fuel based inputs and equipment, enteric fermentation in ruminants, flooded rice fields, animal waste processing and biomass burning (Mishra and Shibata, 2012;) and fertilizer production and use. Besides, agriculture generates a lot of biowastes that are sometimes difficult to manage. For instance, China generates a lot of straw annually because they practice multiple cropping, done mainly through changing single harvest rice to double harvest rice, wheat and winter crops, and intercropping, which give no time for residue decomposition, most of which is burnt in fields and in households (Pan et al.,2011). The process results in the generation of carbon dioxide thus accelerating global warming, increased atmospheric pollution, reduced soil nutrient availability and turnover and consequently reduced crop yield. Fortunately, the GHGs can be reduced through agricultural practices such as reduced land clearing agro forestry and conversion of agricultural bio-wastes to renewable energy.

As a way of solving the problem of agricultural wastes, both farmers and the government are working on the option of converting the agricultural bio-wastes to value-added products and/or renewable energy (MF-SBEMOA, 2012). Burning of biomass at relatively low temperatures in a closed system with limited oxygen produces charcoal like product called biochar. It differs from common charcoal in that it is produced for use as soil amendment primarily for improving soil productivity and enhancing soil carbon storage Lehmann and Rondon (2006).

Figure 1 A. Small scale biochar production using homemade stove

Figure 1 B. Large scale biochar production in a bioenergy plant

Benefits of biochar

Besides, being used for soil amendment, biochar has a number of economic and environmental benefits, ranging from increased yields, reduced pollution and dependence on fertilizers. Research has shown that combining wheat straw biochar with NPK fertilizer at application rates of 450kg/ha increases crop yields through increased nitrogen and phosphorous uptake efficiency of chemical fertilizers and therefore lowers the costs for the farmers. Moreover, Biochar can be produced on-farm by small scale farmers using locally made stoves (Figure 1 A) or small scale ovens or kilns as well as on a much larger scale in a dedicated bioenergy plant (Figure 1 B). A study was conducted to evaluate agronomic practices by smallholder farmers, assess their climate change awareness and their knowledge and use of biochar.

Results

1. Farmers' perception and awareness of climate change

Household survey results showed that farmers have observed weather changes in the past 20 years (Table 1). The observations were corroborated by climate data (Figure 2) and group discussions with key informants. Forty seven percent of the farmers associated the changing climate to an increase in temperature, 52% to a decrease in vegetative cover, 63% reported a decrease in water quality and 59% deterioration of water quality.

Results showed that climate change awareness has influence on the farmers' choice of agronomic practices and adoption of biochar. Farmers who were

Table 1: Farmer perceptions of long-term temperature and precipitation changes and their impacts on water and vegetation.Responses are presented in percent frequency. **(N= 180)**

Parameter	Don't know	No change	Decrease	Increase
Rainfall	2	34	63	1
Temperature	42	3	8	47
Vegetation cover	14	15	52	19
Water quantity	3	35	60	2
Water quality	/	35	59	6

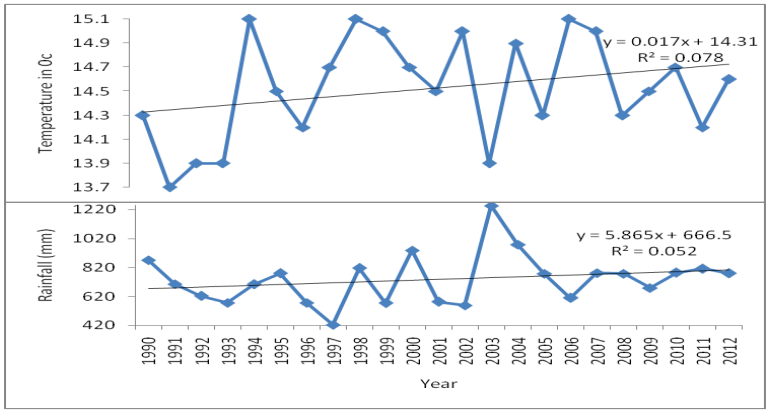

Figure 2: Annual temperature and rainfall in Henan Province, China, 1990–2012. Source: China Metrological data sharing service system

aware of climate change had also adopted farming practices such as organic amendments (biochar) and no till and minimum tillage that can potentially reduce impacts of climate change from cropland (Figure 1).

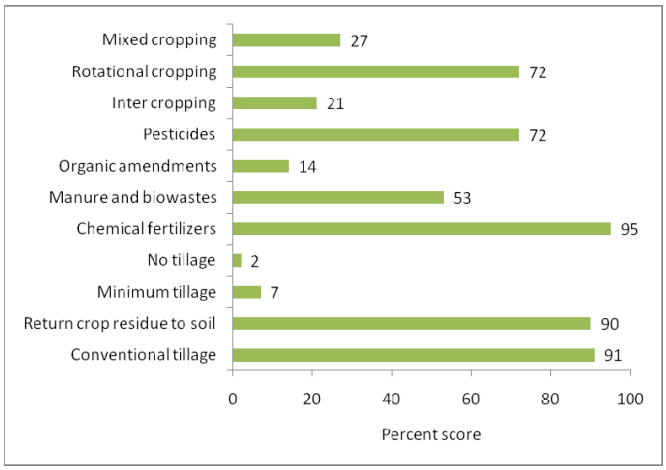

Figure 3: Agronomic practices used on cropland (N= 180)

About the Policy Brief

This policy brief is a product of my PhD research work from Nanjing Agricultural University, China, titled: Farmers' perceptions of climate change and their adaptation strategies. A casestudy in China using questionnaire Survey. The research was partially funded the Chinese Scholarship Council.

2. Agronomic practices used on cropland

The most practiced agronomic practices are, use of chemical fertilizers, conventional tillage, returning crop residue to soil and use of pesticides (Figure 3). Except for returning crop residue to the soil, which, as emerged from a discussion was practiced for lack of choice of waste management, and crop rotation, the main methods are harmful to the environment. For instance, intensive use of chemical fertilizers is a major contributor to GHGs emissions from croplands and conventional tillage interferes with soil carbon. However, if farmers can adopt use of biochar, impacts of climate change from croplands can be reduced. This is because studies have established that besides offering both improved soil fertility and serving as a carbon sink, if mixed with fertilizer, it reduces the amount of fertilizer used.

3. Biochar Adoption

Thirty percent (30%) of the farmer interviewed had knowledge of biochar. This could be largely because the innovation is relatively new and the focus of research by universities has been on field trials with little extension from agricultural departments. Subsequently, few agricultural extension experts have received detailed training or written information about the method of production, application and potential benefits. However, not all the farmers who were aware of biochar used it. Reasons for using or not using biochar are shown on Table 2.

Most farmers who had known about biochar felt motivated to use it because of increased yields (40%), reduced use of fertilizer and pesticides (16%) while 44% used it for all the reasons cited. The major reasons cited by those who did not use biochar were lack of information (65%) and cultural reasons 26 %. This observation highlights the importance of information and and the perceived perception of an innovation for the innovation to be adopted.

Table 2: Reasons for using or not using biochar (n= 60)

Reasons for using biochar	Percent response	Reason for not using biochar	Percent response
Increasing yields	40	Lack of information	65
Reducing fertilizer use	8	Social cultural reasons	26
Reducing pesticides	8	Credit inaccessibility	9
All of above	44		

Way forward

Improving agricultural productivity is critical to achieving food security as well as most of the targets specified under the Sustainable Development Goals. Therefore:

- Since farmers are aware and perceptive of climate change, this offers a good opportunity for of promotion of adaptation strategies
- The government should offer incentives and credit facilities for farmers to adopt biochar to contribute sustainable food production and environmental management. Additionally, the government should give incentives and relevant technical support to the big companies to manufacture biochar
- It is important for the relevant departments to consider sharing information on biochar through social networks addition to conventional methods and also increase and intensify extension services to farmers.

Acknowledgements

Preparation of this policy brief was supported by the AgriFose2030 programme and the International LIVESTOCK Research Institute (ILRI) with financial support from the Swedish International Development Agency (SIDA). Special gratitude to my mentor Dr Charles W. Recha for nominating me to the programe and guiding me though preparation of this policy brief.

References

China: N.B.o.S.o. (2011) Communiqu´e on Major Figures of the 2010 Population Census No.1(12June2013).http://www.stats.gov.cn/english/newsandcomingevents/t20110428_402722244.htm.

Gao, L.W., Ma., L, Zhang, W.F, Wang, F.H, Ma, W.Q, Zhang, F.S., 2009. Estimation of nutrient resource quantity of crop straw and its utilization situation in China. . Transactions of the CSAE 25(7), 173-179 (in Chinese).

IPCC, (2014): Impacts, adaptation and vulnerability. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva.

Lehmann J., Rondon M. (2006) (Ed.)^(Eds.) Biochar soil management on highly weathered soils in the humid tropics. , CRC Press, Boca Raton, FL. pp. Pages.

MF-SBEMOA. (2012) Ministry of Finance, State Bureau of Energy and Ministry of Agriculture of China (MF-SBE MOA)., 2012. Interim measures of administration of subsidy funds for National Green Energy Demonstration County Project. ttp://www.gov.cn/gongbao/content/2011/content_1967422.htm. in Chinese. Last visited: 2013-02-13.

Mishra A.K., Shibata T. (2012) Synergistic analyses of optical and microphysical properties of agricultural crop residue burning aerosols over the Indo-Gangetic Basin (IGB). Atmospheric Environment 57:205-218.

Pan G.X., Lin Z.H., Li L.Q., Zhang A.F., Zheng J.W., Zhang X.H. (2011) Perspective on biomass carbon industrialization of organic waste from agriculture and rural areas in China. Journal of Agricultural. Science and Technology. 13:75-82.

Contact address

Dr. Grace W Kibue
Department of Natural Resources,
Egerton University,
P.O Box 536 – 20115, Egerton
Email: *gkibue@egerton.ac.ke*

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

AgriFoSe2030
Agriculture for Food Security 2030
- Translating science into policy and practice

EGERTON UNIVERSITY