



Climate Change and Access to Farming Support Among Rural Farmers in Southeast Nigeria: Implication for Food Security and Sustainable Development

Nnorom, Kingsley Chukwuma¹, Durowaiye, Babatunde Emmanuel², Adi, Patience Oya³

^{1,2} Department of Sociology, Federal University Wukari, Wukari, Taraba State.

³ Department of Political Science, Federal University Wukari, Wukari, Taraba State.

ABSTRACT: Climate change has become a worrisome phenomenon disrupting global ecosystems with significant impact on agriculture thereby posing a threat to global food production and security. Indicatively, the increasing impact of climate change on agriculture, particularly the rural farmers necessitates interventions in the agricultural sector through various policies and farming support for the rural farmers in the developing nations. This study investigates the impact of climate change on rural farmers and access to farming support in the south east Nigeria with a focus on the implications for food security and sustainable development. It posits that rural farmers in the area experience increased variability in rainfall, temperature extremes, and more frequent extreme weather events, leading to crop losses and reduced yields. The study involved 684 rural farmers in southeast Nigeria rural communities, while survey research method and questionnaire instrument were adopted in executing the study. The collected data were analyzed using descriptive and inferential statistics. According to the findings of the study, majority of the farmers (70%) depended on personal and other supports rather than government farming support, there is a strong negative correlation between climate change impact and food security $\rho(684) = -.856, p < .01$ as well as a strong positive correlation between access to farm support and food security $\rho(684) = .812, p < .01$, while, food security is predicted by education, access to farm support, herdsmen/farmers clash and climate change impacts. In other words, access to farm support, such as climate-resilient seeds, irrigation infrastructure, and extension services, remains limited thereby exacerbating food insecurity in rural areas of south east Nigeria. The study recommends targeted interventions that enhance farmers' adaptive capacity, improve access to resources, and promote sustainable agricultural practices to mitigate the adverse effects of climate change and ensure long-term food security and sustainable development in the region.

Corresponding Author:

Durowaiye, Babatunde Emmanuel

Published Online:

January 28, 2026

License:

This is an open access article under the CC BY 4.0 license:

<https://creativecommons.org/licenses/by/4.0/>

KEYWORDS:

Climate change, food security, farming support, sustainable development, Rural farmers.

Cite the Article: Kingsley Chukwuma, N., Babatunde Emmanuel, D., Patience Oya, A. (2026). Climate Change and Access to Farming Support Among Rural Farmers in Southeast Nigeria: Implication for Food Security and Sustainable Development. *International Journal of Human Research and Social Science Studies*, 3(1), 102-108. <https://doi.org/10.55677/ijhrsss/13-2026-Vol03I01>

INTRODUCTION

With the growing impacts of climate change on different aspects of human existence, there is a growing concern about its bearing on some sensitive aspect of human existence such as agriculture. Agriculture as an essential aspect of human existence has long been recognised from primitive society to the current modern society as an inalienable factor in human survival. In pre industrialization stage of societal development, agriculture operated as naturally occurring activity requiring nothing more than

human resources. However, in the post industrialization stage, agriculture has been subjected to enormous confrontations and attacks by other factors and phenomenon leading to the need for more resources and support. For instance, violence and conflicts predicated on socio-cultural and political activities has drastically affected agriculture in different parts of the globe mostly in the developing nations (Kafando & Sakurai, 2025; Adelaja & George, 2019). More importantly in the current historical epoch, is the issue of climate change, which has affected agriculture across the globe. World over, climate change has been consistently recorded as one of the enduring factors affecting agriculture and farming lately (Nzeh, Uke, Attamah, Nzeh & Agu, 2016). This has been observed in different aspects of agriculture and majorly among the farmers across the globe (Belay et al, 2022). This suggests that climate change has affected agricultural productivity by triggering a number of chain reactions in the global food chain (Myers et al, 2017; Smith et al, 2015; Speers et al, 2016).

Among the developed nations, advanced technologies and researches have changed the global narrative of climate change impacts by devising compatible strategies and tools in addressing exposure to, and impacts of climate change. Policy wise, most developed nations have devised some strategies in managing and adapting to climate change era institutionally and on small-scale basis, depending on the prevailing situation (Masipa, 2017; Okoronkwo et al, 2024). This mostly has given attention to agriculture and farmers who are mostly viewed as the food powerhouse of every nation. For instance, in Europe, America and other developed regions, many agro-related policies have been strengthened to assist the farmers against climate change. These included agricultural support, which is a form of financial support to agricultural activities as a result of government policies including payments of various kinds that go directly to farmers, payments to support agricultural production through general services such as research and development, and market price supports, which are the increased gross returns to farmers from increased prices that result in increased payments from consumers to farmers; general service support, input subsidy, market price support, production payments, coupled payments, decoupled payments, amber box, green box and more (OECD, 2024; Doukas, Salvati & Vardopoulos, 2023).

In the developing nations mostly in sub-Saharan Africa, climate change has disrupted agricultural productivity and food chain with national, regional and rural food security implications (Ani., Anyika. & Mutambara., 2022; Vermeulen et al, 2010). For instance, a number of studies focusing on the impacts of climate change on agriculture have demonstrated the existence of their drastic impacts on food production and food preservation (Ukhurebor & Aidonjio, 2021; Lake et al, 2012; Mirzabaev et al, 2023). Other studies such as Tajudeen, Omotayo, Ogundele, & Rathbun, (2022) have equally highlighted the high rate of reduction of certain food crops leading to their going into extinction. The studies of Kummu, Heino, Taka, Varis and Daniel Viviroli (2021) focusing on global food chain have highlighted the fluctuation in food circulation globally, attributed to indices and indicators of climate change. By regional differences, the studies of Lake et al (2012) and Mendelsohn (2008) demonstrated the high impact of climate change on the food productivity capacity of some developing nations. With specific focus, the studies of Appiah-Otoo, Ntiamoah, Chen and Ankrah (2024) and Muleta and Negera (2023) pointed out the impacts of climate change on food production in sub-Saharan African nations.

In Nigeria, agro-allied policies and support have been made publicly to project the government efforts against climate change in impacts. There a number agricultural and climate change policies aimed at easing the impact of climate change on farming and farmers. These policies included agricultural transformation agenda support program (2013), National Agricultural Land Development Authority, operation feed the nation, green revolution, etc (Daneji, 2011) which by their arrangement were designed to reach out to the farmers in the rural communities. In the last decades, government has consistently showcased agricultural subsidies and supports to enable the farmers function to a capacity in sustaining food supply in the nation.

More specifically, in the south east Nigeria, rural farming support encompasses a range of initiatives aimed at boosting agricultural productivity and improving the livelihoods of farmers. These include agricultural input distribution that involves providing farmers with essential resources such as improved seeds, fertilizers, and pesticides. Also, financial support and access to credit help to provide affordable financing to enable farmers to invest in their operations. Extension services and training are provided for farmers to enhance knowledge and skills on modern farming techniques, climate-smart agriculture, and best practices. Also, there have been significant efforts by government agencies and international organizations towards improving rural infrastructure, such as irrigation systems, storage facilities, transportation networks and strengthening the agricultural value chain as well as climate change adaptation. For instance, organizations like the International Fund for Agricultural Development (IFAD) along with various government and non-governmental organizations, have been actively involved in providing these support services to rural farmers in Southeast Nigeria.

Despite these efforts, the impacts of climate change on agriculture and farming in the south east appear to have continued to portend worrisome trajectory. In this lens, Adesete, Olanubi and Dauda, (2023) pointed out that there have been manifest differences in instability of agricultural activities in the region irrespective of the growing technological and policy tools to manage climate change impacts. Although some studies have given attention to government agricultural policy and the impact on the farmers in the past, some gaps exist in literature about the other dimensional impacts of agricultural policy and climate change among the farmers in the remote communities. Equally, in the wake of exacerbated climate change impact on farming and food security, there is yet to be a study on access to farming support and food security among the rural farmers in south eastern Nigeria. Against this backdrop,

this study examines the impact of climate change on access to farming support by rural farmers in south east Nigeria with a focus on food security and sustainable development. The study was guided by the following research questions:

- i. What is the prevalence of climate change impacts and access to farm support among local farmers in rural eastern Nigeria?
- ii. What is the relationship between climate change impact, access to farming support and food security among rural farmers in rural eastern Nigeria?
- iii. What are the predicting factors to food security among rural farmers in rural eastern Nigeria?

RESEARCH METHODOLOGY

The study was carried out in southeast Nigeria among rural farmers specializing in different farm trades. 684 farmers were selected from 24 farming communities located across southeast Nigeria using random sampling technique. However, inclusion criteria for communities included the large farming communities, communities known for the production of different food crops and communities located in the rural outlets.

At the first stage, the study applied random sampling technique to select 24 farming communities observing the set inclusion criteria; at the second stage, the study applied random sampling technique in selecting villages and rural outlets to pave way for the selection of farmers as the respondents to the study. At the third stage, the study applied purposive sampling in selecting only those classified as farmers in the communities and villages included in the study.

At the household level, the study selected 684 farmers following such criteria as being a farmer for at least 10years, resident in the community of the study for at least 10years, possessing or managing at least a hectare of land for farming in the last five years and belonging to at least one agricultural cooperative society. The study applied survey design and utilized questionnaire instrument for data collection.

The data collected from the field were analysed using SPSS version 25. The issues raised in the study were addressed using descriptive and inferential statistics, focusing on the prevalence of climate change impacts and access to farm support among local farmers as well as the relationship of the variables constituting the major thrust of the study.

PRESENTATION OF THE RESEARCH FINDINGS

Table1 Socioeconomic information of the respondents

		N	Percentage
Age	18-28	92	13.5%
	29-39	182	26.6%
	40-50	307	44.9%
	51-61	100	14.6%
	62 and above	3	0.4%
Education	Primary/Secondary	475	69.4%
	NCE/Diploma	98	14.3%
	HND/Degree	105	15.4%
	M.Sc and others	6	0.9%
Religion	Christianity	488	71.3%
	Islam	105	15.4%
	African Traditional Religion	91	13.3%
Farming types	Cereals	137	20.0%
	Tuber crops	362	52.9%
	Large crops	92	13.5%
	Plantations/Orchards	84	12.3%
	Vegetables	3	0.4%
	More than one crop	6	0.9%
Weather activities that affect your farming activities	Heavy/prolonged rainfall	180	26.3%
	Long period of dry season	152	22.2%
	Loss of forest resources	220	32.2%
	Soil erosion occurrences	132	19.3%
Climate change impact on farm	Witnessing increased and new pests/crop diseases	268	39.2%
	Witnessing decreased animal production	222	32.5%
	Animals and crops are going into extinction	143	20.9%

Sources of farming support	Unpredictable farming season in the last 5years	51	7.5%
	Depending on personal effort	104	15.2%
	Depending on cooperative societies' support	187	27.3%
	Depending on government supports	180	26.3%
	Depending on international grants	213	31.1%
Total		684	100.0%

The above table showed the socioeconomic information of the respondents; according to the table, majority of the respondents (44.9%) are in the age category of 40-50years, 26.6% are in the age category of 29-39years, 14.6% are in the age category of 51-61years, 13.5% are in the age category of 18-28years, while, less than 1% are in the age category of 62years and above. Majority of the respondents (69.4%) were educated up to primary/secondary school certification. 15.4% were educated up to HND/Degree certification, 14.3% were educated up to NCE/Diploma, while less than 1% were educated up to Masters and more. Majority of the respondents (71.3%) are Christians, 15.4% are Muslims while 13.3% are traditionalists. Majority of the respondents (52.9%) specialized in farming tuber crops, 20.0% specialize in farming cereals, 13.5% specialize in large crops, 12.3% specialize in plantations/orchards, while less than 1% specialize in vegetables.

Among the respondents, majority indicated that they are affected by such whether activities like loss of forest resources (32.2%), 26.3% are affected by heavy/prolonged rain, 22.2% are affected by long period of dry season, 19.3% are affected by soil erosion occurrences. Majority of the respondents indicated that they are affected by climate change impact such as witnessing increased and new pests/crop diseases (39.2%), 32.5% are affected by decreased animal production, 20.9% are affected by animals and crops going into extinction, while 7.5% are affected by unpredictable farming season in the last 5years. Finally, majority of the respondents (31.1%) are depending on international grant support, 27.3% depend on cooperative societies' support, 26.3% depend on government support, while 15.2% depend on personal support for their farming.

Table 2. Correlation coefficient of Climate change impact, Access to farm support and Food security

			Climate change impact,	Access to farm support	Food security
Spearman's rho	Climate change impact,	Correlation Coefficient	1.000	.948**	-.856**
		Sig. (1-tailed)	.	.000	.000
		N	684	684	684
Access to farm support		Correlation Coefficient	.948**	1.000	.812**
		Sig. (1-tailed)	.000	.	.000
		N	684	684	684
Food security		Correlation Coefficient	-.856**	.812**	1.000
		Sig. (1-tailed)	.000	.000	.
		N	684	684	684

** . Correlation is significant at the 0.01 level (1-tailed).

The study tested the correlation between climate change impact, access to farm support and food security. Following the p value of .01, the finding demonstrated a strong negative correlation between climate change impact and food security $\rho(684) = -.856, p < .01$; a strong positive correlation between access to farm support and food security $\rho(684) = .812, p < .01$

Table3 Coefficients of Food security among rural farmers

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.642	.086		19.185	.000
Education	.393	.026	.317	15.399	.000
Age	.026	.024	.025	1.096	.273
Farming types	.032	.025	.032	1.264	.206

Access to farm support	.089	.029	.101	3.018	.003
Scale of farming	.014	.030	.014	.455	.649
Herdsmen/farmers clashes	-.095	.019	-.106	-5.058	.000
Climate change impacts	-.660	.019	-.764	-34.690	.000

a. Dependent Variable: food security

* $p < .05$, ** $p < .01$, *** $p < .000$, $R^2 = (71.1)$, $F(240.466)$

The explanatory power of the model according to the R^2 is 71.1% indicating the strength of the model, which was able to explain about 71% of the included variables. Among the included variables, education, access to farm support, herdsmen/farmers clash and climate change impacts were significantly correlated with the dependent variable (food security). The included variables in the model were selected based on the interest of the study and the instrument applied for data collection in the study.

DISCUSSION/CONCLUSION

Among other things affected by the ongoing climate change, farming and food security have more of chain reactions with greater impacts on humanity. Farming activities across the globe have faced with unprecedented dwindling and crisis, which eventually, has brought about food insecurity crisis. Owing to the importance of agriculture and farming to the existence of humanity, the global community has given much attention to greater support to agricultural activities as a decisive way of addressing food shortages caused by the ongoing climate change. However, among the developing nations such as Nigeria the crisis is becoming unbearable due to the attitude of the government to farming and the general corruption issues. Climate change impact on farming can be observed among the farmers in the areas of weather impacts on their farming activities. For instance, among the farmers in rural Nigeria, majority indicated that they are affected by such whether activities like loss of forest resources (32.2%), 26.3% are affected by heavy/prolonged rain, 22.2% are affected by long period of dry season, 19.3% are affected by soil erosion occurrences. This showed among the farmers, the different dimensions of the impact of climate change among the farmers even within a context. According to the study by Abbas, Ribeiro and Santos (2023), the impact of climate change differs with types of farming engaged by the farmers even in the same context. Majority of the respondents indicated that they are affected by climate change impact such as witnessing increased and new pests/crop diseases (39.2%), 32.5% are affected by decreased animal production, 20.9% are affected by animals and crops going into extinction, while 7.5% are affected by unpredictable farming season in the last 5 years. Hwang, Kim and Yu (2018) in a comparative study demonstrated that the volatility of climate change impacts have differential manifestations among the farmers especially with regard to their ability to access modern and efficient farming methods. Similarly, Khan, Ma, Kassem, Kazim, Ray, Ihtisham and Zhang (2022) demonstrated through their study, that climate change impacts on the rural farmers are formidable with virtually every farming aspect affected. All the above aspects and dimensions of farming affected by climate change impacts further affect the quality of food crops produced as well as the overall farm output among the farmers.

Despite the impacts of climate change on the activities of the farmers, there is scanty support from government to the farmers in rural communities in Nigeria; 31.1% of the farmers are depending on international grant support, 27.3% depend on cooperative societies' support, 26.3% depend on government support, while 15.2% depend on personal support for their farming. In other words, more than 70% of the farmers studied were dependent on other sources of support outside Nigeria government, while 42.5% are wholly dependent on personal sources such as cooperative society and individual efforts. Studies in Europe, America and other developed nations have demonstrated the inalienable positive impacts of government subsidized farming especially in the face of climate change crisis (Li, Sha, Sun & Jiao, 2022; Minviel & Latruffe, 2016).

From the study, while there is a strong negative correlation between climate change impact and food security $\rho(684) = -.856$, $p < .01$, the study further demonstrated a strong positive correlation between access to farm support and food security $\rho(684) = .812$, $p < .01$. In any case, provision and access to farm support can go a long way in countering and reducing the impacts of climate change on farming and food security. With 71% of the dependent variable explained in the model, education and access to farm support positively correlated with food security. By implication, food security among the rural farmers as the study has demonstrated is dependent on these factors as the control of these factors will invariably regulate food security. Conclusively, while the rural farming holds key to the control of emerging food security crisis in the developing nations, farming support to the farmers will invariable change the course.

REFERENCES

1. Abbas, M., Ribeiro, P.F. & Santos, J.L. (2023). Farming system change under different climate scenarios and its impact on food security: an analytical framework to inform adaptation policy in developing countries. *Mitig Adapt Strateg Glob Change* 28, 43 (2023). <https://doi.org/10.1007/s11027-023-10082-5>
2. Adesete, A. A., Olanubi, O. E., Dauda, R. O. (2023). Climate change and food security in selected Sub-Saharan African Countries. *Environment, Development and Sustainability* 25:14623–14641 <https://doi.org/10.1007/s10668-022-02681-0>.

3. Ani, K. J., Anyika, V. O. & Mutambara, E. (2022). The impact of climate change on food and human security in Nigeria. *International Journal of Climate Change Strategies and Management*, 14(2), 148-167. <https://doi.org/10.1108/IJCCSM-11-2020-0119>
4. Appiah-Otoo, I., Ntiamoah, E. B., Chen, X., & Ankrah Twumasi, M. (2024). Impact of climate change on food security in Sub-Saharan Africa: Can financial development offset the damages? *Cogent Food & Agriculture*, 10(1). <https://doi.org/10.1080/23311932.2024.2383793>
5. Belay, A., Oludhe, C., Mirzabaev, A., Recha, J. W., Berhane, Z., Osano, P. M., Demissie, T., Olaka, L. A. & Solomon, D. (2022). Knowledge of climate change and adaptation by smallholder farmers: evidence from southern Ethiopia. *Heliyon* 8 (2022) e12089
6. Connolly-Boutin, L. & Smit, B. (2016). Climate change, food security, and livelihoods in sub-Saharan Africa. *Reg Environ Change* 16, 385–399. <https://doi.org/10.1007/s10113-015-0761-x>
7. Daneji, M. I. (2011). Agricultural Development Intervention Programmes in Nigeria (1960 To Date): A Review *Sav. J. Agric.* 6(1): 101-107.
8. Doukas, Y. E., Salvati, L., & Vardopoulos, I. (2023). Unraveling the European Agricultural Policy Sustainable Development Trajectory. *Land*, 12(9), 1749. <https://doi.org/10.3390/land12091749>
9. Hwang, Y. S., Kim, H. S. H., & Yu, C. (2018). The Empirical Test on the Impact of Climate Volatility on Tourism Demand: A Case of Japanese Tourists Visiting Korea. *Sustainability*, 10(10), 3569. <https://doi.org/10.3390/su10103569>
10. Kafando, W.A. & Sakurai, T. (2025). Effects and mechanisms of armed conflict on agricultural production: Spatial evidence from terrorist violence in Burkina Faso. *Journal of Agricultural Economics*, 76, 24–44. <https://doi.org/10.1111/1477-9552.12613>
11. Khan, N., Ma, J., Kassem, H. S., Kazim, R., Ray, R. L., Ihtisham, M., & Zhang, S. (2022). Rural Farmers' Cognition and Climate Change Adaptation Impact on Cash Crop Productivity: Evidence from a Recent Study. *International journal of environmental research and public health*, 19(19), 12556. <https://doi.org/10.3390/ijerph191912556>
12. Lake, I. R., Hooper, L., Abdelhamid, A., Bentham, G., Boxall, A. B., Draper, A., Fairweather-Tait, S., Hulme, M., Hunter, P. R., Nichols, G., & Waldron, K. W. (2012). Climate change and food security: health impacts in developed countries. *Environmental health perspectives*, 120(11), 1520–1526. <https://doi.org/10.1289/ehp.1104424>
13. Li, C., Sha, Z., Sun, X., & Jiao, Y. (2022). The Effectiveness Assessment of Agricultural Subsidy Policies on Food Security: Evidence from China's Poverty-Stricken Villages. *International journal of environmental research and public health*, 19(21), 13797. <https://doi.org/10.3390/ijerph192113797>
14. Masipa T. S. (2017). The impact of climate change on food security in South Africa: Current realities and challenges ahead. *Jamba (Potchefstroom, South Africa)*, 9(1), 411. <https://doi.org/10.4102/jamba.v9i1.411>
15. Mendelsohn, R. (2008). The Impact of Climate Change on Agriculture in Developing Countries. *Journal of Natural Resources Policy Research*, 1(1), 5–19. <https://doi.org/10.1080/19390450802495882>
16. Minviel, J. J., & Latruffe, L. (2016). Effect of public subsidies on farm technical efficiency: a meta-analysis of empirical results. *Applied Economics*, 49(2), 213–226. <https://doi.org/10.1080/00036846.2016.1194963>
17. Mirzabaev, A., Olsson, L., Kerr, R.B., Pradhan, P., Ferre, M.G.R., Lotze-Campen, H. (2023). Climate Change and Food Systems. In: von Braun, J., Afsana, K., Fresco, L.O., Hassan, M.H.A. (eds) *Science and Innovations for Food Systems Transformation*. Springer, Cham. https://doi.org/10.1007/978-3-031-15703-5_27
18. Muleta, B. W., Negera, T. T. (2023). Climate Change and Food Security in Sub-Saharan Africa. *J Eco Res & Rev*, 3(2), 91-97.
19. Myers, S. S., Smith, M. R., Guth, S., Golden, C. D., Vaitla, B., Mueller, N. D., Dangour, A. D. & Huybers, P. (2017). Climate Change and Global Food Systems: Potential Impacts on Food Security and Under nutrition. *Annu. Rev. Public Health*, 38:259–77 <https://doi.org/10.1146/annurev-publhealth031816-044356>
20. Nzeh, E.C. Uke, P.C., Attamah, N., Nzeh, D.C. & Agu O. (2016). Climate Change and Agricultural Production in Nigeria: A Review of Status, Causes and Consequences. *Nigerian Agricultural Policy Research Journal*. 1(1), 102-110.
21. OECD (2024), *Agricultural Policy Monitoring and Evaluation 2024: Innovation for Sustainable Productivity Growth*, OECD Publishing, Paris, <https://doi.org/10.1787/74da57ed-en>.
22. Okoronkwo D. J, Ozioko R. I, Ugwoke R. U, Nwagbo U. V, Nwobodo C, Ugwu C. H, Okoro G. G. & Mbah E. C. (2024). Climate smart agriculture? Adaptation strategies of traditional agriculture to climate change in sub-Saharan Africa. *Front. Clim.* 6:1272320. doi: 10.3389/fclim.2024.1272320
23. Smith M. R., Singh G. M., Mozaffarian D., Myers S. S. (2015). Effects of decreases of animal pollinators on human nutrition and global health: a modelling analysis. *Lancet* 386:1964–72
24. Speers, A. E, Besedin E. Y., Palardy J. E. & Moore C. (2016). Impacts of climate change and ocean acidification on coral reef fisheries: an integrated ecological-economic model. *Ecol. Econ.* 128:33–43

25. Tajudeen, T. T., Omotayo, A., Ogundele, F. O., & Rathbun, L. C. (2022). The Effect of Climate Change on Food Crop Production in Lagos State. *Foods (Basel, Switzerland)*, 11(24), 3987. <https://doi.org/10.3390/foods11243987>
26. Ukhurebor, K. E. & Aidonjio, P. A. (2021). The influence of climate change on food innovation technology: review on topical developments and legal framework. *Agric & Food Secur* 10, 50 (2021). <https://doi.org/10.1186/s40066-021-00327-4>
27. Vermeulen, S.J., Aggarwal, P.K., Ainslie, A., Angelone, C., Campbell, B.M., Challinor, A.J., Hansen, J., Ingram, J.S.I., Jarvis, A., Kristjanson, P., Lau, C., Thornton, P.K., & Wollenberg, E. (2010). Agriculture, Food Security and Climate Change: Outlook for Knowledge, Tools and Action. *CCAFS Report 3. Copenhagen, Denmark: CGIAR- ESSP Program on Climate Change, Agriculture and Food Security*.