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Farm Households Coping Strategies to Climate Change (A Review)

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Abstract

8 Natural and Human activities have overtime caused significant shift in the climate state
9 creating climate change. The change in climate state affects all aspects of human life causing
10 mass migration and great loss of human life. It is believed that agriculture is the most
11 susceptible sector to climate change thus becoming the major force challenging the livelihood
12 of farmers. Therefore, in response to these forces, farm households have developed strategies
13 to cope with the aftermath of climate change induced shocks. The paper highlights some of
14 these strategies among farmers in different locations. It was noted that the coping
15 mechanisms adopted by farmers suggest that actions changes with different situations.
16 Furthermore, it was noted that the sustainability of most of the coping strategies is
17 questionable due to over dependence on the use of natural resources. It was thus suggested
18 that for greater sustainability of the strategies, there is an urgent need to find sustainable
19 livelihood strategies of life. This would only be possible through materialization of existing
20 policies and programmes allocation of resources and building capacity of farm households.

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Key words: climate change, farm household, coping strategies, agriculture.

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Introduction

23

Climate Change is now a reality and its impact on agriculture and other socio-economic
24 activities cannot be under estimated. Global warming due to green house gases can change
25 the variability of climate. Climate variability has attracted much attention in recent decades,
26 not only because of the globally unparalleled persistence of anomalously low rainfall, but
27 also because of the low capacity of society and economical systems to cope with climate
28 change related risks (1). As a result of this low capacity, extreme climate variability, such as
29 drought, is frequently accompanied by ecological decline, decimation of livestock herds,
30 widespread food scarcity, mass migration and great loss of human life (2).

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Many believe agriculture is the most susceptible sector to climate change. This is attributed to

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the fact that climate change affects the two most important direct agricultural production

33 inputs, precipitation and temperature (3). Climate change with expected long term changes in
34 rainfall patterns and shifting temperature zones are expected to have negative effects on
35 agriculture (4). Climate change also indirectly affects agriculture by influencing emergence
36 and distribution of crop pests and livestock diseases, exacerbating the frequency and
37 distribution of adverse weather conditions, reducing water supplies and irrigation; and
38 enhancing severity of soil erosion (5, 6). These climatic hazards are becoming the major
39 forces challenging the livelihood of most farmers (1). The rural population, for whom
40 agriculture is the primary source of food, direct and/or indirect employment and income, will
41 be most affected due to agriculture's vulnerability to climate changes. For instance (7) noted
42 that over 70% of rural populations within sub-Saharan Africa rely on rain fed small holder
43 agriculture for subsistence and livelihood. This dependence makes farmers vulnerable to the
44 adverse impacts of climate change implying that any significant change in climate or weather
45 patterns not only has the potential to impact on farming activities (8) but also threatens to
46 increase poverty in the already vulnerable communities. Therefore, climate change and
47 variability in African smallholder farming systems can be considered as an additional threat
48 to pressures of population, poverty, killer diseases (HIV/AIDS and malaria) to development
49 of sustainable livelihoods (9). Rainfall, in terms of total amount and within season
50 distribution, is the most important climatic element in the predominantly rainfed small holder
51 agricultural systems (10). In addition, floods and drought spells, extreme weather phenomena
52 such as temperature extremes and unpredictable wind movements, strongly impact on
53 agricultural productivity.

54 Despite worldwide coverage of climate change impact, there is intra-sectoral and inter-
55 sectoral variation in vulnerability depending on location, adaptive capacity and other
56 socioeconomic and environmental factors. In Europe, for instance, agricultural sector is
57 believed to benefit from gradual climate change due to the carbon effect and the warming

58 climate (11, 12). On the other hand, on continents such as Africa, continent that has
59 contributed almost nothing to anthropogenic climate change, the impact is believed to be
60 enhanced. This is attributed to the continent's low adaptive capacity, over-dependence on
61 agricultural sector, marginal climate and existence of many other stressors (12, 13). The
62 negative consequences of climate change in Africa are already happening as prevalent from
63 frequent floods, droughts and shift in marginal agricultural systems (13). The climate change
64 impact on agriculture is believed to be stronger in Sub-Saharan Africa (14).

65 In response to climatic change and variability, farm households over the years have
66 developed different coping strategies in the aftermaths of climate change induced shock.
67 Literature have shown that coping and adaptive capacity of people vary from region to
68 region. They are related to changes in societal aspects such as land use and cultural practices.

69 (1) reveals that coping with climatic changes requires a combination of various individual
70 responses at the farm-level and assumes that farmers have access to alternative practices and
71 technologies available in their area. The coping capacity is related to environmental changes.

72 They are related to changes in societal aspects such as land use and cultural practices.

73 Owing to the above mentioned facts, it is thus necessary for the identification of coping
74 measures used by households against the negative consequences of climate variability and
75 extremes as it is considered an imperative if poverty reduction and attainment of the
76 Millenium Development Goals are to be realized. The paper thus brings to light the trend of
77 climate change, its impact on household livelihood and the coping strategies households have
78 adopted and how they can be viewed from sustainability point of view.

79 **Concept of Climate Change**

80 To understand climate change, we must first of all understand what climate is. Climate is the
81 synthesis of weather over a given area or location over a period of at least 30 years. Climate
82 is the end product of the workings of the climatic system consisting of the atmosphere, the

83 lithosphere, the hydrosphere, the cryosphere and the biosphere interacting together and
84 powered by solar radiation. The climatic system is an open system that is in dynamic
85 equilibrium or steady state over a given period. If this steady state is disturbed as a result of
86 significant changes in one or more of the components making up the system or the amount of
87 solar energy powering the system, the climatic system will move over to a new state of
88 equilibrium to produce a new climatic state. In such a situation, a change in climate is said to
89 have occurred. Thus, a change in climate represents a significant shift in the climate state.
90 This shift usually occurs over a long period of time and has a permanent effect on the
91 ecosystem and the environment until another change occurs. (15) stated that authorities have
92 variously defined climate change as follows: “A change in climate that is attributable directly
93 or indirectly to human activities that alter the atmospheric composition of the earth leading to
94 global warming, has the potential of affecting all natural and human systems and may be a
95 threat to human development and survival, socially, politically and economically.” To the
96 Geographers “climate change is the increase in the average temperature of the earths near
97 surface air”. Some institutions equally describe climate change “as a change of climate (air
98 temperature, windfall, wind speed) which is attributable to human activities that alter the
99 composition of the global atmosphere and which are in addition to natural climate variability,
100 observed over a comparative time period”. (15) still went further to say that others see
101 “climate change as a long term shift, alteration, or change in type of climate prevailing over
102 specific location or region”. The most widely used definition of climate change is that given
103 by (6) as statistically significant variations that persist for an extended period, typically
104 decades or longer. It includes shifts in the frequency and magnitude of sporadic weather
105 events as well as the slow continuous rise in global mean surface temperature.

106 **Household Coping Strategies to adverse climatic impacts**

107 Societies are dynamic and they use all possible strategies to reduce the vulnerability to
108 climatic impacts. There are two kinds of responses to crisis that overlaps across the temporal
109 scale, coping mechanisms and adaptive capacity. Coping mechanisms are the actual
110 responses to crisis on livelihood systems in the face of unwelcome situations, and are
111 considered as short-term responses (16). Adaptive strategies are the strategies in which a
112 region or a sector responds to changes in their livelihood through either autonomous or
113 planned adaptation (17). Coping mechanisms may develop into adaptive strategies through
114 times (16). However, it is difficult to make a clear distinction between coping mechanisms
115 and adaptations. This study considers both schemes as coping strategies.

116 Populations have developed a number of coping mechanisms in order to live with climate
117 variations and uncertainty. Indigenous strategies to cope with climatic variability vary
118 between different geographical locations and between social-religious-cultural settings, as
119 well as between livelihood cores (e.g. between agro-pastoral communities depending on
120 livestock raising compared to sedentary farming communities depending primarily on crop
121 production). It is thus impossible to give a generic overview of indigenous coping
122 mechanisms. Suffice it to state that coping with climatic variability forms an inherent and
123 fundamental part of societies hosted in arid, semi-arid and dry sub-humid temperate and
124 tropical landscapes (18). Most individuals and households employ a combination of
125 responses to the impacts of climate on their livelihoods (19). This suggests that actions
126 constantly changes with different situations.

127 In many parts of SSA, households rely on a combination of self-insurance and informal risk
128 sharing arrangements. Many Africans cope with shocks and stresses through informal
129 strategies that rely on family and community structures-gift exchanges, sharing food,
130 migration, remittances, child labour, informal cash or in-kind loans, or sending children to
131 live with relatives- rather than government or market instruments (20). Though, the coping

132 mechanisms are not sufficient to address the challenges, and all societies are vulnerable to
133 climatic shocks, and vulnerability is more acute on the poor, landless and unemployed,
134 children, women, livestock tenders and large sized households. Wedded with landlessness
135 and unemployment, water scarcity, unaffordability and unavailability of agricultural inputs
136 and other stressors, climate change is more likely to continue to gamble the socio-economic
137 activities and exacerbate the society's vulnerability.

138 Food secure households often tend to rely on cash loans from relatives, neighbours and
139 money lending organizations. Conversely, food insecure and extremely food insecure
140 households depend less on informal transfers. This is due to limited networks of relatives and
141 neighbours able to give cash loans. These households often rely on gifts from relatives and
142 neighbours ,and providing labour in-kind payment. Where possible, waged labour on other
143 farms, off-farm employment activities, and livelihood diversification are important livelihood
144 coping strategies. Crop diversification and livestock accumulation are also important risk
145 management strategies in many parts of SSA.

146 The farming industry has a long history of showing it-self capable of responding to changing
147 influences and of implementing adaptations and innovations as circum-stances change.
148 Research findings showed that there are a number of actions that individual farmer can
149 implement, some of which are specific to particular enterprises or land types and others have
150 a more general application (4, 21, 22). In general, households do not follow a single coping
151 strategy during those hard times. At a time a farm households usually take different strategies
152 to maximize their positive survival. These coping strategies include: diversified resource base
153 (to minimize the risk due to harvest failure, they grow many different crops and varieties, and
154 they also hunt, fish, and gather wild food plants); change in crop varieties and species;
155 change in the timing of activities (crop harvests, wild plant gathering, hunting and fishing);
156 change of techniques; change of location; changes in resources and/or life style (resorting to

157 wild foods in the case of emergency situations such as droughts and floods); exchange
158 (obtaining food and other necessities from external sources through exchange, reciprocity,
159 barter, or markets in times of crises); and resource management (enhancing scarce and
160 climate sensitive resources management) (23). It is important to note that some strategies
161 have a negative repercussion on the health, productivity of individuals and psychosocial
162 development of children in a family. From the analysis, it can be concluded that significant
163 number of households took up coping mechanisms that can negatively affect their future
164 livelihood and immediate rehabilitation from the shock. These includes but not limited to sale
165 of farm land, sale of perennial crops, distress sale of farm equipments, sales of household
166 assets and distress migration. However, under normal circumstances, coping mechanisms
167 like seeking additional labour work, borrowing grain, borrowing money and seeking support
168 (from friends, relatives, government and non-government) can be seen as positive coping
169 mechanisms. Coping with climate variability and meeting subsistence needs often means
170 households cannot make productive investments in their farming operation to adapt to climate
171 change or improve long-term productivity. While many households have made minor
172 strategic adjustments to their farming practices in response to climate change (in particular,
173 changing planting decisions), few households can make large investments—in agroforestry or
174 irrigation, for example—although households want to invest in such measures. Some of the
175 coping strategies have eroded the future hope of the farmers, while others have helped them
176 to easily bear the consequences of environmental shocks.

177 **Empirical Studies on Farm Household Coping Strategies to Changing Climate**

178 In a study by (24) it was shown that Northern Shewa farmers of Ethiopian peasant farmers,
179 through continuous experiments on their environment, have managed to learn how to control
180 weeds and insects, select crop varieties, classify vegetation types, and cope with climatic and
181 environmental changes. They have developed various strategies to cope with climate changes

182 induced disasters. They conserve water resources and avoid unnecessary danger and crisis
183 during dry seasons. They use drought-resistant crops to address problems related to climate
184 variability and drought in particular (25). (24) in their study reported that the major coping
185 strategies were reduced frequency of meal, decreased quantity of meal, and decreased
186 diversity of meal as responded by 69.7%, 69%, and 51%, respectively. Other strategies
187 adopted were sale of farm land, sale of perennial crops, distress sale of farm equipments,
188 sales of household assets and distress migration as practiced by 33%, 17.9%, 27.9%, 27.9%
189 and 27.7% respectively. According to the data collected from the households' survey it was
190 only 2.7% of the households that followed only single coping mechanism where as about
191 45%, 41%, 9.9% and 2% have followed 2 to 5, 6 to 10, 11 to 15 and more than 15 coping
192 mechanisms, respectively. Furthermore, (1) conducted another study in Central Tigray,
193 Ethiopia and found that farmers employ various coping strategies against climate risks. In the
194 focus discussion group, the coping strategies to protect against climate related hazards were
195 discussed which include: food for work scheme, credit, petty businesses (such as firewood
196 and charcoal selling), reduction of daily meal in amount and frequency to eat and migration.
197 Similar coping strategies were reported from various studies conducted in different parts of
198 the country (4, 26).

199 In another study by (10) in two districts in Eastern Zimbabwe, they found that in response to
200 observed changes in weather patterns and absence of previously known local indicators,
201 farmers in both communities confirmed to having shifted their normal agricultural practices
202 to minimise risk and maintain crop productivity. Changes in harvesting dates, crop spacing
203 and crop diversification were also mentioned as measures put in place to cope with climatic
204 variability. In one district, the most preferred coping strategy was growing more than one
205 crop type and variety in the same piece of land (52%), followed by increasing inter- and
206 intra-row spacing for maize and legumes to reduce competition for soil moisture, while about

207 12% confirmed having changed their cropping calendar, while opening new fields was a
208 strategy adopted by about 5% of the farmers . In the other district, at least 45% of the farmer
209 had changed their cropping calendars to include dry planting, early and late planting outside
210 the normal planting time. Also of significance were increasing intra- and inter-row spacing
211 for different crops (25%)and combining different crop types and varieties was taken up by
212 >20%. Other options included shifting harvesting dates to include early harvesting as soon as
213 the crop reaches physiological maturity, and late harvest to minimise post-harvest losses
214 associated with attaining the required moisture content before marketing of produce.

215 (27) while studying the factors affecting the choices of coping strategies for climate extremes
216 in the Nile Basin of Ethiopia reported that in general, most of the surveyed farmers who
217 reported experiencing shocks over the past five years sold livestock to cope. The other coping
218 strategies included borrowing from relatives, eating less, depending on food aid and food-for-
219 work programs, and looking for off-farm employment.

220 Another study conducted in West Arsi Zone, Ethiopia by (28) showed that farm households
221 in the area did not follow a single strategy but rather at a time a farm households usually take
222 different strategies to maximize their positive survival. On average 37% of the respondents,
223 use saving as their major coping strategies, another 12.5% reported on-land diversification as
224 their main coping strategy. Wood sell is the third most significant coping mechanisms, on
225 average 12.5% of the respondents. Diversification to off-farm and non-farm activity also
226 helps farmers to retain assets or to withstand climatic shocks. On average 7.7% of the
227 respondents suggested mobility to places where there is available pasture and water as a
228 coping strategy. Nine percent of respondents, also use social interconnectedness (relatives) as
229 coping strategy, credit from informal and formal sectors is used by on average 10% of the
230 respondents, and other off-farm and nonfarm activities.

231 In Chicualacuala District of Gaza Province, Mozambique, (29) in a household the following
232 coping strategies are used in different situations: when crops are damaged by drought, they
233 move to other locations where food is available, sell liquid assets, buy limited food, use
234 remittances and eat wild fruits. In Chigubo and Guijá districts (arid and semi-arid zones),
235 Gaza province, to cope with climate variability and the erratic rains the farmers plant
236 whenever the rain comes (even if is not normal time for planting) and grow different crops
237 with the hope that one of the cultures will survive to the weather conditions and succeed until
238 time of harvesting. When there is crop failure or to compensate low harvesting the following
239 strategies are used: Sell livestock, Collect and eat wild fruits, Exchange of labor, Engage in
240 small business, Engage in fishing, Sell firewood and charcoal, Consumption of wild tubers
241 and fruits, Selling of wild fruits and vegetables, Digging deeper wells and walking long
242 distances to fetch water and Migration to other areas looking for employment (29).

243 In the Great Ruaha River Catchment Area, Tanzania, various ways were reported by the
244 stakeholders consulted to be used in coping with the changing climate, including alterations
245 in the farming activities (30). In crop production, among the coping strategies included the
246 use of early maturing crop seeds in rice and maize, and use of drought tolerant varieties in
247 other crops. Wetland cultivation and migration to other areas were also reported to have
248 become common among household members in the area. Other ways mentioned included in-
249 situ water harvesting using tied ridges and mulching to preserve moistures. Ensuring
250 equitable water allocations for irrigation was also reported as an important attribute of
251 farmers coping with water scarcity particularly in rice fields. Another coping strategy was the
252 planting of drought tolerant crops/varieties like sweet potatoes, cassava, and planting early
253 maturing varieties of maize and beans. Others local coping strategies include engagement in
254 alternative enterprises that are not climate dependent such as raising and selling chickens. In
255 some places local people are planting new fruit trees that were not grown in the past, such as

256 mangoes, avocados, and pineapples. It was reported that as a result of increased temperature
257 these fruit trees now flourish well, a situation that wouldn't be possible in due to the cold
258 temperatures of the past. Banana trees are also grown nowadays in places that were not
259 producing such a crop only a few decades ago. To cope with risks related to climate change
260 impacts, some farmers are now relying on planting crops which were in the past considered to
261 be for the warmer and drier areas because they now seem to do fairly well due to the
262 changing climate. Crops such as cashew nuts, onions, sunflowers, and pepper are nowadays
263 commonly produced in the area. Other farmers also reported to practice fallow where they
264 abandon their farms for a while to allow for natural fertility regeneration and to control pests
265 and diseases. However, this is done by those with large land areas. Some practice crop
266 rotation, while others plant their crops e.g. maize very early in the season, soon after they
267 harvest beans, because they normally plant beans three times a year (in March or April, July
268 or August and in September). To assure themselves against crop failure they do mix various
269 crops together, such as maize and beans with vegetables and sweet potatoes.

270 (31) found that farm households in Kenya employed various strategies in order to cope with
271 climate related risks. The main coping responses involve purchasing additional food,
272 reducing consumption, or consuming different foods; between 37 and 63 percent of
273 respondents reported purchasing food in response to climate-related shocks. Between 11 and
274 24 percent of households reported selling livestock in response to various climate-related
275 shocks. Some households also depended on formal and informal sources of credit, social
276 safety programs, or off-farm employment to cope with climate shocks.

277 In far Coastal Orissa area of India, rural households have being found to use various coping
278 mechanisms to reduce the impact of climate change induced shocks. However as (32)
279 reported the coping mechanisms vary according to the nature of extreme events. Accordingly,
280 the strategies practiced to reduce climate change vulnerability during calamity year in the

281 study area adjustment in crop practices such as late (early) sowing of crops and use resistant
282 crop variety; adjustment in livestock management-changing livestock composition and de-
283 stocking of animals; seeking alternate employment in relief works or migration; drawing
284 down inventories (stored food grains, sale of cattle, sale or mortgage of land, sale of other
285 assets); reduced expenditures towards food consumption, clothes and festivals, education etc;
286 cases of non-payment of dues, postponed family festivals and borrowing.

287 In Upper East Region of Ghana, (33) found that farmers responses for crops in bad years are:
288 relying more on legumes than cereals, for immediate food, exchange for food and sale for
289 cash; shifting planting season; refill, transplanting and plant together; using drought tolerant
290 crops and early maturing varieties; eating crops that are premature on the field before harvest
291 is due; going out of production and selling their labour for cash for food. In the case of
292 pastoral farmers, responses were: animals are sent to areas where water and pasture are
293 available; after harvesting beans and groundnut nines are stored for them; animals are
294 allowed to roam in search of feed and water; reduction of herd size through sale; and storing
295 waste water used in the house for the animals. Other measures included multi-cropping,
296 relay-cropping and inter-cropping. Other peripheral responses include the abandonement of
297 farming to engage in other economic activities such as weaving of door mats, car mats, hand
298 bags and baskets owing to unreliability of rainfall and its consequent poor yield of produce.
299 Also, due to drying up of rivers and streams during drought years, they dug temporary wells
300 within the stream/river bed. Some non-farm coping strategies adopted included petty trading
301 and cottage industries.

302 Coming down to our country Nigeria, farm households have also been found combination of
303 strategies to cope with the effect of climatic change. (34) his study in Ondo State revealed
304 that coping strategies to mitigate effect of climate change on food crop production in
305 descending order were mixed cropping, early planting, mixed farming, off farm activities and

306 also planting of drought resistance crop. Other strategies were delay planting early
307 harvesting, mulching, constructing fire track, use of improved storage facilities, soil
308 conservation methods, increase irrigation system, increase land size cultured, reduce land size
309 cultured and moving to different location.

310 (35) in his study “assessing the vulnerability of fadama (floodplain) agriculture to climate
311 variability and change: a case study of semi-arid northern Nigeria” found that in the past, not
312 many farmers adopted strategies for coping with droughts. However, recently, after the most
313 devastating drought, farmers across the four villages sampled became more vulnerable and
314 adopted the coping strategies. The five most widely used new adaptation strategies in Zangon
315 Buhari in a descending order of importance are the use of early maturing crops, and irrigated
316 crops, keeping of livestock, culling animals, and food storage. The least newly adopted
317 strategies are use of low input varieties, herd movement, herd sedentarization, reduction in
318 herd and farm sizes, receipt of assistance from NGOs and CBOs, and abandonment of
319 activity.

320 At Barkum village, the situation was similar to that of Zangon Buhari in the past, not many
321 farmers adopted the strategies for coping with droughts until the most recent devastating
322 drought before farmers started adopting coping strategies. The five most widely used new
323 adaptation strategies in a descending order of importance are early maturing crops, irrigated
324 crops, drought resistant crop varieties, livestock diversification, and food storage. The least
325 newly adopted strategies are herd movement, herd supplementation, herd sedentarization,
326 labour migration, reduction in herd/farm sizes, and water storage methods. In Matsa, on the
327 other hand, in the past, very few farmers adopted coping strategies. But with the most
328 devastating drought, their attitude changed as they began to adopted some coping strategies.
329 The five most widely used new adaptation strategies in a descending order of importance are
330 early maturing crops, irrigated crops, crop diversification, low input varieties, and culling

331 animals. The least newly adopted strategies are replanting, herd movement, water use
332 changes, herd sedentarization, reduction in herd/farm sizes, and water storage methods.
333 While in Gamsarka-Zimoni village, in the past (earlier than 10 years ago), there was virtually
334 no adaptation of strategies for coping with droughts by farmers. They too had to adopt some
335 coping strategies with the most recent devastating drought. The five most widely used new
336 adaptation strategies in a descending order of importance are irrigated crops, early maturing
337 crops, drought resistant crop varieties, crop diversification, and food storage. The least newly
338 adopted strategies are replanting, herd movement, herd supplementation, water use changes,
339 herd sedentarization, water storage methods, and assistance from NGOs/CBOs (35).

340 **Concluding Remarks and Policy Implications**

341 The coping strategies adopted by farm households suggest that actions constantly changes
342 with different situations. It is important to note that not all strategies to cope with hazards are
343 efficient or appropriate for long term adaptation. Some strategies, based on short-term
344 considerations, survival needs, lack of information or imperfect foresight, can worsen
345 environmental degradation and thereby diminish future adaptive capacity and livelihood
346 options (36). The sustainability of different coping strategies also depends on the intensity,
347 duration and frequency of the hazard. The major threat to most of the coping strategies is
348 their lack of sustainability in the face of current and projected climate change impacts which
349 will lead to ecosystem degradation and loss of goods and services from the natural resources
350 on which community depends on.

351 Also, most of the coping strategies are mostly based on the use of natural resources and their
352 sustainability under a changing environment is questionable. Hence, there is an urgent need
353 to find sustainable alternative livelihood strategies of life that would only be possible through
354 materialization of existing policies and programmes, allocation of resources and capacity
355 building. This further emphasizes the need for greater investments in rural and agricultural

356 development to support households' ability to make strategic long-term decisions that affect
357 their future well-being. Investments in infrastructure (such as roads and irrigation), extension
358 services, credit schemes, and climate information systems would help create the enabling
359 conditions for adaptation. Farmers also need access to essential inputs such as better seeds
360 and fertilizer, as well as other rural services supporting adaptation, such as education and
361 health services.

362 REFERENCES

- 363
364 1. Mengistu, D.K. (2011). Farmers' perception and knowledge of climate change and their
365 coping strategies to the related hazards: case study from Adiha, Central Tigray, Ethiopia.
366 *Agricultural Sciences*, 2(2):138-145. Doi10.4236/as.2011.22020.
- 367 2. Tarhule, A. and P. Lamb (2003). Climate research and seasonal forecasting for West
368 Africans: Perceptions, dissemination, and use? *Bulletin of the American Meteorological*
369 *Society*, 84: 1741-1759. doi:10.1175/BAMS-84-12-1741
- 370
371 3. Deschenes, O. and M. Greenstone (2006). The economic impacts of climate change:
372 evidence from agricultural output and random fluctuations in weather. *American Economic*
373 *Review*, 97(1):354-385.
- 374
375 4. Charles, N. and H. Rashid (2007). Micro-level analysis of farmers' adaptation to climate
376 change in Southern Africa. IFPRI Discussion Paper 00714, Washington DC, USA.
- 377
378 5. Watson, R.T., M.C. Zinyoera and R.H. Moss (1998). *The regional impacts of climate*
379 *change: An assessment of Vulnerability*, Cambridge University Press Cambridge.
- 380
381 6. IPCC (2001). Climate Change 2001: Impacts, Adaptation, and Vulnerability. Report edited
382 by McCarthy J.J. *et al.*, Contribution of Working Group II to the Third Assessment Report of
383 the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge,
384 UK.
- 385
386 7. Schlenker, W. and D.B. Lobell (2010). Robust negative impacts of climate change on
387 African agriculture. *Environmental Research Letters* 5. Doi 10.1088/1748/1/01410.
- 388
389 8. Mapfumo, P., R. Chikowo, F. Mtambanengwe, S. Adjei-Nsiah, F. Baijukya, R. Maria, A.
390 Mvula and K. Giller. (2008). Farmer's perceptions leads to experimentation and learning.
391 *LEISA* 24(4):30-31.
- 392
393 9. Mtambanengwe, F., P. Mapfumo, R. Chikowo and T. Chamboko (2012). Climate change
394 and variability: Small holder farming communities in Zimbabwe portray a varied
395 understanding. *African Crop Science Journal*, 20(2):227-241. ISSN 1021-9730/2012.
- 396

- 397
398 10. Tol, R.S., S. Fankhauser, R.G. Richel, and J.B. Smith (2000). How much damage will
399 climate change do? Recent estimates. *World Economics-Henley on Thames*, 1(4): 179-206.
400
- 401 11. McCarthy, J.J. (2001). Climate change 2001: impacts, adaptation, and vulnerability:
402 contribution of Working Group II to the third assessment report of the Intergovernmental
403 Panel on Climate Change, Cambridge University Press.
404
- 405 12. Collier, P., G. Conway and T. Venables (2008). Climate change and Africa. *Oxford*
406 *Review of Economic Policy*, 24(2):337-352.
407
- 408 13. Kurukulasuriya, P. and R. Mendelsohn (2007). *A Ricardian analysis of the impact of*
409 *climate change on African cropland*, The World Bank.
410 Accessed on 5th January, 2013. Available at: <http://ssrn.com/abstract=1005544>.
411
- 412 14. Leadership (2013). Climate Change and Agriculture in Nigeria, January 16.
413
- 414 15. Berkes, F. and D. Jolly (2001). Adapting to climate change: socio-ecological resilience in
415 a Canadian Western Arctic Community. *Conserv. Ecol.* 5 (2):18-27.
416
- 417 16. Campbell, A., (2008). Managing Australian Landscapes in a Changing Climate a Climate
418 Change Primer for Regional Natural Resource Management Bodies. *Department of Climate*
419 *Change*.
420
- 421 17. Falkenmark, M. and J. Rockström (1993). Curbing Rural Exodus from Tropical Drylands.
422 *Ambio*, 22(7):427-437.
423
- 424 18. Thomas, D., H. Osbahr, C. Twyman, N. Adger and B. Hewitson (2005). Adaptive:
425 Adaptations to climate change amongst natural resource-dependant societies in the
426 developing world: across the Southern Africa climate gradient. Tyndall Centre for Climate
427 Change Research. Technical Report 35.
428
- 429 19. Heltberg, R. and P.B. Siegel (2008). *Climate Change: Challenges for Social Protection in*
430 *Africa*. Paper for conference on social protection for the poorest in Africa. Washington DC,
431 World Bank.
432
- 433 20. Maddison, D. (2006). *The perception of and adaptation to climate change in Africa*.
434 CEEPA Discussion Paper No. 10. Centre for Environmental Economics and Policy in Africa,
435 University of Pretoria, South Africa.
436
- 437 21. Salick, B. and B. Anja eds. (2007). *Indigenous peoples and climate change*. Oxford, UK,
438 Tyndall Centre for Climate Change Research. (Available online at
439 <http://tyndall.webapp.uea.ac.uk/publications/Indigenouspeoples.pdf>).
440
- 441 22. Tesso, G., B. Emana and K. Mengistu (2012). Econometric analysis of local level
442 perception, adaptation and coping strategies to climate change induced shocks in North
443 Shewa, Ethiopia. *International Research Journal of Agricultural Science and Soil Science*
444 (ISSN: 2251-0044), 2(8):347-363.
445

- 446 23. Workineh, K. (2001). Traditional Oromo Attitudes towards the Environment:
447 AnArgument for Environmentally Sound Development. OSSREA Social Science Research
448 Report Series, No. 19. Addis Ababa: Commercial Printing Enterprise.
449 Accessed on 24th December, 2012.
450 (Available online at <http://www.ossrea.net/ssrr/workneh/toc.htm>).
- 451 24. DPPC (2000). Vulnerability profile: Strengthening emergency response abilities. Addis
452 Ababa, Ethiopia.
- 453 25. Deressa, T.T., C. Ringler, R.M. Hassan (2010). Factors Affecting the Choices of Coping
454 Strategies for Climate Extremes: The Case of Farmers in the Nile Basin of Ethiopia. IFPRI
455 Discussion Paper 01032.
456
- 457 26. Senbeta, A. F. (2009). Climate Change Impact on Livelihood, Vulnerability and Coping
458 Mechanisms: A Case Study of West-Arsi Zone, Ethiopia. MSc. Thesis Submitted to Lund
459 University Masters Program in Environmental Studies and Sustainability Science (LUMES),
460 Lund, Sweden.
461
- 462 27. Sacramento, A., A. Matavel, M.Basilio and S. Bila (n.d). Climate Change Impacts and
463 Coping Strategies in Chicualacuala District, Gaza Province, Mozambique. Joint Proqramme
464 on Environmental Mainstreaming and Adaptation to Climate change in Mozambique. MDG
465 Achievement Fund.
466
- 467 28. Kangalawe, R., S. Mwakalila, P Masolwa (2011). Climate Change Impacts, Local
468 Knowledge and Coping Strategies in the Great Ruaha River Catchment Area, Tanzania.
469 *Natural Resources*, 2: 212-223. Doi:10.4236/nr.2011.24027
- 470 29. Bryan, E., C. Ringler, B. Okoba, C. Roncoli, S. Silvestri, and M. Herrero (2011). Coping
471 with Climate Variability and Adapting to Climate Change in Kenya: Household and
472 Community Strategies and Determinants IFPRI Washington, DC.
473
- 474 30. Roy, B. C., T. Mruthyunjaya, and S. Selvarajan (2002). Vulnerability to Climate
475 Induced Natural Disasters with Special Emphasis on Coping Strategies of the Rural Poor in
476 Coastal Orissa, India1. Paper prepared for the UNFCC COP8 Conference organised by the
477 Government of India, United Nations Environment Programmes, and FICCI during October
478 23-November 1, 2002, Vigyan Bhavan, New Delhi, India.
479
- 480 31. Ofori-Sarpong, E. (2001). Impact of climate change on agriculture and farmers coping
481 strategies in the Upper East Region of Ghana. *West African Journal of Applied Ecology*,
482 2:21-35.
- 483 32. Olayemi, A.O. (2012). Determinants of climate change and coping strategies among crop
484 farmers in Ondo state, *Nigeria Agricultural Research and Reviews*, 1(4):127 – 131.
485
- 486 33. Dabi, D. D. (n.d). Assessing The Vulnerability Of *Fadama* (Floodplain) Agriculture To
487 Climate Variability And Change: A Case Study Of Semi-Arid Northern Nigeria.
488
- 489 34. Eriksen, S. (2001). Linkages between climate change and desertification in East Africa.
490 Part I: Physical and social linkages. *Arid Lands Newsletter*, 2001 (49).