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CLIMATE CHANGE AND CROP PRODUCTION IN RURAL MAKHADO LOCAL MUNICIPALITY: ASSESSING THE EFFECTS ON HOUSEHOLD SELF-PROVISIONING DURING PRE AND POST 1990 PERIOD

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─Abstract ─

Many rural households across the globe are known to survive through self-provisioning food production systems. Majority of these households produce agricultural products such as crops and rear Livestock. Over the years, rural household dwellers, particularly those in developing countries have consistently produced enough subsistence food to survive even through tougher economic periods. However, in recent times it is evident that climate change has emerged as one of the most challenging aspects rural household food producers have to deal with. For instance, many food products produced by rural households have been affected and destroyed by different indicators of climate change such as floods; drought and heat waves. The vulnerability context of these households has left them unable to cope, recover and/or produce own crops after a natural hazard occurred. The purpose of this paper is to assess the effects of climate change on crop production with regard to household food self-provisioning in pre and post 1990 period. 30 villages found in Makhado Local Municipality are used for household's questionnaire survey, key informants were interviewed and different patterns of production process, geo-spatial features and settlements patterns were observed. The data analysis results reflect that different households within the municipality experience a variety of effects of climate change in terms of crop production processes in pre and post 1990 period. There is a huge decline in household food production activities and harvest outputs in the post-1990 period. The paper concludes that there are visible negative impacts of climate change within villages in Makhado Local Municipality in the post 1990 period compared

to pre 1990, which are undermining the efforts of households to produce crops for subsistence use.

Key Words: *Climate change, crop production, household self-provisioning, Makhado local municipality*

JEL Classification: Q12, Q54, Q56

1. INTRODUCTION

Climate change is one of the most significant stressor affecting food production systems of many rural areas in recent times. Climate change imposes a variety of direct effects on crop production (for instance, changes in rainfall leading to drought or flooding, or warmer or cooler temperature leading to changes in the length of growing season) and indirect effects such as changes in markets, food prices and supply chain infrastructure (Rosegrant & Cline, 2003; Barnet & Adger, 2007; Brahmbhatt & Christiaensen, 2008). In warmer or tropical environment, climate change has resulted in more intense rainfall events between prolonged dry periods, as well as reduced or more variable water resources for irrigation. Such conditions have promoted pests and diseases on crops and livestock, as well as soil erosion and desertification. Particularly in rural Southern Africa, the short and long-term climate and environmental stressors are found to be endemic to the food production livelihoods and practices (Speth, 1993). Hence, many rural households' food systems have failed to deliver food security because the related determinants and/or the links between them are disrupted by climate change and other climate related stressors. Two categories of occurrence (natural and human processes) namely floods and droughts are virtually universally accepted to be the primary indicators of climate change. Barnet & Adger (2007) stated that, floods and droughts have continuously destabilized the poor household's food production, clean water, energy supply and environmental health, amongst others. The paper commences by providing a theoretical discussion on the effects of climate change on crop production. Secondly the paper looks at the methodology adopted for the study. The third section focuses on the empirical data results and discussion where both qualitative and quantitative data is analysed and discussed. The paper concludes by proposing different climate change adaptation strategies for the poor household's subsistence farmers in rural Makhado Local Municipality and the rest of South Africa.

2. CLIMATE CHANGE EFFECTS ON CROP PRODUCTION FOR HOUSEHOLD SELF-PROVISIONING

Crop production is one of the major and most practiced food security livelihoods in rural areas; however, it has been diminishing in recent years. Recently, crop production in rural areas has been characterised by very low yield due to lack of irrigation supplements, limited use of fertilizers and other climate related complications (Calzadilla, Zhu, Rehdans, Tol & Ringler, 2009; Tshiala &

Olwoch, 2010; Rowhani, Lobell, Linderman & Ramankulty, 2011). For example, the poor productivity of African agriculture is the reflection of its comparatively low input use. Very little of cropland area (6%) is irrigated in Africa. Fertilizer use is also sparse, averaging only around 18 kilogram per hector of cropland; whereas average fertilizer usage is much higher in other developing regions, and has increased since the early 1980s, the rate of application on Africa's cropland has hardly changed (Barbier, 2000). Crop production is rain-dependent in most of rural areas and when rain is scares, the households usually have minimal harvesting (Barbier, 2000; Tshiala & Olwoch, 2010). The productivity of this practice which is mostly subsistence has been less of a success leading to high prevalence of hunger and malnutrition in rural areas. The problems associated with household crop production are reinforced by the fact that farmers with low incomes and few resources have continued their unsustainable cropping activities which deplete soil fertility, causes erosion and environmental degradation (Heerink, 2005). Some of the major food crop produced by households includes maize, sorghum, potatoes, beans and vegetables. These products are produced by households and smallholder farmers with the intention of either home consumption and/or sale in the local markets (Rowhani et al., 2011). However, one of the major challenges to limit crop production in recent times is unprecedented effects of climate change.

Extraordinary climatic conditions have contributed excessively on the limited success of crop production in rural areas. According to Olesen & Bindi (2002), the crops produced by households particularly in rural areas are vulnerable to excessive heat that ultimately destroys them. With an increase in use of less improved seeds, pest attacks and weed infestation, the heat and drier soil conditions in these areas increase the vulnerability of crops to wind erosion and evapotranspiration. Also, low use of fertilizer across Africa is a major cause of concern, both from the food production and environmental perspective (Rowhani et al., 2011). The crops are significantly affected by climatic variables because photosynthetic active radiation, air temperature and water are the driving forces for crop growth (Abraha & Savage, 2006). Meteorological variables, including rising temperatures, changing precipitation regimes, and increased atmospheric carbon dioxide levels are some of the critical elements affecting these crops. Moreover, Calzadilla et al. (2009) highlighted that the increase in atmospheric carbon dioxide concentration and changes in associated climatic variables will

likely have a major influence on regional as well as international crop production and ultimately on food security in rural areas.

The incidents of crop failure are common in rural areas. Miraglia, Marvin, Kleter, Battilani, Brera, Coni, Cubadda, Croci, De Santis, Dekkers, Filippi, Hutjes, Noordam, Pisante, Piva, Nyssen, Poesen, & Deckers (2009) wrote that, crop failure has decreased yields of spring-sown crops such as maize, sunflowers, and soybean. Higher temperatures and a greater incidence and intensity of extreme weather have led not only to significant modifications in crop systems and yield, but also to an expanding range of crop pests and altered transmission dynamics of challenges, which has exacerbated the yield reduction and impaired food safety (Hahn, Riederer & Foster, 2009; Miraglia et al., 2009). For example, the increase of temperature limits crop yield by accelerating the plant development, affecting the floral organs and fruit formation and the functioning of the photosynthetic apparatus (Tshiala & Olwoch, 2010). Climate change effects on many rural situations also influence the decrease in the amount of yearly precipitation, prolonged dry periods and projected temperature increases (Khandlhela & May, 2006; Hahn et al., 2009; Miraglia et al., 2009). This process ultimately alters and enforces faster growing periods and shorter lifecycles. And if the timing and length of growing seasons is shifted or there are possible alteration of the planting and even harvesting period's, such will ultimately reinforce the need to change crop varieties used in a particular area. Unfortunately, many households such as those in the study area of Makhado Local Municipality do not have resources and inputs to cope when these changes are occurring. Moreover, such households are vulnerable to hunger and malnutrition.

3. METHODOLOGY

Makhado Local Municipality is one of the four municipalities in Vhembe District Municipality of Limpopo Province. The municipality consists of five formal towns, namely, Louis Trichards, Vleifontein, Vuwani, Waterval and Dzanani; and, a total of 279 rural tribal villages (Makhado Local Municipality, 2010). The study excluded the five formal towns and focused only on the 279 rural tribal villages. It is estimated that the municipality has about 134 889 households distributed among the 279 rural tribal villages and five towns (Makhado Local Municipality, 2010). Historically, households used to be self-reliant and self-sufficient in their production of food related to crops such as maize, sorghum and ground nuts. Presently, most households can barely produce adequate quantities of

food from crops. For this reason, the study determines the linkages between climate change and food production in this municipality. Qualitative research method was applied to solicit information from the respondents is such a way that they provide thorough descriptions of events about change in rainfall patterns, climatic condition, food production processes, types of crops and livestock and other environmental challenges. The target population for the study consisted of three categories in the Makhado Local Municipality which are: households in the study area, key informants and government officials who are involved with issues of environmental management, climate change or food production. Households provided information on different food production methods, types and volumes of crops they produce and livestock they farm, as well as their opinions on the effects of climate change on their food production systems. The other categories of the targeted population that include key informants and government officials in the municipality provided information on the community-wide food production processes, challenges and historical trends of environmental conditions and climatic patterns, as well as interventions made in the study area over time. It was practically impossible to study the entire target population of 279 villages and the corresponding households, as well as all government officials and elders from the rural Makhado Local Municipality. For the selection of households, a simple random sampling technique was used to select 30 villages from 279 which are found in the municipality. The 30 villages were selected using a random number table from a sampling frame that consisted of all the 279 villages arranged in alphabetic order according to their names. Purposive sampling was used to select 183 households from 9 of the 30 villages for questionnaire surveys. Additionally, another set of 9 villages was used to establish one focus group and in-depth interviews. The remaining 12 villages were used for observations of different production trends and settlements patterns were also conducted. That is, the questionnaire survey was conducted in 9 villages, interviews and focus groups were with different key informants from another 9 villages and observations were conducted in the remaining 12 villages.

4. EMPIRICAL DATA RESULTS AND DISCUSSION

The study results show that majority of households in rural Makhado municipality are affected by many challenges associated with climate change post 1990 compared to pre 1990. The majority of households in these areas are no longer able to produce enough food from their own production activities. Concurrently,

some of the households have abandoned their crop production activities and are relatively vulnerable to food insecurity.

4.1 Challenges Associated with Crop Production Process in the Pre- and Post-1990 Eras

In the pre-1990 period, a reasonable percentage (34%) of respondents indicated that pests attack was one of greatest challenges that they faced when practicing crop production. Locusts and worms ate crops in the period around 1940s. One of the reasons was that as subsistence poor farmers, they did not have access to pest control mechanism like commercial farmers. A marginal proportion of respondents highlighted floods as one of the major challenges that they faced. Low rainfall was also mentioned by a lower percentage (11%) of respondents. Drought and unfertile soil conditions were also named by an even lesser proportions of the respondents constituting 10% and 6%, respectively. 12% of respondents did not practice crop production in the pre-1990 period. The impact of most of these factors was minimal because they occurred once in a while and households were still able to harvest enough crops. However, in the post-1990 era, low rainfall and unfertile land dominated the factors impacting on household crop production according to 27% and 19% of respondents, respectively. Some respondents highlighted that their crop production efforts declined drastically because of limited rainfall which has been experienced in recent years. Also, the land they relied on for crop production has been damaged and degraded because of extreme heat and soil erosion during heavy rains. These observations affirm the theoretical positioning, as reflected above, to the effect that rain-fed agricultural crop production is the only option rural households could exercise. Given the current evidence of limited precipitation and extreme drought conditions, rural households' food production efforts would be unavoidably compromised. Some of the better-off households have resorted to building boreholes in order to have enough water to irrigate their crops and to provide for their livestock. A lower proportion (18%) of respondents mentioned that the continuous episodes of drought in recent years have rendered their effort to produce crops difficult. Furthermore, 10% and 8% of respondents, respectively, identified floods and pest attack as the main challenges they have been facing in the post-1990 period; and, 18% of respondents stated that their households are no longer producing any crops in the post-1990 period.

Table 1: Proportion of the Main Challenges Associated with Household Crop Production Process in the Pre- and Post-1990 Period

Variables	Pre 1990	Post 1990
Floods	27 %	10%
Pest attacks	34%	8%
Low Rainfall	11%	27%
Unfertile Soil	6%	19%
Drought	10%	18%
Not Applicable	12%	18%
T0TAL	**100%**	**100%**

The above results were supported by a number of key informants who stated that, there were few challenges related to crop production in the pre-1990 era. Those respondents whose households practiced crop farming along rivers in Elim Village, for example, established water catchment schemes to guarantee water supplies during dry seasons. However, drought was experienced in most regions in the municipality around 1983 where households lost significant volumes of crops just before harvest. However, the post-1990 period has been generally characterised by numerous challenges pertaining to crop production, including water shortage, limited agricultural land, infertile soil and low rainfall, amongst others. The problem of water has been the most prominent, affecting food production for most households according to key informants. This observation is in line with the theoretical proposition linking water problems with many aspects of rural life support systems in recent times, inclusive of natural habitats, ecosystems, economic and social as well as agriculture and transportation (Farooq, Wahid, Kobayashi, Fujita & Basra, 2009). Furthermore, extreme land degradation occasioned, among other things, by soil erosion and extreme heat was mentioned as one of the major challenges in the post-1990 era.

4.2 Household Crop Yield: Pre- and Post-1990

The majority of household respondents (65%) mentioned that the crop yields were enough in the pre- 1990 era. For example, every household harvested tons of maize in each production season. The harvest catered for the household food requirements beyond four seasons of the year. A negligible proportion (12%) of respondents stated that they were not sure if the crop yields were enough, whereas, similarly a negligible proportion (11%) mentioned that the crop yields were not enough in the pre-1990 period. Furthermore, 12% of the respondents mentioned that the households are no longer practicing crop production.

Unfortunately, there has been a drastic change on the crop yields in the post-1990 era. The majority of household respondents (54%) stated that the crop yields have declined in the post-1990 era. Some of the reasons for this decline include limited access to fertile land for production and lack of rainfall and/or water for irrigation. A negligible proportion of respondents (16%) mentioned that they were not sure if the crop yields were enough in the post-1990 era, whereas, a further negligible proportion (12%) of the respondents mentioned that the crop yields were not enough. Most of the households who still get enough crop yields are those who have established boreholes and irrigate the crops in their yards. Ironically, only the better-off households have boreholes which enables them to irrigate the crops in comparison with the poor households who practiced food production for survival and do not have access to water. A less significant proportion of respondents (18%) mentioned that the households have abandoned crop production activities in the post- 1990 era.

Table 2: The proportion of the Crops Yields the Household Produced in the Pre- and Post-1990 Period

Variables	Pre 1990	Post 1990
Enough crop yields	65 %	12%
Neither/Nor	12%	16%
Not enough crop yields	11%	54%
Not Applicable	12%	18%
T0TAL	**100%**	**100%**

In terms of community wide levels of crop yields as outlined by the key informants, the majority of households produced more than enough crops to sustain the households' food requirements throughout the seasons in the pre-1990 era. For example, one of the key informants mentioned that in Mashau Doli Village, households harvested on average 200 kilograms of ground nuts each year. Interestingly, most of the harvest made was only used for subsistence purpose and at times shared with friends and relatives. Due to the high levels of crop yields, most households built different traditional storage facilities such as Nkundla/Dulu (Xitsonga/Tshivenda) to store and protect the crops. Some of these facilities were built strategically underground inside a house where the household made fire and other storages were built outside on top of rocks. The reason for this specific building measure was to protect crops from insects and small animals such as rats. Different crops produced by households were used to cook different kinds of traditional foods such as Tshidzimba (Tshivenda) which was prepared using a

mixture of maize, beans and ground nuts. However, the key informant asserts that the level of crop yields have declined in the post-1990 era. The circumstances surrounding this decline was affirmed by Parry, Rosenzweig, Iglesias, Livermore & Fischer, (2004) and Abraha & Savage (2006) who argued that the higher temperatures and changing precipitation levels resulting from climate change are depressing crop yields and causing limited harvest especially in most low-income countries, where adaptive capacity is low. Currently, few households are still practicing crop production with a noticeable limited harvest. However, Most of the households are currently bound to purchase staple food such as maize meal from retailers in order to supplement the limited crop yield that they harvest. Contrary to the current situation, pre-1990 period households produced a variety of crops while in post-1990 for example, only maize crops and beans are dominantly produced.

4.3 Soil Conditions at Household Food Production Sites, Pre- and Post-1990

One of the most important aspects which determines the success and lack thereof of crop production particularly in rural areas is the soil conditions in the site where crops are produced. In this instance, the majority of respondents (68%) stated that in the pre-1990 period, the soil was very fertile in the site where they produced food. A variety of food products where produced in abundance in these sites without the use of any soil enhancement.

Table 3: Soil Conditions at Household Food Production Sites, Pre-and Post-1990

Variables	Pre 1990	Post 1990
Fertile Soil	68 %	23%
Neither/Nor	9%	15%
Infertile Soil	17%	49%
Not Applicable	6%	13%
T0TAL	**100%**	**100%**

A less significant proportion (17%) mentioned that the soil in the site where they produced food was infertile, whilst, only a negligible proportion (9%) of the respondents stated that they were not sure if the soil was fertile or not. Similarly, a negligible proportion (6%) of respondents did not practice food production activities in the pre-1990 period. In the post-1990 period, the soil condition changed drastically at some of the villages of rural Makhado Local Municipality. A significant proportion (49%) of respondents mentioned that the condition of the soil in the site where they produce food was no longer fertile. Most of these

respondents were from poor households who were practicing food production activities for survival and who are largely dependent on this process for food security. This circumstance affirms what Yesuf, Di Falco, Deressa, Ringler & Kohlin (2008) stated when he said that, the intensification of agricultural production for survival has led to natural resource degradation, as desperate poor farmers, who mine soil fertility climb the hillsides in an effort to survive. However, a less significant proportion (23%) of respondents stated that the soil in the site where they produce food was fertile. Similarly, a less significant proportion (15%) of respondents mentioned that they were not sure if the soil was fertile or not. Only 13% of the respondents are those who were not practicing food production in the post-1990 era.

4.4 General Climatic Conditions in the Pre- and Post-1990 Period

In the pre-1990 period, the majority of household respondents (55%) mentioned that the climatic conditions of the site where they produced food were wet (Figure 5.13). This circumstance was due to the fact that the area experienced enough reliable precipitation. Crops such as maize and ground nuts had enough water and produced a successful harvest almost every year. However, a less significant proportion (27%) of respondents mentioned that the climatic conditions in the site where they produced food were dry. Nevertheless, they were still able to have successful harvest because the soil was fertile. A negligible proportion (7%) of respondents stated that the climatic conditions were humid, whereas, a further negligible proportion (5%) of respondents mentioned the combination of dry and wet conditions in the same area. Additionally, negligible proportions (6%) of the respondents were those who did not practice any food production activities in the pre-1990 period.

Table 4: General Climatic Conditions at Household Food Production Sites, Pre- and Post-1990

Variables	Pre 1990	Post 1990
Wet Conditions	55 %	7%
Dry Conditions	27%	50%
Humid Conditions	7%	24%
Others	5%	6%
Not Applicable	6%	13%
T0TAL	**100%**	**100%**

The situation shifted significantly in the post-1990 era as it was demonstrated by the significant proportion (50%) of respondents that most areas which experienced wet climatic conditions in the period pre-1990 started to experience more dry conditions in the post-1990 period. These changes led to a noticeable decline in household food production and ultimately exposed some households to food insecurity. This scenario affirms what Khandlhela & May (2006), Hahn et al. (2009) and Miraglia et al.(2009) argued when they said that, climate change effects on many rural situations influences the decrease in the amount of yearly precipitation, prolonged dry periods and projected temperature increases which ultimately have a long impact of food production in rural areas. A negligible proportion (7%) of respondents stated that they experienced wet climatic conditions, whilst, a similar negligible proportion (7%) of respondents mentioned that they experienced humid conditions. Additionally, only 13% are those households who did not practice food production in the post-1990 era.

4.5 Conduciveness of Climatic Conditions for Crop Production, Pre- and Post- 1990 Period

The climatic conditions were good for food production in the pre-1990 period: the majority of respondents (67%) mentioned that such conditions were conducive. The conduciveness of these conditions enabled households not only to produce enough crops to survive but also to store and consume during and after the year of harvest. A negligible proportion (12%) of respondents mentioned that they were not sure if the conditions were conducive or not. Most of these households are those who experienced a fluctuation of different kinds of climatic conditions. Additionally, a negligible percentage of 9% and 12% of respondents stated that the climatic conditions were not conducive and the other respondents were not practicing food production activities in the pre-1990 period respectively.

Table 5: Perceptions of Conduciveness of Climatic Conditions at Sites of Household Crop Production, Pre- and Post-1990

Variables	Pre 1990	Post 1990
Conducive Climate	67 %	21%
Neither/Nor	12%	16%
Not Conducive Climate	9%	45%
Not Applicable	12%	18%
T0TAL	**100%**	**100%**

In the post-1990 era, a relatively significant proportion (45%) of respondents mentioned that the climatic conditions were less conducive for crop production. This was due to the fact that rainy seasons have shifted and most of the rivers have dried up. Furthermore, there were excessive episodes of crop failure due to extreme heat waves. This situation affirms Fraser (2006) assertion that, climate induced natural hazards such as drought has been more than just a simple lack of rainfall: it has negatively impacted the process of cultivating crops in such a way that the majority of rural residence are becoming food insecure. A less significant proportion (21%) of respondents stated that the climatic conditions were conducive, whereas, a negligible proportion (16%) of respondents mentioned that they were not sure if the conditions were conducive or not. Additionally a less significant proportion (18%) of respondents was those who have abandoned food production practices in the post-1990 era.

5. CONCLUSION

It is evident from the discussion above that climate change has negative effects on the production processes of the majority of households in Rural Makhado Local Municipalities. Climate change indicators such as heat waves and erratic rainfall causes a major challenge to the households in these areas whose food production systems are for subsistence use. One interesting observation from the study has been that because of lack of enough rainfall, better-off households have turned into establishing boreholes to access ground water, and such arrangements have allowed them to continue producing a minimum amount of food in their yards. However, poor households who desperately depend of self-production for survival are unable to access alternative water sources than rain because of the limitation of financial resources. Given these climate change-related misfortunes, many households in rural Makhado Local Municipality are now vulnerable to food insecurity and are thus required to diversify to other socio-economic avenues with opportunities to get income and access adequate food. There is a need to introduce other food production and income earning activities beyond agriculture in order that households can rely on different food security portfolios such as rural entrepreneurship, tourism activities and income and food production projects.

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