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ENHANCING AGRICULTURAL INNOVATIONS SYSTEMS AND CLIMATE CHANGE ADAPTATION IN SEMI-ARID REGIONS. A CASE OF LUPANE DISTRICT, ZIMBABWE

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ABSTRACT

Climate change in Zimbabwe presents new challenges for agriculture, particularly for resettled smallholder farmers who continue to be the mainstay of food production. Food insecurity in rural households in the semi arid regions have exposed the structural vulnerability of agri-food systems, highlighting climate change as just one of a complex set of environmental, demographic, social and economic drivers generating instability and food insecurity. The impact of which disproportionately affects poorer groups in marginal environments. This paper draws lessons from Lupane district on adaptation and innovation in pursuit of food security. It reviews three cases of systems of innovation operating in contrasting regional, socio-economic and agro-ecologicalcontexts, in terms of four features of innovation systems more likely to build, sustain or enhance foodsecurity in situations of rapid change. The study utilized a qualitative methodology which was informed by the constructivist philosophy. The research relied on participatory rural appraisal technique to gather primary data, where focus group discussions and face-to-face interviews were carried out. This study noted that, most respondents in the study area were farmers; and have been experiencing changes in rainfall amount and increasing temperature in the past 20 years. In line with these changes, farmers at the local context have been able to adopt new adaptation strategies such as the use of improved seed varieties and application of farm yard manure. Among other factors, such innovations contributed to an improvement in crop yield. Therefore, collective efforts involving different actors are needed to enhance adaptive capacity of smallholder farmers who in most cases have inadequate information on appropriate farming practices relevant to climate change adaptation.

Key Words - Strengthening, Agricultural Innovation Systems, Semi Arid Regions

1.0 Introduction

Farmers have practiced agriculture virtually in almost all climatic zones on earth and have developed a rich tapestry of humaneenvironment relations (Conway, 2005). History shows that farmers and their supporting institutions have been successful in introducing technological

measures to respond and adapt to environmental and socioeconomic challenges. Variation in climatic resources, across space and time, has also spurred innovations in agricultural technologies and has been an integral part of agricultural development (Brush & Turner, 1987). However, the numerous factors that drives innovation makes it extremely difficult to detect and attribute the impacts that climate has on agricultural technology. Yet understanding the interaction between farmers and their supporting institutions is a useful precursor to understanding the importance of technology in the process of adaptation to climate change. In the future innovation and deployment of agricultural technologies will largely shape how well farmers adapt to climate change (Berdegue, 2005). The role of technology in adaptation to climate change is even more crucial in developing countries where food security remain a struggle for significant portion of the population and impending climate change is expected to make it even worse (Devereux, 2007).

A large body of literature establishes that capacity to respond to changing climate depends on knowledge flow through a broad range of institutions including farmers' interactions among themselves and with vulnerable communities (Agrawal, 2008) and the ability of private, public, and civil society institutions to act collectively at multiple scales (Adger, Huq, Brown, Conway and Hulme, 2003; Lasco, Cruz, Pulhin, &Pulhin, 2006). Innovation of technologies at the local level is crucial for enhancing adaptive capacity of farmers. Some of this knowledge is tacit, demanding interaction between farmers, operating at a specific climatic conditions, and their supporting institutions, while the others are scientific knowledge embedded in the institutions that are designed to minimize uncertainties at the decision level (Berdegue, 2005). Yet, much of what is known about the process of technological innovations in agriculture and the role of institutions in it has yet to be captured in the discussions of climate change adaptation. This is partly because appropriate methodologies to study these issues are limited in scope. The role of climate as a driver of technological innovations and the part that institutions play in integrating it into these innovations has been poorly understood (Rosenberg, 1992).

The study sought to answer the following questions;

- What are the community perceptions of social, economic and environmental dynamics in Lupane district?

- How vulnerable is Lupane district to climate change?
- What agricultural innovation systems have been developed by the populace in Lupane district?
- Are agricultural innovation systems being utilized in Lupane district?

2.0 Research Methodology

The study was carried out as follows;

2.1 Study Area and Population

The study was carried out in Lupane district. Two wards in Lupane district were purposively sampled to take part in the study. The selected villages for the study were Gundwane and Kana. The map below show the location of Jotsholo, Lupane district.

Map Showing Lupane district - (ZIMVAC, 2015)

2.2 Data Collection Methods

The study utilized a qualitative methodology which was informed by the constructivist philosophy. The research relied on participatory rural appraisal technique to gather primary data,

where focus group discussions and face-to-face interviews which were carried out. The data collection techniques were useful for triangulation purposes (Kelly, 2009). The study employed two focus group discussions which were used to bring stakeholders on agricultural innovation systems and food security in the two villages. Participants in the focus group discussions were purposively sampled and they comprised of farmers, traditional and spiritual leaders. The groups were also gender sensitive as they included men and women in the study (Mary, 2009). Efforts were also made to ensure that various stakeholders in their different affiliations were part of the study.

The study also utilized semi-structured interviews with key informants which included the forestry expert, two extension service workers and two nongovernmental workers who were also purposively sampled to take part in the study. Photographs were taken as part of the observation process in Lupane district.

3.0 Findings

3.1 Community Perceptions of Social, Economic and Environmental Dynamics in Lupane district

The series of group discussions in the different areas on the dynamics of socio-economic and environmentpatterns in Lupane district indicate that some are increasing ordecreasingtrend, while others are fluctuating. The study noted that there is increasing trend in drought, diseases (human and livestock) and land degradation (Clark, 2002). Similarly components like forest biodiversity, livestock mobility,crop production and role of customary institutions were explored on. Generally the factors are not mutually exclusive and climate change is only one of many drivers of changes in the local community.

Moreover, the increasing and decreasing trend implies agriculture is under a big threat with the wider range of vulnerabilityand decline of resilience to climate change (FAO, 2009). However, mobile agriculture is in a better position to resilience than the agro-pastoralist mainly due to access to wider rangelands and diversity of livestock.Similarly the increase of water points is unevenly distributed and biased to agro-pastoral areas. The concentrated water points attract

many livestock beyond the local boundary under the principles of reciprocity and this attributes to overgrazing, land degradation and spread of livestock diseases (Batchelor, 2002).

Regarding the opportunities and challenges the participants reflectedon the following opinions;

> "The construction of the dam in our locality helps to produce some irrigated vegetables for consumption and sale. However, when the neighboring communities are facing shortage of water for their livestock they consume the water from our dam (reciprocity) and irrigation becomes unreliable"

Another participant was of the view that;

> " we plant some improved seed varieties annually but usually the rain fails in the middle of the growing period and we harvest some biomas if not grain"

On the other hand another participant noted that;

> "I have four wives and seventeen children,one of my wives is in the bush with some goats and cows and my second wife is in this village. Some of the children are also sent to school. The split of the family under the two locations has helped to complement, diversifylivelihood and maximizing the opportunities"

Another participant in FGD 1 noted that;

> "After we lost gradually our livestock due to drought and disease in the last five years, we migrate with our three children tothe town. Our clan has allocated us with a small land for settlement and some fodder production. Myhusband is generating income from charcoal sale while I am engaged on sale"

Generally the water development that does not consider spatial distribution across Lupane district with the strategy of reciprocity has become a threat than opportunity for the locality. Similarly the land security issue, expansion of settlements and marginalization of the customary institutions are the fundamental causes of conflicts and vulnerability to the impact of climate change (de Groote, 2005).

3.2 Lupanedistrict's Vulnerability to Climate Change

The community in the study area is heterogeneous in wealth, power and accesses to natural resource bases, hence their vulnerability to climate change and adaptations are also variable. Usually the landless, women heads and the elderly and children are the most vulnerable to

climate vulnerability mainly due to limited access to resources and range of options.Generally the vulnerability indicators of the pastoral community can be broadly classified as follows;

3.2.1 Type of animal ownership

Those who dominantly rear cattle and sheep are more vulnerable than pastoralist dominantly rearing pigs and goats that have resilience to shortage of water better access to wider range of options for pastures (FAS, 2009). Moreover, cattle assures continuous supply of milk for consumption, sale and for transportation of commodities and water. However, it will be a challenge how such browsers with long threshold of mobility will adapt to the expansion of private enclosures (Ghosh, 2010).

3.2.2 Clan membership

In the study area the dominate clan is Ncube with many sub-clans yet during any livelihood crisis the herders belonging to the majority has more access to the social safety net (livestock contribution and access to food and cash) than the minority. When a member of the sub-clan lost his/her livestock due to drought and diseases usually the better-off contribute small shoots and milking cows or camel to the family until they recover and restock (Hall, 2007). Unfortunately due to the prolonged drought many of the better-off are also losing their livestock assets and forced to depend on relief support.

In a interview a participant noted that;

> " ..... totems work so much as a safety net during the period of drought and hence for those linked to popular totems have brilliant safety nets ...."

3.2.3 Land ownership

The size of land ownership is also a fundamental indicator for vulnerability in semi arid regions. Those farmers with big land enclosures who are not necessarily dropouts are consuming pasture in Lupanefor their own livestock and fodder sale (Haggblade, 2009). They also rent the land for others to graze their livestock. Some have more than two or more plots of land at different locations, while the poor dropouts have very small plot and some without any plot. For example many farmers coming from other areas due to drought and some cooperatives dealing with

livestock fattening are renting such private plots for pasture. However, the land ownership model in Zimbabwe where farmers have no security of tenure. One participant was of the view that;

> " land rights and their lack of tenure have increasing out comes to the foundation of agriculture including communality, mobility, reciprocity and sustainability"

3.2.4 Membership in self-help or cooperatives

Initially NGOs like Oxfam and World Vision play fundamental role in the establishment of self-help and cooperatives in Lupane district area for decades. Gradually the government is supporting these initiatives. Most of the self-help groups and cooperatives are engaged on dairy farming, livestock fatting, and establishment of small shops and sale of vegetables (Haddad, 2009). Some are exporting goats abroad. Usually the group formation is dominated by women and strong among the agro-pastoral areas and gradually diffusing to the pastoral areas. One participant in focus group discussions noted that;

> "Members of the cooperatives have multiple advantages including information on different business opportunities, savings and access to credit, diversification of livelihoods, access to different types of training by government and NGOs. Relatively they are having strong resilience to climate change and other pressures"

3.2.5 Livelihood engagement

Usually the poor and the middle income Agro-pastoralists are engaged on charcoal making and some are organized in a self-help groups. These charcoal makers have to travel long distance due to the continuous deforestation and conflict with the local pastoral community who are losing their rangelands due to deforestation and land degradation (Foder, 2004). Generally the deforestation compounded with the prolonged drought brought both the pastoralist and agro-pastoralists in the vicious circle of poverty.

Fig 3.1 Deforestation due to Commercialization of Charcoal

3.2.6 Uptake of Agricultural Innovation Systems in Lupane district

The construction of water harvesting technologies like the Habanedam bythe NGOs and government has played fundamental role in watering the livestock and for human conceptions. Usually the designof the dam is seventy meters in width and hundredmetersin length and three meters in depth. It has also a silt trap as a package.However, in some localities the Habane dames are constructed as emergency intervention prior to upstream treatment with enclosure and afforestion, hence the Habane dame is silted. This has at least two implications; first the farmers become more vulnerable due to the defective technologyand forced to travel long distance and cover water expenses (Feder, 2004). Secondly they lose trust on the government and NGOs who brought defective technology.

One participant was of the view that;

> "... NGOs are a great source of help to us... but at times their innovations don't meet the needs of the locals people and it does not address challenges faced by farmers in the long run"

Fig 3.2 - Siltation of Dam in Lupane district

3.2.7 Farming system

Agro-pastoralists with limited mobility of livestock and high frequency of crop failure are more vulnerable to climate change than mobile pastoralists. For example some farmers in Luapne area are mobile pastoralists with no any private enclosures but communal resources with traditional rules and regulations. The community utilized the spatial and temporal variability of rangelands with diversified livestock. However, such area has attracted some of the agro-pastoralists from the private enclosures that have a double standard. The agro-pastoralists maximized from both private and communal to develop resilience to climate change while pastoralists are confronted with competition of their communal range lands from agro-pastoralists where overgrazing and decline of biodiversity becomes inevitable (Mosley, 2002). The decline of power of the customary institution and some have split their family under the two systems and become difficult to have rules and regulations on the use of communal rangelands.

3.2.8 Underestimating Local Practices

No due weight has been given to the deep rooted rationality of indigenous practices in livestock rearing and communal resource management. This has attributed to the decline of local resilience to the impact of climate change. Generally combinations of factors including access to resources, type of livelihoods and indigenous practices have influences on the vulnerability and resilience to the impact of climate change.

3.3 Agricultural Innovation Systems in the Adaption of Climate Change

Due to the continuous prevailing of risks and uncertainties farmers have been experimenting, innovating and adapting to the environment and polices changes. Accordingly in the study areas pastoralists have developed some local innovation to enforce their resilience to climate variability and other shocks as indicated below;

3.3.1 Traditional Early Warning Systems

Under the pastoralist system which is characterized by climate variability in space and time, out of necessity thecommunity has developed a wide range of traditional early warning systems. Some of the indicators are known by the community while others are confined to the specific knowledgeable elderly persons. Usually such knowledgeable people inherited it from their parents (IPCC, 2007).

3.3.2 Behavior Changes Of Domestic Animals

Through experience pastoralists have learned livestock behavior as prediction of good and bad seasons. Some of the behavior includes water and pasture demand frequency, pattern of mobility and body weight lose. Some may send to relatives in other areas immediately when they observe changes while others may take some time prior to mobility (Hawkes, 2006).

3.3.3 Astronomical

Where the knowledgeable elderly person will analyze the arrangement of stars on a specific season and time and tell the community member about the season will be good or severe drought. Both the pastoral and agro-pastoralists are still widely practicing the traditional early warnings in the absence of any alternative source of information (Jones, 2005). Usually the

information on the traditional early warning is shared through the elderly leaders of the local community. The elders select few adult and youth to investigate the rangeland conditions, water availability, prevailing of livestock diseases and security conditions in the areas they plan to move. Accordingly with the feedback of the information the community split their family and livestock and move to different directions. Accordingly the actions on the early warnings vary on the magnitude of drought and conditions of the neighboring areas.

3.4 Cooperatives as Agents of Agricultural Innovation Systems

Already there are more than 17 cooperatives around Lupane district. All cooperative members have developed a culture of savings and diversification of their economy through the credit access to the members. Significant number of the members dominantly women areengaged on petty trade, running small shops and cross border trades. Some of the cooperatives engaged on charcoal making for export have also shifted to other businesses due to the awareness of land degradation problem and risks of livelihoods of the community. In addition to the stimulation of marketing the cooperatives also serve as a destocking and restocking process during bad and good seasons (Leach, 2011). Moreover, the cooperatives are supporting school and health service developments in their locality, where many female students who use to drop out due to long distance travel and early marriages are now enjoying education and delay early marriages. The cumulative effect is ecological recovery and economic and political empowerment for better resilience to climate change and other pressures.

3.5 Uptake of Agricultural Innovation Systems In Lupane district

Literature assumes that farmers are backward and reluctant to adapt technologies, yet there are many evidences that pastoralists are adapters of best technologies. Some of the adapted and invented technologies are mentioned as follow:

3.5.1 Use water ponds for nursery and plantation

Some of the agro-pastoralists with private enclosures have constructed ponds and cover with plastic to avoid seepage. This water is used for private nursery as centre of seedling multiplication (Svodziwa, 2018). These seedlings are multi-purpose trees (pasture, medicinal,

and edible fruits). Therefore, the biodiversity improves the ecology recovery with biological conservation, soil fertility improvement, creating micro-climate and diversifying economic benefits. In other words the holistic and integrated practice attributes to develop resilience to the impact of climate change. This practice is gradually expanding among the agro-pastoralists.

Fig 3.3 - Water Ponds for Nursing Development

3.5.2 Diluting of manure

As a component of intensification of pasture and crop production some of the agro-pastoralists are using diversion ditches to harvest water from roads. Manure is accumulated on the different spots of the diversion ditches to be dissolved and transported to the pasture and crop land during the rainy season.This innovative practice is not only improve the fertility of the soil and increase the land productivity and decrease also the labour demand to transport manure to the plots (Mosley, 2002). Therefore, a fertile soil with water harvesting practice is in a better position to develop resilience to climate change.

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Fig 3.4 - Manure on the diversion ditches to be diluted during rainy season

3.5.3 Use of different animals in ploughing

Usually the agro-pastoralists are ploughing their farm plots with a pair of oxen, while the poor have no pair of oxen to plough. However, an innovative agro-pastoralist who has lost most of his livestock due to drought and diseases remains with a young cattle and single donkey has made a pair and start ploughing his farm plot (Svodziwa, 2015). This practice has multiple benefits; first by ploughing timely with the pair of different animals take an advantage of the early rain and the contour plough also helps to harvest water. Secondly it saves human labour and covers relatively bigger areas for grain and biomass production and thirdly community will take an advantage of the new technology for a better resilience to climate change.

3.5.4 Adaptation of mobile phones

The use of mobile phones has been widespread among the pastoral community. The traditional early warning information and situation analysis of the neighboring areas prior to mobility including on pasture, water and prevailing of diseaseare shared to the community with the help of mobile phones (Prasad, 2009). Similarly the mobile phone facilitates livestock market information at different market centers domestically or cross border with merchants and pastoralists.Therefore, the mobile technology ensures safe mobility and access to market information as destocking and restocking strategy on the good and bad seasons

4.0 Implications: Shaping Agricultural Innovation Systems In Semi- Arid Regions

This paper draws a number of implications from the case study. This paper is relevant to public policy, which plays a critical coordinating role even in opportunistic agricultural innovation system, but also to other actors and stakeholders in these systems (Svodziwa, 2018). Maintaining the essential continuity of focus on the well-being of those who depend on agriculture requires efforts by more than just the formal institutions of research and development and their ministries. Ensuring the consistent engagement of these public sector organizations demands political will which, in functioning democracies, can only be sustained by an aware citizenry, able to express it itself through autonomous organizations and prepared to call elected officials to account (Pontius, 2009). A free and responsible press remains a critical source of information on the health of innovation in semi arid regions (Svodziwa, 2015).

Farmer organizations and various stakeholders play important roles in agricultural innovation systems. Maintaining a consistent focus on the well-being of those dependent on agriculture is difficult when organizations control limited parts of its budget and is reliant on donors whose priorities are liable to shift (Adger, 2006). A recent study of Zimbabwe NGOs that have remained influential over a considerable period found that one of the processes that enabled them to maintain focus was harnessing their values as compasses and “litmus tests” to guide everyday and more strategic decision-making.

5.0 Conclusions

It was the purpose of this paper to understand agricultural innovation systems and food securityin semi arid regions by exploring the experiences of farmers in rural semi arid regions and the implications that this has for interventions that seek the same change. The findings, related to concepts of decision making, knowledge and innovation systems, have helped to provide new insights into innovation and knowledge generation in agricultural innovation systems in semi arid regions. It was the intention of the researcher to bridge the gap between the theoretical and the practical by providing a deeper understanding of the external and internal forces of agricultural innovation systems in semi arid regions. The research highlighted the changing nature of agriculture, including the blurring of the line between science and practice. It challenges distinctions between what is local knowledge and what is scientific, and the generators of that knowledge, and reveals the potential role that 'opportunity' plays in theoretical and policy approaches to the decision making of farmers and in creating enabling environments for innovation and food security.

This study concluded that, most respondents in the study area were farmers; and have been experiencing changes in rainfall amount and pattern and increasing temperature in the past 20 years. In line with these changes, farmers at the local context have been able to adopt new adaptation strategies such as the use of improved seed varieties and application of farm yard manure. Among other factors, such innovations contributed to an improvement in crop yield. Therefore, collective efforts involving different actors are needed to enhance adaptive capacity of smallholder farmers who in most cases have inadequate information on appropriate farming practices relevant to climate change adaptation.

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