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Review article

Pro poor research, science and technology for agricultural development in the context of climate change and variability In Southern Africa

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ABSTRACT

Due to climatic change and variability, achieving sustainability in agricultural development with emphasis on satisfying basic human needs and improving people's standard of living through enhancing food security and reducing poverty has been a challenge in Southern Africa. This discussion is a synthesis of counter productive developmental disparities in agricultural production in poor communities, focusing on issues of research, science and technology, and how these may influence agricultural development in the context of climate change. This gives possible insight on research, science and technological innovations that can be explored as strategies for agricultural development tailored made for poor communities, focusing particularly on Southern Africa. Climate change and variability is an area in which considerable uncertainty remains, especially in developing countries with implications suggesting that the future holds many types of disruption in poor communities, but no clear trends have yet been identified, whereas observations of the impact of climate change on agricultural productivity in the world's poorest people are often alarmist. Research, science and technology plays a key role in economic growth, social development, cultural enrichment and democratic empowerment. It is assumed that through the 'gender lens' an understanding of engendered research, science and technology through examination of specific gender roles, activities, responsibilities, opportunities and constraints in agricultural

production which compromise the achievement of greater equality between women and men within their spheres of interaction in agricultural production will address the fundamental issue of climate change and agricultural productivity. Gender is a socio-economic variable which can be used to analyze vulnerability and adaptive capacity of people against climate change and variability in local communities in Southern Africa. Dealing with the inevitable impact of climate change is now high on the agricultural development agenda in most developing countries. Therefore, engaging in appropriate research, climate change science and agricultural technologies targeted at poor rural people through planning adaptation and mitigation efforts can reduce the risks of climate change while accelerating progress towards food security and reducing poverty. In this discussion, it is noted that apart from appropriate research, climate change sciences and technology as some of the strategic steps that can be adopted for future viable agricultural production in the context of climate change, it may also include and not limited to the following: promotion of gender equality and equity in agricultural production in terms of resource allocation, training and gender sensitive policies. This gives room for innovative prospects for the agricultural systems of the future, supplemented by a critical look at all the major mitigation and adaptation attempts under way and what this means for research, science and technology for agricultural development. Developing countries should come up with their own resources to develop the capacity to adapt to environmental change in order to improve agricultural productivity. There is need for constant review of adaptation strategies through research, climate change science and agricultural technologies because the speed and intensity of climate change is outpacing the speed of autonomous adaptations and is threatening to overwhelm the ability of poor rural people to cope. On the other hand developing countries can use climate change policies to leverage human capacity, investment, and climate change and agricultural technology to capture large-scale pro poor mitigation opportunities, while simultaneously augmenting their agricultural development goals. It is vital that we come up with appropriate research, understand climate change science and agricultural technology that underlie the global climate talks, in order to work with poor communities to find concrete alternatives in response to the issues surrounding the climate, while heeding the demands of sustainable agricultural development.

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1. Introduction

In 2008, southern Africa had an estimated population of 135 million people; a moderate estimate has overall regional population increasing roughly 70 percent between 2010 and 2050 to about 241 million (Hachigonta, et al 2013). In this region agriculture plays an important role in pro poor farming systems, as they offer opportunities for risk coping, farm diversification and intensification, and provide significant livelihood benefits. However, the impacts of long-term climatic changes will have significant repercussions for agriculture, requiring adaptation of agricultural systems over time (Meridian Institute.

2011) reducing the overall agricultural development. Poor communities face difficulties in sustainably utilizing research output, scientific knowledge and related technologies to effectively implement agricultural development in the context of climate change and variability. Whilst, great strides have been achieved in climate change science and research on its influence on agriculture production, very little research attempts to disaggregate 'the poor' and look in detail at specific issues and implications for socially excluded groups (GSDRC, 2007). This implies that climate change will almost surely make life even harder for the world's poorest and most vulnerable populations; we must avoid restricting their capacity to adapt by limiting their options (Lybbert and Sumner, 2010). This is mainly due to dispersed and heterogeneous smallholder agricultural systems, predominance of informal markets, poor infrastructure and lack of resources to deliver information, interventions, and regulations. In addition, developing countries lack science and technology evidence base for agricultural planning and targeting developmental efforts. Shao (1996), Moyo (1995) and Muza et al., (1996) cited unreliable and/ or poorly distributed rainfall; low and unattractive prices; lack of small scale irrigation facilities; insufficient selection of suitable crop varieties, especially for the marginal areas; pest and disease problems; large post-harvest losses; poor research-extension linkages; poor supply of inputs, especially seed and fertilizers; infertile soils; and failure of the smallholder farmer to adapt to changing environments and adopt new technologies has some of the factors militating against increased agricultural productivity in smallholder agriculture in Southern Africa. The review argues that understanding of climate change variables and their impacts to agriculture production is the first step in climate change science, research and prerequisite for defining appropriate adaptive technological responses for resource poor farmers to achieve agricultural development.

2. Consideration on climate change impact in pro poor orientation research in enhancing agricultural development

Due to limited access to assets combined with physical exposure to predicted climate-related hazards, it is widely asserted that the poor will be hardest hit by the impacts of climate change because their livelihoods are most heavily dependent on natural resources and agriculture (Tanner and Mitchell, 2008). Therefore, agricultural development should aim at exploiting interdisciplinary scientific expertise and appropriate technologies to bring about step changes in pro-poor agricultural development using community research knowledge-driven and culturally relevant technological strategies that concomitantly improve agricultural productivity and thus improving individual resource poor household welfare in the context of climate change. This understanding will provide baseline climate change knowledge and inform the agricultural design and evaluation of interventions intended to strengthen the robustness agricultural production systems that build on existing formal and informal practices and contexts, implementable in dynamic poor communities settings. The thrust on agricultural research and technology development should seek to investigate the reasons why poor smallholder farmers do the things they do, and attempt to improve on them. This is a more effective strategy than the prevailing agricultural research approaches which seek to displace traditional technologies outright on the grounds that they are irrational, unscientific, primitive and backward. Develop and promote drought-tolerant and heat-tolerant crop varieties and hardy livestock. Promote intersectoral linkages and develop closer collaborations between research and extension institutions for easier and more rapid transmission of weather, climate, and agricultural information to farmers (Hachigonta, et al 2013). Research and technology on adaptive capacity related to climate change is needed in order to empower pro poor farmers to deal with climate change issues beyond what they have experienced previously. The common multipurpose use of indigenous livestock and crops by poor communities requires that correlation among the different productive traits with climatic variability be understood. Lack of insufficient understanding of climate change and its impact on local varieties of crops and livestock production and characterization of these populations are preventing progress in combating the effects of climate change in local communities. It would be a grave disservice endangering the indigenous crop varieties and livestock populations and unrecoverable loss of genetic material in the context of climate change. The research and technologies on crop and animal breeding should be more varied taking into account the existing local animal and crop genetic resources than the narrow production criteria of industrial systems. Indigenous crop and animal

genetic resources constitute as important reservoir of genetic material which has not been given adequate recognition in the context of foreseeable climate change catastrophes in agricultural production in poor communities. It is my own view of point that with these foreseeable catastrophes of climate change, considerable research and technologies targeting poor communities local crop and animal genetic resources as a possible solution to climate change mitigation and adaptability. It would be a grave disservice in the long term if local crop and animal genetic resources are not considered as part of the strategies to combat climate change effect on agriculture development. There can be little doubt that the opportunities for utilization of local crop and animal genetic resources are great if farmers are willing to accept the challenges of climate change and realizes the necessity for exploring adaptive measures in agriculture. Poor communities which have embraced improved crop and animal species in their agricultural development strategy are expected to experience more problems in terms of agricultural production than using local crop and animal genetic resources. However, Successful agricultural adaptation to climate change is not just about adapted crop and animal genetic resources, and agricultural practices, but establishment of appropriate infrastructure and information systems accessible to poor communities that are most vulnerable. Accessibility to market is necessary to make fully informed decisions about new agricultural practices which are in tandem with climate change mitigation.

2. Appropriate climate change research, science and technology targeting pro poor agricultural development

Agricultural technology has been a primary factor contributing to increases in farm productivity in Southern Africa over the past half-century. Although there is still widespread food insecurity, the situation without current technology development would have been unimaginable. The adoption of agricultural technology has faced some resistant from resource poor communities because no adequate incentives were attached to this process. This has also undermined investments in labor or cash unless there are adequate returns. From agriculture development point of view it can argued that the success of agricultural technology adoption in should be simultaneously approached with the provision of markets for outputs and inputs. Although there is much debate regarding the nature and impact of technological change on agricultural productivity, the important issues for pro poor communities has been related to uncertainties. By understanding how poor communities decide whether to adopt a technology, is a prerequisite to refine agricultural technology in order to address the conscious and subconscious concerns of targeted poor communities, and increase the chances that individuals will be able to use the technology. A list of community characteristics have been implicated in agricultural technology adoption in literature, specifically that have the most significant associations with technology adoption, dis-adoption and non-adoption. These include farm size, land tenure system, credit access, labor availability, biophysical characteristics, risk preferences, human capital, and access to commodity markets. This implies that agricultural technology adoption is influenced and addresses multiple, and at times conflicting, objectives, therefore there is need for careful planning and agricultural technology is structuring.

3. Integrating of pro poor climate change research and technology with indigenous knowledge systems

Societies are dynamic and they develop all possible agricultural adaptive measures to reduce vulnerability to climate change employing local indigenous knowledge systems. The notion that the effects of climate change will be graver on poor communities than any other social grouping may be disputable, if only indigenous knowledge is integrated into the climate change scientific research body for the benefit of these communities. In gender discourse, the idea that women should be seen solely as victims of climate change is contested. Instead women due to superior indigenous knowledge on climate change as it relates to agriculture are increasingly portrayed as active agents of change who have an important stake in the future of agriculture development. In a social grouping perspective requires that greater attention be paid to women's issues in climate change adaptation policies and that they play a role in decisions that affect them. Gender differentiated indigenous knowledge systems in terms of crops and livestock production adaptation to climate change can be useful for agricultural development

programs on the basis for upgrading knowledge and practices in the existing situation. This engendered indigenous knowledge base can be manipulated as a key factor in determining the appropriateness of new science and technologies for agriculture development and the likelihood of their acceptance, since the latter may depend on how they relate to or compete with traditional expertise in agriculture. Use of gender analysis and participatory research and communication for agriculture development methods to work with poor communities to understand and value their own indigenous knowledge systems and build their capacity to respond to and benefit from climate change mitigation strategies may be employed in successful in agriculture development. The use of indigenous knowledge has been seen by many as an alternative way of promoting development in poor rural communities in many parts of the world (Briggs, 2005). Policy makers are increasingly acknowledging the value of indigenous knowledge in agriculture to the extent that it is now perceived that integration of such knowledge as it related to climate change and agriculture production will promote rural development.

4. Engendered pro poor climate change research and technology for agriculture development

Poor communities have not adequately benefited from climate change science, research and technologies to deal with enhanced agricultural productivity due to the failure of the research traditions of vulnerability to environmental change to appreciate that gender differentiated knowledge on climate change and agriculture exist in communities. Gender relates to socially assigned roles and behaviors attributable to men and women (Muhammad et al., 2012), and as stakeholders in agriculture production, women and men contribute to the enhancement of gene flow and domestic crop and animal diversity (FAO 2002). Applying a “gender lens” to identify and address women’s and men’s different needs and constraints related to relevant agricultural activities is important for determining the most optimal outcomes as well as the most effective use of both crop and livestock genetic resources in agriculture development. Poor communities are highly vulnerable to climate change and variability due to a myriad of contextual challenges bases on different factors such as the pre-existing political, institutional, economic and social context within which the impacts of climate change are experienced. Therefore, it is assumed that taking cognizance of gender differentials in agriculture production intervention programs will result in effectively implementation of development programs ensuring more optimal outcomes in the context of climate change. The rationale for gender integrated approach in development is driven by the fact that different household members typically hold different agricultural knowledge and responsibilities; they also may have different priorities and production constraints as impacted by climate change. Gender sensitive agricultural policy should be adopted in order to address specific concerns and priorities of different social groups as major stakeholders in agricultural production. It is imperative that climate change researchers, developmental agents and policy makers should be aware of the need to incorporate gender issues in pro poor agricultural development planning in order to building the capacity of social groups to cope with a range of potential climate change stresses and changes in agriculture.

There are two approaches to understanding climate change influence, as either a biophysical or social condition, depending on whether climate change is conceived principally as a scientific or a social concern. This differentiated approach in understanding climate change is crucial for developing appropriate and effective mitigation and adaptation research responses in poor communities. In this regard, climate change research and technologies can be developed based on technical responses at the resource poor community level based on probable scenarios, whereas the social approach focuses on building the capacity of social groups and institutions to cope with a range of potential stresses and changes, including but not limited to, climatic changes. One might suggest that gender in addition to socialization, age, culture, education and ethnicity are bound to determine vulnerability if climate change discourse takes a social perspective, emphasizing the importance of social and institutional context in dealing with vulnerability of the poor communities. It is crucial that engendered science, research and technology in climate change, might increase the chances of giving attention to the role of such social groups in developing effective responses to, rather than simply as victims of, climate change.

The challenges for present climate change research in integrating with the domains of resilience and adaptation has failed to take into account the gender differentiated knowledge on climate change and how this has derailed agricultural development. It is assumed that the fields of vulnerability, adaptation

and resilience in agricultural activities share many points of convergence and mutual challenges, however, disregarding building the capacity of social groups on gender lines to cope with a range of potential climate change stresses and changes, might be catastrophic for poor communities. This review argues that adaptation to climate change on agriculture production will be inefficient and inequitable if it does not consider the gender differentiated knowledge on response and vulnerability in poor communities. This discussion contends that while there is gender differentiated impact and a unique vulnerability to the effects of climate change on social groupings, many of the mechanisms currently being used to address this phenomenon fail to take this into consideration. As a result it is recommended that gender differentiated knowledge be made central to climate change solutions in poor communities, and that women be given a larger role to play in influencing and creating policy to address climate change to enhance agricultural development. Climate change researchers and scientists often do not have the necessary familiarity and competence with gender analysis and participatory skills to implement a gender balanced assessment or response in agricultural production issues to climate change.

5. Policy environment in mitigating climate change impact and agriculture development

Countries in southern Africa has promulgated different public policies to counter the effects of climate change on agriculture development and food security, however, climate change adaptation policies are not informed by robust research evidence combining socioeconomic and biophysical models that makes the poor communities more vulnerable. An policy shift or attempt has been made in developing crops and livestock suitable for hotter and drier environments and providing farmers with irrigation, weather, and climate information (Hachigonta, et al 2013). It should be noted that policy objectives for agriculture are multifaceted in many Southern African countries focusing on prioritize on food security. For this reason, there is benefit in a robust exchange between international deliberations on food security and climate change (Meridian Institute. 2011) as a basis for agricultural development. This exchange could increase the likelihood that climate change actions ensure the availability and accessibility of food, and that food security interventions take full account of climate change impacts and options. Identification of policy options and incentives that enable adoption of climate-smart practices, and possible measures to ensure implementation. Public policy must support poor agricultural communities through assisting them adapt farm structures and production methods, helping them continue to provide services for the rural environment, keeping the farming community well informed about climate risk, adapting options to the farming community, and providing advisory services and training (EU, 2009). The prospects are that policy will have time to respond to some impacts, such as possible global decreases in agricultural production despite considerable uncertainty surrounds long-term patterns of climate change and their likely impacts on agriculture (Rachel, et al 2007). Effective agricultural policy responses to encourage the development, transfer and diffusion of appropriate agricultural technologies to promote food security and climate change adaptation and mitigation are the key to successful pro poor agricultural development. Climate change policies which target changing natural resource management practices, building institutions, promoting technology change, changing agricultural practices and improving infrastructure are crucial to agricultural development in resource poor communities. This will result in raising all stakeholder including poor communities awareness of climate change, specific climate impacts, adaptation strategies, or the environment in general and how this can affect agriculture production. Poorly designed climate change mitigation policies which do not take into account the thrust of agricultural development are likely to further restrict access by the poor to productive resources, access which is already under threat from numerous development pressures on resources. Policy makers are increasingly acknowledging the value of indigenous knowledge in agriculture to the extent that it is now perceived that integration of such knowledge as it related to climate change and agriculture production will promote rural development. The proposed sub region climate change policies either proposed or already implemented will ultimately fail to realize maximum benefits unless they are grounded in recognition of indigenous knowledge and gender differentiated climate change impact. Strategies that are meant to spearhead agriculture development taking cognizance of climate change adaptation and resilience should be inseparable from creating an equitable and respectful space

for integrating local Indigenous and conventional scientific paradigms for the purpose of developing climate change mitigation and adaptation strategies and actions.

Gender in changing climate change should be a component of focused climate change research and agricultural development with a commitment to generate climate change information which is responsive to the need of different social grouping through coordinated agriculture activities and work with both men and women as agents of change in agriculture development. This is possible only if the policy environment is conducive to ensure that climate change policies, decision-making, and initiatives at the global, regional, and national levels are gender responsive. Gender mainstreaming in policy responses to climate change into poverty reduction and agriculture development strategies and into other national development policies and programs should be synchronized. Policies need not be discriminatory, but should address women as well as men as both the clients and actors in agriculture development. Gender disparities in climate change information is a result of non gender responsive policies that have become a major constraint to promote agriculture development through decreased food production and security in Southern Africa. Non gender responsive policies are meant to catalyze gender discrimination in climate change information and science, and impede women's access to key agriculture productive resources. It is believed that without specific attention to the gender dimension in climate change adaptation issues in agriculture production strategies, unknowingly policy may reinforce inequalities between women and men, and may even increase productive resources imbalances translating to slowed agriculture development. Emphasis on engendered climate change science and research and development of gender sensitive policies should be an integral part of a holistic strategy to deal with the negative impact of climate change and variability on agriculture development. Little attention has been paid to the gender differential impacts of climate change as the basis of developing gender sensitive policies on agriculture development. It is assumed that traditional agriculture development policies are not gender responsive and typically do not consult women who are the majority end users, hence addressing climate change science, research and technologies do not take into account the gender dimension.

6. Implications

Climate change has deleterious impact on many sectors but the extent of its adversity on smallholder agriculture has been partly highlighted in different world forum. But the degree to which such impact will produce damage will differ, depending on geographical circumstances, the capacity to withstand the impact and the nature of the economy. Climate change would have serious implications for southern Africa because of its inability to fund comprehensive climate change research and create climate change knowledge which can be useful in mitigating efforts in agriculture development. New and innovative pro-poor research approaches promise to enhance agricultural development and capture the impact of technology from a societal perspective and the perspective of poor resource farmers through more comprehensive frameworks that consider benefits of science to poor communities. It is challenging to better assure agricultural development in developing countries focus on community research based approaches with participatory elements providing a framework in which communities can decide an appropriate technological empowerment to balance the needs for agricultural production and pro-poor economic growth. Targeting appropriate technologies for resource poor farmers will facilitate capacity-building of national and regional authorities which becomes an important element of agricultural development process in the context of climate change. Agricultural scientific and research diagnostic tools that are accurate and easily used in developing-countries' agricultural development strategies can assist in pro-poor agricultural and economic growth taking into account the deleterious impact of climate change which might derail the whole process. It is undisputable that agriculture is likely to be substantially affected by climate change and variability, however, agricultural development policies in most cases have underestimated the impacts of climate change on agriculture and the importance of possible adaptations and mitigating the effects of climate change. The discussion concludes with the recommendation that any conceptual framework meant to develop a comprehensive program for climate change adaptation and mitigation in agriculture development should consider indigenous knowledge utilization and gender meaning streaming. Such an approach would be of immeasurable value to the poor communities allowing scope for intergenerational transfer of climate change adaptation knowledge, and also potentially to

contribute to a greater understanding of sub regional climate change impact without alienating poor communities. Integration of climate change related indigenous knowledge in formal climate change research and meteorological forecasts through planning decisions and monitoring mitigation and adaptation to drought may accelerate agriculture development.

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