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### Review article

## Prospects and challenges of increasing the development impact of agricultural research in enhancing food and nutrition security in Sub Saharan Africa

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#### ABSTRACT

Increasing the development impact of agricultural research as it relates to promoting food and nutrition security continues to be a major challenge in Sub Saharan Africa. The preceding review explores the opportunities and constraints that are associated with increasing the development impact of agricultural research in enhancing food and nutrition security in Sub Saharan Africa. The engendered agricultural research approach in promoting food production and security is examined. There is an attempt to describe the impact of gender-sensitive agricultural research on food production and its implication for food and nutrition security. The influence of policy environment, inclusion of micro-livestock and insects farming in the mainstream agriculture production and agricultural research priorities in increasing the development impact of agricultural research are highlighted. It is also suggested that incorporating indigenous knowledge as the basis of agricultural research may promote increasing development impact of agricultural research in the region. Climate smart agricultural research should become increasingly important such that it influences food production and achieve the primary objective of achieving food and nutrition security. Sub Saharan Africa is endowed with potential good agricultural space which can be put in good use through increasing the development impact of agricultural research in a manner that the ultimate goal of self

food and nutrition sustenance is attained. The review concludes that in the planning and implementation of agricultural research to enhance food and nutrition security, gender sensitive agricultural policies should be put in place such that women become the focal point of food production in Sub Saharan Africa. The sustainable development goals aimed at achieving food security and improved nutrition and promoting sustainable agriculture can be only realized through increasing the development impact of agricultural research in Sub Saharan Africa.

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## **1. Introduction**

By the year 2050, Sub Saharan Africa's population is likely to grow by a staggering 1.3 billion people the largest growth of any region in the world (Lazuta, 2013), hence the implications for food and nutrition security are not favorable. It is suffice to suggest that agricultural research has the potential to play a key role in enhancing agricultural development in Sub Saharan Africa. Even from the very early years of modern agriculture, the challenge of feeding increasing global populations with limited land was met as a direct result of strides in agricultural research, development, and extension (Waite, 1915; James, 1996). Although agricultural research impact has had its own share of success, the truth of the matter is that more needs to be done to make it more development oriented. With this in mind, increasing the development impact of agricultural research with emphasis on satisfying basic human needs, improving people's standard of living, enhancing food and nutrition security pose a surmountable task in Sub Saharan Africa. There are many measures which need to be explored with the aim of increasing the development impact of agricultural research as a driving force of Sub Saharan Africa economies which are mainly agro based. Some of the strategic steps that can be adopted for future viability and increase of agricultural research impact include and not limited to the following: gender sensitive agricultural research, intensification of research in micro livestock and insects species, application of indigenous knowledge as a component of agricultural research and setting up an appropriate and conducive agricultural policy environment and models. These factors become crucial in the context of the negative impact of climate change and variability which has derailed agricultural productivity. There is need to improve the diversity and response capacity of smallholder livestock production systems through appropriate agricultural research to enhance resilience. The integration of micro livestock and insects into the mainstream agricultural production system may play a pivotal role in complementing conventional smallholder livestock production systems in enhancing food and nutrition security. Simultaneously, planning for women's participation does, in fact, improve the likelihood that women contribute to agricultural production and improve overall agricultural productivity. The recognition of gender equality is fundamental to agricultural and rural development in Sub Saharan Africa. Agricultural research focusing on improving the status of women within the household and at the community level would deliver significant improvements to smallholder agricultural production systems and food security. The preceding review explores the opportunities and constraints that are associated with increasing the development impact of agricultural research in enhancing food and nutrition security in Sub Saharan Africa.

## **2. Engendered agricultural research, food and nutrition security**

Overall development on the continent has been curtailed by failure to take into account gender disparities in agriculture and recognizing that gender inequality fundamentally constrains the ability of agricultural research to impact greatly on development and achieve major strategic results. In Sub Saharan Africa women grow 80 to 90 percent of food (FAO, 2008) in a situation where food insecurity has worsened since 1970, and the proportion of malnourished has remained within the 33 to 35 percent range (Rosengrant, 2005). Many studies on gender and agricultural commercialization have found that changes in systems of commodity production, particularly the shift

from food crop to cash crop, can have a significant impact on the gender dynamics of intra-household decision making (Daley and Park, 2012; Arndt et al., 2011; Whitehead, 2009; Dolan, 2001; Evers and Walters, 2000; Warner and Campbell, 2000; Darity, 1995; Mbilinyi and Semakafu, 1995; von Bülow and Sørensen, 1993; Carney and Watts 1990). It is imperative that agricultural researchers gain the technical skills of how to incorporate gender into their research processes. This entails developing, adapting and delivering appropriate engendered agricultural technologies for sustainable use by smallholder farmers in Sub Saharan Africa. Public investment in agricultural research should take cognizance of the gender differentials in order to increase the development impact of agricultural research in Sub Saharan Africa. Gender disparities in access to productive resources which result in insufficient purchasing power, especially of women are product of a series of interrelated social, economic and cultural factors which need to be addressed. Appropriate market agricultural research oriented interventions that facilitate gender equality and full participation in food production are suggested. Food production interventions with specific gender objectives can be better understood by understanding the history of incorporating gender into agricultural research and development initiatives. If both men and women are to be effective in contributing to food security, discrimination against one group should be eliminated and the value of each group participation promoted. Awareness of gender roles in food production is critical for bringing about sustainable development impact of agricultural research in Sub Saharan Africa at a faster pace. Gender sensitive policies in the planning, implementation, monitoring and evaluation of food production initiative are integral to understanding the complex social, cultural, economic, and environmental factors that may inhibit equal gender participation in helping a community to become more self-sufficient in food. Most instances, gender blind planning will force women into a subordinate role to the detriment of their own development and that of the societies at large. The impact of gender sensitive policies particularly removing barriers against women to effectively participate in food production and enhance food security should not be undervalued as we aim to increase development impact of agricultural research in Sub Saharan Africa. This implies removal of gender inequality obstacles require more than good intentions and reforms which challenge the gender discriminatory laws in agricultural research. Simultaneously, planning for women's involvement in agricultural participatory research participation does, in fact, improve the likelihood of increasing the development impact of agricultural research in Sub Saharan Africa. The recognition of the role women play in agriculture and rural economics is fundamental to agricultural and rural development. Marginalization of women who are the custodians of food production and are the majority provide the explanation why there is lack of increase in development impact of agricultural research in Sub Saharan Africa. Sub Saharan Africa should respond to food insecurity by adopting engendered agricultural research solutions and appropriate interventions in the drive to produce enough food to ensure self sufficiency. Its undisputable that agriculture will continue to play a vital role in the economies of the region for years to come, however the low level of women participation in food production will still contribute to decline, if gender sensitive agricultural research strategies are not put in place. This is on the background that ensuring adequate food supply to the growing population ought to be supported by appropriate agricultural research. Increasing the development impact of agricultural research should be a major priority because the majority of the population in Sub Saharan Africa is estimated to be absolutely poor and malnourished.

### **3. Policy environment, agricultural research priorities and food security**

Despite most sub Saharan African countries being signatories of most continental and international food conventions, majority of the governments, have not made increasing the development impact of agricultural research on food and nutrition security a policy priority. Several policy documents have been drafted pertaining to food and nutrition security, however lack of implementation has been the order of the day. All the existing regional and international food security guidelines are voluntary and non-binding. They emphasize the need for interpretation and consistent application with existing obligations under national and international laws, and with due regard to voluntary commitments under applicable regional and international instruments (Sulle and Hall, 2014). To some extent, some of the Sub Saharan African agricultural policies have addressed some of the issues reflected within the various international guidelines on food security. However, the guidelines themselves have yet to be translated into binding domestic law and policy (CFS, 2014). It is undisputable that agriculture plays a key role in the provision of food and nutrition security in Sub Saharan Africa. However, agricultural programs and policies have failed to automatically lead to better nourished populations. In some cases agricultural programs and policies have even been detrimental to the nutritional situation of vulnerable groups or fail to proffer solutions to

food insecurity in general. Agricultural programs and policies need to take nutrition outcomes and food security into account, as recent research shows that improving nutrition from the health domain only nor from the agricultural domain only brings sufficient progress, but that progress will be highest at the intersection of agriculture, health and nutrition. Agricultural research programs supported by appropriate agricultural policies need to become nutrition sensitive to increase the availability and accessibility and consumption of diverse and nutritious foods, especially in the smallholder resource poor communities. Agricultural research and policies can become nutrition sensitive to achieve the nutrition objectives and food security agenda. However, there are different agricultural pathways in terms of agricultural research leading to food and nutrition security. Through appropriate research, experts can facilitate in the provision of the needed knowledge and skills to design and strengthen the implementation of nutrition sensitive agricultural programs and policies. Beside the need to adopt an integrated approach, sustained implementation of a mix of complementary and comprehensive food security and nutrition policies and programs is required over time to effectively make an impact on hunger, food insecurity and malnutrition in Sub-Saharan Africa (FAO, 2015). Sub Saharan Africa countries have promulgated different public policies to improve food security. Some of the policies are meant to counter the effects of climate change on agriculture development and enhance food security, however, climate change adaptation policies are not informed by robust research evidence combining socioeconomic and biophysical models. There is need for policy shift in an attempt to increasing the development impact of agricultural research through promoting food production and security. It should be noted that policy objectives for achieving food security are multifaceted. For this reason, there is benefit in a robust exchange between international deliberations on food security in order to increasing the development impact of agricultural research as the basis for agricultural development. This exchange could focus on the likelihood of increasing the development impact of agricultural research by ensuring the availability and accessibility of food, and that food security interventions take full account of climate smart agricultural research options and gender sensitive policies. Identification of food security policy options and agricultural research incentives that enable adoption of climate-smart practices, and possible measures to ensure implementation are suggested. Public policy must support agricultural research through assisting smallholder farmers 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 from research institutions to promote food security and climate change adaptation and mitigation are the key to successful pro poor agricultural development. Agricultural research and 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 the need for food production, specific climate impacts, adaptation strategies, or the environment in general and how this can affect agriculture production. Poorly designed 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 agriculture production, climate change and gender will promote rural development. The proposed sub region food security policies either proposed or already implemented will ultimately fail to realize maximum benefits unless they are grounded in recognition of climate smart agriculture research, indigenous knowledge and gender disparities in agriculture production. Policies and strategies that are meant to spearhead food security taking cognizance of increasing the development impact of agricultural research should be inseparable from overall agricultural development.

According to DFID (2014) governments of low-income countries and international development donors are increasing their funding for research at least in part on the assumption that research has positive impacts on socioeconomic development. Four pathways are commonly cited to describe how research will contribute to development: 1. Investment in research will drive economic growth, 2. Investment in research will increase human capital, 3. Investment in research will lead to the development of pro-poor products and technologies and 4. Investment in research will provide evidence to inform policies and practice. In recent years, a number of

international development donors have renewed and strengthened their commitments to research (DFID, 2008; SIDA, 2010; USAID, 2014). However, one of the questions which might be asked is how appropriate, relevant and sustainable are the research themes imposed on the continent by respective donor communities? In many poor countries, agriculture has stagnated and failed to deliver its potential, this is despite a number of international development donors having renewed and strengthened their commitments to assist in agricultural research. Sub Saharan Africa has nothing to show due to perpetual food insecurity which is wrecking havoc on the continent. Someone might suggest that possibly the agricultural research priorities or themes imposed by international development partners or donors are inappropriate for the region or the models for implementing agricultural research are irrelevant. Alston, (2010) in his report containing a review of the literature on the role of agricultural research and development in fostering innovation and productivity in agriculture. A key finding was that the social rate of return to investments in agricultural research and development has been generally high. Specific findings differ depending on methods and modeling assumptions, particularly assumptions concerning the research lag distribution, the nature of the research-induced technological change, and the nature of the markets for the affected commodities. Previously, agricultural economists have used supply and demand models of commodity markets to represent agricultural research impacts, beginning with Schultz (1953) and Griliches (1958), with important subsequent contributions by Petersen (1967), Duncan and Tisdell (1971), Duncan (1972), Akino and Hayami (1975), and Scobie (1976), among others. Such a model is explicitly used in many studies. The same model is implicit in other studies that infer a rate of return to research from the parameters of an econometric model of production (Evenson, 1967) or use short-cut approximations to measure benefits (Griliches, 1958). Priority areas for agricultural research emphasize attention to smallholder farming systems, practical business models, the integration of gender, and multidisciplinary research that is sensitive to nutritional and food security outcomes. Engagement of public-private partnerships towards the strategic use of renewed stakeholder commitments to achieve food security and prevent future crisis is imperative. A shared position in increasing the development impact of agricultural research as it relates to promoting food and nutrition security, would increase the appreciation of how different disciplines and approaches fit in the overall context and create synergistic value added rather than existing in a state of internal competition. Approaches to agricultural research such as linear, bottom up and integrated approaches have been implicated in increasing the development impact of agricultural research as it relates to promoting food and nutrition security. Different research approaches or research models are valid in some cases, and utterly wrong in others. How we perceive adoption and diffusion of agricultural innovations is therefore a key element in our position of agricultural research for development (Toborn, 2011). The bottom up approach was designed to be complementary to linear approaches (top-down). This took into account reversals in research, planning and management structures so as to build on farmers' talents and knowledge. Farmers are no longer passive recipients of scientific innovations or technology. This time decision making process in research enabled to include farmers' agendas. The reductionist approach failed in terms of developing technologies for resource-poor farmers. However, in bottom-up approaches getting farmers involvement is difficult and time consuming, which can make the whole process expensive. In an attempt to improve on the bottom-up approaches integrated approaches were suggested. Integrated Approaches included the Sustainable Livelihood Approaches, Innovative Platforms and Value Chain Development Approach. This was meant to provide space where different stakeholders interact to understand each other better, learn and develop shared priorities, define roles and agree on joint actions (Hall et al., 2003). The systems approach to agricultural research evolved where thinking is about the whole instead of component parts separately emphasizing relationships between the components, within the physical, social and environment context. The systems approach integrates the analytic and the synthetic method, encompassing both holism and reductionism. However, systems are difficult to analyze because of the many interacting parts with many nonlinear feedback loops. On each hierarchy level there are some emergent properties that come from the interactions and they cannot be easily explained possibly reducing the development impact of agricultural research as it relates to promoting food and nutrition security. Due to this proliferation of competing theories and approaches, "misalliance of models" is not that uncommon in agricultural research which might reduce the development impact of agricultural research as it relates to promoting food and nutrition security.

#### **4. Climate smart agricultural research, indigenous knowledge and food security**

There is a serious threat of climatic changes (in the form of severe droughts, floods, intense rainfall, and landslides) undermining the increasing the development impact of agricultural research programs and millennium development goals aimed at reducing poverty and food insecurity. Climate induced disasters directly affect the livelihood of the smallholder resource poor farmers. Since livelihood of the smallholder farmers is based on crop and livestock production, as a result of the decrease in crop-livestock productivity due to the negative impact of climate change stressors will weaken the socio-economic condition at household level. Climate smart agricultural research should take into account climate change impacts and adaptation strategies to sustain livestock and crop production to enhance food security. Sub Saharan Africa is one of the most vulnerable regions to climate variability and change because of multiple existing climatic stresses and low adaptive capacity. It is now undisputable that climate change will have a grave effect on agricultural development in poor countries, coming as an additional factor affecting both crops and livestock production that are already highly dynamic and facing a host of challenges. The major concern in Sub Saharan Africa is the visibility of lack of institutional research capacity to address the issues pertaining to climate change and variability. Climatic change has a negative bearing on the sustainability of agricultural production systems by reinforcing existing stressors such as heat stress, droughts, and flooding events which have lead to reductions in agricultural productivity. The likely impacts of climate change on agricultural production systems, and the influence of climate change on crops and livestock have been documented in developed world but less in poor countries. Therefore, it is imperative that poor nations should focus on climate smart research to proffer solutions to the imminent climate change negative impact on agricultural productivity. This is on the understanding that the impact of climate change on agricultural production through natural disasters and environmental challenges are likely to affect Sub Saharan Africa indiscriminately. Agricultural production systems need to adjust through adoption of possible strategies to reduce vulnerability to climate change which affects production in various direct and indirect ways. In order to be able to adequately address agricultural production challenges in the context of climate, there is need for Sub Saharan Africa to carry out thorough agricultural research and, climatic vulnerability and adaptation assessments, before responses are suggested. Apart from climate smart agricultural research, the region needs comprehensive training of researchers in carrying out vulnerability and adaptation assessments on agricultural production, which is crucial in order to develop climate change adaptation measures on agricultural production. The vulnerability to climate change impact is a function of several biophysical and socioeconomic factors which need to be taken into account if we are to increase the development impact of agricultural research in Sub Saharan Africa. As crop and livestock are and will play very important role in smallholder farming communities, it is necessary to find suitable solution to reduce the ill effect of climate change on crop and livestock production through climate smart agricultural research.

Sub Sahara African countries should explores the gender dimension of climate change and the policies enacted to mitigate and adapt to its impacts with the aim of developing gender sensitive approaches with regards to mitigation measures and adaptation strategies, especially targeting resource poor smallholder farmers. This is on the backdrop that climate change research knowledge is accumulating at a remarkable pace, it is intersecting with disasters regarding developing nations in fascinating ways. The gender –climate discourse focuses on the relationship between women and the environment which revolves around their concerns for providing family food security, fuel, water, and health care. This implies that the discourse on climate change should provide adequate attention to gender differentiated roles and vulnerability, either at the local community level and international climate change negotiations because the impact of climate change affects women and men differently. There is a missing link to scientific assessment of climate change and responses to climate through a gender dimension and the policies enacted to mitigate and adapt to its impacts. Currently, there is insufficient knowledge regarding gender differentiated impacts of climate change world over. However, there has been a consensus that in trying to understand climate change in general, we need to appreciate gender and gender relations. Women and men in most developing countries are especially vulnerable to climate when they are highly dependent on local natural resources for their livelihood. It is important to remember, however, that both men and women are not only vulnerable to climate change but they are also effective actors or agents of change in relation to both mitigation and adaptation. With the present climate change discourse, a number of questions have been asked: to what extent are the strategies adopted by the local communities based on indigenous knowledge in sub Saharan Africa able to cope with climate change and variability?. Since time immemorial, smallholder farmers have traditionally

adapted to climatic changes by building on their in-depth indigenous knowledge of their farming environment. The indigenous farming knowledge has helped smallholder farmers in evolving measures and technique to deal with situations arising due to climatic vagaries on livestock and crop production. However, these measures and techniques are community specific, require no external help and are inherently scientific. It is suffice to suggest that documentation of such practices and techniques, farmer to farmer dissemination and sharing such innovative approaches at large platforms will be the basis of formulating research questions which might increase the development impact of agricultural research to enhance food security on the continent. This is on the assumption that strategies adopted by the local communities based on indigenous knowledge will help in influencing agricultural research focus of academic institutions and setting the agricultural research priorities.

### **5. Increasing the development impact of agricultural research through focusing on micro-livestock and insect farming**

Diversification in animal agriculture through intensification of agricultural research of non-conventional livestock such as micro livestock species (goat, sheep, poultry, rabbits, guinea pigs, pigeon, ducks, snails, grasscutter etc) and insects species (crickets, cicadas, termites, grasshoppers, palm weevils, mopani worms etc) provide options that would guarantee fully participation of vulnerable groups in agricultural production to alleviate rural households protein shortage or deficiencies. Agricultural research focusing on micro livestock and insects appears to be the most promising and sustainable means of producing high quality animal protein for the expanding populations of the lesser developing countries which might increase the development impact of agricultural research. DeFoliart (1997) assumed the number of insect species to be eaten worldwide to be about 1000 and Ramos-Elorduy (1997) mentioned 1391 insect species eaten worldwide, of which 524 are eaten in 34 countries of Africa representing 38% of all species consumed. Like most micro livestock, insects are rich in protein, vitamins and minerals, and a good source of iron and B-vitamins (Van Huis, 2003). The nutritional value (amount of proteins, fat, vitamins and calories) of insects compares very favourably with that of meat and fish (Nkouka, 1987). Whether or not insects are eaten depends not only on taste and nutritional value, but also on customs, ethnic preferences or prohibitions. Considering the economic, nutritional and ecological advantages of this traditional food source, its promotion deserves more attention both from national governments and donor assisted programmes. However, it should be known that managing insects in the interest of food security, more attention should be given to environmentally sustainable harvesting methods. They should be made better available throughout the year by developing improved conservation methods or by farming or harvesting methods. The micro livestock and insects are likely to become increasingly important source of animal protein as a result of rapid increase in human population and in the light of dwindling land sizes and natural resources in general. This is on the backdrop that micro livestock and insects have untapped diverse economic and social functions in rural communities, and different types of micro livestock and insects have been associated with women due to their significant potential for alleviating malnutrition and food insecurity. This implies that supporting micro livestock and insects research should be considered as a means to empower women in rural development which has the capacity to improve household nutrition and food security. There are greater opportunities of empowering local communities through micro livestock and insects as means of alleviating poverty and solving the food insecurity challenges in rural communities in Sub Saharan Africa. The basis of micro livestock and insects farming may be taken from the perspective of animal products supply being outpaced with the increased human population in Sub Saharan Africa. In this case, alternative sources of animal protein such as micro livestock and insects need to be promoted, and if not, livestock products will be beyond the reach of the majority of the ordinary persons. The space for large ruminants rearing have decreased, and this scenario will suit the keeping of smaller animals which are prolific and easy to manage. This warrant serious consideration of micro livestock and insects farming as one of the major component of the livestock production systems. Micro livestock and insects farming have greater opportunities in improving livelihoods among the rural poor households, provided that productivity is enhanced through appropriate agricultural research, input and services can be availed. Gender sensitive programs that promote micro livestock and insect farming contribution to optimization of animal product supply and enhance food security on sustainable basis are recommended. The micro livestock and insect farming will compensate for the experienced convectional livestock decline in production. This is possible only by pursuing essential forms of management conducive to sustainable exploitation of micro-livestock and insects to meet the target of poverty reduction and food security. Improved supply side will translate to adequate protein supply hence Sub Saharan

Africa will not continue to worry about human population growth which has out paced the ability to meet the predicted food demand. It is crucial to recognize the different links to factors which affect food production, while acknowledging that any long term strategy need to address the core issues perpetuating food insecurity. Micro livestock and insect species have a diverse nutritional, economic and social functions in smallholder farming sector. If supported by appropriate research micro livestock and insect species can be valued as livestock sub sectors having enormous potential for enhancing food nutrition and security. The conventional livestock production sector has been facing multiple challenges as a result of rise in human population, urbanization and climate change. This trend has lead to a rise in demand for livestock products, which means meat productivity or the number of meat animals will have to increase to meet the animal protein demand. The protein production from conventional livestock has been falling, as a result there is need for alternative sources of animal protein supply. Focusing on micro livestock and insect species as alternative source of protein may be just as important. Most species in the micro livestock and insects classes are promising in enhancing food security because they require little capital, equipment, space and labor. It is suffice to mention that micro livestock and insect species constitute important reservoir of genetic resources which has not been given adequate recognition. However, it is envisaged the utilization of micro livestock and insects species will address the animal protein challenges facing Sub Saharan Africa, especially in the resource poor rural communities where the problem is most apparent. Given the economic, social and ecological advantages of micro livestock and insect farming it is arguably deserve even greater research attention. If supported by appropriate research, micro livestock and insects farming are sustainable forms of protein sources that have significant potential for alleviating malnutrition and food insecurity in Sub Saharan Africa. These forms of food sources should be considered as a normal component of food production and rural development which has the capacity to improve nutrition and food security. It is possible to assume that micro livestock and insects farming are very much associated with increased food security as they lend themselves to small scale family production.

## **6. Implications for stakeholders in agricultural research**

The review concludes that Sub Saharan Africa is endowed with potential good agricultural space which can be put in good use through increasing the development impact of agricultural research in a manner that the ultimate goal of self food and nutrition sustenance is attained. However, in addition to engendered agricultural research focus enhancing the development impact of agricultural research, an attempt should be made to close the gender gap in terms of access to productive resources, education, training and extension services, credit facilities and appropriate technology to maximize production and enhance food security. It is imperative that development impact of agricultural research is based on understanding of how gender differentials and gender relations affect agricultural innovation, productivity, and sustainability. This calls for integrating gender analysis into wider issues of agricultural research in order to realize maximum benefit in increasing the development impact of agricultural research on the continent. Gender inequality within Sub Saharan Africa agricultural production systems is a critical issue; yet limited empirical research exists on the dynamics of gender implications of agricultural productivity on food security. In order to understand the social and economic consequences of the impact of agricultural research transformation, it is critical to evaluate the nature and extent of gender-differentiated impacts and their implications for food security. Gender sensitive policies in the planning, implementation, monitoring and evaluation of food production initiative are integral to understanding the complex social, cultural, economic, and environmental factors that may inhibit women from fully participating in helping a community to become more self-sufficient in food. On a different note lack of institutional capacities have widened the gap in integrated quantitative and qualitative methods for studying climate change perception and policy support in Sub Saharan Africa. Local theoretical and practical knowledge of the environment and resource conservation should be given due consideration in climate change mitigation and adaptation strategies. Local communities' potential contribution to climate change mitigation and adaptation through application of indigenous knowledge by being part of the agricultural research intervention strategy should be sufficiently exploited. On the other hand, diversifying farming practices act as major adaptation strategy for sustainable livestock and crop production in smallholder farming sector in the context of climate change. Due to climatic change and variability, increasing the development impact of agricultural research through promoting food production and security with emphasis on satisfying basic human needs and improving people's standard of living will continue to be a major challenge in Sub Saharan Africa. Therefore, engaging in appropriate agricultural research, climate change science and development



of agricultural technologies targeted at poor rural communities through planning adaptation and mitigation efforts can reduce the risks of climate change while accelerating progress towards food security and reducing poverty. On the other hand, it seems that there is enormous opportunity of utilizing micro livestock and insects species as an alternative source of protein solving the food and nutrition insecurity challenges in Sub Saharan Africa. The scope of increasing the development impact of agricultural research should expand from mere narrow effort to measure adoption to research output, but should go further in quantifying a wide array of development impact on society, livelihoods, individuals as well as socio-economic cultural aspects.

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