

ENGENDERING RURAL LIVELIHOODS IN MALAWI THROUGH AGRICULTURE INNOVATION SYSTEMS

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ABSTRACT

The study evaluates the gendered impacts of Agricultural Innovation Systems driven research on livelihood improvements in Africa. Using a case study from Malawi, the study employs a quasi-experimental research design with propensity score matching to establish a counterfactual and single differencing to measure impact. Results demonstrate that innovation systems driven agricultural research programs impact positively and significantly upon the livelihood outcomes of rural women. The findings reflect differences in benefits accruing to women in rural communities depending on headship of the household with female-headed households benefiting more in comparison to women in male-headed households. Policy implications are that: although innovation systems thinking has the potential to improve the livelihood outcomes of the poor in Africa, there is need for deliberate gender facilitation in program implementation to ensure equitable and sustainable livelihood improvements. This requires budgetary support to and capacity building of grassroots agricultural advisory service providers and researchers.

Keywords: Gender equity, Quasi-experimentation, Enabling Rural Innovation, Africa

INTRODUCTION

In realization of the importance of agriculture to economic development of the African continent, there has been a shift in the agricultural research paradigm from a “top down” approach in which communities are mere recipients of agricultural technologies to an innovation systems perspective in which they are part and parcel of the research process. This shift towards innovation systems thinking in agricultural research has resulted in greater involvement in the research process of the intended beneficiaries of agricultural technologies. Despite this paradigm shift in African agricultural research and the recognition of the importance of the involvement of end-users, there are few empirical studies in literature that quantify the potential and actual impacts of the use of innovation systems concepts in agricultural research on the livelihood outcomes of rural end users. These include studies by Barham & Chitemi (2009); Kaaria, Njuki, Abenakyo, Delve & Sanginga (2008; 2009); Kaganzi *et al.* (2009); Magreta, Zingore & Magombo (2010); and Mapila, Kirsten & Meyer (2010). None of these however provide robust empirical evaluation of the impact of the use of agricultural innovation systems concepts from a gendered perspective. In view of this, this study aimed to assess the impacts of the use of innovation systems concepts in agricultural research and development on the livelihood outcomes of rural end users with a specific focus on quantifying the effects on rural women.

The paper defines gender as the socially constructed role of women and men and therefore understands that male headed and female headed households have different roles, responsibilities and resources afforded to them especially in rural

areas where gender roles are critical to the functioning of those communities. In view of this definition, the paper will pay special attention to female headed households. The study aims to generate credible evidence for developing effective agricultural research policies for ensuring greater involvement of and for enabling innovation of rural end users with particular emphasis on women; who are critical for the agricultural sector in Africa but who are often marginalized due to pre-existing socio-cultural and economic factors.

The gendered nature of agricultural rural livelihoods

Gender concepts and concerns have been on the global agenda for over three decades and have radically changed the manner with which development and poverty are conceptualised. Gender is defined as the socially constructed roles, duties, practices and attributes that are ascribed to females or males (Food and Agricultural Organization, 1997). Gender is often used as a euphemism for women's empowerment but it includes both women and men and pertains to the relations between them. Gender values and roles are dependent on the country, culture and context. These roles are not static and vary among different societies, cultures, classes and during different periods in history. Gender-specific roles and responsibilities are often conditioned by location, household structures and access to resources (Food and Agricultural Organization, 1997).

In Africa, women play a key role in agriculture and development with about 80% of all the basic food production for both consumption and marketing in Sub-Saharan Africa being produced by women (World Bank, 2007a). For Malawi, agriculture is the largest contributor to the economy with nearly 90% of the population living in rural areas and engaging in subsistence farming. The sector accounts for 38% of Gross Domestic Product, 80-90% of export earnings and employs about 80% of the total population (World Bank, 2007b). In Malawi female-headed households are more likely to engage in farming with 95% of all female headed households as compared to 88% male headed households being engaged in agriculture in the rural areas. In addition, a larger proportion of employed women (84%) are engaged in the agriculture sector than employed men (71%) at a national level.

Despite the importance of women in subsistence agriculture in Africa, gender inequalities are very prevalent. This emanates from women having lowered socio-economic status which results into constrained access to resources, technologies and information (World Bank, 2009a). In addition to this, women in rural areas also bear the larger burden of household's chores and this negatively affects their ability to engage in activities outside of the home. Even within the home, it is mainly male members of the household who are involved in resource allocation and decision making. As a result of this women are often excluded from the development process. Kaaria & Ashby (2001) found that initiatives that only focused on women without focusing on the male/female dynamics of the household and inter community dynamics although succeeded in reducing women's drudgery, failed to significantly increase labour productivity. This is because the initiatives focused on women's domestic/traditional activities as opposed to economic productivity because of the prominence of women's domestic role. As such, any development initiatives that aim to sustainably and equitably improve rural livelihoods need to take into account the intra and inter-household gender dynamics. Without this, it likely that development initiatives will tend to benefit men more than women, lessening the workload of the former and increasing the activities linked to the latter. This is true, as Quisumbing & Pandolfelli (2008) have shown that the design of some successful development initiatives has led to the total exclusion of women from economic opportunities altogether.

The Enabling Rural Innovation (ERI) initiative

The Enabling Rural Innovation initiative is an agricultural research intervention that was developed by the International Centre for Tropical Agriculture (CIAT) and it was driven by innovation systems concepts. Innovation system concepts focus on a network of actors and organisations that are linked by a common theme with the aim of developing new technologies, methods and new forms of organisation for use by the end users of technology to tackle identified problems (World Bank, 2006). An innovation system is comprised of the agents involved in the innovation process, their actions and interactions, as well as the formal and informal rules that regulate this system. It is governed by the prevailing institutions and policies that affect performance of the actors involved and the regulation of the technologies developed (Ekboir & Parellada, 2002; World Bank, 2006). The innovation systems concept embraces not only the scientists who are traditionally involved in agricultural research but also the end users of technologies and the interactions that take place between all the actors in the research process (World Bank, 2006). In this process, non-traditional research actors such as agribusiness owners and policy makers as well as all other relevant players in the agricultural value chain are deliberately incorporated in the research and development process. On the beneficiary side, there are deliberate efforts to explicitly incorporate beneficiaries that are often marginalized such as women and the youth.

The Enabling Rural Innovation initiative was a research framework for linking smallholder farmers to markets and its focus was on strengthening the capacity of resource-poor smallholders to access market opportunities. The main aim of the Enabling Rural Innovation initiative was to create an entrepreneurial culture in rural communities of Africa (Kaaria, *et al.* 2008; 2009). The approach also integrates specific strategies to encourage and promote participation by the poor and women by building their capacity to effectively engage markets in a more sustainable manner (Kaaria *et al.*, 2009). This was achieved through the establishment of a multi-disciplinary team of social scientists; extension agents from the Department of Agricultural Extension Services as well as local extension staff based in the community; researchers from the Department of Agricultural Research Services; and other agricultural social scientists from the Ministry of Agriculture. The research team, together with the community, conducted a participatory diagnosis of the community challenges and opportunities. This process was the initial way of engaging the communities in order to sensitise them to the Enabling Rural Innovation initiative and also to develop a shared vision for the future of the community (International Centre for Tropical Agriculture, 2007).

The outcome of the participatory diagnosis was the development of a collective plan of action for overcoming identified problems using available community resources and assets. Representatives from the community were selected and trained in market research. The results of the market surveys led to the community choosing piggery as an agro-enterprise to be developed as an income generating activity and maize as the food security enterprise. Finally, the research team planned and implemented simple research experiments around various other agro-enterprises in the community. Community members were involved in designing the experiments, setting up, as well as data collection and analysis. This was done in order to build the capacity of the community to conduct scientific experiments to enable them to better understand their farming enterprises and, in so doing, to demystify the scientific research process and build their ability to innovate. Throughout the work of the program, there was deliberate gender facilitation to ensure that women fully benefitted.

METHODOLOGY

Primary data was collected from 300 households in two communities in Ukwe Extension Planning Area in Lilongwe Agricultural Development Division in the Central Region of Malawi. The two communities namely Kandutulu and Ukwe represent an intervention community and a counterfactual community, respectively. The intervention community is one in which the Enabling Rural Innovation (ERI) initiative was implemented. A quasi-experimental research design was used to measure the impact of the use of innovation systems on rural livelihood outcomes with a focus on women and female-headed households. Although it has been noted by Doss (1999) that conducting a gender analysis by way of examining the sex of the head of household only captures one component of many gender-linked barriers, this study illustrates that this singular element is important in determining the outcomes of agricultural research and development interventions that are driven by innovation systems concepts.

Propensity score matching was used to establish a valid control group in order to identify a valid comparator group, while single differencing was used to determine the average effect of the intervention on the participating households. According to Ravallion (2003), the underlying concepts of propensity score matching are that two groups are identified, one that took part in the intervention denoted $H_i = 1$ for household i and another that did not participate in the intervention denoted as $H_i = 0$. Intervention households are matched to non-intervention households on the basis of the probability that the non-participants would have participated in the intervention and this probability is called the propensity score. It is given mathematically as follows:

$$P(X_i) = \text{Prob}(H_i = 1 | X_i) \quad (0 < P(X_i) < 1)$$

Where:

X_i is a vector of pre-intervention control variables

These pre-intervention control variables are those which are based on knowledge of the programme under evaluation and on the social, economic and institutional theories that may influence participation in the intervention. The vector can also include the pre-intervention values of the outcome variables. Propensity score matching is not able to reproduce the results of randomisation if the variables that influence participation in the intervention are not properly defined.

Propensity score matching is driven by two main assumptions:

- The H_i 's are independent over all i 's
- The assumption of "conditional independence" or "strong ignorability" which says that outcomes are independent of participation given the variables that determine participation (X_i). In addition, outcomes are also independent of participation given $P(X_i)$ as they would be in a randomised experiment.

Propensity score matching equalises the probability of participation across the population just as in randomisation. The difference however, is that propensity score matching achieves this based on conditional probabilities which are conditional on the variables determining participation (X_i). In this study, propensity scores for each household in the sample were estimated using logistic regression modelling. Using the estimated propensity scores, matched pairs of households were established on the basis of the proximity of propensity scores of the probability of participation in the Enabling Rural Innovation initiative between the intervention and counterfactual samples. Unmatched counterfactual households were dropped from the analysis in order to remove bias and to increase robustness (Rubin & Thomas, 2000 in

Ravallion, 2003). The best matched or "nearest neighbour" to the j^{th} intervention household is the counterfactual household that minimises $[P(X) - P(X_j)]^2$ over all j 's in the set of counterfactual households.

A typical matching estimator of the average treatment effect of any intervention takes the following form (Ravallion, 2003):

$$\Delta \bar{Y} = \sum_{j=1}^T \omega_j (Y_{j1} - \sum_{i=1}^C W_{ij} Y_{ij0})$$

Where:

Y_{j1} is the post intervention outcome variable for the j^{th} household in the intervention

Y_{ij0} is the outcome indicator of the i^{th} counterfactual household matched to the j^{th} intervention household

T is the total number of interventions/treatments

C is the total number of counterfactual households sampled

W_{ij} 's are the weights applied in calculating the average outcomes of the matched counterfactual households

ω_j are the sampling weights used to construct the mean impact estimator

This effect, more commonly known as the Average Treatment Effect on the Treated (ATT); measures the average causal difference in selected outcome variables between the treated (intervention) group and the untreated (comparator) group. The focus is on measuring the average effect because it is impossible to measure causal effect on an individual level (Angrist & Imbens, 1995).

To avoid contamination by endogeneity of access to the program intervention, the regression model for the Enabling Rural Innovation program participation (which was estimated to generate propensity scores) was run only for the matched comparator group; which was matched with the intervention group using Nearest Neighbour Matching. In such cases, the average treatment effect on the treated (ATT) becomes as follows:

$$\Delta \bar{Y} = \sum_{j=1}^T \omega_j \left[(Y_{j1} - X_j \hat{\beta}_0) - \sum_{i=1}^C W_{ij} (Y_{ij0} - X_i \hat{\beta}_0) \right]$$

Where:

$\hat{\beta}_0$ is the Ordinary Least Squares estimate for the matched group

The ATT is approximated without any arbitrary assumptions about functional forms and error distributions; because propensity scores matching techniques do not require a parametric model linking programme participants to outcomes (Ravallion, 2003). This therefore makes it superior to non-experimental regression-based approaches.

RESULTS AND DISCUSSION

Socio- economic characteristics of sampled households

The majority of respondents that were interviewed were women, representing 67.3% of all respondents while only 32.3% of the respondents were male. The counterfactual community had more female respondents (77.7%) as compared to the intervention community (46.5%). Despite this, the majority of households in the entire study area were male headed at 82.2% of the total sample whilst only 17.8% of the households being female headed. Further analysis shows that there were statistically significant differences in the marital status of sampled households in the two communities, with more sampled households in the intervention community (87.1%) being in legally-binding and socially-acceptable marriages than households in the counterfactual community (78.7%). This may explain the larger number of female-headed households in the counterfactual community (20.3%) as compared to the intervention community (12.9%). In addition, it was found that the counterfactual community had a significantly higher number of households that were in polygamous marriages (14.4%) as compared to the intervention community (10.1%); and this difference was statistically significant at the 10% level of confidence.

Table 1, illustrates that the female household heads in the counterfactual community were on average older as compared to the female household heads in the intervention community with the average age for the counterfactual community being nearly 50 years of age while in the intervention community the average age of the household head was about 43 years. Table 1 further shows that on average, female headed households in both communities had on average about 5 people. Households in the intervention community owning and cultivating on average just slightly over a hectare of land while in the counterfactual community, the households owned on average just under one hectare of land. The household sizes as well as the land holding sizes make the sampled households in this study similar to a typical household in the rural areas of Malawi which on average has about 4.4 people per household (National Statistical Office, 2008) who own and cultivate a piece of land that is on average not greater than 1.5 hectares (World Bank, 2009b).

Table 1: Descriptive analysis of sampled female headed households

Household characteristics*	Female headed household (FHH)	
	Intervention community	Counterfactual community
Average age (FHH)	43	49
Average household size	5.15	5.00
Average farm size (hectares)	1.74	0.989
% of HH with no formal education	30.8	38.5
% of HH with some primary education	69.2	53.9
% with no access to extension	38.5	53.8
% with access to credit	7.7	0
% with other source of occupation	7.7	23.1

* Household characteristics as of the 2008/09 cropping season

In addition as with many typical rural households in the country, Table 1 shows that the majority of the household heads had no formal education or very little formal education. The majority of the female household heads have had little formal education in both the intervention and counterfactual community with about 70% and 53.4% of all sampled female household heads having had some form of primary school training respectively. A large proportion however had no formal education with 30.5% and 38.3% of all the household heads in the intervention community and counterfactual community having had no formal education respectively. Access to informal education was measured as it is an

important source of new information and a means of acquiring new skills. In this study the contact with an agricultural extension agent was used as a proxy for measuring access to informal education. As can be seen from Table 1, the majority of households in the counterfactual community (53.8%) had very little contact with an agricultural extension agent in the 2008/09 cropping season. For the intervention community, this was not the case as only a minority of the female headed households (38.5%) stated that they had no contact with an extension agent throughout the 2008/09 cropping season.

Further analysis shows that generally the sampled households had very little access to credit services with only 7.7% of the sampled female headed households in the intervention community stating that they had some access to credit. In the counterfactual community all the sampled female headed households stated that they did not have access to credit. The lack of credit services was a key factor that prevented many of the households in either community from starting income generating activities such as small businesses. Although all the households in the counterfactual community stated that they had no access to credit, further observations showed that more households in the counterfactual community had an alternative source of income apart from farming with 23.1% of all the female headed stating this as opposed to only 7.7% in the intervention community. Informal interviews with the counterfactual community revealed that this was the case as the community was very close to a tarred road (about 4km way) as compared to the intervention community (about 18 km away). In addition, the counterfactual community was much closer to one of the main government agricultural research stations in the country. Both the proximity to the tarred road and to the government research station offered many opportunities for unskilled labour employment for counterfactual community members which provided income.

Differences in livelihood outcome between female headed households

Table 2 presents the results of the analysis of the differences in production outcomes pertaining to maize harvests for the 2007/08 and 2008/09 cropping seasons, the market value of livestock that a household owned and the market value of all household assets.

Table 2: Mean differences in production outcomes between FHH's in the two communities

Production outcomes	Intervention community		Counterfactual community		ATT
	Mean	Standard deviation	Mean	Standard deviation	
50kg bags of maize harvested (2007/2008)	18.72	26.85	7.78	8.46	10.92**
50 kg bags of maize harvested (2008/2009)	17.47	21.59	6.18	6.49	11.26**
Market value of livestock (USD)	229.15	424.29	31.76	63.16	197.38***
Market value of household assets (USD)	255.18	570.12	25.69	45.73	229.48***

* Significant at 10 % level, ** Significant at 5 % level, *** Significant at 1 % level

An analysis of the results shows that there were statistically significant differences between the maize harvests for female headed households in the two communities. In the 2007/08 cropping season, female headed households in the intervention community harvested on average nearly 11 more 50 kg bags of maize than female headed households in the counterfactual community and this difference was statistically significant at the 5% level of confidence. Similarly in the 2008/09 cropping season, female headed households in the intervention community harvested on average 11 more 50 kg

bags of maize than female headed households in the counterfactual community and this difference was also found to be statistically significant at the 5% level of confidence.

In rural Malawi, a households' level of maize production is used to assess the households' food security status. This is because maize is the main staple food crop for the majority of the rural population, therefore the findings of this study have food security implications as the per capita requirements per annum for a household of 5 people in Malawi is 18.5 bags (50 kg bags) of maize (based on per capita maize requirements of 185 kg per annum). The results in Table 1 indicate that female headed households in the intervention community were food self sufficient in the 2007/08 season and had almost enough maize given their household sizes. This however was not the case for the female headed households in the counterfactual community as the results indicate that in both the 2007/08 and 2008/09 cropping seasons, these households were not food self sufficient. Consequently, the use of innovation systems concepts in agricultural research has the potential to improve the food security status of female headed household in rural Malawi.

Despite the ability of female headed households in the intervention community to produce sufficient maize for their households, threats to their food security still exist. Firstly in the 2008/09 season, female headed households in the intervention community had a decrease in the average number of 50 kg bags of maize that they produced with a decrease of 1.25 bags (50 kg bags) being observed. This represents a 6.7% decrease in maize production. This decrease in maize production can not be attributed to climatic factors as the 2008/09 cropping season was an exceptionally good cropping season for maize producers throughout the country with maize yields increasing by 6% and 13% at the national level and in the local extension planning area respectively. The decrease in maize production can mainly be attributed to the phasing out of the Enabling Rural Innovation intervention as the 2006/07 cropping season was its last full implementation year. The implications of this are that the sustainability of the positive livelihood outcomes that the initiative produces is threatened by the phasing out of the programme. This is mainly because local public agricultural extension agents who work in the area lack both the human and financial capacity to maintain the higher level of contact and innovative strategies that the Enabling Rural Innovation initiative employed. This is the case despite that the local public research and extension departments, namely the Department of Agricultural Research Services (DARS) and the Department of Agricultural Extension Services (DAES) in the study area, were involved in the implementation of the initiative and staff from different levels of both government departments were trained, there was no mainstreaming of the innovative research and development principles in other research and extension work carried out by either department. Therefore after its phasing out, although maize production for participation households remained higher as compared to the maize production for non-participating households, it is demonstrated that the sustainability of the higher production outcomes are threatened.

Apart from the decrease in maize production, another threat to the sustainability of the Enabling Rural Innovation initiatives' work is further demonstrated by a change in decision making patterns of the participating female headed households. This is because an analysis of the marketing behaviour of participating female headed households shows that in the 2007/08 and 2008/09 cropping seasons, approximately 2.31% and 30.9% of all the female headed households in the intervention community sold part of their maize harvest in order to get access to cash income. The number of female headed households selling maize in the 2008/09 season was far greater than those who sold maize in the 2007/08 cropping season. This can be attributed to that during its implementation, the Enabling Rural Innovation initiative

worked towards changing households understanding of their farm enterprises and livelihoods so that they would be in a better position to understand the threats and opportunities that exist.

One key area of this was ensuring that a household understood the importance of not marketing their own food produce if their own household food security was threatened. As part of this, a focal point of the Enabling Rural Innovation initiative was working with communities to develop agro-enterprises that were especially for cash income and for the market. Hence households learned that although their need for cash was genuine; the traditional strategies of selling their own food production at low prices during the harvest season; only to purchase the food later in the season from the market at a higher price; was a major threat to their livelihoods and food security. Hence during the full implementation of the initiative, households were encouraged to refrain from selling their food produce but to develop other agro-enterprises for the market. In this study area, the cultivation of beans and the piggery enterprise were developed as the key cash agro-enterprise while maize production was cultivated for ensuring household food security. The results conclude that phasing out the initiative led to households reverting to traditional strategies for income generation that threatened their food security.

Apart from the analysis of differences in maize production between intervention and counterfactual community households, the study also analysed the impact of the initiative on the value of household assets and livestock ownership. From Table 2, it can be seen that female headed households in the intervention community owned on average higher valued livestock than their counterparts in the counterfactual community. This difference in value of livestock owned was found to be highly statistically significant. The value of livestock was calculated based on prevailing market prices for the 2009/2010 season which were found to be the same in both communities (and the surrounding markets) hence the differences in value of livestock cannot be attributed to differences in market prices for the two communities but to two other reasons. Firstly the initiative worked with the intervention community to develop a piggery enterprise; therefore households in the intervention community had more pigs as compared to those in the counterfactual community. In addition due to training on piggery management, appropriate feeding, feed formulation, appropriate housing as well as pest and disease control (Njuki, Kaaria, Sanginga, Kaganzi & Magombo, 2007); households in the intervention community had higher quality piglets and pigs that were worth more on the market. Secondly these changes, coupled with greater market access arising from the establishment of a marketing committee in the community which was responsible for sourcing markets, led to the establishment of a stable market especially for piglets and this resulted in increased incomes. From informal interviews with participating households, it was revealed that this increased income, in combination with changes in the decision-making processes in these households, enabled them to invest more in other types of livestock. Participating households, who developed a piggery enterprise, used the income from that enterprise to purchase local and hybrid chickens as well as small ruminants.

A final observation from Table 2 is the differences in household assets with the results showing that female headed households in the intervention community had on average higher valued household assets as compared to female headed households in the counterfactual community. This difference was found to be highly statistically significant. Informal interviews with intervention community households revealed that, the higher incomes obtained from the piggery and bean enterprises (that were developed under the Enabling Rural Innovation initiative) allowed them to invest in

household assets. This included purchasing assets such as corrugated iron sheets; push bicycles; mobile phones; farm implements (hand held hoes, wheel barrows and machetes) and battery operated radios.

The differences in fertilizer use patterns between female headed households from the two communities were also assessed. Table 3 shows the differences in fertilizer use patterns between female headed households in the two communities from the 2004/05 cropping season to the 2008/09 cropping season. The impact of the ERI intervention on fertiliser use patterns was assessed by analysing the differences in the number of 50 kg bags that female headed households used per hectare of farm land. Inorganic fertilisers, in combination with hybrid seeds and good rainfall, play a crucial role in ensuring high maize production and food security in Malawi. Hence purchasing inorganic fertiliser demonstrates a household's decision making patterns in terms of reinvestment in their farm enterprise.

Table 3: Mean differences in fertilizer use patterns between FHH's in the two communities

Fertiliser use patterns (no. of 50 kg bags)	Intervention Community		Counterfactual community		ATT
	Mean	Standard deviation	Mean	Standard deviation	
2004/2005	1.23	0.56	0.75	0.89	2.28**
2005/2006	1.46	0.40	0.96	1.64	1.50*
2006/2007	1.30	0.26	0.81	1.14	1.23*
2007/2008	1.60	0.72	0.69	0.93	1.91*
2008/2009	1.00	0.20	0.75	1.15	1.24*

* Significant at 10 % level, ** Significant at 5 % level, *** Significant at 1 % level

The results indicate that there were statistically significant differences in fertilizer use between female headed household in the intervention community and female headed households in the counterfactual community. The differences in fertilizer use were found to be statistically significant at the 5% level of confidence for the 2004/05 cropping season and statistically significant at the 10% level of confidence for the 2005/05, 2006/07, 2007/08 and 2008/09 cropping seasons. Hence female headed households in the intervention community were applying significantly more fertilizer as compared to female headed household in the counterfactual community. This difference can be attributed to the Enabling Rural Innovation initiative, as the increased market outcomes from the program acted as an incentive for households to reinvest in their farm enterprise in order to sustain their agro-enterprise. Further observation shows that fertilizer use differences are less distinct from the 2005/06 cropping season with statistical significance in fertilizer use differences reducing from the 5% level of confidence to the 10% level of confidence. This can be attributed to the increased availability of inorganic fertiliser in rural areas due to the implementation of a fertiliser subsidy programme in the country which was implemented in the 2005/06 cropping season.

The implementation of the fertiliser subsidy programme in Malawi increased the availability of and accessibility to inorganic fertilisers throughout the rural areas of the country, thus increasing the opportunity for all female headed households (as well as other farmers) to access and use inorganic fertiliser. This was the case despite informal interviews with farmers (both male and female headed households) revealing that initially when the fertiliser subsidy programme had started in the 2005/2006 season, farmers tended to sell their fertilizer coupons for cash. They would then use part of the cash received to purchase a small amount of fertiliser (e.g. one 20 kg bucket) and to meet other household needs. In the intervention community, it was found that in subsequent years as farmers become more organised under the Enabling Rural Innovation initiative programme, they refrained from the practice of selling their subsidised coupons. Hence, the

increased fertiliser use in the intervention community; by female headed households; can further be attributed to not only the implementation of the fertiliser subsidy programme but also due to improved and better decision making on the part of farmers as a result of the Enabling Rural Innovation intervention.

Further analysis however shows that in general all the female headed households in the two communities were applying an amount of fertiliser that was below the recommended rates for the Lilongwe Agricultural Development Division where the communities are located. The recommended fertiliser rate for home consumption for Lilongwe is the application of two bags of 23:21:0+4S and three bags of urea (with 46% nitrogen), while for production for the market, the recommended application rate is one bag each of 23:21:0+4S and urea (Benson, 1999). The implications of this are that although the Enabling Rural Innovation initiative increased the use of inorganic fertilizer amongst participating female headed households (through changes in decision making for farm reinvestment); households were still not able to reach recommended farming practices. This can be attributed to either participating household using the cash obtained from their agro-enterprises to meet other needs or cash inflow from the agro-enterprises not coinciding with the time in which farmers purchase fertilizer. This is especially the case as farmers in many parts of Malawi do not have a savings culture nor do they have the habit of purchasing agricultural inputs in advance. As such when the time to use an agricultural input does not coincide with cash inflows, farmers often are unable to cope.

Differences in livelihood outcomes between female headed households and women in male-headed households

Apart from analyzing the differences that the Enabling Rural Innovation initiative made between female headed household that participated and those that did not participate; the study also analyzed the differences in social and human capital outcomes of female headed households and women in male headed households. Summarising gender dynamics within African households and communities is by no means simple. Quisumbing & Pandolfelli (2008) found that African households are complex and diverse, that gender roles are equally intricate and are embedded in both agricultural and non-agricultural production systems. These roles and responsibilities are not only dynamic but respond to changing economic circumstances. The manner with which these roles are manifested can reinforce or challenge existing norms, patterns and stereotypes. This section of the paper presents but one strand of gender matters in Malawian agrarian societies and will determine whether the gender facilitation that was an integral part and parcel the Enabling Rural Innovation initiative was able to fully benefit all women regardless of their marital status and social-economic standing in the community.

Table 4: Mean differences in training between FHH and women in male headed households

Training	Intervention community				ATT
	Female headed household (FHH)		Women in male-headed household		
	Mean	Standard deviation	Mean	Standard deviation	
Average number of trainings five years ago	2.23	2.43	0.72	1.17	1.66***
Average number of trainings in 2007/2008	0.28	0.27	0.36	0.64	-0.08
Average number of trainings in 2008/2009	0.23	0.44	0.200	0.50	0.03

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level

Table 4 shows the differences in training received by female household heads and women in male headed households in the 2007/08 cropping season, the 2008/09 cropping season and five years prior to 2007. An analysis of the results shows that female household heads attended on average about two trainings per year five years ago while women in male headed household attended on average less than one training per year during the same time period. The difference in the training attendance was found to be highly statistically significant. Further observations shows that for the 2007/08 cropping season and the 2008/09 seasons there are no statistically significant differences between the number of trainings that female household heads and women in male headed households received. This can be attributed to the phasing out of the Enabling Rural Innovation intervention that led to local agricultural extension officers reverting to pre-intervention training strategies in the intervention communities, which entailed less training. The results therefore indicate that the initiative, during its implementation had a positive impact, in that it increased the number of trainings that a female household head attended. Studies by Mapila, Kirsten & Meyer (forthcoming) also showed that in general the Enabling Rural Intervention led to an increase in the number of trainings for all intervention community households as compared to households in the counterfactual community.

These findings have two major implications. Firstly although the Enabling Rural Innovation initiative was able to increase the number of trainings for all households in a community, the headship of a household determined to a large extent the participation of females in the community. Women in male headed households were less likely to take part in capacity building and skills development exercises such as the trainings that were part of the Enabling Rural Innovation initiative as in many cases the male member of the households was the sole participant. Females, however, who were heading a household, were more likely to participate in training activities despite that in many cases female headed households have more time constraints due to limited labour and other productive resources. These findings are a reflection of the decision making process in many rural households in the country, with the male household member being the sole decision maker and therefore participant in development activities. Female household heads, although more vulnerable, are better able to participate in development initiative, as they are in many cases, also the only sole decision maker. These findings are in line with the finding of the World Bank (2007b) which asserted that whilst women held decision making power in female-headed households, in male headed households, women are generally involved in making decision only for crops that did not require fertilizer application and where seeds are recycled. In fact, research shows that they make these decisions about 50% of the time, compared to just 10% of decisions where fertilizer is applied. For cash crops that require purchasing more inputs (fertilizer, seeds and pesticides etc), men make almost all decisions.

Trainings were an important component of the Enabling Rural Innovation initiative and they were used as a means of creating opportunities for knowledge and skills sharing in order to facilitate the community's livelihoods. Thus the exclusion of women in male headed households is a key finding as it entails that although the Enabling Rural Innovation initiative made great efforts to incorporate women through deliberate gender facilitation, women who were in male headed households; who are consequently in the majority; did not benefit fully. This is especially the case, as the trainings organized by the initiative called for participation of the entire community where the intervention was implemented. This therefore entails that in male headed households, decisions were made to only have the male member of the households participate to the exclusion of the female members.

Further observation shows that in more recent cropping seasons (2007/08 and 2008/09) there are fewer differences between the training received by female household heads and women in male-headed households. In addition, in more recent cropping seasons, both female household heads and women in male-headed households attended fewer training sessions than five years prior to the 2007/08 cropping season. This can be attributed to the phasing out of the Enabling Rural Innovation initiative in the 2006/07 cropping season which led to local agricultural extension officers reverting to pre-ERI training strategies in the intervention communities, which entailed less training. The results therefore indicate that the initiative had a positive impact during its implementation phase in that it increased the number of trainings that women in the intervention community attended. This finding is not surprising as informal trainings and other capacity building activities were a major component of the Enabling Rural Innovation initiative.

The phasing out of the initiative reduced the number of trainings for individuals in the participating communities to the extent that the number of trainings attended by female headed households did not differ statistically to the trainings attended by women in male headed households. The implication of this finding is that the sustainability of the impacts of the Enabling Rural innovation initiative are threatened by its phasing out. This is especially the case as local agricultural research and extension agents lack both the human and financial capital to use the innovative strategies employed by the initiative during its implementation. The threat to the sustainability of impact was also demonstrated earlier for the production outcomes with the production of maize by female headed households in the intervention community decreasing each subsequent year after the phasing out of the initiative.

Apart from training, participation and membership into farmer groups and engagement in community leadership roles were also analysed for female headed households and women in male-headed households in the intervention community.

Table 5: % difference in group membership and community leadership (intervention)

Group membership (%)	Intervention community		ATT
	Female headed household (FHH)	Women in male-headed household	
Membership in farmer groups	69.20	17.00	52.20*
Membership in more than one farmer group	84.62	7.95	76.66***
Leadership position	46.15	20.45	25.69*

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level

Table 5 shows that there were statistically significant differences between the levels of membership into farmer groups between women in male-headed households and women who were themselves household heads. The results indicate that the majority of female household heads (69.2%) had membership into a farmer group while only a small percentage of women in male-headed households (17.0%) did so. The difference between the levels of participation of 52.2% was found to be statistically significant at the 10% level of confidence. Furthermore, Table 5 shows that those females who were themselves household heads were also more likely to have membership into more than one farmer group as compared to women in male-headed households. This is the case as the majority of the female household heads who had membership into a farmer were found to have active membership into more than one farmer group (84.62%) while a very small percentage of women in male-headed households (7.95%) who had membership into a group were found to have

membership into more than one farmer group. The difference in the levels of participation in more than one farmer group was 76.6% and this was found to be highly statistically significant.

The implications of these findings are that female household heads in the intervention community were more likely to be empowered as compared to women in male headed households. This is because farmer groups have been known to increase access to services which include agricultural advisory services, market information, as well as being a channel for both formal and informal networking and knowledge sharing (Hellin, Lundy & Meijer, 2009). These are important factors that increase self reliance which is an important aspect for empowerment. Generally, female headed households in many rural communities in Malawi are worse off as compared to male headed households in terms of socio-economic standing. This is due to limited access to resources such as land, credit and labour. This study demonstrates that the use of innovation systems concepts in the implementation of agricultural research and development programs has the potential to increase their participation in farmer groups which can allow them to have greater linkages with service providers and to have access to information and new knowledge.

An analysis of the group membership and leadership engagement of female headed households and women in the counterfactual community further reinforces that the above stated point; that without innovation systems and deliberate efforts to include women, they are often left out of development initiatives. Table 6 shows that in the counterfactual community where there was no agricultural research and development program that was driven by innovation system concepts, female household heads and women in male headed households had similar low levels of participation in farmer groups.

Table 6: % difference in group membership and community leadership (counterfactual)

Group membership (%)	Counterfactual community		ATT
	Female headed household (FHH)	Women in male-headed household	
Membership in farmer groups	15.0	18.4	-3.4
Membership in more than one farmer group	2.20	1.00	1.20
Leadership position	15.1	17.2	2.10

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level

As can be seen from Table 6, in the counterfactual community, female household heads and women in male-headed household who had membership into at least one farmer group were only 15% and 18% respectively, while a much lower percentage of female household head (2.0%) and women in male-headed households (1.00%) had membership into more than one farmer group. As a result, the absence of a deliberate effort to encourage women in development activities (such as participation in farmer groups) leads to their marginalization and this is more so felt among female headed households. Deliberate efforts such as those under the Enabling Rural Innovation initiative have the potential to increase women's participation in development activities with female household heads being more enabled to participate as compared to women in male headed households.

Similar results can also be seen for the leadership positions with only a few female household heads (15%) and women in male headed household (17%) having leadership positions in the counterfactual community. While in the intervention

community it can be seen from Table 6 that female household heads were more likely to be in a leadership position as compared to women in male-headed households. This is demonstrated by the results (Table 6) which indicate that nearly half of all the female household heads in the intervention community (46.15%) had some form of a leadership position as compared to approximately a quarter of the women in male-headed households (20.45%). The difference in the percentage of female household heads and women in male headed households who had leadership positions in the community of 25.69% was found to be statistically significant at the 10% level of confidence.

CONCLUSION AND POLICY RECOMMENDATIONS

In conclusion, the analysis of the impacts of innovation systems driven agricultural research initiatives has shown that the initiative impacted positively upon the production outcomes, the social and human capital outcome and the fertilizer use patterns of female headed households who participated in the program. The effect on fertilizer use patterns was significant even in the presence of government policies that made inorganic fertilizer more easily accessible and readily available to all rural producers. Despite the positive impact on fertilizer use, the results further demonstrated that participating households still applied a level of inorganic fertilizer that was below the recommended rates for the study area. This was attributable to participating households using cash returns from the agro-enterprise to meet other needs as well as the lack of a savings culture in rural areas of Malawi; which is problematic as cash inflow from the agro-enterprises does not always coincide with the time for fertilizer application.

Sustainability of the positive impacts are threatened by the phasing out of the initiative as this study shows that production outcomes had declining trends and other important decision making processes were found to be altered merely a year after the initiative had been phased out. This was attributed to the lack of sufficient human and financial capital on the part of local agricultural research and extension agents to replicate the innovative strategies employed by the initiative during its implementation. Secondly women in male-headed households; who are consequently in the majority in rural areas; benefited less as individuals as compared to females who were themselves household heads. This was the case despite that the Enabling Rural Innovation initiative made deliberate and consistent efforts to incorporate women through deliberate gender facilitation.

Policy recommendations are that there is firstly need to mainstream innovation systems concepts into public and private research and development programs and policies. Innovation systems mainstreaming will only be successful if it is concurrently implemented with increased budgetary support for and capacity building of grass roots agricultural advisory service staff. Secondly, policies and programs incorporating innovation systems concepts need to ensure deliberate gender facilitation that takes into account the intra and inter-household dynamics within rural communities. This will ensure that all women (female headed households and women in male-headed households) benefit fully from development initiatives.

Finally future research should focus on going beyond the quantification of the impacts of the use of innovation systems at the household level. This is because innovation systems concepts work towards creating greater linkages between rural households and the market economy, thus allowing rural households to take advantage of market incentives but also at the same time potentially making them more vulnerable to market forces. Therefore in order for studies to produce

robust evidence for effective policies, they must also include an assessment of the resultant impacts of the greater market linkages which arise from both policy shocks which transmit through the market.

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