CGIAR

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Food security and better livelihoods

for rural dryland communities

The CGIAR Research Program on Dryland Systems aims to improve the lives of 1.6 billion people and mitigate land and resource degradation in 3 billion hectares covering the world's dry areas. Dryland Systems engages in integrated agricultural systems research to address key socioeconomic and biophysical constraints that affect food security, equitable and sustainable land and natural resource management, and the livelihoods of poor and marginalized dryland communities. The program unifies eight CGIAR Centres and uses unique partnership platforms to bind together scientific research results with the skills and capacities of national agricultural research systems (NARS), advanced research institutes (ARIs), non-governmental and civil society organizations, the private sector, and other actors to test and develop practical innovative solutions for rural dryland communities.

The program is led by the International Centre for Agricultural Research in the Dry Areas (ICARDA), a member of the CGIAR Consortium. CGIAR is a global agriculture research partnership for a food secure future.

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DISCLAIMER

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Table of Contents

List of Acronyms

BMZ - German Federal Ministry for Economic Cooperation and Development

CIAT – International Center for Tropical Agriculture

CIP – International Potato Center

DS – Dryland Systems

EPA – Extension Planning Area

FGD – Focus Group Discussion

GIZ - Gesellschaft für Technische Zusammenarbeit

ISFM – Integrated Soil Fertility Management

LUNAR – Lilongwe University of Natural Resources and Agriculture

NGO – Non-Governmental Organization

NPK ….– Nitrogen, Phosphorus and Potassium (23:21:0 +4S) fertilizer

OFSP – Orange Fleshed Sweat Potato

RDP - Rural Development Project

SLM – Sustainable Land Management

SWC – Soil and Water Conservation

TLC – Total Land care

SECTION I – Key MESSAGES

a. Synthesis of Progress and Challenges

As part of continued demonstration and out-scaling exercises, we have introduced drought resilient bean varieties complemented with various agronomic practices during the 2014/15 season. Results show that the new varieties had an average yield of 1050 kg ha^{-1}, which was about 263% higher than the reported mean yields in Malawi (about 400 kg ha^{-1}) and much higher than yields obtained by farmers in the study sites (0 – 500 kg ha^{-1}) (Ndengu *et al*., 2015$_a$). It was further observed that treatments under Integrated Soil Fertility Management (ISFM) had better yield (500 - 1200 kg ha^{-1}) as opposed to those without ISFM (350 - 550 kg ha^{-1}). The drought resilient bush bean varieties introduced in the study site have thus been instrumental in reducing the impact of the drought that affected 30% of crop yield in Malawi. These gains contribute towards achieving IDOs 1.3, 1.4 and 3.3. The soil and water conservation (SWC) technologies implemented also enhanced crop productivity whereby maize did very well (13-28% higher than farmer practices) due to availability of residual moisture despite the drought (IDO1.1, IDO1.4) (Mponela et al., 2015$_a$). In this activity 1200 households benefited from the new varieties and good agronomic practices introduced. As much as the year was a disaster for other crops, it presented a great opportunity for the participating farmers to learn and gain first-hand experience on how improved genotypes (that are drought resilient) and ISFM and/or SWC technologies synergistically work in buffering effects of drought on bean yields (IDO1.1, 1.4, 3.3).

In an effort to curb the impact of the 2014/15 pronounced dry spell, we introduced sweet potato genotypes to the local communities. During focus group discussions (FGD) aimed to identify potentials and constraints related to land degradation and resources management in four villages of Ntcheu, communities requested for the introduction of alternative varieties to cope with the failing maize due to drought (Braslow *et al*. 2015). Based on this, we collaborated with the International Potato Centre (CIP) and introduced orange fleshed sweet potatoes (OFSP) that can help buffer communities against drought and crop (maize) failure. The OFSPs were distributed to about 1200 farming families to plant on their fields where maize failed and/or inter-cropped with maize when relevant. In addition, different OFSP varieties were demonstrated on 60 farmers' plots. Results show that 66% of farmers who participated in this intervention received yield of between 2 - 9 t ha^{-1} though in some cases it is much lower than 2 t ha^{-1} (Mponela *et al*., 2015$_b$). In addition, yields from the demonstration plots were more than double (9 t ha^{-1}) than the average yields realised by farmers from existing varieties. The introduction of OFSPs helped cope with drought and increased household's transformative resilience (IDO1.1) as well as provided the much needed vitamins (Abdin *et al*, 2013) to households whose diets lack essential nutrients (IDOs1.1, 2.1, 2.3). Through the demonstrations, the farmers also learnt good agricultural practices for improved sweet potato production (IDO3.3).

Understanding crop yield gap among farmers and the associated determinants can help design appropriate mechanisms that can help curb the gap. We analysed maize yield gap based on agronomic survey data and modelled the determinants. The study demonstrated that closing the gap between the higher and lower ends of the yield continuum in maize mixed farming system and designing interventions geared to specific household categories and contexts require addressing agronomic, biophysical and socio-economic constraints through an integrated approach (Tamene *et al*., 2015). In addition to yield gap analysis, we also modelled the determinants of technology choice and adoption by smallholder farmers. Results show that farmers' adoption of more than one technology is positively influenced by land fragmentation, literacy and experience with farming, masculine gender of household head and higher wealth index while factors exerting negative influence include larger size of the household and larger land size used/owned (Mponela *et al*. under review).

As part of synthesizing systems research, we invited partners and stakeholders in the region to discuss opportunities and constraints related to farming systems at a workshop held in Lilongwe in February 2015. Among others, influence diagrams (that show interactions and feedbacks involving livelihoods sources and their determinants) were produced by participants (CGIAR CRP DS, 2014). Based on outputs of the workshop and literature review, an agricultural systems framework has been developed that shows linkages and feedback loops of processes within maize mixed farming system (Mponela *et al*, 2015c). This forms the foundation for assessing performance and trade-offs among competing and complementing functions and processes. To support the systems modelling exercise in 2016, we also conducted detailed household typology analysis that has revealed plausible grouping of households (Mponela *et al*., 2015) whose behaviour and production functions will be modelled for type specific performance indicators. In 2016, the influence diagram framework, household typology and results of technology adoption determinants will be used in an integrated manner to develop a dynamic land-use and technology choice simulator/tool for the study site. The tool will be used to simulate the impacts of endogenous and exogenous factors on land use and technology choice decisions. It will also facilitate modelling feedbacks, interactions and resulting emergent behaviour. The support given by the DS System Analyst Dr Quang Bao Le was and will be instrumental in our effort to develop integrated systems analysis tool (CGIAR CRP DS., 2015).

Our activities in 2014/15 season have been seriously challenged by the flood and drought which caused some of our trials fail and affected farmers' enthusiastic participation in managing the trials. This was specifically the case when some farmers 'out-migrated' looking for other livelihood options during the time of the crisis. Another serious bottleneck was the continuous reduction of budget that affected implementation of some activities and our ability to conducted detailed data analysis. The fact that there was delay in releasing the available funds also constrained planning activities and engaging partners on time.

b. Significant Research Achievements

In the East and South Africa (ESA) region, 2014/15 has experienced one of the worst droughts caused by El-Nino. In Malawi, the rainy season has been characterized by very severe flood affecting many livelihoods at the onset of rains followed by long dry spell that severely influenced crop performance. Anticipating that their major crop, maize, will be impacted by the drought, community members (men, women and youth), during a focus group discussion (FGD)) with male, female and youth groups (Braslow *et al*. 2015), requested for alternative crops to buffer the impact of crop failure. In this regard, we collaborated with the International Potato Center (CIP) to solicit and distribute orange fleshed sweet potatoes (OFSPs) to 1200 households (about 100 veins cuttings per farmer) in six villages of Ntcheu site. Six OFSP varieties were also distributed to about 60 farmers (more than 50% women) to test and demonstrate performances of different genotypes. From these interventions, farmers realised 2- 9 t ha^{-1} of potato yield. The result was encouraging not only to complement farmers' food and income but also as source of back-up seed for the next season (Mponela *et al*. 2015b). The wide variability was because of differences in different genotypes and treatments. The intervention was very interesting because it was demand driven and also diversified farmers' source of income and provided supplemental nutrition.

As part of technology demonstration and out-scaling exercise, we have also introduced two drought resilient bush bean genotypes to about 209 households (83% were women) in the action site. The farmers were provided with adequate trainings on good agronomic practices and also on how to make records at various stages of crop development. Results showed a yield advantage of over 260% compared to existing varieties under traditional practices. The high yield was due to the drought resilient nature of the varieties and associated improved agronomic practices (Ndengu *et al* 2015a). This has been hugely appreciated by the local communities and some such as Mrs Lebita Pokoma of Ungwe village commented "This is a magic bean, how I wished I had an opportunity to plant a big area?" (Chataika *et al*., 2015a). This achievement also attracted lots of interest during a beating famine international conference at Lilongwe (Kabena, 2015) where among others a journalist from Kenya requested for a field visit (based on our poster presentation). Arrangement was made for field visit and the journalist was impressed of his observation and the positive sentiments of local communities.

The above two 'stories' showed how the unpleasant situation (drought) has become an opportunity for participating communities and researchers. The farmers received improved yield from the new varieties and OFSPs. This can facilitate future technology adoption and out-scaling. The stakeholders (researchers, extension, lecturers, NGO, and farmers) were encouraged to be able to deploy and co-implement problem oriented action research and demonstrated the benefits of technologies that can help boost productivity and buffer livelihoods in case of difficult circumstances. The coordination among the partners to act fast was also very encouraging. In addition, the interventions highlighted the benefit of context-specific interventions, promoted framers' yields and should be a stepping stone to enhance their further technology adoption.

c. Financial Summary (1/2 page)

This section will be updated once your center closes the accounting books in 2016.

SECTION II– IMPACT PATHWAY AND INTERMEDIATE DEVELOPMENT OUTCOMES (IDOS)

a. Progress Along the Impact Pathway

During the 2014/15 season, we have introduced drought resilient bush bean varieties, integrated soil fertility management (ISFM) and sustainable land management (SLM) practices, within maize mixed farming systems. Over 1400 farmers (239 male and 1253 female) in Ntcheu and Dedza districts of Malawi have participated in various interventions related to genotypes and good management practices. In this regard, around 20 different technologies have been introduced/out-scaled in the action site and demonstrated for farmers. On average, some of the interventions (i.e. in SLM plots) resulted in a yield gain ranging between 13 – 26% (Mponela *et al*., 2015a) compared to those without SLM. This was against a serious drought event and the gain could serve buffer its impact (IDO1.1, 1). During out-scaling from extension planning area (EPA) to the level of rural development project (RDP), over one million people in Dedza and Ntcheu districts as potential secondary out-scaling areas could directly and indirectly benefit from the different interventions (new varieties, ISFM, SLM and SWC practices). For specific interventions (trials) over 12 ha of land has been covered.

The program has trained 226 female and about 71 male farmers on various good agricultural and agronomic practices. In addition, around three extension workers have participated in the training. As part of our collaboration with local partners, we are supporting two students towards their Masters studies in the LUNAR University. The co-learning among farmers, extension agents, partners and researchers has promoted trust and understanding which will facilitate adoption and out-scaling.

b. ESA/Rainfed

I. Progress towards outputs

During the 2014/15 season, we have focused our activities on five aspects: 1) participatory action research where we co-planned, co-implemented and co-evaluated with farmers, extension agents and local non-governmental organizations different ISFM and SLM practices; 2) conducted yield gap analysis across households and analysed the factors that determined the observed variability; 3) modelled the major determinants of technology choice and adoption; 4) conducted stakeholder workshop to have common understanding of systems analysis and modelling; and 5) developed framework and pathways towards integrated systems analysis. Brief description of each item is provided below.

1. Co-implementation and co-evaluation of ISFM and SLM practices

As a continuation of the previous work, we co-implemented cereal-legume integration under ISFM practices using the mother-baby approach. Maize and two high yielding bean varieties (bush and climbing) were intercropped with different input application (organic and inorganic) to identify practices that enhance system performance efficiency and resilience. The study involved about 209 farmers, out of which over 82% were female (because beans in Malawi are considered female crops). Results showed that yield in pure stands treated with chicken manure were higher (0.76 - 1.85 ton ha^{-1}) while control plots without manure and business as usual management gave low yields (0.4 - 1.0 ton ha^{-1}) (Ndengu *et al*., 2015b). Manure application significantly increased overall grain yield by 60% in sole bean stands and 53% in bean-maize intercrops over the control. Bean yield in the common practice of maize intercrop was higher by 15% in manure compared to NPK treatments. Combining manure and NPK resulted in 9% yield gain over manure treated stands in sole crops while in intercrop, the yield gain was 27% and 11% over the merely fertilizer and manure treatments, respectively (Ndengu *et al*., 2015c). It was observed that use of chicken manure on small farms has the potential to significantly increase bean yield and improve fertilizer use efficiency of some varieties under maize mixed farming systems. The most interesting result of the study is the performances of the drought resilient bush varieties (SER45 and SER 83) despite the prolonged dry spell (drought) (Chataika *et al*., 2015a; Ndengu *et al*., 2015a;FAO, 2016)

In addition to the planned cereal-legume integration, we introduced orange fleshed sweet potato genotypes to serve as buffer against the prolonged dry spell. This was an interesting intervention because it was based on demand from the local communities. The interventions benefited communities where a yields of up to 9 t ha^{-1} was achieved. This achievement was a result of strong and efficient collaboration between CG centres (CIAT and CIP) and other partners in the area (TLC and LUNAR University) (citation and hyperlink should be made here).

2. Yield gap analyses across households and their determinants

Unpacking the significances of genotype-environment-management as well as socio-economic and institutional factors that determine yield gap of different households can facilitate designing options to narrow the gap between those getting relatively higher and lower yields. By integrating co-located biophysical, agronomic and socio-economic factors, the impact on the yields of smallholder farmers was analysed using multilevel mixed-effect models. Results show that some farmers in the study area did not follow the recommended practices as yield varies with weeds, number of seeds per planting station, plant density, and NPK fertilizer use (Tamene *et al*., 2015). Those farmers who have weeded their plots and used appropriate spacing as well as applied fertilizer had higher yield and vice-versa. An important issue is 'why those farmers who received low yield did not adopt/implement appropriate agronomic practices to enhance crop yield'? Integrated analysis of biophysical and socio-economic factors revealed that exposure, knowledge, farming experience, resources endowment, labour availability, off-farm employment have contributed for the adoption of good agronomic practices (Tamene *et al*., 2015). Generally, households with limited resources tend to be risk averse and will not have the ability to invest in productivity enhancing technologies. Improving extension services and creating awareness can increase maize yield and reduce the gap between the higher and lower ends of the yield continuum. One of the implications of the study is that interventions should be context-specific and consider the socio-economic status of households and biophysical conditions of farmers' plots.

3. Determinants of integrated soil fertility technology adoption by smallholder farmers

Sustainable intensification is generally about balanced input use to enhance productivity per unit of land without expanding the extent of the farming area. However, adoption of input use by smallholder farmers in Africa is generally low. Understanding the socio-ecologic determinants of technology adoption is crucial in designing technologies and out-scaling best fits for optimal set of complementarities.

The integrated soil fertility management (ISFM) framework suggests that progressive adoption of combinations of technologies can maximise agronomic use efficiency of the applied nutrients and improve crop productivity. However, there are cases where some farmers adopt part of a given technology while other adopt a combination of technologies. These differences are governed by various biophysical and socio-economic conditions. An attempt was made to assess the probability of adopting a combination of technologies and also help distinguish between the farmers who adopt one technology and those who adopt multiple technologies. It is also important to define the cut-off point between adopters and non-adopters. In this regard, the study aims to address the following questions: (i) what are the common combinations of ISFM technologies employed by smallholder farmers in the study area; (ii) which are the key farm and household attributes that drive farmers' decision to adopt a set of ISFM technologies. We used the number of ISFM technologies adopted to analyse multiple adoption decisions using a pooled and random effects ordered probit model in maize mixed cropping system of the Chinyanja Triangle.

Results showed that farmers' adoption of more than one technology is positively influenced by high land fragmentation, high literacy and experience with farming, masculine (man) gender of household head and higher wealth index while factors exerting negative influence include larger size of the household and land used/owned (Mponela *et al*., in review). This shows that resource endowment lowers farmers' propensity to adopt multiple ISFM technologies. Farmers with resources chose from a wide range of ISFM options, a few best bets with complementarities that enhance productivity. On the other hand, those with small land holdings tend to adopt more ISFM technologies. The positive influence observed among farmers with higher literacy and wealth index indicates that they are the ones that test/practice several technologies to harness full benefits of IFSM as these farmers are generally better able to bear risk. However, with the lower education levels of household heads that make most of the decisions, there is need for adult literacy learning through demonstrations and farmer schools to ensure that they are able to process information and make informed decisions regarding improvement of farmland productivity. The results have implications for programs that scale-out ISFM technologies in the resource constrained farming households of the Chinyanja Triangle. It is important to take into account complementarities among the technologies so as to hasten uptake by farmers at different socio-ecological levels. The farming systems dominated by small to medium scale farmers provide a platform for development of technologies that utilise local resources. However it is also important to consider heterogeneity in farmers and their farms.

4. Stakeholder workshop to create common understanding on the needs and approaches of systems analyses and modelling

Agricultural and livelihood systems are results of different actions/activities and processes that interact with one another, have feedback mechanisms and these lead to emerging behaviours. Livelihoods analysis provides an entry point for adopting a systems approach as it provides a pathway for the analysis of complex and dynamic rural contexts. A workshop was thus organized in in February 2014 to establish an inventory of existing projects and knowledge on livelihoods in the action sites as a focal point for initial systems analysis (CGIAR CRP DS, 2014). It was also intended to foster common understanding of livelihood sources/determinants and the role of system analysis to unpack complex issues. Diverse stakeholders and partners from different disciplines and knowledge sources (Government, CGIAR, Universities, and NGOs) participated in the workshop, and this provided the basis for further system analysis. Among the various outputs include the different 'influence diagrams' related to the sources, constraints and potentials of different livelihood sources in the study sites. Because it is based on local stakeholders who have activities in the region, the 'diagram' supported with typology analysis will form the foundation for the systems analysis and modelling exercise to be undertaken in 2016. Details are provided in a workshop report (CGIAR CRP DS, 2014)

5. Household typology and characterization for integrated systems analysis

Lack of differentiated data about the real situation of households and their farms is cited as major challenge in coming up with a decision support system for agricultural production planning. Development of farming system decision tools requires an understanding of both proximate and underlying determinants of farmers' motivation to land use choice, farm transition alternatives, and farming practices. Plots/farms and landscapes have different potentials and constraints due to their environmental conditions and human-natural processes that influence them. On the other hand, farmers of different resource endowment, education level, age, livelihood sources, access to information and market have different decision making abilities and their level of technology adoption also vary significantly. In addition, the mechanisms by which they cope to risks and their ability to bounce back from stresses differ. These call for explicit examination of the combined role of households' characteristics, farm and neighbourhood biophysical attributes and linked external socio-institutional factors on farmers' behaviour. The overall aim of the study was thus to understand the heterogeneity among farming households by classifying them using household, plot and ecological variables to support niche-relevant determinant analysis for targeted interventions. This helps capture variability of farming systems to examine context-specific determinants of households' usage of sustainable agricultural intensification enhancing technologies. This also forms a basis to conduct integrated systems analysis and development of decision support tool.

Principal component and cluster analyses were used to achieve the above considering about 149 households from six villages that are distributed across the landscape – upland-lowland continuum. The PCA results showed that nine PCs explain about 80% of the variation. Through cluster analyses, households were grouped into three 'classes or types'. Income was the variable with the most discriminating power that significantly distinguished the classes into plausible types. Type I class was also distinguishable by having significantly fewer communication facilities. Other variables with high discriminating power between types I and II include family labour, transport facilities, household and farm equipment and tropical livestock units per person. Household types I and III differ significantly in terms of age and level of education of the household head. The types II and III are significantly distinguished only by income levels. For details refer to Mponela *et al*. (2015d)

The household types identified sets a meaningful compromise between analysing every single farm and assuming broad categories such as smallholders in general. The study revealed that heterogeneous smallholder households can be grouped using production factors into 3 subsets (types), homogenous within a certain range of attribute values which can be used for technology targeting. Hence, instead of providing 'blanket' or precise single farm recommendations for smallholder farmers in certain areas (which will not be feasible and possible), recognizing and responding to the variability in local farm characteristics promises more appropriate, targeted and efficient design recommendations to achieve improvements in agricultural production. In addition, the result can form a basis as recommendation and/or extrapolation domain for technology out-scaling with anticipated impacts.

II. Progress towards the achievement of research outcomes and IDOs

We report three major accomplishments towards achieving research outcomes and IDOs in 2014/15: enhanced partnership, participatory action research and framework towards system modelling.

1. Enhanced partnership

Fostering partnership is the foundation for successfully implementing integrated systems research. As a result, we have established partnership with various stakeholders within the Chinyanja Triangle. These include Malawi Department of Research, Total Land Care, LUNAR University, Zambian Agricultural Research, and Agricultural Research Institute of Mozambique. With increasing focus on limited 'action sites' we now have close partnership with extension officers, development agents, local NGOs and Universities within Malawi, one of the action sites. In order to fully engage and receive support from local partners there is a need to bring them on board from the beginning and provide them financial support to undertake their obligations. However with the declining fund from the CRP, providing adequate fund to partners was not possible. We thus devised a mechanism whereby they continue to be engaged in other bilateral projects (e.g., TLC and LUNAR under AGORA project, extension workers and development agents under Africa RISING project). As a result, we managed to continue fostering sound collaboration and partnership in the action site. Because of this, there is good understanding and the partners can be called to assist implementing projects and activities at short notice and with minimum funding (IDO D.1). In addition to local partners who facilitate project implementation and management, our collaboration with the local farmers have also been transformed to the positive because of our demand driven, participatory action research (IDO C.1). For one, we work with local farmers when designing and implementing activities (trials, demonstrations) as well as evaluating the outputs. Because of this the farmers internalize the purpose behind the various interventions and readily collaborate towards successful implementation, management and evaluation. Another attractive situation that promoted our collaboration and partnership with the local farmers is the 'demand-driven' introduction of sweet potato vines to buffer crop failure due to moisture stress cause by El-Nino drought. The success of drought resistant bean varieties during this challenging season also made it clear that our research is geared towards tackling farmers' problems and enhancing their livelihoods (IDOs 1.1, 1.3, 1.4). This forms basis to facilitate technology adoption and out-scaling as evidenced from some of the comments of local communities.

2. Participatory action research

With regards to participatory action research (that combines research and development), we co-implemented various trials and demonstrations – two bush and two climbing bean varieties, agronomic (plant spacing and density, ridge spacing and density, weeding time and frequency, etc.) and soil fertility management (organic and inorganic input) practices. The joint implementation and monitoring facilitates co-learning and experience sharing among stakeholders. This further enabled communities understand and appreciate the impacts of different treatments as they are able to observe progress from planting to harvesting). With the interventions, productivity has increased significantly (IDO1.4). The fact that farmers evaluated and assessed the effects of different treatments means also that they can be confident in employing the technologies they think are successful considering their contexts. Because we implemented cereal-legume inter-cropping, this also promotes the possibility for farmers to be able to diversify their livelihood sources and most importantly improve their nutrition and health (IDOs 2.1 and 2.3). Our participatory action research, which is based on close collaboration and co-implementation with local farmers, also enabled to promote not only use of improved agronomic practices, but also adoption of sustainable land management such as bench terraces (at the required standard) and incorporation of agro-forestry practices. This has improved system efficiency and productivity such that crop yield has improved (IDO3.3).

The soil and water management technologies promoted in Ntcheu significantly increased yields of maize and common beans. Comparisons between farmer practice with SLM technologies of conservation agriculture (minimum tillage) and box ridges indicated that maize yield increased by 28% and 13%, respectively (Mponela *et al*., 2015$_a$). The yield variability was high among farmers and technologies with co-efficient of variations of above 50%. Yield in agroforestry was found to be the most varied. This entails large yield gaps and attempts in closing such gaps would further improve the situation beyond the one reported in the current study. The results also showed that farmer practices kept more farmers within the low yield range while minimum tillage technology pushed more farmers above the average yields. Maize-legume intensification trials also performed well such that some maize variety DKC8033 with the use of NPK did well (5.5 – 8.0 ton ha^{-1}) (Ndengu et al., 2015$_a$). Climbing bean genotype such as MBC33 produced the highest yield of 6 ton ha^{-1} in pure stand where stick stakes and manure were used (Ndengu *et al*., 2015$_a$). Intercropping was preferred by farmers because of the overall high yield from both crops in association. Among bush varieties, SER45 genotype performed better under maize without fertilizer (1.076 ton ha^{-1}), while SER83 did well with addition of manure in maize intercrop system (0.897 ton ha^{-1}) indicating that SER varieties respond differently to soil fertility amendments. Because of the success observed in trials and demos, farmers are interested to adopt these and similar technologies as they indicated during participatory performance evaluation of treatments through field days.

3. Household and farm typology as basis for systems modelling and context-specific recommendation domain

The last three decades have seen widespread efforts to develop and transform agricultural practices in developing regions. Progress has been made in various fronts though technology adoption by smallholder framers is still limited due to different reasons as documented in the study on Determinants of integrated soil fertility management technologies adoption by smallholder farmers in the Chinyanja Triangle of Southern Africa. Farmers can be reluctant to adopt a technology when: (a) the technology does not fit or resonate well with (some) farmers' cultural repertoires/practices; (b) the subscribed technology or intervention is not suitable to the conditions under consideration (soil, farming system, crop); (c) the technology is not appropriate to address the problem(s) under consideration (soil erosion, nutrient mining, salinity, weed, pest); (d) the technology is complex enough to be understood, adopted and applied by farmers; (e) the land condition is so poor that technologies/interventions cannot improve its capacity or are too costly to be successfully implemented; (f) there are no conduce policy and institutional settings that can facilitate technology dissemination and adoption. The first constraint relates to a technology recommended by researchers or development agencies that is not culturally suitable or acceptable. This can be due to an attempted up-or-out-scaling of options from 'other' cultural or socio-economic environments. The second is related to the technology development process that sometimes ignores farmers' knowledge and constraints in the specific farmer production environment. This can also be a case related to resources constrained farmers who tend to avert risk and thus become less enthusiastic to adopting technologies or part of. The third one is similar to the first but it also includes the ability (or not) to design site-specific problem-oriented options that can address the problem(s) under consideration. The forth includes cases where options are complex and complicated for farmers to be properly understood and applied. The fifth issue is whether the problem at hand has passed the critical level as a result of which it is either too expensive or impossible to improve with technology. The sixth is related to absence of appropriate policies and enabling conditions that can help create awareness; facilitate dissemination and enhance adoption. The results of this study contribute to IDOs 2 and 4.

The above shows that understanding processes and their interactions at plot, farm, landscape and household levels is necessary to develop technologies that are suitable, acceptable and ecoefficient. Household typology creates clusters of household units that share 'similar' attributes considering different livelihood variables. Farm typology characterizes what biophysical and ecological processes distinguish landscape units – based on similar characteristics. The two interact – farmers modify, manage farms and the status of farmers in turn influence farmers how to interact with farms and surrounding landscapes - resulting in emergent behaviour. Integrated modelling of their interactions and feedbacks is thus essential. One of the best approaches to achieve this is integrated socio-ecological modelling which helps combine socio-economic and ecological processes, handle interactions and feedbacks, and assess cost-benefit and trade-offs. To achieve this, step-wise analysis of household and farm as well as landscape characteristics is necessary. Accordingly, we have assessed the household attributes (typology) to form clusters based on similar characteristics. We also have modelled the determinants of technology adoption in the region. This will be the platform to undertake integrated socio-ecological modelling to develop decision support system that can facilitate designing site-specific and problem-oriented interventions, assess cost-benefit and conduct trade-off analysis of interventions under various socio-ecological contexts and endogenous and exogenous drivers. This allows us to understand which interventions are best suited and have the highest likelihood of success and positive impact on farmers' livelihoods.

III. Progress towards Impact

Due to our interventions, the income (from crop yield) of over 1400 farmers in Ntcheu has improved. In addition, the food diversity and nutrition of over 1000 farmers in the same areas improved due to the introduced orange fleshed sweat potatoes. The interventions also helped buffer communities against the impact of the prolonged dry spell (FAO, 2016) that affected the region. The participatory implementation and evaluation of technologies introduced over 300 farmers to OFSP and its potential benefits. Due to this, participating and neighbouring farmers have showed interest in the technologies and are asking for more of them during field days and participatory technology evaluation.

Three extension workers who closely collaborated with the project and about five staff members of the two partners (TLC and LUNAR) have gained experience from the co-implementation, management and monitoring exercise and indicated adoption similar approaches in their other projects and activities.

IV. Unexpected Outputs, Outcomes and or Impact

One of the unexpected but plausible outcome that we can highlight include the introduction of sweet potatoes vines against the observed drought in the study area. We would not have introduced those varieties had there been no drought and had community members not emphasized its need during our FGD. The incident brought about great collaboration between CG centres (CIAT and CIP) operating in Malawi as well as the partners who are collaborating under the CRP (TLC and LUNAR). CIAT coordinated the whole exercise, CIP provided vines and free transport to all locations, CIAT, CIP, TLC and LUNAR along with participating communities co-managed the implementation of interventions and other subsequent activities (trainings, field and exchange visits and data collection). This coordinated effort had to take place within two weeks (not to miss the available residual moisture) which could be considered very effective. Farmers were mobilized, vines distributed, trainings given, and cuttings planted within three days Access to the sweet potato vines and subsequent crop allowed farmers to enhance their food security during the hungry months of drought that followed and understand potential options more resilient to extreme weather events and future climate change.

The prevalence of the El-Nino drought also created awareness of the benefits of not only high yielding but also drought resistant varieties. In this context, farmers, extension agents and other stakeholders appreciated the drought resistant climbing and bush bean varieties are owing to the severe drought and their great performances. We intend to continue working with the varieties and partner with Total Land Care as an 'out-scaling' agent because they have projects covering larger areas and communities. Through TLC's network of projects and community engagement we will help spread the preferred and best adapted bean varieties to farmers who are interested. We will also use the electronic media (radio) to create awareness to non-participating farmers. We will try to engage with TLC's radio network and others to share success stories and best practices around the resilient varieties, which will allow us to have a wider reach to potential beneficiaries.

SECTION III – CROSS-CUTTING ISSUES

a. Gender Research Achievements

We integrated a gender component to both quantitative and qualitative analysis. We conducted a socio-economic survey and focus group discussions as well as participatory resources analysis to collect sex-disaggregated data and better understand the perspectives and differential access to resources of various groups (men, women, and youth). Analysis of the socio-economic survey conducted in 2015 show that out of the 165 respondents, one third were female-headed households. Although average household size is larger for male-headed households (5.8 persons) than female-headed ones (4.1 persons), household make-up is similar as regards children, adults and elderly people. A similar proportion of household members provide farm labour (59-60%) and work off-farm (15-16%). This context helps us to better target activities and understand the potential differential impacts they might have on men and women.

Average farm area is around a third higher for male-headed households (1.8 ha) than female-headed households (1.3 ha), although differences in household size mean that average land per capita is higher in female-headed households (0.40 ha) than male-headed households (0.33 ha). There is little difference in land tenure, though the matrilineal nature of tenure in the central and southern regions of Malawi seems to push towards women headed households. Differences do appear in livestock ownership with a higher proportion of male-headed households owning livestock than female-headed households (47% as compared to 38%), and average herd size is also larger (1.5 as compared to 1.1 TLU). According to the combination of assets owned, (farm area, livestock, equipment & other bought assets, cash earnings), wealth is higher for male-headed households than for female-headed households.

Regarding income, absolute levels of cash income and crop production value are similar (livestock, petty trade, remittances) or higher (crop earnings, crop production value, employment, casual labour) for participating male-headed households as compared to participating female-headed households. Average cash earnings are two and a half times higher, employment income five and a half times higher, casual labour three times higher. Although average earnings from skilled labour are three times higher for participating female-headed households, more than two and a half as many male-headed households (15%) participate in skilled labour. A higher proportion of male-headed households also earn cash income from crops (87% as compared to 75%), livestock (49/27%) and employment (12/8%). It is however more common for female-headed households to participate in casual labour (31%/25%) and receive remittances (38/15%). Average per capita income is slightly higher for female-headed households due to smaller household size (USD$257 a year as compared to USD$226).

With regards to farming practices, more male-headed farming households irrigate (35%) than do female-headed ones, and irrigate a slightly larger average area (0.26/0.21 ha). Male-headed households apply higher average amounts of purchased inputs (fertiliser, seed, labour), although a similar proportion of male-headed and female-headed households use fertiliser and manure. The incidence and area of cash crop production is slightly higher for male-headed than for female-headed households.

With regards to sustainable land management, similar proportions of male and female-headed households have at least some knowledge of soil and water conservation and integrated soil fertility management techniques and apply these techniques on their farms (almost all), male-headed households claim both to know about (17 as compared to 15 on average) and apply (10 as compared to 8) a wider range of techniques. In general, rates of participation are however similar. Of a total of 24 techniques, a similar proportion of male-headed and female-headed households claim to have ever used 10 techniques, substantially more male-headed households claim to have ever used 6 techniques, and substantially more female-headed households claim to have ever used 8 techniques. Historical rates of use of SLM practices are higher for female-headed households for crop residues (80% ever having used, as compared to 50%), burying weeds (82%/41%), conservation agriculture (18%/11%), contour ridges (79%/35%), box ridges (68%/40%), basins (29%/15%), on-farm trees (86%/44%), contour planting (64%/32%) and lower for compost (6%/35%), crop rotation (44%/68%), mulching (19%/29%) and rainwater harvesting (4%/9%). Current rates of participation (i.e. the last season) are also higher for female-headed households for crop residues (71%/48%), burying weeds (86%/38%), conservation agriculture (14%/8%), on-farm trees (82%/41%), contour planting (50%/29%) and lower for compost (2%/24%), crop rotation (38%/67%), mulching (17%/27%), rainwater harvesting (2%/9%), woodlots (4%/12%).

These results present intriguing patterns which the project intends to examine further through a variety of qualitative methods to better understanding of the causes of these differences. They are an important step however in understanding gendered differences in land use and in SLM preferences which is important for avoiding blanket approaches to addressing land degradation.

We generally observed two challenges when mainstreaming gender: 1) in order to properly address gender in the research, there is a need to engage and consult women separately which requires more time and resources. This can also be challenging as women generally have also to take care of household activities and look after children, 2) in order to involve adequate number of women, there is a need for more logistical arrangement which makes the exercise more expensive visa-vis the allocated funding.

Generally, our observation shows that women are at a disadvantage when it comes to pursuing off-farm livelihood activities. But they also usually have better access to credit because NGOs are targeting them.

b. Partnerships Building Achievements

We continued to work with the same partners (Total Land Care and LUNAR University) as it was not conducive to engage new partners due to fund unavailability. We used bilateral project funds to motivate our existing partners to continue collaboration and engagement.

We conducted a workshop in February 2015 to discuss constraints, opportunities and priorities by various stakeholders (governmental and non-governmental organizations). This was instrumental in aligning CRP activities with national and regional priorities, specifically related to tackling vulnerability, promoting sustainable intensification and conducting integrated systems analysis.

Total Land Care is engaged in various interventions and is vital in taking up and out-scaling technologies. We thus consider it a very strategic partner. Currently, we are co-implementing soil and water harvesting and agro-forestry interventions following mother-baby trial approach. The partner will thus be good vehicle to out-scale the approaches to other areas.

c. Capacity Building Achievements

During sweet potato establishment, on 3 mother trials, CIP, CIAT, LUNAR and TLC scientists provided on-field training to farmers, extension officers and lead farmers on how to locate the site, lay out the plots, prepare the field, establishment and tending. Those trained ably established the remaining 3 trials under supervision of TLC field officer assisted by a lead farmer. During this year about 300 farmers have been trained in various good agronomic practices.

In collaboration with LUNAR University and bilateral project, 2 Msc students (both male) are conducting their study in the Ntcheu site.

In collaboration with the DS system Analysis, a half-day seminar was given to partners and stakeholders (9 males and 2 females) in Malawi related to the need, purposes and processes of systems modelling. The participants showed great interest and enjoyed the presentation by Dr. Le. This will be good foundation for our systems modelling work in 2016.

d. Risk Management

Unreliability and continuous reduction of CRP fund was a serious bottleneck towards implementing activities. From the outset, it was not clear how much fund would be available and we were forced to revise plan repeatedly. Since revising and reduction of funding continued until late, it was not possible to plan and act strategically.

Another risk is possibility of reduction of trust from our partners. Because the budget continued to decline and was not possible to provide partners with adequate budget, they can be reluctant to cooperate. This even has been mentioned in some meetings where partners mentioned “we are not sure/certain of the degree of their involvement in the CRP as there is no clear consistent budget allocation across the years)”.

The mitigation action we took was to pre-finance the CRP activities from other projects and also use bilateral funds to complete activities. We also involved partners in other bilateral projects.

The incidence of drought influenced farmers’ active participation in technology adoption, especially use of input by smallholder farmers who tend to avert risk. This camouflaged the amount of yield expected and resulted in lower outputs.

Drying up of wetlands during the winter season affected potato seed systems as farmers faced challenges in managing the vines. Some farmers set up nurseries besides their houses.

e. Lessons Learned

Introduction of drought tolerant bush bean varieties was a key intervention that demonstrated the performances of those genotypes under challenging climatic conditions. This has ‘opened’ the eyes of the local farmers which was also reflected during participatory technology evaluation of the technologies in the demonstration plots (Desta et al, 2015).

The introduction of orange fleshed sweet potatoes to buffer the severe drought was another highlight. Farmers benefited from better yield and also have got seed for future use. Besides, it demonstrated a successful partnership among the different actors: CIP, CIAT, TLC, LUNAR and communities. We will also support farmers with bamboos and agroforestry trees to reclaim gullies and degraded areas.

It is known that local stakeholder and partners are key to out-scale technologies in the long-run. Involving them and managing their interests are thus crucial. Since the CRP funding was limited, we made sure that our partners are fully engaged with us through involving them in bilateral projects.

Involve stakeholders (national partners, NGOs, CG centres) in systems understanding and designing suitable approaches. The workshop held in Lilongwe in February 2015 was great example to work together for a common goal.

f. CRP Financial Report

This section will be completed when your centre will close the accounting books in 2016.

SECTION IV - RESEARCH OUTCOME STORIES

OUTCOME STORY 1 Orange-fleshed sweet potato lift small-scale farmers trapped under maize poverty and climate variability

OUTCOME STORY 2 The rise of a magic bean as Malawi is hit by floods and terminal drought

Name of research activity/project title:	Acting Together Now for Pro-poor Strategies Against Soil and Land Degradation (AGORA)
Flagship:	Rainfed
Geographical region:	ESA
Name and email of Activity Lead:	Lulseged Tamene – lt.desta@cgiar.org
Name and email of Outcome Story Lead:	Powell Mponela – p.mponela@cgiar.org
Activity Lead Center:	CIAT
Activity Partner Center(s):	CIP, TLC, LUNAR University (Bunda College)
Activity Partner CRPs:	

1. Outcome Story Headline:

Orange-fleshed sweet potato buffered small-scale farmers trapped under "maize poverty" and climate variability

2. Outcome Story Abstract

During 2014/15 season, the main staple food crop in Malawi (maize) was seriously affected by dry flood and spells. A looming reduction in harvest and probable hunger forced farmers to seek alternatives. During focus group discussions and resource mapping, the farmers requested for sweet potatoes to help buffer the effect of the disastrous drought. The farmers also generally identified fields where potatoes could be grown identified fields where potatoes could be grown (Braslow et al, 2015)). Potato vines were sourced from CIP and distributed to more affected areas in the action site where about 1200 farming families in 6 villages benefited. Farmers were grouped into clubs to share lessons related to managing treatments used to test 6 varieties. Results show a wider yield range for different varieties with a maximum of about 9 t ha-1. Varietal performance also varied between treatments (about 6 ton ha-1 difference). There was also variation between clusters within mother trials (some having yield lower than 2 ton ha-1). Although they planted small areas, farmers recognise that the intervention was a success as it could potentially enable them diversify their food, income as well as complement their nutrition. This can be an 'eye-opener' as the farming system in the area is dominated by maize. The differences in performances between varieties and treatments require studying the determinant factors leading to the observed variation to devise appropriate management interventions.

Word limit: 200 words

3. Problem/Challenge Overview:

The rainy season of 2014/15 was a bad year for farmers across Malawi, (for instance 1.1 million were affected in southern Malawi only) who faced challenges of alternate flooding and dry spells. This resulted in a looming reduction in harvest and probable hunger which forced farmers to look for alternatives. Through a BMZ-GIZ funded bilateral project called "Acting Together Now for Pro-poor Strategies Against Soil and Land Degradation (AGORA)", CIAT and its partners joined forces to help buffer the immediate impact of the drought. The team with initial plan to implement SLM, had to rethink and provide transformative solutions to enhance resilience. Team members engaged CIP and requested potato vine cuttings to be distributed to farmers for which CIP responded swiftly and positively. The collaborative effort resulted in the distribution of orange fleshed sweet potatoes to over 1200 farmers. As the estimates from government showed a yield reduction by 30% due to the drought, the potential yield of the newly introduced varieties that, food and nutrition farmers realised cannot be underestimated. The swift collaboration and response by the CG centres and local partners to respond to the demands of communities is also exemplary.

4. What are the main research activities?

We fostered collaboration with sister CGIAR centre, CIP, for a 'problem oriented intervention'. Using a transformative approach towards building reliance each farmer was given 100 vine cuttings to buffer drought and re-use in subsequent wetland season. Using a smaller asset transfer method, 1200 farming families in 6 villages benefited. Senior staff member Thomas Remington who lead the collaboration from CIP highlighted that, although the one bundle could not compensate for the loss of a 0.1 ha maize field, it can be enough to 'inject' a new variety into the farmer seed system. Note: one bundle can plant 20 m2 but the vines harvested from that plot could plant a much larger area. The project also set up 6 mother trials each with 6 new varieties. Instead of one farmer managing the mother, farmers formed clubs as a way of sharing lessons. The approach facilitated co-learning among farmers, extension and researchers. Extension workers and

staff members from LUNAR University also shared the experiences while implementing the project.
This season we will ascertain if the initiative has raised the interest of non-participating farmers (to get vines).

5. What are the main Outcomes of your research?

An outcome is generally defined as the short-term and medium-term effect of an intervention's outputs, such as change in knowledge, attitudes, beliefs, behaviors.

Because of the better yield farmers enjoyed despite the drought season, their interest towards new varieties and agronomic practices has improved. The success of the trails was also beneficial for extension workers and NGOs as they can be able to convince communities on the buffering ability of drought resilient interventions as well as 'moisture' harvesting technologies. The performance of the varieties under challenging climatic circumstances raised the interest of researchers and extension to further promote the varieties in this semi-arid region.
Realizing their performances and future benefits, it has been observed that some farmers kept vines in a nursery beside their main houses (which is usually used for vegetables and communal tree nurseries) for planting the next season. This is a result of change in behaviour and can facilitate out-scaling.

☐

6. What are the main research Outputs that resulted in the outcome(s)?

- Six varieties of rich in pro-Vitamin A potato vines were introduced in 6 villages to demonstrate performances of varieties and allow farmers to select those most promising
- Vine cuttings were distributed to about 1200 farming families (100 cuttings per farmer) to serve buffer the impact of the drought in 2014/15 season and increase food security and nutrition.
- About 90 farmers were trained in trial establishment and to attend mother plots
- Farmers received sweet potato yields of up to 9 ton ha-1 against the national average of 4 ton ha-1.
- A learning alliance was formed through farmer clubs who manage the mother trials and engagement with extension workers and staff members from LUNAR University

7. Who were the intermediary and direct users of your research outputs and what role did they play in achieving the outcome:

The 1200 farmers who participated in the trials and received vine cuttings were the primary beneficiaries (from the yield gained). In addition, about 60 farmers benefited from the demonstration trails of six genotypes. Based on the success observed, non-participating farmers should be aware of the interventions and got interested to adopt the technologies.

Two partners (TLC and CIP) were the intermediary users of the research outputs for dissemination of the improved OFSP varieties. TLC and LUNAR University participated in co-implementing interventions while CIP provided vine cuttings and collaborated in transporting materials and training farmers. Next-users could include other development agencies, NGOS, implementers working to promote food security, nutrition and climate change resilience who might be interested in promoting the promising genotypes.

8. How were your research outputs used (will be used in the future)?

The joint implementation and collaboration in implementing trials and demonstrations of different varieties and corresponding good agronomic practices has encouraged our partners such as TLC and LUNAR to use similar approach to introduce drought resilient varieties and good agronomic practices in the succeeding years. Farmers were encouraged with the results of the sweet potatoes and most have reserved seed for future planning. We will continue participating communities and co-implementing interventions as well as evaluating their performances.

9. What is the Evidence of Your Research Outcomes?

The communities who received sweet potato vines have kept reserves for future use which is an indication of success of the current undertaking. In addition, some farmers commented on the benefits (as food and seed reserve) of the introduced potato genotypes.

10. Lessons Learned:

Problem oriented solutions are attractive and beneficial. The introduced potatoes not only provided valuable nutrition and income but also provided seed for next season planting. Some of the challenges were that the demand from the communities was so big that the project could not satisfy within short time notice. In addition, some community members and government officials wanted broader intervention (supply as many vines as possible as a kind of aid) because of the magnitude of the drought which the project cannot accommodate.

11. Full reference citations and URL link to published research work.

http://ciatblogs.cgiar.org/soils/land-management-matters-malawian-communities-create-maps-to-find-answers/ The Devil is in the details: Understanding the realities of land management in Malawi Poster:

https://www.slideshare.net/CIAT/ciat-global-soil-week-2015-participatory-mapping-malawi-renting-land

Name of research activity/project title:	Sustainable Intensification and Diversification of Maize based farming systems in Malawi: CIAT Bean integration program
Flagship:	
Geographical region:	Eastern and Southern Africa
Name and email of Activity Lead:	Lulseged Tamene lt.desta@cgiar.org
Name and email of Outcome Story Lead:	Gift Ndengu – gndengu@cgiar.org
Activity Lead Center:	International Centre for Tropical Agriculture (CIAT)
Activity Partner Center (s):	Michigan State University (MSU)
Activity Partner CRPs:	

1. Outcome Story Headline:

The rise of a magic bean as Malawi is hit by floods and terminal drought

2. Outcome Story Abstract

Common beans (Phaseolus vulgaris L) play an important role in food and nutrition security and income for farmers in Malawi. However, its yields have remained low (400 kg ha-1). The main causes for the low yield include pest and diseases, declining soil fertility, poor quality of genotypes, adverse climatic conditions and slow adoption rate of new technologies. CIAT has developed improved drought resilient genotypes (SER43 and SER83), which were introduced along with appropriate integrated soil fertility management (ISFM) practices. Within a backdrop of the 2014/15 drought season, the trials showed yield of 1050 kg ha-1, which is 162.5% higher than reported. In addition, maize planted with appropriate ridging and spacing (under the guidance of the project)

performed well due to residual moisture. This indicated synergy in drought resilience between the SER genotypes and ISFM technologies. As much as the year was a disaster for crops, it presented a great opportunity for the participating farmers to learn how drought resilient genotypes and ISFM technologies help buffer the effects of drought.

3. Problem/Challenge Overview:

Despite the importance of beans to the livelihood of rural farmers in Malawi (food, nutrition, and income), the average yield of the crop has persistently remained low (400 kg ha-1). A combination of factors have been blamed for this. On top of that, the drought of 2014/15 due to the prolonged dry spell seriously impacted crop performance. In its effort to buffer communities in case of climate change and variability, CIAT has released various drought resilient and disease resistant bean varieties. Before wider distribution and out-scaling, it is important to test performances considering different soil types and management practices. Against this background, we demonstrated the productivity of two drought resilient bean varieties complemented with ISFM technologies to evaluate their productivity. We employed a mother-baby trial approach to co- implement, co-manage and co-evaluate the various treatments. The work was very relevant to demonstrate the resilient of the crops against drought and their potential to buffer its impacts. The preferred and best adapted varieties could be disseminated to a wider population facing similar drought and resource constraints.

4. What are the main research activities?

The main research activity was introducing and demonstrating different drought resilient bean varieties (SER45 and SER83) and co-evaluate their performances with regards to various input use and agronomic practices in Linthipe and Kandeu in Dedza and Ntcheu districts, respectively. High yielding, drought resilient, and disease resistant genotypes were introduced based on mother-baby participatory approaches, to enhance learning by farmers and provision of feedback to researchers for improvement in real time. Management and technology implementation were done by farmers and technicians, facilitated by research scientists. Split plot design was used, where varieties were whole plots, and management option as split plots. Farmers were trained on crop, pest and disease management. Different treatments including sole bean, beans+manure, maize+manure+NPS, bean+maize+NPS, bean+maize+manure+NPS, bean+manure+NPS fertilizer, bean+maize, and bean +maize+manure were tested. Participatory evaluation of the different treatments was conducted through field days and exchange visits.

5. What are the main Outcomes of your research?

Introduction of improved of bean genotypes together with use of ISFM technologies in bean production influenced the attitude of the 209 farmers as far as bean production is concerned. Other farmers who participated in field days have also been positively influenced by the positive developments with respect to varieties and agronomic practices. This followed an improvement of yield by almost 163% (1050 kg ha-1), despite drought. Sentiments expressed at the performance of the introduced beans (SER45 and SER83) provided evidence to scaling the outcomes up and out. “This is a magic bean. How

I wished I had an opportunity to plant it in a big area," said Pokoma Lebita, a farmer hosting the Mother trial at Ungwe village in Linthipe, Dedza district. Not only were the participating farmers interested and motivated to plant more of the drought resistant varieties, but also scientist and journalists recognized the performances (Chataika et al., 2015a). These could enhance technology adoption by non-participating farmers as the number of interested farmers increased.

6. What are the main research Outputs that resulted in the outcome(s)?

Famers who participated in bush varieties received over 160% yield gain compared to existing varieties under traditional management practices, increasing their food security and income and inspiring them to share their successes with neighbouring farmers in field days

Yield of maize also increased on areas with SWC practices due to residual moisture (despite the observed drought).

Participatory evaluation of treatments during exchange visits and field days allowed farmers to understand the impacts of different technologies and interventions. These served as trainings and awareness campaigns for the participating farmers

7. Who were the intermediary and direct users of your research outputs and what role did they play in achieving the outcome:

The 209 farmers who actively participated in the trials and demos were the primary beneficiaries.

The local farmers who participated in field days, and are neighbours to the participating farmers were the intermediary users of the research outputs, now interested to try the new drought resistant varieties and spread the word about the varieties that could potentially help them improve yields and incomes

ICRAF, Michigan State UniversityLUANAR and CIAT scientists and DAES extension gained experiences and formed learning alliances from the participatory action research.

8. How were your research outputs used (will be used in the future)?

1. Participating farmers are using the selected and preferred bean varieties and management techniques in the production of beans to increase productivity.
2. Results from the research would help in facilitating the release of the drought resistant varieties understudy to benefit a wider farming. In addition, organisations such as TLC would then consider replacing currently used bean varieties with these drought resistant varieties and associated management techniques in their development projects.

9. What is the Evidence of Your Research Outcomes?

A poster was presented at the Beat the famine in May at the Bingu International conference center in Lilongwe describing the success of the drought tolerant beans has attracted a lot of interest and has been used as a background for some interviews.

A journalist (Clifford Gikunda (Contacts: cngikunda@gmail.com) who travelled from Kenya to attend the conference was very much interested in our poster which reflects the performances of bush beans despite the serious drought and asked for a field visit. This was arranged whereby the Journalist discussed with farmers. He listened to the positive comments made by the farmers he interviewed and was himself impressed with the performances of the varieties despite the drought.

Comments given by Chiefs and some farmers (during field visits organized in March 2015) for the release of the new varieties. This will facilitate releasing genotypes.

10. Lessons Learned:

1. Use of ISFM significantly increases bean yields and improved the resilience to drought.
2. The project used chicken manure, hoping it is a common livestock, however, it was found to that access to this kind of manure was a challenge by most farmers, as most have small numbers of livestock. This necessitated the need for training farmers in making compost. This would sustain the technologies even after the lifespan of the project activities.

11. Full reference citations and URL link to published research work.

(https://vimeo.com/125072271)

Participatory Technology Evaluation Poster: https://cgspace.cgiar.org/handle/10568/65722

SECTION V – LIST OF 2015 PUBLICATIONS AND SCIENTIFIC OUTPUTS

Table 1. Summary of all ISI publications

Region/ALS	ISI Factor [range of ISI scores]	ISI Open (% of ISI articles)	ISI Monodisciplinary (% of ISI articles)	ISI Multidisciplinary (% of ISI articles)
ESA/				
TOTAL				

Table 2. Summary of Non-ISI Publications

Region/ALS	Non-ISI Articles	Book Chapters	Technical Reports & Working Papers	Proceedings	Datasets	Other
ESA/						
TOTAL						

Please list in alphabetical order, full citation, weblink and codes as applicable for all publications as shown in the examples below under each category of research output.

ISI Journal Articles (2)

1. (S) Tamene L., Mponela P., Ndengu G. & Kihara J., (2015). Assessment of maize yield gap and major determinant factors between smallholder farmers in the Dedza district of Malawi. Nutr Cycl Agroecosyst. DOI 10.1007/s10705-015-9692-7 [1.897]
2. (S) Mponela P., Tamene L., Ndengu G. & Mango, N., (under review). Determinants of integrated soil fertility management technologies adoption by smallholder farmers in the Chinyanja Triangle of Southern Africa. Land Use Policy (under review). http://mel.cgiar.org/reporting/download/hash/I78BAZ77

Non-ISI Journal Articles and Theses ()

Books (total count)

Book Chapters (total count)

Technical Reports and Working Papers (4)

1. Mponela P., Ndengu G., Desta L., Cordingley J., Snyder K., Nalivata P., and Sawasawa H. (2015$_a$). Effect of best-bet sustainable land management technologies of minimum till, agroforestry shrubs and box ridges on yield of maize (SC403) in Nsipe, Malawi. CIAT, Lilongwe. Author. http://mel.cgiar.org/uploads/reporting/5HYM6TLWJZYSr5OqeN1WxcOflSSI7W.docx
2. Mponela P., Desta L., Ndengu G., Remington T., Nyirenda J., and Snyder K. (2015$_b$). Orange-fleshed sweet potato an alternative for small-scale farmers trapped under Maize Poverty and climate variability. CIAT, Lilongwe, Malawi. Author. http://mel.cgiar.org/uploads/reporting/CDLqgOv43Fh37pUl1KKqSVDfgDVii7.docx
3. Mponela P, Tamene L., Ndengu G., and Le Q.B. (2015$_d$). Farming household types and their characterization in complex crop-livestock smallholder agricultural systems for contextual analysis and extension intervention: case of Riviridzi Catchment in Ntcheu. Author. http://mel.cgiar.org/uploads/reporting/lNrKykL2aWxu9dutZfOPCCgSxr1uIi.docx
4. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015$_a$). Evaluation of Bush and Climbing Beans under different Cropping Systems and Nutrient Management Regimes in Linthipe and Kandeu, Malawi. 2014/15 season Annual Report for Africa RISING, CIAT, Lilongwe. http://mel.cgiar.org/reporting/report/id/2810

Proceedings (2)

1. Chataika B., Mponela P., Ndengu G., Desta L., and Chirwa R. (2015). Drought tolerant bean varieties offer hope to smallholder farmers in Malawi. Poster presented at Beating the Famine Conference held in Lilongwe, 2015.

   http://mel.cgiar.org/reporting/download/hash/G2JULRR

2. Chataika B., Ndengu G., Mponela P., Magreta R., Desta L., Chirwa R. and Chikowo R. (2015). Participatory Yield Assessment of Climbing and Bush Beans under Different Management Options in Malawi. Poster presented at the Humid Tropics workshop in Abuja, Nigeria in March 2015. http://www.slideshare.net/humidtropics/participatory-yield-assessment-of-climbing-and-bush-beans-under-different-management-options-in-malawi

Factsheets (6)

1. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015_b). Effect of chicken manure in boosting bean yield. CIAT, Lilongwe, Malawi. http://mel.cgiar.org/reporting/download/hash/1J6B2II
2. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015_c). Performance of common beans with chicken manure and NPS fertilizer (23:31:0+4S) applications. CIAT, Lilongwe, Malawi. http://mel.cgiar.org/reporting/download/hash/8G7GBZ88
3. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015_d). Performance of SER45 bushbean variety under drought. CIAT, Lilongwe, Malawi. Author. link
4. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015_e). Performance of SER83 bushbean variety under drought. CIAT, Lilongwe, Malawi. Author. link
5. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015_f). Technology: the DC80-263 climbing bean variety. CIAT, Lilongwe, Malawi. Author. link
6. Ndengu G., Desta L.T., Mponela P., Chataika B. and Chirwa R. (2015_g). Technology: the MBC33 climbing bean variety. CIAT, Lilongwe, Malawi. Author. link

Data sets ()

We have datasets, lets upload

Other publications (3)

1. Mponela P, Tamene L., Ndengu G., and Le Q.B. (2015_c). Systems dynamics framework for Ntcheu – Changara Transect. CIAT, Lilongwe, Malawi. Author. http://mel.cgiar.org/uploads/reporting/tto9bLW75r9fvX7LiiqoMTblPKZlLk.pptx
2. CGIAR CRP DS (2015). Model parameterization for systems analysis: Proceedings of the training and stakeholder discussion held in Lilongwe, Malawi. Author.

http://mel.cgiar.org/reporting/download/hash/JLPUNPII
3. CGIAR CRP DS (2014). Systems and Livelihoods Meta-analysis Workshop. DS, Lilongwe, Malawi. http://mel.cgiar.org/uploads/reporting/kB3TZXmTnrWErEvtFGge18WgX5Kps8.pdf

Annex 1: CRP indicators of progress, with glossary and targets

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
KNOWLEDGE, TOOLS, DATA				
1. Number of "products" produced by the Center	1 systems analysis framework as a basis for systems modelling. Not published yet and advanced draft is available.		1 framework	2
2. Number of products produced that have explicit target of women farmers/NRM managers	Glossary: The web pages, blog stories, press releases and policy briefs supporting indicator #1 must have an explicit focus on women farmers/NRM managers to be counted Provide concrete examples of what you include in this indicator			
3. Number of products produced that have been assessed for likely gender-disaggregated impact	Glossary; Reports/papers describing the products should include a focus on gender-disaggregated impacts if they are to be counted Provide concrete examples of what you include in this indicator			
4. Number of "tools" produced by the Center	Glossary: These are significant decision-support tools, guidelines, and/or training manuals that are significant and complete enough to have been highlighted on web pages, publicized through blog stories, press releases and/or policy briefs. They are significant in that they should be likely to change the way stakeholders along the impact pathway allocate resources and/or implement activities. Based on the glossary, describe the types of outputs you include in this indicator			
5. Number of tools that have an explicit target of women farmers	Glossary: The web pages, blog stories, press releases and policy briefs supporting indicator #4 must have an explicit focus on women farmers/NRM managers to be counted			

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
KNOWLEDGE, TOOLS, DATA				
6. Number of tools assessed for likely gender-disaggregated impact	Glossary: Reports/papers describing the products should include a focus on gender-disaggregated impacts if they are to be counted			
7. Number of open access databases maintained by Center	Socio-economic survey data for five sites within CT; agronomic survey data for one site, field trial data for 2 sites.		0	2
8. Total number of users of these open access databases	Total Land Care, LUNAR University, Extension Officers within the different Extension Planning Areas, and other projects in the region. Please not that we mentioned institutions and not individual users.	-		3
9. Number of publications in ISI journals produced by Center	One paper on yield gap analysis		1	2
10. Number of strategic value chains analysed by Center				
11. Number of targeted agro-ecosystems analysed/ characterised by Center	1. Maize-legume dominated mixed crop system		1	1

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
KNOWLEDGE, TOOLS, DATA				
12. Estimated population of above-mentioned agro-ecosystems	Number of people in the extension planning areas (EPAs) which are delineated based on agro-ecosystems: Linthipe, Kandeu and Nsipe EPAs		1,096,034	1,200,000
CAPACITY ENHANCEMENT AND INNOVATION PLATFORMS				
13. Number of trainees in short-term programs facilitated by Centre (male)	36 male farmers trained on best-bet ISFM practices 30 male farmers trained on SLM practices 3 extension officers trained to backstop trial management.		69	20
14. Number of trainees in short-term programs facilitated by Centre (female)	176 female farmers trained on best-bet ISFM practices 50 female farmers trained on SLM practices		226	100
15. Number of trainees in long-term programs facilitated by Center (male)	2 MSc students		2	
16. Number of trainees in long-term programs facilitated by Center (female)	(see above, but for female)			

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative	2015 Actual	2016 Target
CAPACITY ENHANCEMENT AND INNOVATION PLATFORMS				
17. Number of multi-stakeholder R4D innovation platforms established for the targeted agro-ecosystems by the Center	Glossary: To be counted, a multi-stakeholder platform has to have a clear purpose, generally to manage some type of tradeoff/conflict among the different interests of different stakeholders in the targeted agro-ecosystems, and inclusive and clear governance mechanisms, leading to decisions to manage the variety of perspectives of stakeholders in a manner satisfactory to the whole platform. Indicate the focus of each platform in this cell, including geographical focus			
TECHNOLOGIES/PRACTICES IN VARIOUS STAGES OF DEVELOPMENT				
18. Number of technologies/NRM practices under research in the Center (Phase I)				
19. Number of technologies under research that have an explicit target of women farmers	The papers, web pages, blog stories, press releases and policy briefs supporting indicator #x must have an explicit focus on women farmers/NRM managers to be counted			

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
TECHNOLOGIES/PRACTICES IN VARIOUS STAGES OF DEVELOPMENT				
20. Number of technologies under research that have been assessed for likely gender-disaggregated impact	Reports/papers describing the products should include a focus on gender-disaggregated impacts if they are to be counted			
21. Number of agro- ecosystems for which CRP has identified feasible approaches for improving ecosystem services and for establishing positive incentives for farmers to improve ecosystem functions as per the CRP's recommendations	1. Mixed farming system		1	1
22. Number of people who will potentially benefit from plans, once finalised, for the scaling up of strategies	Number of people in Dedza and Ntcheu districts which is an aggregate of EPAs with similar agroecological conditions and used for decentralised planning		1 million	1 million

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
TECHNOLOGIES/PRACTICES IN VARIOUS STAGES OF DEVELOPMENT				
23. Number of technologies /NRM practices field tested (phase II)	Two drought tolerant bush genotypes; Two high yielding and disease resistant climbing bean varieties; (all varieties showed high potential, so we wanted to further test their performance under best farmer management and different agroecologies: high altitude plains and middle altitude rift valley escarpments) one hybrid maize (DKC8031) Chicken manure(1) Fertilizer (1) NPS + chicken manure (1) CA, agroforestry, double up legumes, box ridges and contour marker ridges (5) Vetiver grass (1) ProVitamin A Orange Freshed Sweet Potato varieties (6) Insecticides and fungi- & bactericides for P&D and weed control in beans and CA plots (3) ISFM and SLM technologies, plus the OFSP varieties		22	12
24. Number of agro-ecosystems for which innovations (technologies, policies, practices, integrative approaches) and options for improvement at system level have been developed and are being field tested (Phase II)	1. Maize-legume mixed intercrop (common beans)		1	1
25. Number of above innovations/approaches/options that are targeted at decreasing inequality between men and women				

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
TECHNOLOGIES/PRACTICES IN VARIOUS STAGES OF DEVELOPMENT				
26. Number of published research outputs from CRP utilised in targeted agro-ecosystems	Tamene et al 2015 Article Chataika et al 2015 Poster Mponela et al. (under review) Article		2	2
27.Number of technologies/NRM practices released by public and private sector partners globally (phase III)	Vetiver and agroforestry nurseries established for landscape approaches (2)		2	6
POLICIES IN VARIOUS STAGES OF DEVELOPMENT				
28. Numbers of Policies/ Regulations/ Administrative Procedures Analyzed (Stage 1)	Number of agricultural enabling environment policies / regulations / administrative procedures in the areas of agricultural resource, food, market standards & regulation, public investment, natural resource or water management and climate change adaptation/mitigation as it relates to agriculture that underwent the first stage of the policy reform process i.e. analysis (review of existing policy / regulation / administrative procedure and/or proposal of new policy / regulations / administrative procedures).Please count the highest stage completed during the reporting year – don't double count for the same policy. Clearly identify in this cell the type of policy, regulations, etc. from the above list			

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
POLICIES IN VARIOUS STAGES OF DEVELOPMENT				
29. Number of policies / regulations / administrative procedures drafted and presented for public/stakeholder consultation (Stage 2)	....that underwent the second stage of the policy reform process. The second stage includes public debate and/or consultation with stakeholders on the proposed new or revised policy / regulation / administrative procedure. Clearly identify in this cell the type of policy, regulations and so on, and the geographical location of the consultations			
30. Number of policies / regulations / administrative procedures presented for legislation(Stage 3)	: ... underwent the third stage of the policy reform process (policies were presented for legislation/decree to improve the policy environment for smallholder-based agriculture.) Clearly identify in this cell the type of policy and the country/region concerned			
31. Number of policies / regulations / administrative procedures prepared passed/approved (Stage 4)	: ...underwent the fourth stage of the policy reform process (official approval (legislation/decree) of new or revised policy / regulation / administrative procedure by relevant authority). Clearly identify in this cell the type of policy and the country/region concerned			

Indicator	Description of Activities and Products measured by Indicator	Deviation narrative (+/- 10%)	2015 Actual	2016 Target
POLICIES IN VARIOUS STAGES OF DEVELOPMENT				
32. Number of policies / regulations / administrative procedures passed for which implementation has begun (Stage 5)	: ...completed the policy reform process (implementation of new or revised policy / regulation / administrative procedure by relevant authority) Clearly identify in this cell the type of policy and the country/region concerned			
OUTCOMES ON THE GROUND				
33. Number of hectares under improved technologies or management practices as a result of CRP research	The ISFM mother- baby trials were located in Dedza and Ntcheu and this was the second year to introduce new technologies (2.3 ha) The SLM (2 ha) Orange fleshed sweet potato (OFSP) genotype in Ntcheu (2.5 ha) Contour marker ridges introduced in Ntcheu sloping areas (6 ha)		12.8	15
34A. Number MALE of farmers and others who have applied new technologies or management practices as a result of CRP research	Clearly identify in this cell the geographic location of these farmers and whether the application of technologies is on a new or continuing area and indicate: AGORA Ntcheu OFSP (200), SLM (30) and marker ridges (32) also took part dissemination of OFSP) Africa Rising Dedza and Ntcheu ISFM (39)		239	100
34B. Number of FEMALE farmers and others who have applied new technologies or management practices as a result of CRP research	Clearly identify in this cell the geographic location of these farmers and whether the application of technologies is on a new or continuing area and indicate: AGORA Ntcheu OFSP (1000), SLM (50), marker ridges (30) Africa RISING Dedza and Ntcheu ISFM (173)		1253	500

Annex 2: Performance indicators for gender mainstreaming with targets defined

Please delete the part not achieved by your centre and add details.

Performance Indicator	CRP performance approaches requirements	CRP performance meets requirements	CRP performance exceeds requirements
1. Gender equality targets defined	Sex-disaggregated social data is being collected and used to diagnose important gender-related constraints in Ntcheu action site, Malawi	Sex-disaggregated social data collected and used to diagnose important gender-related constraints in the Ntcheu action site, Malawi	Sex-disaggregated social data collected and used to diagnose important gender-related constraints in Ntcheu action site, Malawi
2. Institutional architecture for integration of gender is in place			

ANNEX 3: List of Centre Research Staff contributing to Dryland Systems

Please provide list and relevant information of all research staff in your centre involved in Dryland Systems research from all Windows of funding by completing the attached excel document and submitting it separately as an attachment to the annual report.

Lulseged Tamene

Katherine Snyder

Juliet Braslow

Powell Mponela

Gift Ndengu

RESEARCH PROGRAM ON
Dryland Systems

The CGIAR Research Program on Dryland Systems aims to improve the lives of 1.6 billion people and mitigate land and resource degradation in 3 billion hectares covering the world's dry areas.

Dryland Systems engages in integrated agricultural systems research to address key socioeconomic and biophysical constraints that affect food security, equitable and sustainable land and natural resource management, and the livelihoods of poor and marginalized dryland communities. The program unifies eight CGIAR Centers and uses unique partnership platforms to bind together scientific research results with the skills and capacities of national agricultural research systems (NARS), advanced research institutes (ARIs), non-governmental and civil society organizations, the private sector, and other actors to test and develop practical innovative solutions for rural dryland communities.

The program is led by the International Center for Agricultural Research in the Dry Areas (ICARDA), a member of the CGIAR Consortium. CGIAR is a global agriculture research partnership for a food secure future.

For more information, please visit

drylandsystems.cgiar.org

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ICARDA — Science for Better Livelihoods in Dry Areas

In partnership with:

ICRISAT — Science with a human face

Bioversity International

CIAT

Centro Internacional de la Papa — CIP

World Agroforestry Centre

ILRI — International Livestock Research Institute

IWMI — International Water Management Institute