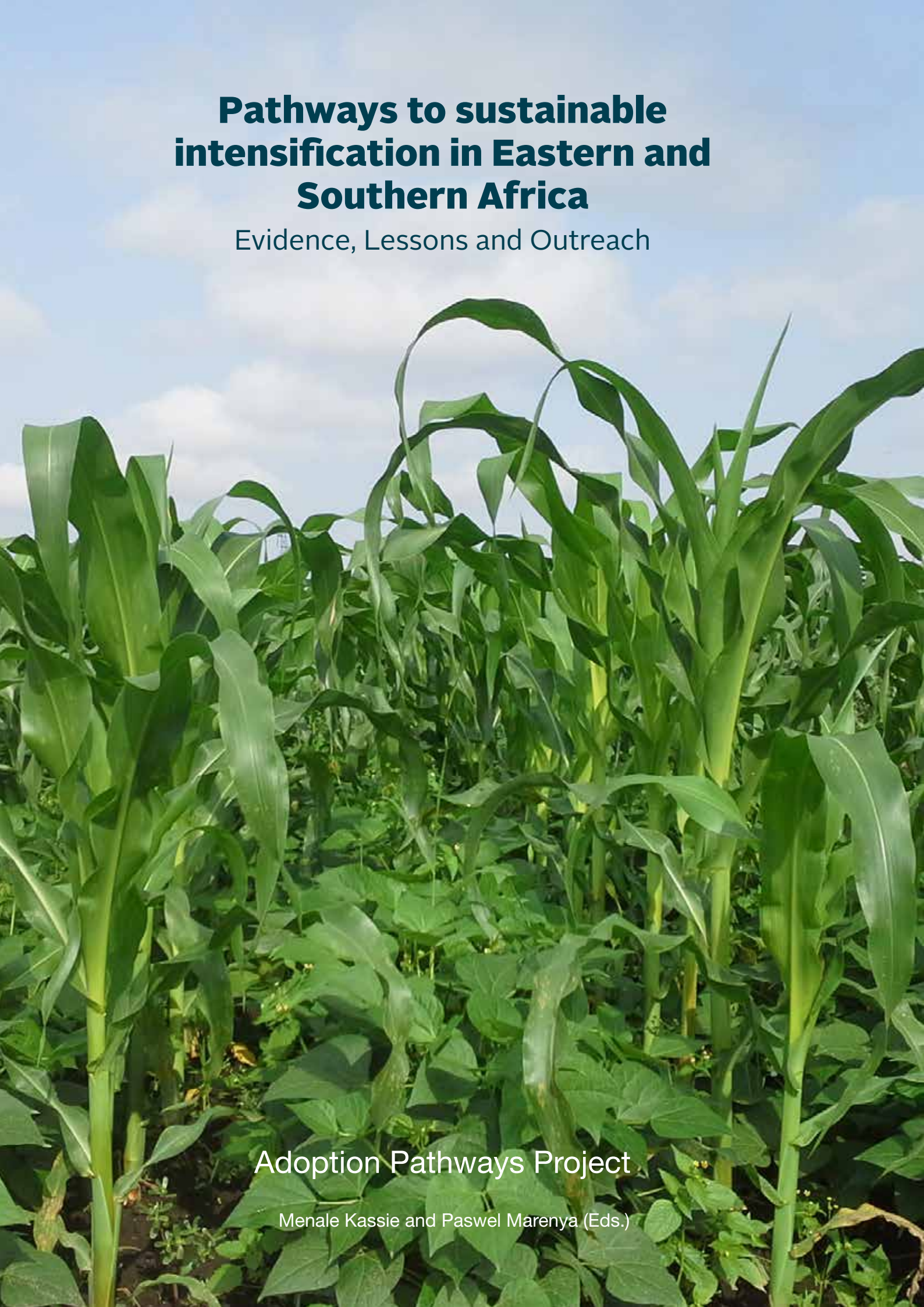
Pathways to sustainable intensification in Eastern and Southern Africa

Evidence, Lessons and Outreach



Adoption Pathways Project

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Pathways to sustainable intensification in Eastern and Southern Africa:

Evidence, Lessons and Outreach

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ETHIOPIA
KENYA
TANZANIA
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Led By
CIMMYT
International Maize and Wheat Improvement Center
Funded By
Austrialian International Food Security Research Centre (AIFSRC)
Lilongwe University of Agriculture and Natural Resources
Norwegian University of Life Sciences (NMBU), Norway
Egerton University, Kenya
The University of Queensland, Australia
Ethiopian Institute of Agricultural Research
Universidade Eduardo Mondlane, Mozambique
Sokoine University of Agriculture, Tanzania
IFPRI
International Food Policy Research Institute (IFPRI)

Preamble

Nearly a decade and a half into the 21st century, hunger and malnutrition are still harsh realities for more than one billion people around the world[1]. In addition to this, the challenge of feeding a growing world population that is projected to reach 9 billion by 2050[2] has to be met despite a declining resource base and in particular dwindling supplies of water and land. Achieving this challenge while protecting the natural ecosystem that supports agriculture and other human needs will involve finding smarter ways to *produce more with less*. To do this in ways that create opportunities for those on land, earning only a meagre income, is no easy task. *Adoption Pathways* is taking this challenge head on by critically examining practicable options to make *sustainable intensification* (SI) of agriculture a reality for Eastern and Southern Africa (ESA).

Our search is for ways to increase crop yields to improve food and nutrition security for Africa without exerting undue pressure on the natural environment, and to limit the need to expand the agricultural frontier further into fragile environments.

Why this Adoption Pathways Project?

It is clear that knowledge gaps about how ecosystems interact with managed agriculture led to farming becoming *unsustainable* across the world. To avoid that happening in emerging Africa, we need to improve our knowledge base on the economic, social, and environmental necessities for the sustainable growth of our farming systems. This involves a two-part effort:

- First, a strong pillar of research in agricultural sciences (involving many disciplines) to support an intense effort to produce critical knowledge.
- Second, sharing the knowledge that helps understand the puzzles of farming with farmers and testing on their fields to see what works better, and why.

The pathways to SI may involve two segments. The first pathway will lead farmers to adopt new knowledge and tools to help them cope better with what they do now and help them find what they could do better later. This would only be an intermediate outcome. The second, the lasting adoption-to-impact pathways would lead farmers to long-term adoption/adaptation; paving ways to increased production, profitability and improved livelihoods.

This second segment involves identifying and understanding important drivers or critical enablers of technology adoption: ways to reduce risks and improve profits from farming. Addressing issues of knowledge transfer through better extension, improving credit markets, price signals, helping farmers to more accurately read consumers' tastes

The Adoption Pathways Project is formally entitled "Identifying socioeconomic constraints to, and incentives for, faster technology adoption: Pathways to sustainable intensification in Eastern and Southern Africa (Adoption Pathways)".

1 FAO 2010. The State of Food Insecurity in the World Addressing food insecurity in protracted crises
2 United Nations: http://www.un.org/apps/news/story.asp?NewsID=45165#.VPSXHtH9Ijo

and preferences, and identifying infrastructure needs and/or policy directions to make those support services possible would take time and resources. And, it would involve asking pertinent questions:

- What are the drivers/impediments of adoption of multiple SI practices (SIPs) under different social, agro-ecology and market conditions?
- Does adoption of SI practices including new varieties lead to positive impact for productivity, incomes, food security and nutrition?
- Does adoption of SI practices serve as coping strategies to climate-induced production risks?
- Can SI, including new varieties and production methods, help men and women on farm equally?
- Do existing agricultural policies (e.g. subsidy) trigger adoption of SI and improve households' welfare?
- What would be better ways to package the evidence and provide support services?
- And, how would this new knowledge help develop new policy directions?

The Adoption Pathways Project (APP) was conceived to contribute to the answers to the above questions. It is part of a portfolio of projects that contribute to the broader theme of sustainable intensification research led by the International Maize and Wheat Improvement Center (CIMMYT) and made possible by the contribution of a dedicated team from national and international research groups brought together by the Australian Centre for International Agricultural Research (ACIAR), which is helping to achieve the policy goals of the Australian International Food Security Research Centre (AIFSRC).

The central objective of the Adoption Pathways project is to:

> *"…support researchers, decision makers, farmers and development partners in making high quality decisions that improve food security…by providing appropriate panel data sets, knowledge base, tools and methods…that can be used for better targeting of technologies, accelerating adoption and to understand the dynamics of socio-economic development because of technology and policy interventions… within maize farming systems in Eastern and Southern Africa…"*

The project is undertaken in the five ESA countries of Ethiopia, Kenya, Malawi, Mozambique and Tanzania (Figure 1). Over the past two years and nine months, APP has analysed an array of issues relating to the adoption of sustainable agricultural practices (SIPs) and agricultural polices (e.g. subsidy) as a means to improve agricultural productivity and to help agriculture adapt to an uncertain and variable climate.

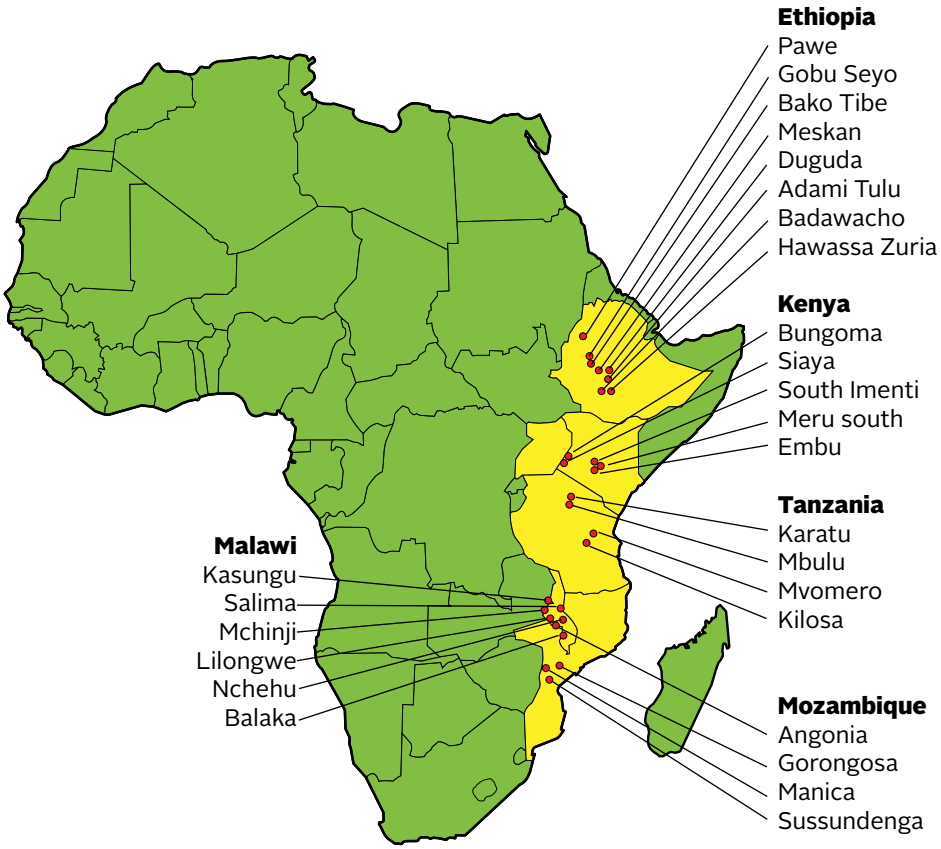
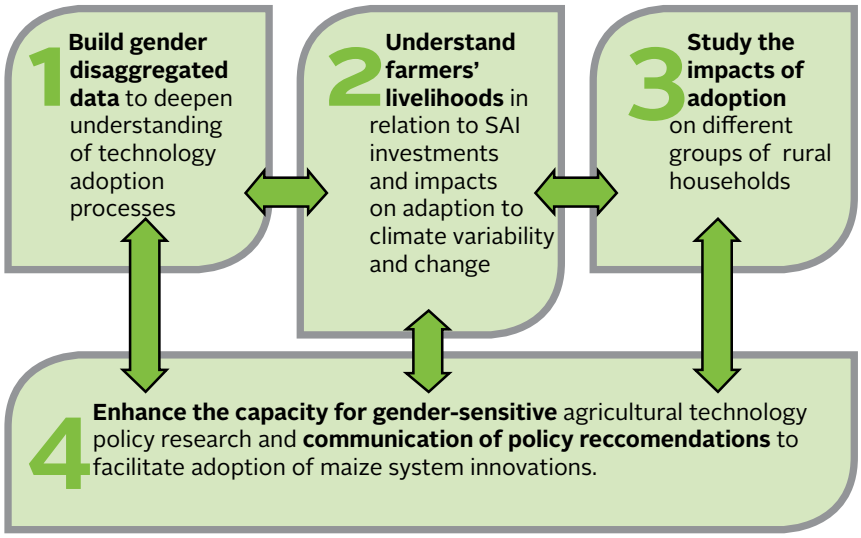


Figure 1. Project target districts

APP is contributing to a strong and growing evidence base on how farmers adopt SIPs, impacts of SIPs including their role on production risks, aspects of social capital and broader policy environment in creating the conditions for faster technology adoption among farmers in ESA.

The project's specific objectives are outlined in the figure below.

Specific Objectives of the Adoption Pathways Project



The journey so far:
key milestones since project inception

Signing of APP-Tegemeo Institute MoU: (left) Prof. James Tuitoek, Vice Chancellor of Egerton University, Kenya and (right) Dr Stephen Mugo, CIMMYT-Africa Regional Representative

The project was formally launched in June 2012 in Addis Ababa, Ethiopia. The focus of the first year was to set the project in place with key stakeholders, establish country project teams and procurement including of field vehicles. Summarized below are key milestones reached during the first two years and nine months of operation.

Developing institutional linkages—the signing of a Memorandum of Understanding between CIMMYT and Egerton University in November 2014 was a major milestone. This collaboration linked APP with the Egerton University's policy research think tank—Tegemeo Institute of Agricultural Policy and Development (Tegemeo Institute). This strategic link between Tegemeo Institute and CIMMYT brought together a prominent policy research centre that addresses key issues in agriculture and natural resources in Kenya with an international research hub with advanced analytical capability and a broad research mandate to focus effort on technology adoption. In the Kenyan context, Tegemeo Institute has easier access to policy makers than CIMMYT does. This synergistic link will offer a strong pathway to accelerate the adoption of agricultural technologies in Kenya by bringing together policy makers and development partners to share resources to progress evidence-based policy development.

Adoption Pathways Project also entered into an informal collaboration with the Development Fund of Norway (DFN) in 2014; a non-profit development organization supporting a number of agricultural initiatives in Ethiopia over many years. The aim is to involve DFN in up-scaling agricultural technologies and practices promoted by the Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) programme to which APP contributes and to use information from APP and SIMLESA in guiding the up-scaling process. This strategic link offers an additional pathway to spread APP benefits beyond immediate APP activities.

Data to support policy analysis—One of the major aims of APP is to develop panel datasets to facilitate robust econometric and modelling analyses that will help identify constraints to adoption and factors enabling adoption processes among smallholder farmers. A first round of data collection, which will eventually build a comprehensive panel dataset for the 5 project countries covering 2,338 men and 2,504 women farmers, has been completed. The data coverage includes household and plot level data, and risk experiment data collected in Ethiopia, Kenya and Tanzania to understand farmers' risk preferences on technology adoption.

Preparing for the future: **training, capacity building and outreach**

Over the last two years and nine months, major efforts were made on the capacity development of partners in large survey data collection, coordination and analytical methods. Staff from national partner institutes and CIMMYT (32 in total) received hands-on training on gender integration analysis and social experiments design, production risk, adoption analysis and impact measurement.

APP has contributed to and supported graduate-level training by way of providing access to data sets and technical support to graduate students. Three MSc students (one each from Tanzania, Kenya and USA) who used the APP data and received technical support from APP-affiliated scientists graduated during the last two years. Four new MSc students, three from Mozambique and one from Tanzania, started their research programs under co-supervision of the APP country coordinators in those two countries. Four APP-affiliated researchers from Malawi, Kenya and Ethiopia started PhD programs at universities in Norway, Kenya, South Africa and Sweden and Ethiopia. These students will use APP data and will also have co-supervisors from CIMMYT and partner country universities. Five other PhD students from the Norwegian University of Life Sciences (NMBU), Georg-August-University of Gottingen, University of Nairobi, the University of Western Australia, and University of Adelaide are using the APP data. Their dissertation topics include work on gender and sustainable intensification in Ethiopia, dynamics of technology adoption, productive efficiency and risk, agricultural commercialization and its impacts on welfare among smallholder farmers in Kenya, economy-wide effects of input subsidies in Malawi and livelihood framework approach on technology adoption.

As part of capacity building, partners from Tanzania and Malawi and the University of Queensland (UQ) attended the African Agricultural Economics Association conference in Tunis and the 20th Annual Conference of the European Association of Environmental and Resource Economics in France,

respectively. The UQ partners, apart from presenting a paper at the conference, made a presentation at the Organisation for Economic Co-operation and Development (OECD) in Paris where they discussed APP in the broader productivity research context. These were opportunities in which APP activities were showcased in a broader context. Additionally, the project engaged 18 early career economists (MSc) from partner institutions in various activities including survey implementation and coordination. These engagements contributed in many ways to build their research skills and professional influence.

The project fieldwork offered opportunities to train 120 enumerators, field supervisors and data entry clerks who received targeted training in survey data collection, supervision and data entry. The project thus helped build capacity and created employment opportunities for dozens of mostly young men and women over a period of three months on average. Finally, to strengthen the field capacity of national partners, the project purchased five field vehicles.

Communication, dissemination **and contribution to international knowledge exchange**

Since its inception, the project has produced nine peer-reviewed papers, 24 discussion papers and eight policy briefs across a range of topics. The results were presented and exposed to a variety of audiences through various dissemination fora (such as peer reviewed journals, social media, workshops, meetings, radio programmes, magazine articles and websites). For example, presentations based on the research conducted under APP were made to various audiences at Minnesota, San Diego, California and Minneapolis, USA; Toowoomba, Brisbane and Canberra, Australia; and Rotorua, New Zealand. As previously mentioned, partners from UQ made a presentation at an OECD conference in Paris where they discussed APP in the broader context.

During CIMMYT board meetings and field days in Kenya in November 2013, APP fliers were distributed to participants and posters were presented on sustainable intensification and its impacts on crop and input use. Policy briefs were distributed to all participants at the Adoption Pathways and SIMLESA annual review and planning meetings in April 2014. These forums provided opportunities for APP research teams to directly interact with various stakeholders such as those from government (policy makers), the donor community, vice chancellors from participating universities, leading researchers from national and international research organizations, and the media.

At a national level, the regional project leader (Menale Kassie) made a presentation to the directors of different programmes at the Ethiopian Agricultural Transformation Agency (ATA). Following this presentation, ATA's Climate and Environmental Sustainability programme formally expressed their interest to work with CIMMYT and with the Ministry of Agriculture to incorporate conservation agriculture into the Ministry's extension programmes. The regional project leader also shared results of the project to DFN in Ethiopia, to the five major NGOs (World Vision, Oxfam America, Concern, Care, Christian Relief Services) in Ethiopia, to researchers and Ministry of Agriculture experts, and to farmers in Kenya and Ethiopia. The five major NGOs meeting was facilitated by the Royal Norwegian Embassy of Ethiopia. In addition, project data and empirical results were shared with the SIMLESA team (Ethiopia, Kenya, Malawi and Tanzania), donors (e.g. USAID) and research institutes (e.g. CSIRO, Australia), thus enabling further value adding. In terms of participation in conferences, seven papers were submitted to the 29th International Association of Agricultural Economists conference that will be held in Milan, Italy, August 2015. Finally, various media including Kenya Broadcasting Corporation (KBC); Kenya Woman, Scidev.net, and the Kenyan newspaper Daily Nation broadcasted the project and its outputs (See Stories section, page 28).

Empowering women in agriculture – a pathway to improving agricultural productivity

Information is a part of empowerment: an extension officer communicating with a farmer

Gender-anchored research is a unique feature of the APP research portfolio. The International Food Policy Research Institute (IFPRI) APP team, in collaboration with Tanzania partners, has developed components of an index (Women Empowerment in Agriculture Index – WEAI) using Tanzania data. This effort is now being extended in Ethiopia and a PhD student has drafted the index. This index will be an input into the analysis of gender-related aspects of technology adoption and food security issues.

Tracking progress though monitoring and evaluation: APP has developed a low cost monitoring and evaluation (M&E) framework, which is now ready for partner inputs. This tool is expected to facilitate effective monitoring of project activities across partners. The information gathered will help review progress, refine implementation plans and maintain integrity of project objectives. CIMMYT drafted the framework.

Country summaries

Kenya: The Kenyan team launched the project in early 2013 at a forum attended by senior officials of Egerton University, including the Vice Chancellor, SIMLESA team members, and participants from a number of development and policy institutions. In close collaboration with CIMMYT, in 2014, the Kenyan team contributed to the fieldwork for the first round of household surveys; undertaking risk experiments, data entry and initial data cleaning. A presentation on the progress of APP in Kenya was made to a visiting ACIAR and AIFSRC team (including Nick Austin, CEO ACIAR, Mellissa Wood, Director AIFSRC, and Liz Ogutu, ACIAR representative in Africa). The presentation included an overview of preliminary research results. Similarly, the Kenya country team organized a one-day stakeholder workshop at Egerton University to share preliminary research and survey results. Stakeholders at this event included Nakuru County government representatives; the SIMLESA team; extension staff; farmers; and representatives from Tegemeo Institute, Kenya Institute of Public Policy and Research

Analysis(KIPPRA), Kenya Agricultural and Livestock Research Organization(KALRO, Egerton University Management and farmer organizations.

The Kenyan team has also drafted discussion papers on impacts of adoption of multiple sustainable intensification practices, crop choice and adaptation of sustainable agricultural intensification practices in Kenya, farm plot level determinants of the intensity of sustainable agricultural intensification practices in a maize-legume cropping system, determinants of market participation regimes among smallholder maize producers, a comprehensive survey report, a brief synthesis on constraints and drivers of adoption, rural livelihood strategies and ex-ante and ex-post coping strategies to climate risk. The results of the survey report have been shared with the SIMLESA team in Kenya and with farmers and policy makers.

Malawi: The Malawi country team launched the project in May 2013, led by the Vice Chancellor of Lilongwe University of Agriculture and Natural Resources. The directors of the Ministry of Agriculture and Food Security and SIMLESA partners also attended the launch meeting.

Key milestones achieved by the Malawi country team over the past two years include the completion of a preliminary survey and research report describing the role of gender in adoption of agricultural technologies, which has been widely shared with stakeholders. Draft discussion papers on impacts of conservation agriculture on maize output and income and on econometric analysis of the factors influencing multiple technology adoption using cross-sectional data have been produced. The team has also produced a brief synthesis adoption and rural livelihood strategies and ex-ante and ex-post coping strategies to climate risk.

Mozambique: The Mozambique country team completed data collection and cleaning with regard to the gender disaggregated household data including sharing this within the project team. Within the Mozambique team, three MSc candidates developed their thesis proposals using Adoption Pathways data. The team drafted a survey report and part of this was shared during the 3rd annual meeting of the project. Like other countries, a brief synthesis of previous adoption and rural livelihood strategies and ex-ante and ex-post coping strategies to climate risk was produced.

Tanzania: In the first year of the project, the team introduced the project to the SIMLESA team, the Ministry of Agriculture and others. The Tanzania country team completed data cleaning and has started work on a number of empirical topics. In addition to implementing household and plot level survey data collection, the team implemented risk experiments in collaboration with IFPRI. The APP Tanzania country coordinator presented a seminar to introduce APP and present opportunities for training though the project. This was attended by the newly matriculated students at Sokoine University of Agriculture. The team has completed a survey report and an MSc student produced a discussion paper on adoption of sustainable agricultural intensification technology under small-scale maize-legumes production in Mvomero and Kilosa districts. Further, the team produced a brief synthesis of adoption and rural livelihood diversification strategies.

Ethiopia: The Ethiopia team, like the other country teams, launched the project in the presence of major stakeholders including the SIMLESA team (SIMLESA meaning “sustainable intensification of maize and legume systems in east and southern Africa”, a project implemented by CIMMYT and partners with funding from ACIAR). The country team completed both household and individual level and social experiment surveys in 2013. Notably, much of the data collection was done using computer-assisted personal interviews (CAPIs) and captured using Census and Survey Processing System (CSPro). This represented considerable capacity building and innovation in data collection for the Ethiopian Institutes of Agricultural Research (EIAR) partners. They contributed to data cleaning and generating variables to finalize the survey report. The familiarity of the local context and farming system was pivotal in accomplishing this task timely. The Ethiopian team has also produced a synthesis of drivers of adoption of technologies and livelihood strategies based on existing literature.

International partners **outside Africa**

Adoption Pathway Project partners: achieving our goals by working together in collaboration

As expected in the APP design, collaboration between national partners and the APP CIMMYT team with the Norwegian University of Life Sciences (NMBU), UQ and IFPRI was a strong element of the project achievements.

Norwegian University of Life Sciences: NMBU led the economy-wide impacts assessments of technologies and policies including the subsidy programme using household models, Computable General Equilibrium (CGE) model and Social Accounting Matrix (SAM). The NMBU researchers also implemented household sW urveys including experiments on risk and time preferences as well as input demand in Ethiopia and Malawi. The team has produced a number of research outputs (see list on pages 26-28) including the economy-wide impact (on maize price and rural wage rate) of the Malawi subsidy programme controlling for market imperfections and household heterogeneity, Input subsidies, cash constraints and timing of input supply, Input subsidies, factor productivity, and land use intensification in Malawi, Input subsidies and improved maize varieties in Malawi. They also investigated the link between exposure to drought shocks and adoption of drought-tolerant maize varieties, and how differential access to labour and land markets affects incentives to intensify production. Agricultural farm household and CGE models for technology and policy interventions were developed using household and plot level data from the central and southern regions of Malawi covering the 2005-2009 period. In the last two years the NMBU research done has been widely disseminated in national and international workshops and annual meetings.

International Food Policy Research Institute: IFPRI led the gender-related research activities of the project. IFPRI's main contribution to the project in the last two years has been in the development of gender disaggregated survey tools in collaboration with other project partners and developing WEAI. IFPRI also implemented gender-disaggregated risk and time preference experimental data in Kenya and Tanzania based on protocols developed by the NMBU. The IFPRI team provided training on gender integration and analytical analysis to about 20

national partners and CIMMYT staff. On research outputs, the team analysed men and women risk preference and its impact on technology adoption in Kenya. This paper was presented at the Agricultural and Applied Economics Association's annual meeting in 2014. In addition, WEAI in agriculture in Tanzania was developed and a report produced.

International Maize and Wheat Improvement Center: In addition to playing a role in overall coordination of the project, CIMMYT is leading the implementation and management of household surveys in each country and the analyses of the impacts of sustainable intensification investments on household welfare. CIMMYT's contribution was in the assistance given to partners in implementing and supervising the surveys in all the five project countries. The training of survey teams on the survey instrument design and implementation of actual field surveys was provided by CIMMYT. CIMMYT also assisted the country team in data cleaning, generation of variables and writing of survey reports.

Since the inception of the project, CIMMYT produced a number of policy-focused papers covering topics on the impacts of multiple sustainable intensification practices adoption on income, input use and downside (crop failure) and costs of risk, gender food security gaps and causes of these gaps in Kenya and Malawi, cross-country adoption analysis, commercialization and welfare, gender market participation gap, conservation agriculture adoption under alternative policy scenarios, and determinants of climate adaptation strategies. Finally, CIMMYT led the development of a low cost M&E framework and the analyses; and drafting and finalizing a number of policy relevant peer reviewed papers that were published in international journals based on SIMLESA and Adoption Pathways datasets.

University of Queensland: UQ led the livelihood strategies, sustainable intensification investment and climate change components of the project. A key output of the UQ team was to develop a state-contingent model of a farm household for Ethiopia. This model, initially calibrated to the Ziway region of Ethiopia representing lowland maize mixed farming system, has been used to explore implications of farmers' risk attitudes on the take-up of technology in the presence of external risks arising from a changing climate. Key features of the model are its representation of the imperfect market setting and the resulting production-consumption focused behavioural pattern observed in these semi-subsistent farming systems. The model is therefore designed to examine how farmers' ex-ante risk management and ex-post risk coping strategies impact on farmers' propensity to take up strategies that could enhance their production performance. This model specification provides a robust basis to examine farmers' technology take-up under changing climate risk. The model specification and preliminary results were presented at the 8th International Congress on Environmental Modelling and Software in California in June 2014 and subsequently at the 59th Annual Conference of the Australian Agricultural and Resource Economics Society in Rotorua, New Zealand in February 2015. UQ also shared early results of the model in a presentation to the OECD, while attending the 20th Annual Conference of the European Association of Environmental and Resource Economics in France in July 2013. This was a major undertaking that required significant input from a range of sources including the household survey, NMBU previous modelling experience, and local input from the EIAR and CIMMYT led team. The UQ team, in collaboration with national partners, also developed a discussion paper on 'Understanding Farmers' Ex-Ante Risk Management and Ex-Post Risk Coping Strategies for Climate Risk'. This work focuses on northwest Ethiopia.

A bird's eye-view on **major research highlights**

In this section, we summarize a number of key results that have come out of published papers and some in the process of being published. These results came from a number of analyses of the datasets generated by the SIMLESA programme, APP as well as data generated by NMBU. Broadly, the results address some empirical questions about the causes of the gender food security gap, adoption and impacts of SIPs on crop income, input use, downside risk, cost of risk and food security, policy lessons from national level Agricultural Household Modeling in Malawi and factors influencing portfolio of SIPs adoption and adaptation strategies. Following are summaries of some of these researches.

1 More than a green revolution: explaining the adoption of multi-combinations of technologies

The green revolution was a pivotal achievement in the history of agricultural development that featured widespread adoption of high-yielding varieties, agro-chemicals and improved farm management practices, accompanied by public support for research and development and irrigation development. While it was an uncommon period of sustained effort to increase food production from multiple fronts, the highly intensive production systems that emerged from green revolution technologies was later attributed as a source of the unsustainability of the global agricultural production system. Notably, the intensive use of fertilizers to meet the designed high input-demand for high-yielding varieties and the widespread investment in irrigation to pave way for enhanced production resulted in widespread externalities such as groundwater depletion, soil fertility degradation, and chemical runoff that threatened the wider ecosystem that sustains agriculture. Hence, a production system based on intensive use of inputs has proven to be inadequate to sustain agricultural productivity in the face of a deteriorating global ecosystem.

Research has highlighted that the unintended consequences of the green revolution could have been minimized had a broader systems perspective been used to understand production constraints and had resource use patterns been appropriately guided by a broader, efficiency-focused policy framework that allowed adequate incentives for wise use of resources and opportunities to internalize externality impacts of production systems.

APP was developed to provide a programme of research that could offer insights on new policy directions for enhancing agricultural productivity in resource-poor, smallholder-based production systems in ESA. A key focus was to understand the determinants of the adoption of a portfolio of practices under the broad banner of SIPs in four countries (Ethiopia, Kenya, Tanzania and Malawi). The project provides a platform to focus on socio-economic constraints and incentives that influence the take-up of a suite of agronomically proven practices such as maize-legume intercrops and rotations, *in situ* crop biomass recycling through mulching and reducing aggressive tillage, manure and soil and water conservation.

The hypothesis behind APP is that these agronomic practices used in combination with green revolution technologies can increase yields, conserve water, reduce erosive soil loss, and improve ecosystem functions; creating win-win situations for African farming systems.

Social Capital

In Ethiopia, Kenya and Malawi the results consistently showed that farmers belonging to groups (having some social capital) were more likely to have more diversified cropping patterns. They were also more likely to try new minimum tillage methods, improved maize varieties and build soil and water conservation.

Access to markets

Markets are a key to enhance surplus production. Indications are that farmers who were close to markets and therefore had better access to inputs and output disposal, all else equal, were also more likely to have adopted diversified cropping patterns involving maize legume intercrops and rotations, improved varieties and were more likely to have tried minimum tillage.

Household assets

Reflecting the fact that most smallholder farmers do not rely on credit markets, asset ownership had the effect of increasing adoption of soil conservation practices, crop diversification, and implementation of minimum tillage.

While the evidence base for thoroughly examining the overall merit of SIP is progressing, the interim research outputs, based on household surveys, indicates that there were complementarities between SIPs in many instances with substitutability effects in limited cases. These cross-technology correlations have two important implications. Firstly, policy changes that affect adoption of a given SIP will in all likelihood affect the adoption of other SIPs.

Close interactions between different farm practices (and possible synergies) mean that it is important to improve input supply systems in a coordinated fashion. It is incumbent on all those working in sustainable agricultural intensification to ensure that policy actions or programmes meant to support fertilizer and seed use among farmers must also provide concomitant support for better agronomic practices. It is critical that extension messages emphasize co-benefits, drawing on complementarities. The central message is that if a set of SIPs are complements, then it is important to find ways of promoting these as packages. This is because partial adoption of single practices may not achieve the desired outcomes, whether these are productivity or environmental outcomes. For example, in the need to ensure that they get the most out of their fertilizer and improved seeds, farmers must accompany these with better and timely agronomic management such as weeding and other farm operations. More focused work with targeted case studies would be needed to understand the adoption process and the full range of interactions and impediments for improving an existing regime of farm management. *The full range of economies arising from complementary, competitive and scope economy interactions are yet to be fully documented and tested in different locations. These are key prerequisites for designing effective policies in support of SIPs broadly.*

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2 Portfolio selection: technology combinations lead to highest impacts

To achieve sustained high productivity food systems, improved and resilient varieties, application of adequate amounts of fertilizer and high standards of agronomic practices are part of the package. A research paper based on data from Ethiopia and Malawi showed that adopting a suite of SIPs together with complementary inputs such as improved seeds can raise the net maize income in Ethiopia by 47 to 67 percent and 117-171 percent in Malawi and reduce or (or at least not increase) fertilizer and chemical application without necessarily reducing farmers' net crop income. Farmers net crop income was calculated as net maize income by deducting the cost of fertilizer, hired labour, seed and pesticides from the value of maize sales.

These results may suggest that while the high input mono-cropping systems have been the basis for a potential green revolution in Ethiopia and Malawi (and East and Southern Africa region generally), the sustained application of resource conservation practices and crop diversification can deliver increased productivity and improve the agricultural resource base. The needed increases in inputs and production should take place within a framework of crop system diversification and sustainable intensification. *How the production context affects technology choice and farm management is crucial to inform better public policy. Further work needs to address these research-policy linkages under alternative socio-economic and agro-ecology settings.*

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3 No free luch: tradeoffs in crop residue utilization

Promotion of SIPs has close implications for residue utilization; in particular on crop-livestock farming systems in the tropics. Given that permanent soil cover is one of the key features of conservation agriculture (CA), the adequate availability of crop residue to meet competing needs is central to successful implementation of CA and related practices. These trade-offs will determine the success (or lack thereof) of CA under farmers' conditions. *We lack a clear understanding about how to deal with these trade-offs.*

A study on the competing choices in crop residue utilization found that for the most part, in Kenya, livestock feed is the predominant use, followed by soil mulch. This is not surprising because 84 percent of the households report to own some livestock. The average household in the entire sample owned 1.5 tropical livestock units (TLUs) of cattle. In total, 83 percent of maize residue was used either as mulch, livestock feed or both. The average amount of maize stover produced per household per year (1.1 tonnes) could feed one TLU cow (consuming at a rate of 3.93 kg dry matter/day) for about 9.3 months. From this study, an average household owns 1.5 TLU. This means that the maize stover when harvested and preserved properly can easily feed a dairy cow for six months. In the relatively livestock-abundant parts of Kenya, it was observed that a higher proportion of residue was used as livestock

The twin issues of residue use tradeoffs and labour allocation imply that the element of residue retention as a critical part of CA-based intensification can only succeed if alternative feeds are identified and if returns to labour in residue management justify such resource reallocation.

feed. Moreover, adoption analysis showed that households that had more family labour used lower levels of residue as mulch – family labour being an enabling factor in transporting residue from the fields to the livestock pens or feeding points. *The twin issues of tradeoffs and labour allocation imply that the economics of residue retention is a critical part of CA-based intensification. Success of CA take-up will impinge on the net benefits to farmers of alternative feed management systems. Before committing CA as a silver bullet for SIP take-up, more work is needed to ascertain potential net benefits in an integrated resource use system.*

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4 Alternative policy scenarios to support conservation agriculture-based intensification

In a policy simulation study, the role of alternative policies such as input subsidy policies, investments in agricultural extension and access to markets in predicting the adoption of CA was analysed. Using data from 2,700 households in Ethiopia, Kenya, Malawi and Tanzania, and controlling for household and farm level factors, the study implemented a series of policy simulations to compare the predicted probabilities of adoption under the above different policy scenarios. The results indicate that high extension-personnel-to-farmer-ratios and input subsidies enhanced the adoption of CA, while there was an inverse relationship with the distance to input markets. The results imply that good market infrastructure, low input-output cost ratios and strong extension systems provide clear basis for increased CA adoption. We conclude that the same favourable policy preconditions needed for other agricultural innovations generally are equally relevant for CA-based intensification as well. *Markets are a key – we need to better understand how they can be developed fast and efficiently.*

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5 Technology adoption and managing the risky business of smallholder farming

Smallholder agricultural production in Africa is done under various abiotic and biotic stressors. It is a truism that risks are an unavoidable part of many economic and social undertakings. In smallholder agriculture, managing these risks is an important aspect of protecting livelihoods and opening up opportunities for investment and income growth. In African agricultural production systems that feature unmitigated production risks, weak risk-transfer mechanisms and limited or non-existent formal social safety nets, undertaking self-protection is critical in agricultural systems. Under these circumstances, emphases on agricultural practices or technologies that can increase the resilience of crop production against environmental risks are a key feature in protecting livelihoods. In this study, the effects of SIPs on risk showed that crop diversification and minimum tillage were risk-reducing strategies in maize production. A higher crop yield and a reduction in the chance of crop failure were achieved when farmers jointly adopted crop diversification and minimum tillage. The adoption of SIPs was found to be associated with changing the distribution of maize yields above the mean suggesting reduced probability of crop failure. When analysing how to achieve productivity and resilience, the SIPs practices can be seen as important risk mitigation strategies. It follows that adoption of agronomic and resource-management practices among smallholder farmers

...adoption of appropriate agronomic and resource-management practices among smallholder farmers should be promoted as elements of productivity enhancement but also as opportunities for production risk mitigation.

should be promoted by extension programmes as important elements of productivity enhancement but also as opportunities for production risk mitigation. *SIPs certainly have a place in improving productivity, but the form and composition will vary in different contexts. The wrong package in the wrong context may lead to undesired outcomes.*

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6 No shortcuts: Food security is tied to adoption of hybrids and other improved varieties

Even when research and extension systems have evidence that improved varieties are superior in terms of yield, their impact on household welfare cannot be taken for granted. Research that evaluated the impact of improved maize varieties on food security and other welfare indicators in Tanzania showed that moving along the scale of area allocated to improved maize varieties, the per capita food consumption more than doubled from $124 at 0.125 acres under improved maize varieties to $283 at 10-acre adoption level. Growing improved maize varieties on average increased the chance that a household would be food secure by 18 percent. The chance that a household would be in a food surplus category increased from 1.4 percent at a 0.125-acre allocation to 25 percent at a 10-acre improved seed allocation. The study demonstrated that an extra acre of land allocated to improved maize varieties *reduced* the probabilities of chronic (transitory) food insecurity from between 0.7 - 1.2 percent (1.1 - 1.7 percent) and *increased* the probability of breakeven and food surplus food security by 1.2 percent.

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7 Agricultural Household Models: What Can We Learn about Agricultural Policies in Malawi?

Malawi has one of the highest population densities in East and Southern Africa. In the absence of alternative economic opportunities, many households can remain stuck in an endless poverty trap of low agricultural productivity and low incomes. The government of Malawi has in recent years implemented large scale fertilizer and seed subsides in an effort to boost maize production and avoid food crises.

Agricultural Household Models for Malawi were developed to investigate the household level responses and impacts from the input subsidy program for different types of households as well as international price shocks that occurred in the period 2005-2010. Several lessons emerged from this research. First, land-poor households are much more vulnerable to price shocks and limited market access than more land-rich households. The share of land-poor households is constantly increasing due to population growth and represents one of the biggest development challenges in Malawi. Access to subsidized inputs can be a safety net for land-poor households that otherwise may come into a destitute situation because of failure to access off-farm employment or to access land through the land rental markets. Second, access to subsidized fertilizer can stimulate demand for land through the land rental markets and/or reduce the supply of land in these rental markets. These potential additional effects have been ignored in earlier studies. Third, access to subsidized improved maize seeds can crowd out commercial demand for improved maize seeds. It is better to ensure availability of improved maize seeds at local market outlets than to provide the seeds for free. Households that are convinced about the benefits of such seeds are able to mobilize the limited cash required to purchase these seeds. Crowding-out and –in effect is also observed for commercial fertilizer demand for maize production and tobacco production, respectively. A major feature of the subsidy programme is to target households with land without too much consideration of the equity issues arising from the fact that near-landless or landless households may

be bypassed by the subsidy programme. To rectify this situation, one suggestion is that, because fertilizer is a land augmenting technology, the subsidy may need to be progressive with land-limited households receiving priority. If this kind of targeting is not possible, this may point towards alternative employment creation as a more efficient mechanism to reach the poor and needy than the input subsidy programme. Model results also suggest that fertilizer price shocks did not affect maize production much because this production is driven by subsistence needs more than profitability of production. There was, however, a stronger effect of the fertilizer price shock on tobacco production which was reduced due to diminished profitability and the effect of this shock being transmitted through the household's cash constraint. Finally, in the interest of sustainability, it is important to consider the effects of these programmes on long term input market development, given the crowding out effects on the relatively small and still developing private sector. *The results point to the longstanding conclusion that better targeting of policies can reduce unintended consequences and enhance policy effectiveness.*

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8 Farmers know what they do: Sensitivity of farm household resource allocations to changes in risk factors

Much of the literature on farm performance analysis and development pathways assume that farmers operate in a competitive environment and when they are offered technically proven technologies to help improve their situation, they disregard good advice as they are unwise. This assessment is misplaced, particularly in the context of Africa where market failure is commonplace and there are many constraints that prevent farmers from accepting good advice. The failure [of farmers to adopt what appear to be technically and economically superior technologies], it appears, is not in the farmers' way of thinking, but in the way economists and other analysts saw the farmers' operating context and failed to recognize their behavioural constraints.

The UQ research team, in close collaboration with the CIMMYT and national partners in Ethiopia, has developed a new tool – a farm household decision analysis model that captures the reality of decision making by poor farm households. The model incorporates farmers' well-known tendencies for risk aversion and the safety-first approach to ensuring family food security in determining options to improve their livelihood attainments working within tight resource constraints and limited opportunities

The failure [of farmers to adopt what appear to be technically and economically superior technologies], it appears, is not in the farmers' way of thinking, but in the way economists and other analysts saw the farmers' operating context and failed to recognize their behavioural constraints.

for trade-linked exchange. Initial simulations centred around mixed lowland maize-based farming systems in the Central Rift Valley region of Ziway indicate that farmers have limited ex post risk management measures, and hence they tend to discount potential gains more heavily and prefer farming systems that are more like the status quo.

While those with access to irrigation and markets can improve income significantly through diversified farming systems involving multiple cropping, staggered planting and the use of improved varieties and practices, maize-legume farming system appears to be the solution for more risk averse farmers who have limited abilities for risk mitigation. Farm size is a limiting factor for expanding farm incomes and the availability of off-farm wage income is a prerequisite to allow the full use of the available land. In that sense, farm size per se is not the binding constraint but the lack of an environment that allows opportunities for exchange, which could offer incentives for a surplus oriented production. It is unlikely that the majority of farmers who own less than 0.9 ha of land will find full self-sufficiency of family food requirements from a family farm, unless intensive multi-crop farming systems can be supported with irrigation, making the farm less sensitive to variation in climate. More work that examines risk-return trade-offs under alternative farm management systems will be required before firm recommendations can be made about ways to improve farmers' risk preparedness, and hence adaptation to an increasingly uncertain production environment.

Linking farm household model with regional analysis to investigate different development pathways under alternative socio-economic and ecological regimes would allow more meaningful insights on possible intervention options to enhance farm productivity and growth.

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9 Understanding how farmers cope with and adapt to climate-related risks

It is now a firmly established fact that sub-Saharan African countries will be amongst the worst hit in terms of the adverse effects of climate change. Given these dire predictions, it is important to obtain a better understanding of how farmers have coped with past and current climate change and variability. Such knowledge can assist us to propose more effective strategies to reduce their vulnerability in the future. This study therefore sought to examine the factors affecting Ethiopian smallholder farmers' choice of ex-ante adaptation and ex-post coping strategies for climate risk. We found that plot characteristics such as slope, depth, soil type and soil fertility, and farm size significantly affect the choice of adaptation strategy. These plot characteristics also significantly affect the choice of particular coping strategies such as selling livestock, reducing meals and borrowing. Additionally, particular plot management practices significantly affect the choice of adaptation strategy. For example, the use of improved maize varieties on a plot is also strongly related to an increased likelihood of choosing early planting, tree planting and construction of soil and stone bunds. Plot management practices also significantly influence the choice of coping strategies. Specifically, higher levels of intercropping and use of hybrid maize reduces the likelihood of choosing to sell livestock, reducing meals or borrowing. Two key policy recommendations emanate from this study. Firstly, we need to redouble our efforts to educate farmers to adopt plot management practices such as leaving crop residues, intercropping and use of non-recycled hybrid maize. These measures not only help to improve farm productivity, but as we have shown in this study, also help to reduce the household's vulnerability to adverse climatic events. Secondly, we observed gender effects in the choice of some adaptation and coping strategies. This calls for special programmes targeted at improving the skills and knowledge of women.

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A special mention:
Results from gender research

1 Looks can be deceiving: why do otherwise-equivalent male-headed households have better food security

The notion of gender equity is central to the very concept of social development. Gender equity as a requisite for inclusive development is hardly a debatable issue. However, the manifestations of gender inequality are widespread in the developing world. These include issues such as unequal access to schooling, resources, and social norms that constrain the participation of women in the development process. Research papers completed in 2013 and 2014 examined how the differential food security situation is determined by the gender of the household head in Kenya and Malawi. The research results summarized here explained why given equivalent opportunities in terms of resources and demographic profiles to those of male-headed households (MHHs), female-headed households (FHHs) still tended to perform worse than their MHH equivalents. Specifically, the research indicates that two households that are similar in every respect (except that one is headed by a woman and the other by a man) have different food security outcomes. What explains this? What does this mean for gender-sensitive inclusive and equitable agriculture development? The research unearthed an important empirical finding. If *de jure* FHHs had the same level of resources/characteristics and these resources had the same returns as MHHs current characteristics, that fact alone would be enough to reduce their food insecurity status by an average of 11.5 percent and 6.0 percent in Kenya and Malawi, respectively. On the other hand, if their current resources had the same returns as their MHH counterparts, *de jure* FHHs food insecurity would reduce by 4.2 percent and 9.8 percent in Kenya and Malawi, respectively. The estimated results indicate that 73 percent (63 percent) of the gender food security gap is explained by observable differences in *de jure* FHHs and MHHs resources use, and the remaining 27 percent (37 percent) is attributable to gender differences in returns to resources use in Kenya (Malawi). Their food security status would thus be enhanced by improving their resource levels and quality. This implies that by working closely with social scientists in advanced research institutes and international agricultural centres, policymakers in ESA can take advantage of the cutting edge social science research in these institutes to clarify the subtleties of gender inequality and help inform appropriate policy response by identifying and dealing with causes of gender inequality such as differences in the level of resources use and their quality and discriminatory social norms and biases against women.

Policymakers in the region should take advantage of available cutting edge social science research...to help inform appropriate policy response by identifying and dealing with causes of gender inequality such as differences in level of resources and their quality and discriminatory social norms and biases against women and other groups.

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2 Market access and gender differences: can female-headed households be better off?

Gender equality in access is a major determinant of successful participation in agricultural markets among rural households in sub-Saharan Africa. Critical knowledge gaps remain on how to improve female participation so that opportunities for agricultural development are inclusive, equitable and broad based. This research examined the implications of the gender of the household head on market participation among 2,800 smallholder maize farmers in Ethiopia and Kenya.

One of the key findings was that FHHs in Ethiopia were found to be twice as likely to be net buyers of maize as MHHs. When simulations were done to equalize the endowments of FHHs to those of MHHs, this analysis showed that Ethiopian FHHs would still be 69 percent more likely to be net buyers of maize than MHHs. When the endowments between MHH and FHHs were left at their observed levels but both groups assumed to derive same rate of returns to their endowments, (e.g. effectiveness of land) the results revealed that FHHs would still be less likely to be net sellers than MHHs by a 17-percentage point margin in the Ethiopia sample. In the Kenya sample, even though the endowment and return effects were detectable, FHHs fared much better than was observed in the Ethiopian sample. Greater participation in and reliance on agriculture among FHHs in Kenya (compared to FHHs in Ethiopia) appear to be a factor in this. Therefore minor gender-based differences in participation were observed *ex ante*. The relatively lower participation of FHHs in agriculture in Ethiopia compared to Kenya appears to translate into their lower participation in markets. This suggests that for FHHs (as is true for MHHs), market participation requires access to key agricultural resources and ability for agricultural production as preconditions for such participation.

For women, market participation requires access to key agricultural resources and ... meaningful engagement in agricultural production in the first place

To the extent that observed differences in resources explain differences in market participation to that extent should policies (and programmes) aim to alleviate these differential opportunities. Specifically, because these differences are accompanied by returns effects, then policy focus should shift toward more socially-oriented reforms designed to remove entrenched disparities not observable in typical household surveys.

In essence, gender-related development issues are complex and public policies can benefit from a greater awareness of unintended biases and an explicit focus on creating more equal access to opportunities could enhance net social benefits.

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3 (Dis) empowerment and (under) development: indicators of lack of empowerment among men and women farmers in Tanzania

In order to achieve equity, both men and women have to be empowered to make informed decisions and participate meaningfully in agricultural production. *Greater understanding of how the rural development context affects men and women in their participation in development activities is critical for the effectiveness of development of interventions*. In relation to this, the APP data from Tanzania and Ethiopia were used to compute the Women Empowerment in Agricultural Index (WEAI). The APP data captured four domains of empowerment (4DE)[3] instead of the 5DE proposed by USAID. Findings from the two countries are discussed below.

3 These domains include production, resources, income and leadership. The fifth domain was time used in productivity, domestic tasks and leisure. Each domain except income has more than one indicator. The input in productive decisions and autonomy in production and group membership and speaking in public indicators represent production and leadership domains respectively. Ownership of assets, purchase, sale or transfer and access to and decision about credit fall under resource domain.

Findings from Tanzania

Figure 2 reports that women disempowerment is different from men's. The largest area of disempowerment for both women and men was access to credit: over 90 percent of both women and men were reported to lack credit, with men slightly more likely to be disempowered in this respect. Community leadership skills ranked second as a source of disempowerment, but among these indicators, women had a 7-point advantage in group membership, but were much less likely than men to be comfortable speaking in public. Ownership and control over assets, control over income, and input in productive decisions are other areas in which women lagged behind men. By contrast, there was little disempowerment in the "autonomy in production" indicator, with women having a 1-point disadvantage compared to men.

While a full-scale women empowerment index was not computed in this study, the disempowerment measure suggests women are empowered in terms of social capital (as defined by group membership), compared to men. Access to credit, participation in community governance (speaking in public), and control of assets and income are areas of disempowerment to be dealt with. Women's relative autonomy in production should be matched by the ability to make production decisions, control resultant incomes and participate in community governance.

Findings from Ethiopia

A similar story emerged in Ethiopia where women tended to be more disempowered compared to their male counterparts (Figures 3 and 4).

The indicators that contribute the most to women's disempowerment in Ethiopia are input in productive decisions; ability to speak in public, ownership and control over resource use and control over use of income. Over half of the women were found to not belong to any group compared to only 35 percent men. On the other hand, almost half of the observed disempowerment among men is attributed to autonomy in production indicators and access to and use of credit.

Comparison between the three research regions Oromia, SNNP, and Benshangul Gumuz bring to light more aspects that are useful in understanding the situation of men and women. Women are more disempowered than men across the three regions. Women in Benshangul are the most disempowered and the men the least disempowered when compared to the other regions. For men, almost half of the observed disempowerment occurs in the domain of production. Among women, the domains of production and weak leadership make comparable contribution to their disempowerment. In addition, in all three regions, control over the use of income contributes to the disempowerment of women more than it does to the disempowerment of men.

In summary, the comparison of the national level analysis from the two countries bring out important differences that one has to pay attention to when dealing with disempowerment in different contexts. Lack of autonomy in production is

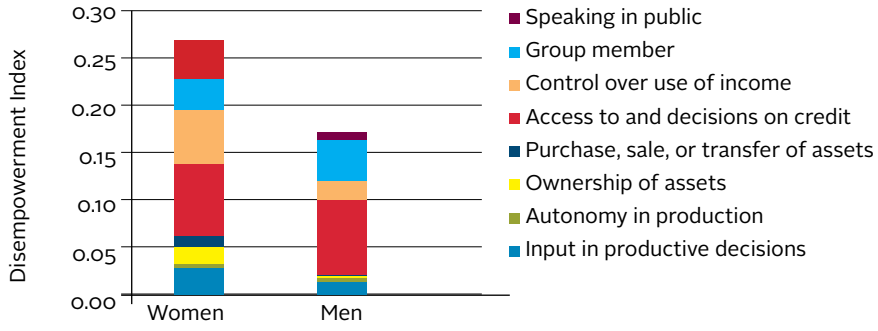

Figure 2. Contribution of each indicator to disempowerment in Tanzania

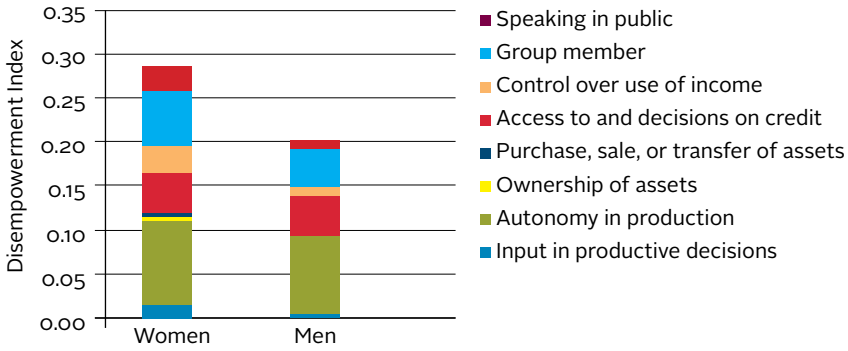

Figure 3. Contribution of each indicator to disempowerment in Ethiopia

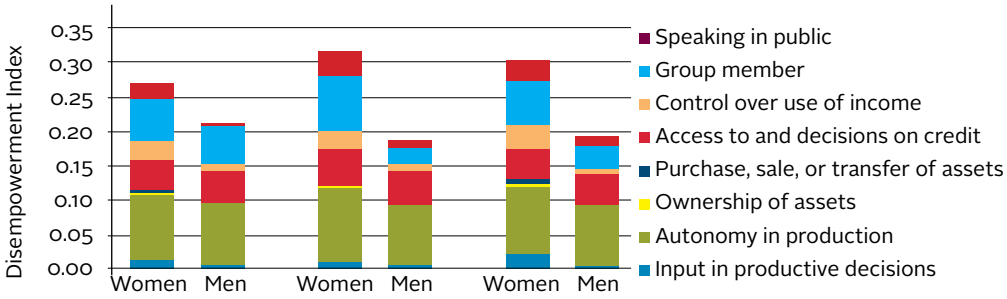

Figure 4. Contribution of each indicator to disempowerment by region

an area that makes a significant contribution to disempowerment in Ethiopia while in Tanzania access to and decision on use of credit is a major source of disempowerment. Access to and use of credit seem to be a common constraint in both countries, but its level of importance is different taking a primary place in Tanzania. *Does gender disempowerment in the same household matter for technology adoption and food security status of a household?*

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4 Gains with no pain: The role of risk preferences and loss aversion among men and women in the adoption of hybrids in Kenya

There are many hybrid maize varieties that have been developed and released in recent years in Kenya. They include hybrids that are tolerant to drought or other stressors. The availability of these varieties should expand the choices that farmers have in the maize seed market and lead to increased productivity and profit. However, adoption of hybrid seeds among households in Kenya is low. One set of factors that is often discussed is risk preferences, and economists have increasingly used experimental measures of risk aversion to explain technology adoption. These studies, however, rarely consider that agricultural households contain multiple decision-makers, each with their own personal risk preferences.

An empirically innovative study using APP data by Abby Love and colleagues at University of Georgia quantitatively estimates three aspects of risk preferences for both men and women: risk aversion (the unwillingness to make productive decisions and stake resources in outcomes with uncertain yields given the vagaries of the environment), loss aversion (the relative unwillingness to accept possible losses than equivalent gains with similar chances of occurrence), and probability weighting (over-consideration of very unlikely outcomes). The study found that on average, males and females generally have very similar risk preferences, contrary to what studies on the topic in other contexts have found. Females in FHHs were more loss averse than both males and females in MHHs.

In all cases most farmers tended to be very risk averse, moderately loss averse, and slightly over-weight the probability of unlikely events (such as drought).

The main goal of the study was to examine how male and female risk preferences distinctly shape adoption outcomes. The authors found that male risk preferences have no statistically significant effect on technology choice, but female preferences do. Specifically, MHHs with a loss averse female are less likely to adopt high yielding (but riskier) hybrid seeds. The same is true of FHHs. We also find that risk averse females in FHHs are more likely to adopt stress tolerant (and risk reducing) hybrid seeds. Lastly, the authors found that FHHs that over-weight the probability of unlikely events are *less likely* to adopt stress tolerant hybrids. This last result is puzzling although it may be due to these women considering the probability that the seeds will fail as being the unlikely event, rather than the stress itself.

The finding that female risk preferences matter (and male risk preferences do not) in this case underscores that females do play a role in choosing maize varieties. For researchers, this means that that it is important to consider the preferences of both men and women when doing research on seed choice. The results also suggest that including women in the marketing of seeds and insurance products can help facilitate adoption, as they may be more sensitive to risk, perceived and real, than men.

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From results to lessons: **Messages from Adoption Pathways Research**

Win-win-win outcomes are possible with adoption of SIPs: The cross-sectional results emerging from APP provide evidence of win-win-win outcomes (in terms of crop income, food and nutrition security, environment and risk) if implemented as composites of practices. This implies a large role for information, extension and adaptive research to improve farm management and produce evidence on where and when such benefits would occur. This is because the adoption of multiple practices combined in specific patterns and in a judicious manner is necessarily a knowledge intensive process. *Because farmers' capacities and their operating environment vary widely, understanding the performance of SIPs under various conditions and building the capacities of farmers to operate flexibly is a key to success.*

For many rural households, food security depends on productivity enhancement through improved maize varieties. Appropriately targeted SIPs could be a part of the solution: The empirical studies associating food security with intensity of adoption (acreage of improved varieties) suggests that outside own farm production; there are limited opportunities for alternative routes to food security in rural areas. It is easy to see why one of the pathways to food security will involve smallholder productivity and technology improvement on own-farms. Improved seeds varieties are a vital part of this progression and the results reported in the research summaries confirm this.

The need to expand the analytical frontiers of gender research in agriculture: The counterfactual analysis emerging from food security and market access studies reported in this project suggest that latent and difficult-to-observe factors lie behind the gender-linked food security gaps. Therefore, in addition to ensuring equal access to resources and markets and to ensure broad-based food security achievements among all groups of rural populations, policies need to focus on removing disparities not readily observable in typical household surveys and analyses. It is also important to expand the frontiers of gender analyses to include methods such as those found in the labour economics and wage differentials literature to capture the effects of unobserved factors that hinder gender parity, but this time in the context of agriculture and rural development.

Social capital, public goods, and private assets remain critical preconditions for the adoption of SIPs: A variety of *social capital* indicators were found to be important for the adoption of SIPs. These included factors such as membership to various economic interest and social groups, availability of friends or relatives who could provide support in times of need, and acquaintances in positions of importance, power or influence. The message from this is that opportunities to build the social capital of farming communities, and formalizing and supporting farmers' groups is an important opportunity to create networks of information exchange, market access and resource mobilization. The influence of *public goods* on adoption was found in the strong positive association between extension contacts, and farmers' perceptions of these services on probability of adoption of various SIPs. Where farmers had favourable views of extension workers, there was also a greater chance that these farmers would adopt various improved practices. Strengthening agricultural extension services and expanding the space of agricultural advisory services to include multiple players should be a policy priority. *Private asset* endowments (such as land, equipment, livestock) were consistently associated with higher probability of adoption of SIPs. Thus suggesting that those without these assets are less able to access liquidity (or credit markets) to finance adoption of SIPs while those with these assets are probably able to liquidate some of it to generate the finances for input purchases and other farm investments. The policy message being that building up systems for financial inclusion is important, and strengthening and protecting the assets of the poor should be central to agricultural development policies.

Finally policies aimed at providing large scale input subsidies as a means of boosting food production need to be targeted carefully. Most importantly, these policies should consider the principle of supporting the most vulnerable. When agricultural input subsidies or other farm-based support are implemented with boosting aggregate food production as the goal; the most vulnerable rural households (e.g. those that are land-poor or landless) can be bypassed as one of the unintended consequences. The recommendation being that expanding the range of safety net support policies to include employment schemes for land-poor or landless households should be seriously considered as complements to agricultural subsidies and other farm support policies. Further, it is important to consider the effects of subsidy programme on long term input market development, given the crowding out effects on the still developing private sector.

The road ahead:
the next two years and beyond

In terms of the analytical and empirical research agenda, the next major milestones marked for the second half of the project involve the commissioning of a series of studies that utilize the knowledge, data and modelling frameworks that have been produced over the past two years. This involves making further use of the panel datasets that have been compiled within and by the partnering institutions and linking survey-based information with targeted case studies to identify gaps in data, structural and behavioural impediments to adoption that are not readily discernible from either econometric or normative economic analysis.

The construction of the Women Empowerment in Agricultural Index will also be given priority and will be done beyond Tanzania and Ethiopia to extend to more countries in the project area. The index is important to identify interventions needed to empower female and male farmers. Additionally, gender studies on equitable access to technology and on whether impacts of improved agricultural practices are shared broadly will be continued beyond Kenya, Malawi and Ethiopia. Since the empirical analyses undertaken so far relied mostly on cross sectional data, the next phase of analyses will be designed to understand the dynamics of livelihood diversification, technology adoption and adaptation strategies and impact (e.g. nutrition, food security) analysis for different social groups, agro-ecology and policy environment. Economy-wide impacts of multiple SIPs interventions will be conducted in some project target countries. The construction of models to understand an economy-wide impact is time demanding and thus this activity will be carried out beyond the two years. In the coming years, using the panel datasets and case studies, the role of market and agribusiness in the process of SIPs adoption will be examined. In terms of productivity analysis and SIPs adoption, focus will be given on total factor productivity (TFP) as the relevant productivity concept rather than the partial productivity measure of yield (yield/hectare). An econometric analysis of scope economies to exploit product complementarities and diversification to manage risk will be estimated in some of the maize-dominant farming systems of the five countries.

A series of second round data collection is now planned for each of the five countries in 2015. Finally, an emerging area where APP can make significant contribution is the capacity development and development of decision support tools for policy and development practitioners specifically by offering scenario-based analyses on key issues. The national partners' capacity is limited in terms of designing survey instruments, implementing large surveys and the application of the state of the art methods to undertake relevant policy research. In order for partners to own the project and utilize the available data, if funding is available in the coming two years and beyond, hands-on trainings on various important issues that will have impact beyond the project period will be provided to partners and students of project countries and SIMLESA spill over countries. A non-traditional training approach will be developed based on stakeholders' discussion and feedback from the medium-term review of the project. The support tools would be simple applications or algorithms that can be used by development partners and policy makers to determine and understand the adoption process and compute the micro- and macro-economic benefits of multiple SIPs and policies adoption. In terms of policy outreach, APP in collaboration with national, regional and international think-thank institutions will increase efforts in reaching policy makers and media, with more emphasis on engaging policy makers and development partners in policy dialogue.

Further readings:
Publications and stories from the Adoption Pathways Project

The results presented in this brochure are a summary of a series of publications that have variously been produced by researchers working within the Adoption Pathways Project and in collaborating projects. These are listed below to provide the interested reader with a more complete reading of these results and most of these publications are available at http://aciar.gov.au/aifsc/projects/adoption-pathways.

Journal Articles

Beyene, A.D. and Kassie, M. (forthcoming). Speed of adoption of improved maize varieties in Tanzania-an application of duration analysis. Accepted for publication in Technological Forecast and Social Change.

Kassie, M., Teklewold, H., Marenya, P., Jaleta, M. and Erenstein, O. (forthcoming). Production risk and food security under alternative technology choices in Malawi. Application of a multinomial endogenous switching regression. Journal of Agricultural Economics. doi: 10.1111/1477-9552.12099.

Kassie, M., Teklewold, M., Jaleta, M., Marenya, P., and Olaf, E. (2015). Understanding the adoption of a portfolio of sustainable intensification practices in eastern and southern Africa. Land use Policy, 42: 400-411.

Wagura, S.; Kassie, M. and Shiferaw, B. (2014). Are there systematic gender differences in the adoption of sustainable agricultural intensification practices? Evidence from Kenya. Food Policy, 49:117-127

Kassie, M, Simon, W., and Jesper, S. (2014). What determines gender inequality in household food security in Kenya? Application of exogenous switching regression. World Development, 56: 153-171.

Kassie, M., Jaleta, M., and Mattei, A. (2014). Evaluating the impact of improved maize varieties on food security in rural Tanzania: A continuous treatment approach. Food Security, 6:217-230.

Hailemariam, T., Kassie, M., Bekele, S. and Kholin, G (2013) Cropping Systems Diversification, Conservation Tillage and Modern Seed Adoption in Ethiopia: Impacts on Household Income, Agrochemical Use and Demand for Labor. Ecological Economics, 93: 85-93.

Holden, S. T. and Lunduka, R. (2013). Who benefit from Malawi's input subsidy program? Forum For Development Studies 40(1), 1-25

Holden, S. T. and Lunduka, R. (2013). Input subsidies, cash constraints and timing of input supply. American Journal of Agricultural Economics. 96(3):290-307.

Discussion papers

Skjeflo, S. and Holden, S. T. (2014). Economy-wide effects of input subsidies in Malawi: Market imperfections and household heterogeneity. CLTS Working Paper No. 7/2014.

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