1. Activity Reporting.

Activity 338-2014

Conduct integrated assessments of climate change impacts on agricultural systems and food security using AgMIP protocols and simulate benefits of plausible adaptation packages at representative sites in EA, Saf, WA

Status	Extended	Milestone	1.2.1 2014
Start date	2012 Sep	End date	2015 Dec

Description: Site specific, integrated assessments of climate change impacts on agriculture and food security are today essential in planning appropriate adaptation strategies. This work aims to fill knowledge gaps about i/ current production systems sensitivity to climate change, ii/ impacts of climate change on future production systems and iii/ benefits of adaptation under plausible representative agricultural pathways and climate scenarios for selected sub-national sites in Eastern, Southern and Western Africa in partnership with AgMIP. Targeted enterprises include chickpea, livestock, maize, millet, peanut, sorghum representing AgMIP and Global Futures interests.

Additionally, previous research has shown that millet models are among the least tested and weakest relative to simulation of tillering and leaf area development, grain formation and growth responses to soil and climate conditions, partitioning of growth to yield components, and response to phosphorus, which greatly limits growth and yield in large areas of the semi-arid Tropics. A new research objective is proposed to evaluate and improve the pearl millet model in DSSAT, using the open Crop Model Improvement Team (CMIT) approach developed in AgMIP. This effort will also articulate with other millet modeling work with CSIRO/APSIM and activity # 3 below.

At the aggregate scale, outlooks and adaptation benefits for dryland cereals and grain legumes will be examined using the IMPACT model, and national partners capacity will be strengthened by trainings in the use of new tools and methods and through collaborative work in the execution of integrated assessments.

Status: Extended. Comprehensive assessment of climate change impacts on smallholder agricultural systems was carried out at selected locations in eastern Africa, Southern Africa, Western Africa and South Asia using AgMIP developed protocols and tools. The assessment includes analysis of historical climatic data, generating downscaled location specific future climates, assessing impacts of current and future climatic conditions on maize and evaluating economic impacts of these changes.
In Eastern Africa, the assessments were carried out in Ethiopia (Adama Woreda), Kenya (Embu county), Tanzania (Wami Basin) and Uganda (Hoima and Masindi districts). Observed Climate data for the period 1980-2010 was collected for sixteen different locations within the target areas and used

as baseline climate. Forty different climate change scenarios (20 CMIP5 AOGCMs and two RCPs 4.5 and 8.5) were generated for mid (2040-2070) and end (2070-2100) century periods for each of the sixteen locations and performance of smallholder agricultural systems under each scenario was simulated using crop models APSIM and DSSAT. The diversity of the smallholder systems was captured by setting up 1469 different simulations with various combinations of soil, variety, fertilizer, manure, plant population and planting dates based on the results from a survey conducted on these farms. Representative Agricultural Pathways (RAPs) were developed to represent the current production system in the future through stakeholder discussions separately for each country. The economic impacts of climate change on agricultural production were assessed with TOA-MD under current and future systems. Stakeholder meetings with members from policy, research and developmental organizations were held in all the four countries to present the results and get receive their feedback. Findings from the assessment with due consideration to the stakeholder feedback were summarized as country and regional reports and policy briefs. The first phase of this work is completed and the second phase has started with emphasis to include livestock in the assessments and extensive engagement of stakeholders

Gender Component: This is an assessment on how climate variability and change impact the performance of crops and cropping systems as a function of resource status and their management. Based on the differences in the management that exist between different gender groups, it is possible to assess how the impacts vary from one group to the other. During the implementation of the project adequate attention was paid to achieve proper mix of gender groups in the teams, workshops and meetings and in capacity building activities.

Objectives:

1. Develop and maintain a database of high quality climate, soil, crop, livestock and socio-economic datasets required for calibrating and validating a range of climate, crop, livestock and economic models and for quantifying impacts of climate variability and change on agricultural systems
2. Improve pearl millet crop model for accurately simulating growth and yield under a wide range of climate, soil, genetic, and management conditions (including improved tillering and P response)
3. Calibrate baseline crop cultivars (chickpea, maize, millet, peanut, sorghum) for the target sites and simulate yields with current farmer management practices under current and future climates (sensitivity analysis)
4. Develop plausible adaptation packages (entry points: systems / policy, seed technology, agronomy) for representative agricultural pathways in target sites
5. Working together in partnership with global and other regional AgMIP teams and using AgMIP protocols, conduct an integrated assessment of climatic change impacts on agricultural systems and food security at selected sub-national sites in East, Southern and West Africa
6. Assess spatial variation in productivity of pearl millet and chickpea in target regions using spatial crop modelling suite

Deliverables:

Description	Type	Year	Status	Justification
Database on key soil, crop, livestock and socio-economic parameters including new pearl millet database	Data	2014	On going	
Calibrated crop and socio-economic models for running climate change impact integrated assessments at sub-national sites in target regions	Platforms - Data Portals for disseminati on	2014	Complete	
Enhanced and improved pearl millet crop model suite with documentation	Platforms - Data Portals for disseminati on	2015	Incomplete	
Climate change impact assessment reports to mid-century for sub-national sites in target regions and for contrasted socio-economic and climate scenarios	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	Complete	
Scientific paper on model evaluation and improvement components	Peer-reviewed journal articles	2015	Incomplete	
Workshops to bring together all partners to assess imapcts and interpret the results	Policy briefs - Briefing paper	2014	Complete	
6 MSc students, training for NARS on integrated assessment of crop-livestock systems	Capacity	2014	Complete	
Book chapter	Book chapters	2014	Complete	

Description	Type	Year	Status	Justification
Project report CALESA	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	Complete	
Proceedings of the special session on climate change held during Soil Science Society of East Africa (SSSEA) and the Africa Soil Science Society (ASSS) conference, Nakuru, Kenya, 21st - 25th October 2013	Books	2014	Complete	

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Location(s):
Countries: Burkina Faso, Ghana, Mali, Niger, Senegal, India, Malawi, Mozambique, South Africa, Zimbabwe,
Benchmark Site: Nyando (Katuk Odeyo), Albertine Rift (Hoima), Usambara (Lushoto), Borana (Yabero), Kollo (Fakara), Kaffrine,

Regions: East Africa (EA),

Activity 883-2014

Developing most appropriate protocols, geospatial analysis, and crop simulation models in yield gap assessment at local, regional, and global scales for assessment of current and future food security and potential for sustainable intensification.

Status	On going	Milestone	1.2.1 2014
Start date	2011 Dec	End date	2014 Dec

Description: This project will provide the first easily accessible, transparent, reproducible, and agronomically accurate web-based platform to estimate exploitable gaps in yield and water productivity for the world's major food crops, enabling farmers, governments, policy makers, agricultural research and extension institutions, funders of agricultural research, foundations, private sector organizations and others to to identify regions with the greatest potential to sustainably increase global food supply with improved management practices.

Status: On going. The project is progressing as planned and will continue in 2015 in the form of a 'bridging project' (FP1 EA)

Gender Component: Not defined

Objectives:

1. Provide geospatially explicit estimates of yield gaps for major staples (maize, rice, wheat, millet, sorghum, cassava, soybean, groundnut) in 12 countries in SSA and SA
2. Make available a user-friendly web-based platform with a geospatially explicit assessment of yield gaps for major staple crops

Deliverables:

Description	Type	Year	Status	Justification
Calibrated and validated crop growth models to simulate potential and water-limited yields of major cereals (maize, wheat, rice, millet, sorghum) and some additional crops (cassava, groundnut, soybean, common bean)	Platforms - Data Portals for dissemination	2015	Incomplete	
A network of country agronomists in the 12 countries trained in yield gap assessment and national to regional food security studies	Capacity	2015	Incomplete	
Weather data (observed and propagated) and data used for crop growth simulation available on the website (IP issues pending)	Data	2014	On going	The website www.yieldgap.org is currently being populated with data used for yield gap assessment. Major problem is making actual weather data (from stations) publicly available.
Papers published on yield gap assessment protocols. MSc thesis on importance of soil information for yield gap assessment (link with AfSIS).	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	On going	4 papers under review.
User friendly and transparent global yield gap atlas available on the website	Articles for media or news (radio, TV, newspapers, newsletters ,etc.)	2014	On going	Project ongoing.

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Location(s):

Countries: Burkina Faso, Ghana, Mali, Niger, Nigeria, Bangladesh, India,

Benchmark Site: Nyando (Katuk Odeyo), Makueni (Wote), Albertine Rift (Hoima), Kagera Basin (Rakai), Usambara (Lushoto), Borana (Yabero), Yatenga (Tougou), Lawra-Jirapa (Lawra), Segou (Cinzana), Kollo (Fakara), Bagerhat (Morrelganj), Vaishali, Karnal,

Regions: East Africa (EA),

Activity 884-2014

Addressing the climate variability and climate change consequences on crops drought/heat adaptation

Status	Complete	Milestone	1.1.1 2015 (1)
Start date	2014 Jan	End date	2015 Dec

Description: Climate change is often seen as dreadful waves of heat annihilating crops by their effect on grain set, and this has put a lot of emphasis on heat tolerance research. Increases in temperature also accelerate the accumulation of thermal time for the different phenophases. Model simulations predict major yield decrease in future climate in different crops (Cooper et al 2009), mostly because of shorter cropping cycles, but that could fairly easily be dealt with by breeding longer duration cultivars. However, the improvement of the crops high temperature tolerance is not so simple task and it is clear now that high temperature will affect many crops' yield. In the case of chickpea and millet, in many seasons the flowering take place during the summer months and drastically reduces yield by an effect of the high temperatures on flower and seed set. Our objective here is to understand the mechanisms of heat tolerance (chickpea and millet is planned in 2014) and reflect these in the crop coefficient that characterize the effect of temperature on yield, especially: (i) the threshold temperature where yield starts being affected by higher temperature; (ii) the percentage yield losses associated to any additional increase by one degree above the threshold temperature. Less focus has been put on the effects that slight changes in temperature can have on the plant-water relations. Under climate change conditions, but also under current climate variability, an increase in temperature increases the evaporative demand (Vadez et al., 2012) and by definition decreases the productivity of water (TE, Tanner and Sinclair 2003). Therefore, adapting to climate change or current climate variability is first an issue of maintaining high water productivity, especially where drought is an issue (Vadez et al., 2012).

In the past few years, we have accumulated considerable evidence of intra-specific diversity for the capacity of stomata to partially close under vapor pressure deficit (VPD) above 2-2.5 kPa. The “midday stomatal closure” has been known for long (Black and Squire, 1979). Genotypic differences for that trait have been identified only recently in soybean (Fletcher et al., 2007), pearl millet (Kholova et al., 2010), chickpea (Zaman-Allah et al., 2011), cowpea (Belko et al., 2012), sorghum (Gholipoor et al., 2010). This trait has dramatic beneficial effects on the soybean yield across the US (Sinclair et al., 2010), especially so in the driest years. Our hypotheses are: (i) H1- that there is untapped genetic diversity in the reference collections; (ii) H2 – that differences in these responses lead to higher water productivity (TE); (iii) H3 – That this trait relates to plant hydraulics; (iv) H4 – that crop simulation modeling can tell us in what crop/region combination there can be a worthy-of-breeding yield increase due to this trait. Additionally, we will initialte the activities to understand interactions between high temperature tolerance and VPD response, if any. In view of the hypotheses that are presented above, the activities that are proposed will be a combination of systematic phenotypic assessment of trait diversity in representative germplasm collections, across crop species (even outside of ICRISAT

mandate), developing mechanistic understanding of the trait in order to generate the input coefficients and to improve the models using this knowledge wherever needed, and finally simulate the trait effects in crops . These activities represent a huge task that will be undertaken over several years, crop after crop, and will need to build on crossdisciplinary experience and interaction between physiologists (VV, JK), breeders (SKG&PG) and modellers (MD, VV, JK).

Status: Complete. Sub-Activity 1 - Test seed setting under a gradient of temperature and humidity conditions in selection of pearl millet (APSIM, JK&students) and chickpea (i-Legume, VV&students) genotypes, to generate coefficients to develop crop simulation model that are "CC-aware"
Two trials have been carried out in pearl millet to: (i) determine the temperature threshold where seed setting starts being affected. In short, tolerant material show no sign of decrease in seed set below 42°C, whereas sensitive genotypes have a decrease in seed set above 36°C; (ii) Test the respective effect of high temperature and relative humidity on seed set in a range of tolerance and sensitive pearl millet genotypes. High maximum and minimum temperatures had a strong negative effect on PNHI. However, low maximum relative humidity percentage (RH %) had an equally strong negative effect on PNHI, highlighting that the late night conditions were probably more determinant in impacting a heat effect than the daytime conditions. Tall genotypes were more sensitive to an increase in temperature than short genotypes, although part of this could be explained by the slightly different temperature and RH% conditions at the height of the panicle. Selection of tolerant and sensitive genotypes under a combination of high temperatures and low relative humidity could be made on the basis of the percentage reduction of PNHI under the three harshest environments. It is concluded that genetic variation for the tolerance to high temperature during anthesis exists in pearl millet. Methods are described to carry out relevant screening and need to take care of relative humidity as a factor as well as plant height as another factor influencing reproduction response to heat stress.
For chickpea, trials are being conducted with 4 contrasting genotypes, and consist of a staggered planting (early to late) to force flowering to occur during a range of temperature conditions at the beginning of the Indian summer. Two sowing have been done in the 2012-13 season, 4 during the 2013-14 season, and 5 more sowing have been done during the 2014-15 season (and are still in the field at the time of reporting). The main purpose was to establish a relationship between the harvest index (HI) and the mean temperature during the R1-R5 stage (flowering to beginning of seed growth). We expect to find an exponential decay function, whose coefficient would be used to develop a loop where HI is made temperature-dependent in the i-Legumes family of legume crop models (Soltani and Sinclair, 2011, FCR 124, 252-260). However, sowing date experiments intended to expose the crops' reproductive period to an increasing temperature are confounded by two factors: (i) the effect of temperature on the phenological development and then the fact that late sowing (exposed to higher temperature) have shorter stages; (ii) the fact that the vapor pressure deficit increases and interacts likely with the carbon fixation processes. To offset these two potential factors, the analysis of the first two years of data (six sowing dates) used a photothermal quotient to normalize PAR interception by the mean temperature and the same photothermal quotient normalized by the VPD. The phothermal quotient explained 50% of the yield variations (i.e. those related to the effect of temperature on development) and then the photothermal quotient normalized to VPD explained 75%

of the yield variations (those explained both by temperature effect on development and VPD). In this case, the residual yield variations were not correlated to the maximum temperatures, indicating that in these 6 sowing dates, the chickpea yield reduction had not been explained by a stressful effect of temperature on reproduction, but purely by effect of temperature on a faster development and by an effect on an increased VPD.

Sub-Activity 2 - Assess reference collections of germplasm in different species to identify variants for the capacity of restricting transpiration under high VPD conditions (mainly chickpea &pigenopea planned for 2014) and develop model input coefficients related to this trait (VV)
This activity is a generic activity that will be continued for several years. So far, it entirely depended on outdoors gravimetric measurement of transpiration in fully irrigated plants under challenging VPD conditions (period of the year when the vapor pressure deficit crosses an indicative threshold of 2.0 kPa, known to be a value around which stomata are likely to respond in specific genotypes), followed by manual and destructive measurements of the leaf area to calculate a “canopy conductance rate” as gram water transpired per unit of leaf area and time. Using this method, it has been completed for the reference collection of sorghum (close to 400 entries), in the scope of a training of a PhD student from CERAAS (Senegal – Bassirou Sine). A portion of the reference collection of has been assessed in peanut (60 entries), pearl millet (20 entries), chickpea (20 entries). It had also been done in several types of breeding populations (234 recombinant inbred lines of chickpea, 110 RILs of cowpea, 320 RILs of peanut), or in lines introgressed with drought adaptive trait QTL (e.g. staygreen introgression lines of sorghum). Because the measurement of leaf area is a major bottleneck to the throughput of this activity, a large phenotyping platform has been developed in 2014 to speed up the leaf area development, and in 2015 the platform will be equipped with load cells to automate the transpiration measurements. This platform is now fully functional for the measurement of the leaf area and the canopy conductance under challenging VPD conditions has been assessed in the reference collection of chickpea (288 entries) and in 234 RILs of chickpea. Currently, the pearl millet reference collection (PMiGAP, pearl millet inbred germplasm association panel) is being tested. This will be followed by the reference collection of sorghum and 320 RILs of peanut.

Sub-Activity 3 - Assessment of the link between the VPD response trait and high TE within the germplasm in lysimetric trials (VV&SKG&PG))
This link is now established. In the case of sorghum, both germplasm from the reference collection and staygreen QTL introgression lines were assayed for transpiration efficiency (TE) in a lysimetric system (see Vadez et al 2011a Crop and Pasture Science 62 (8) 1-11, and Vadez et al 2011b Functional Plant Biology 38, 553-566). The extreme lines for TE were tested for their transpiration response to increasing vapor pressure deficit (VPD) and showed a clear contrast (high TE lines were VPD-sensitive, whereas low TE lines are VPD-insensitive). This link has been reported during the Interdrought IV conference (Perth, Australia, 2-6 Sept 2013). A publication is in preparation where the link between the differences in the response to high VPD and a possible involvement of aquaporin genes is also discussed.
Similar work has been carried out in three sets of pearl millet genotypes: (i) the pearl millet inbred germplasm association panel (a sort of reference collection); (ii) a recombinant inbred line population;

(iii) a fine mapping population. In the case of the RIL and fine mapping population, we have exactly the same link we found in sorghum. In the case of the germplasm the link was incomplete since out of 10 low-TE materials, about 2/3 were VPD-insensitive, whereas in the 10 high-TE materials, also 2/3 were VPD-sensitive. In the pearl millet germplasm, the range of variation in TE was also quite limited compared to other reference sets (for instance sorghum). We have repeated the TE assessment using the inbred germplasm (not testcross hybrids as in the previous trials). Much larger variation for TE was identified among the inbreds. A repeat of this assessment is on-going. Once the most TE contrasting will be confirmed, we will test again the VPD response in these lines. On a similar line, in 2014-15 we have assessed TE in a large portion of the reference collection of chickpea. Assuming TE variation will be identified, we will be able to also test this TE-VPD response link in a legume specie.

Sub-Activity 4 - Run simulations and developing maps representing traits effects (VPD response/heat response) on yield across crops/regions and giving a probability of success (VV&JK&MD)
Simulations using APSIM have been carried out in sorghum and these cover the postrainy sorghum area of south India (covering about 5 M ha across Andhra Pradesh, Maharashtra, and Karnataka). In short, the VPD response trait would have a positive effect both on grain yield and stover yield across the entire region, although the benefit would be the highest in the areas affected by the most severe forms of water stress (onset of terminal drought at pre-flowering and flowering stages). This trait would also have an impact on the net monetary benefit. The details of this study are now published in Functional Plant Biology. The main outputs have been reported at the Interdrought IV conference (Perth, Australia, 2-6 Sept 2013) and in other fora.
Similar simulation studies have been undertaken in peanut using the i-Legume crop model version of peanut, for a large block of latitude and longitudes in West and Central Africa. Maps showing the effect have been generated and show a positive effect of that traits in latitudes roughly ranging above 11 degree North, whereas there would be no effect (but no detrimental effect either) at lower latitudes.
Similar simulations have been carried out in soybean and show a clear benefit of the trait in latitudes above 8 degres North in West and Central Africa, and in several part of East and Southern Africa (see Fig. 7 in Sinclair et al 2014, Soybean production potential in Africa, Global Food Security, forthcoming).
Simulations have been carried out also in chickpea, as part of a larger set of simulations for traits affecting the canopy development in chickpea. A VPD sensitivity threshold set at 2.0kPa in chickpea would bring about 10% yield benefit across the 14 locations that were tested in India. Interestingly, there was a clear regional separation, with location at latitudes above 23 degres North showing only a minor benefit whereas latitudes below 17 degres North, where much of the chickpea is now grown, would show a yield increase of about 20%.

Gender Component: Not defined

Objectives:

1. Test seed setting under a gradient of temperature and humidity conditions in selection of pearl millet (APSIM, JK&students) and chickpea (i-Legume, VV&students) genotypes, to generate coefficients to develop crop simulation model that are "CC-aware"
2. Assess reference collections of germplasm in different species to identify variants for the capacity of restricting transpiration under high VPD conditions (mainly chickpea&pigenopeaplanned for 2014) and develop model input coefficients related to this trait (VV)
3. Assessment of the link between the VPD response trait and high TE within the germplasm in lysimetric trials (VV&SKG&PG))
4. Run simulations and developing maps representing traits effects (VPD response/heat response) on yield across crops/regions and giving a probability of success (VV&JK&MD)

Deliverables:

Description	Type	Year	Status	Justification
Linkage established between transpiration response to VPD and high transpiration efficiency across crops (VV&JK&students)	Data	2015	Incomplete	
Model assessment of the value of the VPD response trait in different crops/regions (VV&JK)	Peer-reviewed journal articles	2015	Incomplete	
Germplasm sources having transpiration sensitivity to high VPD provided to breeders (for CRP3 breeding targets, VV&JK&SKG&PG)	Data	2014	Complete	
Model input coefficients for the temperature responses (chickpea 2014/ millet 2015; VV&students)	Data	2015	Incomplete	
Loops in i-Legumes that are “temperature-sensitive” (VV&?)	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	Complete	Model input coefficients for the temperature responses (chickpea 2015) and pearl miillet. Delivery was planned to be coming in the course of 2015 only. However, the analysis of the first two years in chickpea indicates that the model input coeficients are going to be somewhat more complex to put in place since the effect of heat is through three factors: (i) phenological development, (ii) negative VPD effect on biomass accumulation, and (iii) heat effect on reproductive biology. Deliverable will also be in form of journal articles (one is about to be submitted on the pearl millet work – One more paper reporting the chickpea data of the first two years is currently under review with Field Crops Research).
Impact high temperature on sorghum & millet simulated (VV&JK?)	Peer-reviewed journal articles	2015	Incomplete	

Description	Type	Year	Status	Justification
Sub-Activity 4 - Run simulations and developing maps representing traits effects (VPD response/heat response) on yield across crops/regions and giving a probability of success (VV&JK&MD) "Threshold temperatures above which temperature impacts seed setting identified in sorghum and pearl millet". The experimental work on pearl millet and sorghum has been completed and one paper is about ready for submission in pearl millet. The experimental work of sorghum has been completed. In short, both crops have fairly high temperature thresholds (42 degres and above for pearl millet, 39-40 degres or so for sorghum). Our analysis of weather data in Mali and India, focusing on a window of time when either sorghum or pearl millet reaches flowering, suggest that the probability of temperature crossing these sensitivity thresholds is quite low, suggesting that heat stress effect on the reproductive success of pearl millet and sorghum may not be a major issue. Crop simulations on the effects of the VPD response trait on yield - The work has been done for sorghum in the postrainy season of India. The work on sorghum is published in Functional Plant Biology. Similar work is also on-going for West and Central Africa although this is not planned as a CCAF activity. We are also planning similar type of evaluation for pearl millet, although it is not planned as CCAF activity. For that in pearl millet we first needed to have the APSIM version of sorghum used to upgrade the APSIM version of pearl millet. Once we have this in hand, and not only, we will be	Peer-reviewed journal articles	2014	Complete	

Description	Type	Year	Status	Justification
able to test the effect of the VPD response trait on pearl millet productivity. Much effort has been achieved in 2014 and the pearl millet module of APSIM is now working. If all goes well a new release of APSIM including these upgrades should take place in 2015. The peanut work still needs to be published, as part of a much more exhaustive set of simulations. It has been reported in different meetings (GCP Annual Research meeting, 27-30 sept 2013, Lisbon - This presentation is available in the GCP website, the AAGB meeting in November, Charleston, GA, USA). For peanut, breeding should integrate this trait for the development of any material at latitude of and above 11 degree North in West and Central Africa.				
Sub-Activity 3 - Assessment of the link between the VPD response trait and high TE within the germplasm in lysimetric trials (VV&SKG&PG))	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	Complete	

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Location(s):
Global

Activity 885-2014

Assessing the effects of climate change on pest population dynamics

Status	Complete	Milestone	1.2.1 2015 (1)
Start date	2014 Mar	End date	2015 Sep

Description: Climate change is one of the major challenges being faced by Agriculture in India, more so in the Semi-Arid Tropics (SAT) in ESA and WCA. Analysis of long-term trends in temperature based on 47 stations in India has indicated that overall, there was an increasing trend in temperature at 55 to 80% of the stations. Climate change models have predicted an increase in temperature and variability in precipitation in the SAT of WCA.A few studies have indicated significant negative or positive trends in annual rainfall at different locations, which will have a major influence on the length of the growing period (LGP). The anticipated climate change is likely to affect the crop - pest interactions and pest dynamics, which will have a major bearing on pest incidence, severity, and crop loss, threatening sustainability in crop production and food security.

Therefore, there is a need to assess the effects of climate variability and change on pest population dynamics, particularly their rates of growth and survival across a range of temperature and humidity regimes - to which the pests are highly sensitive, activity and efffectiveness of matural enemies, and the efficacy of various methods of pestcontrol.

Status: Complete. Reporting on activities in India. Report on activities in WCA in 886-2014

Gender Component: Not defined

Objectives:

1. Analyze historic Helicoverpa, Spodoptera, groundnut leafminer and groundnut sucking insects data in relation to weather parameters, and document shifts in pest spectrum over time (GVRR/AVRKR)
2. Study rates of growth of different life stages of pod borers, Helicoverpa and Maruca, and stem borer, Chilo partellus at different temperatures to develop simulation and forecasting models for these pests (HCS/ARW)
3. Analyse historic pearl millet head miner, stem borer, and panicle feeding beetle, Rhinyptia data in relation to climate change/weather events in WCA (MB).

Deliverables:

Description	Type	Year	Status	Justification
Databases on population of Helicoverpa, Spodoptera, GN leafminer, sucking insects on groundnut and weather are available for developing pest-weather relationships in India.	Data	2015	Incomplete	
Data on effect of temperature and RH on rate of growth, survival and fecindity of Helicoverpa, Spodoptera, and Chilo for use in pest forecasting models (RACLIM/CLIMAX).	Data	2015	Incomplete	
Data on the relationship between climatic factors and incidence/severity of pearl millet headminer, stem borer and head beetle in WCA.	Data	2015	Incomplete	
Data on effect of temperature on rate of growth and survival of groundnut aphids for use in pest forecasting models.and and groundnut aphid/rossette in WCA.	Data	2015	Incomplete	
Areas with high climate variability in India mapped, changes in pest population, relation to climate established and documented. 3 publications on effect of drought stress on aphid and groundnut rosette transmission	Peer-reviewed journal articles	2015	Incomplete	
Training of 2 MSc and 2 PhD students on climate change effects on pest management.	Capacity	2015	Incomplete	
Effects of climate change on insect-pest incidence in pigeonpea; Helicoverpa armigera – genotype – environment interactions in chickpea; Study and document changes in geographical distribution of major insect pests of ICRISAT legumes, based on past and present surveys and historic climate data	Data	2014	Complete	

Description	Type	Year	Status	Justification
Effects of climate change on insect-pest incidence in pigeonpea; Helicoverpa armigera – genotype – environment interactions in chickpea; Study and document changes in geographical distribution of major insect pests of ICRISAT legumes, based on past and present surveys and historic climate data	Data	2014	Complete	

Partners:

Partners not defined

Location(s):

Global

Activity 886-2014

Climate change and Disease and Pest dynamics: Effect of groundnut water stress and plant nutrients on aphid (Aphis craccivora) infestation, development and groundnut rosette disease transmission in the semi-arid tropics

Status	Complete	Milestone	2.1.1 2015
Start date	2014 Mar	End date	2015 Sep

Description: Sustainable crop production in the sub-Saharan Africa is strongly impeded by limited availability of water, low soil fertility and by crop losses to insect pests and diseases. Climate change models predict increase variability in precipitation, with increasing water shortage worldwide (IPPC, 2007). Intense precipitation events, which could lead to increase runoff, soil erosion and reduced soil fertility is also expected (Easterling et al., 2000; StClair & Lynch, 2012). For semi-arid regions of Africa where rainfall shortage and low soil fertility are already known as major constraint for crop production, the situation is expected to be worsened by climate change related events. While intermittent periods of drought are known to have significant detrimental effects on plants, their effect is also known to stretch to associate herbivorous arthropod populations (Showler, 2013). Chemical compositions of plants change and make them more vulnerable or resistant to pests (Warnig and Cobb, 1992; Hogendorp et al., 2006).
Groundnut is an important legume crop in SSA, providing protein, numerous vitamins and a source of oil. However, its production is constrained by Groundnut Rosette Disease (GRD), known as the most important viral disease of groundnut. Transmitted by the common aphid, Aphis craccivora Koch, GRD epidemics are known to cause up to 100% yield losses (Naidu et al., 1999). Disease impact is significant. Losses of US$250million in 1975 in Nigeria (Yayock et al. 1976) and US$4.89 million in eastern Zambia in 1995 (Waliyar et al., 2007) illustrate this.
Increases in drought associated with climate change could increase the frequency and severity of insect population outbreaks (Koricheva et al., 1998; Huberty & Denno, 2004) and occurrence of disease epidemics. It is imperative to understand the effects of drought on plant aphid population; GRD transmission and groundnut yield performance. This study aims to understand the effect of drought and low nutrients stress on population dynamics of Aphis craccivora and the transmission of rosette disease in groundnut.

Status: Complete. The experiments have been completed. A paper will be prepared for publication

Gender Component: This experiment has been conducted by two female students, one MSc and one from technical school

Objectives:

1. Understand the effect of drought and low nutrients stress on population dynamics of Aphis craccivora and the transmission of rosette disease in groundnut.

2. Study groundnut injury by A. craccivora injury under drought and low phosphorous conditions and effect on groundnut rosette disease transmission
3. Effect of water stress on susceptibility of groundnut varieties to aphids and groundnut rosette transmission
4. Study the synergistic effects of drought and aphids on groundnut crops

Deliverables:

Description	Type	Year	Status	Justification
These experiments will provide an accurate quantification of the specific combinations of drought/low nutrient and aphids/rosette on groundnut productivity. Since drought tolerant groundnut varieties are being developed, this project aims also to determine their impact on the development of aphid population and the rosette virus transmission. The expected findings of this project will serve as basis for decision in prediction of what would happen to the groundnut-aphid-rosette interaction under drought/low nutrient severity due to climate change.	Data	2015	Incomplete	
3 publications on effect of drought stress on aphid and groundnut rosette transmission	Peer-reviewed journal articles	2015	Incomplete	
Training of 2 MSc students on groundnut entomology/ pathology and physiology	Capacity	2015	Incomplete	
Annual reports on the activity implementation	Articles for media or news (radio, TV, newspapers, newsletters ,etc.)	2015	Incomplete	

Description	Type	Year	Status	Justification
This experiment has been conducted by an MSc thesis student	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	On going	The MSc thesis is being drafted and will be ready by April 2015

Partners:

Partners not defined

Location(s):

Countries: Niger,

Activity 887-2014

Testing and promotion of effective communication methods and formats for presenting climate information, including seasonal climate forecasts, tailored to the end user needs in three sites across EA and SA.

Status	On going	Milestone	2.1.3 2014
Start date	2013 Aug	End date	2015 Jul

Description: The aim is to expand the concept of agricultural extension beyond the use of inputs and technologies. The project seeks to make sure that agricultural extension also includes the use of information based inputs such as seasonal climate forecasts (SCFs) which may serve to reduce risks at farm level. The activity builds on the lessons and opportunities identified from the work conducted to date by ICRISAT on providing and interpreting SCF for crop production in Zimbabwe. It also builds on the lessons of other projects' use of mobile phones to communicate with farmers, including SCF.

Over the last 3-4 years, ICRISAT has worked with groups of farmers to help: 1) interpret the forecasts using simple means of expressing probability of different amounts of rainfall occurring; and 2) exploring (using participatory approaches with and without crop models) the likely effects of different crop and farm management decisions. This worked well with farmers but there were some recommendations from this research which this study project seeks to implement including the following:

(i) Enhanced capacity of extension staff in AGRITEX so that they can train farmers and facilitate climate variability (and change) coping and adaptation planning. Impart increased understanding and skills on (1) practical implications of climate variability (and change) and (2) appropriate coping and adaptation strategies for smallholder farmers. Extension staff and contact farmers will be capacitated to access/ understand both SCF and "weather-within-climate" information

(ii) Enhanced communication of climate-related information . Packaging SCF with historic climate data (analyses that can be tailored to farmers' needs so that the probability of weather events that are important to farmers) as well as shorter range forecasts together with the experience of the season as it develops could aid in the provision of relevant climate information. This will integrated with agricultural technologies through Climate Field Schools (CFS)

Status: On going. This activity is partially complete.
-Capacity building of extension staff in AGRITEX so that they can train farmers and facilitate climate variability (and change) coping and adaptation planning has been done.
-15 Climate Field Schools established and seasonal forecasts (and weather updates through sms) have been delivered in 2014/15 seasons in Hwange district of Zimbabwe.
-Household surveys to be used to ascertain benefits of using climate information and these will be

done in April after the 2014/15 season.
-The study should be complete and written up by July 2015..

Gender Component: Female headed households will specifically be targeted to be part of the contact farmers that will receive training on the use and interpretation of the SCF and weather forecasts and they will also host demonstration plots that will be used as a learning tool for decision making given the weather forecast information.

Objectives:

1. To enhance the capacity of Agricultural and Technical Extension Service of the Ministry of Agriculture (AGRITEX) and contact farmers to understand both SCF and “weather-within-climate” information in semi arid Zimbabwe, for improved decision making in farm management.
2. To scale up the use of weather related information, including SCF to farmers, through a combination of participatory dissemination workshops, through climate field schools, and the use of information and communication technologies (ICTs).

Deliverables:

Description	Type	Year	Status	Justification
Training workshops for staff from NARES as well as contact farmers in use of climate data and SCF interpretation with facilitation from the National Met. Services (NMS)	Workshop	2015	Incomplete	
Scaling up the use of seasonal climate forecasts, using farmer participatory research approaches linked with ICTs (mainly mobile phones)	Articles for media or news (radio, TV, newspapers, newsletters ,etc.)	2015	Incomplete	
Assess the impact of using both ICTs and a participatory agro-meteorology based extension strategy on adaptation to climate variability and change	Peer-reviewed journal articles	2015	Incomplete	
Training workshops for staff from NARES as well as contact farmers in use of climate data and SCF interpretation with facilitation from the National Met. Services (NMS)	Workshop	2014	Complete	

Description	Type	Year	Status	Justification
The project aims to scale up the use of weather related information, including seasonal climate forecasts to farmers through a combination of participatory dissemination workshops and through the introduction of cheaper and manageable means of scaling up the use these i.e. through bringing in the shorter range forecasts to add value to climate information dissemination through the use of information and communication technologies (ICTs), in this case through short message services (SMS) through mobile phones. It is in this regards that the project seeks to assess the benefits of this agro-meteorology based extension strategy through a survey that will be done in April-May 2015.	Peer-reviewed journal articles	2014	On going	The summer production season in Zimbabwe ends in April 2015, hence the assessment of the benefits of our agro-meteorology based extension strategy through a survey that will be done in April-May 2015.

Partners:

1- Zimbabwe Meteorological Services (MSD):
Mr. John Mupuro <john.mupuro@gmail.com>

2- Department of Agricultural Technical and Extension Services of Zimbabwe (AGRITEX):
Mr. Daveson Masendeke <davemasendeke@gmail.com>

Location(s):

Countries: Kenya, Zimbabwe,

Benchmark Site: Nyando (Katuk Odeyo), Makueni (Wote),

Activity 888-2014

Scaling up Climate Services: Enhancing the capacity of intermediaries and communicators (public and private extension services, media, rural radios, NGOs. CBOs and private sector) for communicaticating and applying climate information services , with development of two-way communication platforms and public-private partnerships for sustainable and effective delivery and tailoring of climate services to support farm-level planning, ex-ante decision-making and resilience to climate variability in smallholder agriculture systems across WA, EA and SA.

Status	On going	Milestone	2.3.1 2015
Start date	2014 Jan	End date	2015 Jan

Description: An important component of the agenda to scale up Climate information and advisory Services for farmers in countries is strengthening the capacity of public and private extension and communication networks to serve as the 'missing link' between those who have knowledge on climate/agriculture (national hydrometeorological services and national agricultural) and those whom can use this knowledge to make better informed ex-ante decisions at the farm-level (farmers, pastoralists, fisherfolks and communities at risk from climate shocks), adding to their indigenous know-how. This activity aims to improve communication capacity of climate services, starting in 4 CCAFS sites across EA, WA and SA, by: 1) exploring feasibility of public-private partnerships to communicate climate services at scale, involving private telecommunication companies, learning form the pioneering experience of India/South Asia; 2) Training of intermediaries to understand and communicate climate services at scale, and serve as a missing link between knowledge providers and communities at risk; 3) Developing best practice tools and methods to train intermediaries to communicate climate services for farmers. Completion of the above activites will go a long way towards developing CCAFS' strategy 2.3 to scale up climate information and advisory services for farmers in Africa and South Asia.

Status: On going. Effectively communicated seasonal rainfall forecast based crop management options discussing with practicing farmers for their farm-level crop decision-making by smallholder farmers to cope with climate variability in Ananthapur and Kurnool districts of AP in the southern India (South Asia region). A number of IT based products are also developed and are currently being tested. These include GreenPHABLET, GreenSIM, KGS and KV and PICO Projector.

Gender Component: These products help in providing equal access to information for all gender groups. Women participated more actively in these activities and preliminary results indicate significant benefits to this group.

Objectives:

1. Continue development of relevant innovative tools and methods to train intermediaries to communicate climate services at scale

2. Test models to communicate climate services at scale in 4 CCAFS sites in EA, SA and WA, with development of two-way communication platforms in partnership with telecommunication companies, learning from the experience of India/South Asia
3. Continue working with community of practice across CGIAR centers on communication of Climate Services at scale for resource-poor farmers under a changing climate across Africa and South Asia

Deliverables:

Description	Type	Year	Status	Justification
Relevant context-specific two-way communication platforms developed, linking providers and farm users of climate services in 4 sites across WA, EA and SA	Articles for media or news (radio, TV, newspapers, newsletters ,etc.)	2014	On going	
Public-private partnerships tested with national telecommunication companies, sector experts and relevant intermediaries to sustain communication of climate services at scale	Platforms - Data Portals for dissemination	2014	On going	
CCAFS Report: Guidebook to Train Intermediaries to Communicate Climate Services at Scale	Peer-reviewed journal articles	2014	On going	
Training of intermediaries (public and private extension services, media, rural radios, NGOs. CBOs and private sector) to understand, apply and communicate climate services at scale	Workshop	2014	On going	
Community of practice within ICRISAT an across CGIAR centers around communication of Climate Services for ressource-poor farmers under a changing climate	Capacity	2014	On going	
Journal article	Peer-reviewed journal articles	2014	Complete	
Jornal article	Peer-reviewed journal articles	2014	Complete	

Partners:

1- Kenya Agricultural Research Institute (KARI):
Anthony Esilaba <aesilaba@gmail.com>

2- Kenya Meteorological Department (KMD):
Mary Kilavi <marykilavi@yahoo.com>

3- Agence National de l'Aviation Civile et de la Météorologie (Senegal) (ANACIM):
Ousmane Ndiaye <ousmane@iri.columbia.edu>

Location(s):

Countries: India, Kenya, Senegal,
Benchmark Site: Nyando (Katuk Odeyo),

Activity 889-2014

Participatory testing of gender-responsive M&E protocol to design, monitor and evaluate concrete outcomes from farmers' use of Climate services in three sites across WA, EA an SA.

Status	Cancelled	Milestone	2.1.3 2015
Start date	2014 Jan	End date	2015 Jul

Description: Making the case for Climate Services as a relevant Farmer Livelihood support strategy under a changing climate is a pre-requisite. In 2014, we'll develop and test relevant tools to co-design with farmers climate services that address their information needs, as well as assess the added-Value and impact of Climate Services utilization on farmer livelihoods across 3 CCAFS sites in EA, SA and WA, with: 1) Participatory design of context-specific and gender-responsive M&E protocol to evaluate concrete results/transformation from farmer use of Climate services; 2) Collection of Baseline data against which to measure impact, with synthesis of traditional local knowledge climate indicators and knowledge gaps. From this research will emerge a clearer understanding of the decision-making context and climate as well non-climate related constraints under which farmers, notably female farmers, operate, and the pathways through which climate services can impact on/improve the latter decisions , if at all.

Status: Cancelled. This activity was canceled because the PIs resigned.

Gender Component: Differential impacts of climate change and variability on women and male farmers will be collected in the baseline across target CCAFS sites where Climate Services research will be conducted. M&E protocol and tools developed to measure impact of Climate Services on farmer livelihoods will be gender-responsive in nature, assessing the differential baseline knowledge and information access of male and female farmers in the community, in order to test and promote appropriate communication channels and institutional setups that reach smallholder farmers equitably with climate information and advisory services.

Objectives:

1. Continue development of relevant, context-specific and gender-responsive tools and indicators to assess added-value of climate services use on farmer livelihoods
2. Test climate services evaluation tools across three CCAFS sites in EA, SA and WA
3. Collect baseline data against which to measure impact of climate services in three sites across WA, EA an SA, with synthesis of traditional local knowledge climate indicators and knowledge gaps
4. Continue working with community of practice across CGIAR centers on impact assessment of Climate Services for resource-poor farmers under a changing climate

Deliverables:

Description	Type	Year	Status	Justification
Gender-responsive M&E tool to assess progress and evaluate concrete results/transformation from farmers' use of Climate services	Platforms - Data Portals for disseminati on	2014	On going	
Baseline data against which to measure impact of climate services in three sites across WA, EA an SA, with synthesis of traditional local knowledge climate indicators and knowledge gaps	Data	2014	On going	
Peer-reviewed journal article on gender-responsive context-specific methods to evaluate Climate Services for farmers	Peer-reviewed journal articles	2014	On going	
Community of practice within ICRISAT an across CGIAR centers around impact assessment of Climate Services on ressource-poor farmers under a changing climate	Capacity	2014	On going	

Partners:

1- World Agroforestry Centre (ICRAF):

2- Kenya Agricultural Research Institute (KARI):

3- Kenya Meteorological Department (KMD):

4- Agence National de l'Aviation Civile et de la Météorologie (Senegal) (ANACIM):

5- Institut de l’Environnement et de Recherches Agricoles (INERA):

6- India Meteorological Department (IMD):

Location(s):
Countries: Burkina Faso, India, Kenya, Senegal,
Benchmark Site: Nyando (Katuk Odeyo), Yatenga (Tougou), Kaffrine,

Activity 890-2014

Designing climate-smart landscapes in dryland areas using the CCAFS site of Makueni as a pilot: Intensification of crop production through the introduction of climate smart agricultural practices linking to smart livestock management (ILRI, ICRAF, CIFOR)

Status	Complete	Milestone	3.3.1 2014
Start date	2014 Jan	End date	2015 Dec

Description: This component will assess, including costs and value of benefits, climate smart practices such as management of planting dates, soil fertility improvement, dryland crop and variety choices, intercropping, alternative crop rotations and targeted use of mineral fertilizers (e.g. micro-dosing) and manure. This will include participatory trials to evaluate grain and crop residue production with the potential to feed livestock. Crops common in the Makueni site include maize, sorghum, pigeon peas, cowpeas, and greengrams and preliminary analysis of baseline household data suggests that there is considerable potential for Sustainable Intensification at this site. This project will assess potential for utilization of manure and mineral fertilizers to recover degraded (or non-responsive) cropland soils, while at the same time investigating environmental impacts such as nutrient leaching and dispersal or changes in soil C stocks and GHG fluxes. Since landscape changes are the aggregate of individual household decisions, attention will be paid to the type and scale of incentives associated with improved technologies and their influence on household decision making. Tradeoffs between various livelihood strategies and tactics will be evaluated in this context.

Status: Complete. This the PhD study that Anthony Oyoo started beginning of 2014. Some data have been collected (see deliverables), analysis is ongoing. This project has no continued funding in next phase of CCAFS and unfortunately has to phase out.

Gender Component: Not defined

Objectives:
1. Participatory testing of climate smart practices for their potential to sustainably increase crop production while integrating better with livestock

Deliverables:

Description	Type	Year	Status	Justification
Results from participatory trials (yields of crops and residues, soil nutrient and carbon analyses,…)	Data	2014	On going	
Demonstrations of climate smart practices with farmer organization	Workshop	2015	Incomplete	
PhD thesis	Peer-reviewed journal articles	2017	Incomplete	
Refereed publication demonstrating greater understanding of the potential for, and process of, Sustainable Intensification in rural, rainfed communities.	Peer-reviewed journal articles	2015	Incomplete	
	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	Complete	

Partners:

1- International Livestock Research Institute (ILRI):
Klaus Butterbach-Bahl <k.butterbach-bahl@cgiar.org>

2- Center for International Forestry Research (CIFOR):
Mariana Rufino <m.rufino@cgiar.org>

Location(s):

Countries: Kenya,
Benchmark Site: Makueni (Wote),

Activity 891-2014

Assessment of greenhouse gas (GHG) emissions from maize-chickpea cropping systems in the semi-arid tropics

Status	On going	Milestone	3.3.1 2014
Start date	2013 Jan	End date	2015 Dec

Description: Agriculture contributes significantly to anthropogenic emissions of greenhouse gases e.g. carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Information on GHG fluxes throughout the day and night from semi-arid agricultural systems is still limited. Assessment of GHG emissions from agricultural fields in the semi-arid tropics has become a major research area due to the significant impact on increasing atmospheric temperature vis-a-vis climate change. Emissions of these gases may occur either directly during cultivation practices or indirectly during the production and transport of agricultural inputs. Successful development and implementation of mitigation strategies for GHGs require a clear cut understanding of the effects of agricultural practices on fluxes of these gases and their control mechanisms.

Status: On going. This activity will be completed in the 2nd week of May 2015 with the end of dry season fallow (maize-legume-dry season fallow system). The project received bridging funding (FP 3 SA) for 2015 to complete this activity. (ICRISAT quantification and mitigation of greenhouse gas emissions-2015).

Greenhouse gas emissions were quantified from maize-legume-dry season fallow systems in Telangana, India using an automated chamber sampling system. The system allows sub-daily (n=8) datasets of N2O, CH4 and CO2 fluxes to be collected from 12 pneumatically operated static chambers, together with high resolution rainfall, temperature and soil moisture data. Twelve automated chambers were installed in the maize-chickpea rotation from June 2013 to May 2014, and were moved to the same treatments in the maize-pigeonpea rotation from the 30th May 2014 to February 2015 (ongoing). Three replicate chambers were placed in each of the following treatments: Conventional tillage: all crop residues added (CT CR), Conventional tillage: no crop residues added (CT ZR), Minimum tillage: all crop residues added (MT CR) and Minimum tillage: no crop residues added (MT ZR).

Over 58, 000 fluxes of N2O, CO2 and CH4 have been collected and analysed from the 6th June 2013 to the 15th February 2015. Rainfall over the 2014-15 crop rotation (ongoing) was less than a third of the 1142 mm recorded in 2013-14 rotation. As such, losses from the 2014-15 year were only half to a third of emissions from 2013-14 due to the greatly reduced rainfall. Cumulative N2O emissions over the 20 months of measurement were generally low, with highest losses of just over 1 kg N from the MT treatment with residues returned. A significant influence of tillage was observed with the MT treatments emitting 55-60% higher N2O than the respective CT treatments. No significant difference in emissions following residue application was observed but losses tended to be higher from the treatments receiving crop residues. Highest losses were from the maize 2013 crop which represented

45-55% of total emissions over the 20 month experiment.
Highest daily CO2 emissions from the experiment of over 50 kg CO2-C day-1 where observed during late December 2013 when the measurements included respiration from the mature chickpea plants as well as the soil. Highest emissions were recorded in the MT CR treatment, followed by the MT ZR, CT CR and CT ZR respectively. Significant differences ($P < 0.05$) in cumulative CO2 emissions were only recorded between the MT CR and CT ZR treatments. But CO2 emissions were quite low from 2014-15 rotation, with cumulative emissions (on-going) almost half of the 2013-2014 rotation.

Gender Component: Not defined

Objectives:

1. To generate high quality GHG datasets for the first time from semi-arid tropical maize-chickpea cropping systems
2. To evaluate the impact of different tillage and crop residue management practices on GHG emissions
3. To find out fertiliser emission factors from semi-arid tropical maize-chickpea rotation
4. To examine the influence of rainfall and temperature on GHG emissions

Deliverables:

Description	Type	Year	Status	Justification
Quantified information on GHG emissions throughtout the year for the first time from Indian semi-arid tropics	Data	2014	On going	Datasets from dry season fallow-2015 (on-going) is yet to be included (up to 2nd week of May 2015) into the single database (Semi-arid Tropical Dryland Cropping Systems GHG Emission Datasets 2013-15).
International journal research papers on: i) GHG emissions from maize-chickpea rotation in the semi-arid tropics ii) Influence of rainfall and temperature on GHG emissions	Peer-reviewed journal articles	2014	On going	Manuscript is still under preparation (GHG emissions data from dry season fallow 2015 to be included).
Improvements in modelling of GHG emissions in the semi-arid tropics	Capacity	2014	On going	Capacity building (please see below) has already done on different aspects to improve modelling of GHG emissions. However, one training programme which was supposed to be undertaken during 22-26 September 2014 was delayed until 23-27 March 2015. Conference Abstracts published in 2014. Hai Nguyen Trung, Merv E. Probert, Anthony M. Whitbread (2014). Modeling Carbon and Nitrogen Mineralisation from Diverse Crop Residues Measured from Incubation Studies. 20th World Congress of Soil Science 2014.6, 313-313, June 8-13, 2014, Jejo, South Korea. (http://www.dbpia.co.kr/Journal/ArticleDetail/3477371). Dewi, E., R., Hueso, S., Whitbread, A. (2014). The dynamics of residue decomposition under aerobic and anaerobic systems. In: Book of Abstracts, Tropentag 2014, September 17-19, Czech University of Life Sciences, Prague, Czech Republic.

Partners:

1- Queensland University of Technology (QUT):
David William Rowlings <d.rowlings@qut.edu.au>

Location(s):

Countries: India,

Activity 892-2014

Towards the co-production of socio-economic scenarios, representative agricultural pathways, disaggregated food security assessments, and climate-smart services at the district scale: activating citizen science in support of national adaptation

Status	On going	Milestone	4.2.1 2015 (1)
Start date	2014 Jan	End date	2017 Dec

Description: Agricultural and development organizations have long recognized the importance of addressing climate-related challenges for rural farmers. Yet, the design of programs to address these challenges have often been top-down, driven by the predictions and capacities of the climate science community. Uncovering and incorporating local knowledges and needs has been secondary to this process, resulting in design processes that often fail to address critical requirements for targeted constituencies, and fail to realize the potential of local knowledge in achieving development goals.

Involving a diverse set of local actors and their knowledge is critical to the achievement of development goals, including improving rural incomes and achieving food security at community, state, and regional levels. This requires new design processes through which actors ranging from development donors to agricultural and climatological institutions to farmers co-produce relevant, actionable knowledge and climate smart services to meet this wide range of goals. In this activity, we propose to develop and test an alternative consultative process for climate service design including various co-learning activities around weather, climate, and agricultural practice. These co-learning activities will build the capacity of farmers, communities and districts to visualize and inhabit alternative futures (scenario planning), translate them into quantitative outcomes with locally valid adaptation packages (representative agricultural pathways), critically review disaggregated climate, crop and food security outlooks and policy instruments, and to relate such capacity to their own agricultural observations through farmer-led experiments.

Status: On going. This is the policy/stakeholder dimension of the AgMIP project (reported under activity 338-2014). Socio-economic scenarios (RAPs, Representative Agricultural Pathways) have been developed in several stakeholder workshops in WA, EA and SA. AgMIP regional research teams have been using the RAPs in combination with integrated assessment tools/models to simulate potential impacts of climate change on agricultural systems and feasible adaptation packages.

Gender Component: Feasible adaptation packages are tested with a gender and social differentiation dimension

Objectives:

1. Strengthening local capacity for strategic foresight and policy guidance through district-level scenario visioning workshops and public review of policy instruments and disaggregated science products
2. Develop training modules and curricula on methods and tools for integrated climate change assessment at Universities of Eastern, Southern and West Africa
3. Testing the comparative advantages of devoluted weather data collection networks (relying on farmer-operated raingauges, semi-automated sensor networks such as e-buttons) vs. automated weather stations

Deliverables:

Description	Type	Year	Status	Justification
A seminal Community of Practice is established across a network of district stakeholders including local government officials, locally active CBOs, FOs, NGOs, private sector, research, extension, and national policy makers in at least 3 countries of West (1), East (1) and Southern (1) Africa	Capacity	2014	On going	AgMIP phase II is ongoing and focuses a lot more on stakeholder involvment
A series of scenario visioning workshops, integrated assessment dissemination and policy and disaggregated science product review events is organized in at least 9 districts in West, East and Southern Africa	Workshop	2014	On going	Several stakeholder workshops were held during 2014: http://www.agmip.org/agmip-workshop-reports/
Data and information products on disaggregated climate projections, sensitivity of current production systems, plausibility of representative agricultural pathways and adaptation portfolios, impacts of climate change on future production systems and food security are available for 9 districts in West, East and Southern Africa	Data	2014	On going	AgMIP II ongoing
Papers published on integrated assessments of climate change impacts on agriculture and food security at sites in West, East and Southern Africa	Peer-reviewed journal articles	2014	On going	Peer reviewed book with AgMIP regional integrated assessments is in press: Hillel, D. and Rosenzweig, C. Handbook of Climate Change and Agroecosystems. The Agricultural Model Intercomparison and Improvement Project (AgMIP) Integrated Crop and Economic Assessments. ICP Series on Climate Change Impacts, Adaptation, and Mitigation Vol. 4. Imperial College Press, in press

Description	Type	Year	Status	Justification
Dissemination material for disaggregated science products developed and standardized and shared with partners at the district level (e.g. agro-climatic diagnostic briefs)	Articles for media or news (radio, TV, newspapers, newsletters ,etc.)	2014	On going	Information will be disseminated and communicated during stakeholder workshops in 2015
Academic curricula incorporating standard AgMIP and GYGA tools and methods at 3 universities in West (1), East (1) and Southern (1) Africa	Capacity	2014	On going	

Partners:

1- Mekelle University:
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19- Institut de l'Environnement et de Recherches Agricoles (INERA):
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24- CGIAR Research Program on Integrated Agricultural Production Systems for Dry Areas (CRP1.1):
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25- Agricultural Model Intercomparison and Improvement Project (AgMIP):
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Location(s):
Countries: Burkina Faso, Ghana, Mali, Niger, Nigeria, Senegal, Bangladesh, India, Malawi, Mozambique, South Africa, Zambia, Zimbabwe,
Benchmark Site: Makueni (Wote),

Regions: East Africa (EA),

Activity 893-2014

Collect and analyze bio-physical and household survey data from CCAFS sites, ICRISAT sites, ICRISAT village level studies in India and WA, and AgMIP project sites for integrated assessment of climate change impact and adaptation with the Tradeoff Analysis model TOA-MD (regional) and IMPACT (global)

Status	On going	Milestone	4.2.1 2015 (1)
Start date	2011 Jan	End date	2015 Dec

Description: AgMIP, in collaboration with CCAFS and other related initiatives, is establishing an integrated, trans-disciplinary framework for assessing climate impacts on the agricultural sector while building capacity for continuing agricultural assessment and management in developing countries. The goals of AgMIP are to improve substantially the characterization of risk of hunger and food security due to climate variability and change, and to enhance adaptation capacity in both developing and developed countries.

Status: On going. Reported in activities 338-2014 and 892-2014

Gender Component: Not defined

Objectives:
1. Incorporate state-of-the-art climate products as well as crop and agricultural trade model improvements in coordinated regional and global assessments of future climate impacts

2. Include multiple models, scenarios (Representative Agricultural Pathways, RAPs), locations, crops and participants to explore uncertainty and impact of data and methodological choices
3. Collaborate with regional experts in agronomy, economics, and climate to build strong basis for applied simulations addressing key climate-related questions
4. Improve scientific and adaptive capacity for major agricultural regions in the developing and developed world
5. Develop framework to identify and prioritize adaptation strategies

Deliverables:

Description	Type	Year	Status	Justification
Participatory stakeholder and training workshops conducted, including scenario/RAPs development.	Workshop	2014	On going	
TOA-MD set up for CCAFS, ICRISAT and AgMIP sites	Platforms - Data Portals for dissemination	2014	On going	
Links made with IMPACT model (global)	Platforms - Data Portals for dissemination	2014	On going	
Papers published on climate change impacts and adaptation (regional and global)	Peer-reviewed journal articles	2014	On going	

Partners:

1- Oregon State University (OSU):
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2- University of Cape Town (UCT):
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3- AGRICULTURAL RESEARCH COUNCIL (ARC):
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4- Universidade Eduardo Mondlane (UEM):
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Location(s):

Countries: India, Mozambique, Zimbabwe,

Benchmark Site: Makueni (Wote),

Regions: East Africa (EA),

Activity 894-2014

Assess the impact of changing socio-economic conditions and climates on production of dryland crops, prices, food availability and nutritional security in the semi-arid regions of Africa and Asia using an integrated modeling approach (linked with CRP2, AgMIP, ILRI).

Status	On going	Milestone	4.3.3 2014
Start date	2013 Jan	End date	2014 Dec

Description: In face of increasing variablity of socio-economic conditions (liberalizationof trade and markets, urbanization, population and income growth etc.) and biophysical environment (e.g. climate change, land degradation, water scarcity, etc.), dryland crops (Sorghum, millets, groundnut, chickpea and pigeon pea) have remained an important mainstay of food economies in the semi-arid tropical countires of Africa, Asia and Latin America. the relative hardiness of staple dryland cereals and legumes has made it possible to provide livelihood opportunities for growing popualtions under harsh and incrasingly mariginal environment under changing climate. These crop play an important part in maintaining availability of food and feed resources that help diversify prodcution into livestock and create opportunities for risk environment and income growth. Despite this curcial role, much less is know about the potential impacts of cliamte change and globalization on future of dryland crop especially on production, prices, food availability and nutritional security in the semi-arid regions of Africa and Asia. This activity will answer the question like what are the alternative futures and outlooks for dryland cereals and grain legumes under changing climate and socio-economic scenarios? The global integrated model framework of IMPACT is used to examine such issues and look at the possible adaptation strategies the developing countries might undertake to cope the changing climate scenarios. This model will also integrate the high resolution climate change impact results from spatial crop model of dryland crops in to economic model to assess the impact of climate on production, prices and food security level in the semi-arid regions of Asia and Africa.

Status: On going. In 2014 we completed the assessment of climate change impacts on sorghum and chickpea crop yields using the crop model and integrated the results to global economic model - IMPACT 3 to assess the plausible future of those crop in different climate scenarios.

Gender Component: Not defined

Objectives:

1. The future outlooks for dryland crops under changing climate will be examined through changes in projected supply, trade and prices under baseline and alternative climate and socioeconomic scenarios
2. Assess the povery related effects of alternative changing climate in SAT regions of Africa and Asia will be captured through projected outcomes on child malnutrion and per captia calorie intake

Deliverables:

Description	Type	Year	Status	Justification
The different scenarios results will be documented and published in the web portal for easy access and retrieval	Data	2014	Complete	
Research report on Climate change impact on dryland agriculture and food security in SAT regions	Peer-reviewed journal articles	2014	Complete	
A policy brief on climate change impacts and its implication on dryland agriculture in Asia and Africa	Articles for media or news (radio, TV, newspapers, newsletters ,etc.)	2014	On going	
Climate change impacts and potential benefits of drought and heat tolerance in chickpea in South Asia and East Africa	Peer-reviewed journal articles	2014	Complete	
Presented a paper in 8th International Asian Society of Agricultural Economists Conference, Viability of Small Farmers in Asia, 15-17th October 2014, Savar, Bangladesh.	Presentations	2014	Complete	

Partners:

1- International Food Policy Research Institute (IFPRI):
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2- Agricultural Model Intercomparison and Improvement Project (AgMIP):
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Location(s):

Countries: Burkina Faso, Ghana, India, Mali, Niger, Nigeria,

Regions: East Africa (EA),

Activity 1024-2014

Testing and promotion of effective communication methods and formats for presenting climate information, including seasonal climate forecasts in the CCAFS site in Kenya (Makueni).

Status	Complete	Milestone	2.1.3 2014
Start date	2013 Aug	End date	2015 Jul

Description: Over the last 3-4 years, ICRISAT has worked with groups of farmers to help: 1) interpret the forecasts using simple means of expressing probability of different amounts of rainfall occurring; and 2) exploring (using participatory approaches with and without crop models) the likely effects of different crop and farm management decisions. This worked well with farmers but there were some recommendations from this research which this study project seeks to implement including the following:

(i) Enhanced capacity of extension staff so that they can train farmers and facilitate climate variability (and change) coping and adaptation planning. Impart increased understanding and skills on (1) practical implications of climate variability (and change) and (2) appropriate coping and adaptation strategies for smallholder farmers. Extension staff and contact farmers will be capacitated to access/ understand both SCF and “weather-within-climate” information

(ii) Enhanced communication of climate-related information . Packaging SCF with historic climate data (analyses that can be tailored to farmers’ needs so that the probability of weather events that are important to farmers) as well as shorter range forecasts together with the experience of the season as it develops could aid in the provision of relevant climate information. This will integrated with agricultural technologies through Climate Field Schools (CFS)

Status: Complete. This activity was conducted over three seasons involving nearly 600 farmers to test different communication methods to present the probabilistic climate information including seasonal climate forecasts in a way that farmers interpret the same and use it in planning and managing their farms. The methods tested included interpretation and presentation of forecast information in the form of weather based advisories, training and enhancing the capacity to understand and utilize the climate information and training along with advisory. The changes in planning and conducting the farm operations were quantified by conducting surveys before providing the information and after the season. These are also compared with those by a control group that received no information.
The results indicated significant differences between the control and treatment groups in the way they planned and managed the farms. The major differences were observed in the selection of crops and varieties, allocation of land to different crops and use of cash inputs. The forecast information has little or no influences on land preparation, planting and pest management. In the target area, land preparation is generally carried out well before the season starts and dry planting is a common practice. Use of pesticides is also very low. Because of these climate information has no impact on

these operations. In addition, a change in attitude towards climate impacts was also noticed.
The farmers in the treatment groups have understood the value of climate information in planning and managing their farms and the confidence in the information was found to be higher in the third season compared to the first season. Almost all farmers have shown interest to receive the climate information and expressed willingness to pay up to KSh 200 (equivalent to US$ 2.5) per season. The extension system has taken up this service and are currently providing forecast information through mobile network. The extension material prepared (posters and videos) were found to have made significant impact on the way extension officers tried to make farmers understand and utilize climate information. The training material, posters and videos are made available through a blog.
This activity is concluded at the end of 2014 short rain season. The data is currently being subjected to critical analysis and a journal article is under preparation. This is taken up for further testing and scaling up in the Dryland Systems action site in East Shewa in Ethiopia. Additional support is provided to extension office of Wote for further refining the work they are doing especially through mobile services.

Gender Component: Deliberate efforts were made to include women and youth in the program. More than 50% of the farmers involved are from these groups. The women represent two different groups. The women who are the household head and the women who are a member of the men headed households. The changes to the initial plans between and men and women headed households are mainly observed in the selection of crops, women preferring short duration legumes. No major differences were observed in valuing the information or willingness to pay.

Objectives:

1. To enhance the capacity of Agricultural and Technical Extension Service of the Ministry of Agriculture and contact farmers to understand both SCF and “weather-within-climate” information in semi arid Kenya, for improved decision making in farm management.
2. To scale up the use of weather related information, including SCF to farmers, through a combination of participatory dissemination workshops, through climate field schools, and the use of information and communication technologies (ICTs).

Deliverables:

Description	Type	Year	Status	Justification
Annual project report with analysis of the impact of seasonal forecasts on farmer's management practices	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	On going	Compilation of survey reports and summarizing the available information was delayed due to farmer availability for surveys and some crops going beyond August. However, the field work is complete now and analysis and preparation of the report is in progress.
Submitted journal paper.	Peer-reviewed journal articles	2014	On going	The publication was delayed due to the delays in data compilation and analysis
Curriculum materials.	Non-peer reviewed articles	2014	Complete	
This is the structure of the training manual that was developed based on the experiences form the work carried out under this activity. A full manual is under development.	Research report (i.e. workshop report, consultant's report, discussion paper, project report, student thesis, etc.)	2014	On going	The content and the compilation of the material is completed. Organizing the manual in a proper format is pending. The same will be completed this year.

Partners:

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2- Kenya Meteorological Department (KMD):
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Location(s):

Countries: Kenya,

Benchmark Site: Makueni (Wote),

Activity 1025-2014

Scaling up Climate Services: Enhancing the capacity of intermediaries and communicators (public and private extension services, media, rural radios, NGOs. CBOs and private sector) for communicaticating and applying climate information services , with development of two-way communication platforms and public-private partnerships for sustainable and effective delivery and tailoring of climate services to support farm-level planning, ex-ante decision-making and resilience to climate variability in smallholder agriculture systems across WA, EA and SA.

Status	Cancelled	Milestone	2.3.1 2015
Start date	2014 Jan	End date	2015 Dec

Description: An important component of the agenda to scale up Climate information and advisory Services for farmers in countries is strengthening the capacity of public and private extension and communication networks to serve as the 'missing link' between those who have knowledge on climate/agriculture (national hydrometeorological services and national agricultural) and those whom can use this knowledge to make better informed ex-ante decisions at the farm-level (farmers, pastoralists, fisherfolks and communities at risk from climate shocks), adding to their indigenous know-how. This activity aims to improve communication capacity of climate services, starting in 4 CCAFS sites across EA, WA and SA, by: 1) exploring feasibility of public-private partnerships to communicate climate services at scale, involving private telecommunication companies, learning form the pioneering experience of India/South Asia; 2) Training of intermediaries to understand and communicate climate services at scale, and serve as a missing link between knowledge providers and communities at risk; 3) Developing best practice tools and methods to train intermediaries to communicate climate services for farmers. Completion of the above activites will go a long way towards developing CCAFS' strategy 2.3 to scale up climate information and advisory services for farmers in Africa and South Asia.

Status: Cancelled. Duplication of activity 888-2014

Gender Component: Not defined

Objectives:

1. Continue development of relevant innovative tools and methods to train intermediaries to communicate climate services at scale.
2. Test models to communicate climate services at scale in 4 CCAFS sites in EA, SA and WA, with development of two-way communication platforms in partnership with telecommunication companies, learning from the experience of India/South Asia.

3. Continue working with community of practice across CGIAR centers on communication of Climate Services at scale for resource-poor farmers under a changing climate across Africa and South Asia

Deliverables:

Description	Type	Year	Status	Justification
Gender-responsive M&E tool to assess progress and evaluate concrete results/transformation from farmers' use of Climate services	Platforms - Data Portals for disseminati on	2014	On going	
Baseline data against which to measure impact of climate services in three sites across WA, EA an SA, with synthesis of traditional local knowledge climate indicators and knowledge gaps	Data	2014	On going	
Peer-reviewed journal article on gender-responsive context-specific methods to evaluate Climate Services for farmers	Peer-reviewed journal articles	2014	On going	
Community of practice within ICRISAT an across CGIAR centers around impact assessment of Climate Services on ressource-poor farmers under a changing climate	Capacity	2014	On going	

Partners:

1- International Livestock Research Institute (ILRI):

2- Kenya Agricultural Research Institute (KARI):

3- Kenya Meteorological Department (KMD):

4- Agence National de l'Aviation Civile et de la Météorologie (Senegal) (ANACIM):

5- Institut de l’Environnement et de Recherches Agricoles (INERA):

6- India Meteorological Department (IMD):

7- Nepal Development Research Institute (NDRI):

8- Ministère de l'Agriculture et de l'Equipment Rural:

Location(s):

Countries: India, Kenya, Senegal,

Benchmark Site: Nyando (Katuk Odeyo),

2. Succinct summary of activities and deliverables by Output level.

Output: 1.1.1

Summary: Activity 884-2014

Addressing climate variability and climate change consequences on crops drought/heat adaptation
Seed setting was tested under a gradient of temperature and humidity conditions in a selection of pearl millet and chickpea (i-Legume) genotypes, to generate coefficients to develop crop simulation model that are "CC-aware" (APSIM for pearl millet, i-Legume for chickpea). Reference collections of germplasm in different species were assessed to identify variants for the capacity of restricting transpiration under high VPD conditions (mainly chickpea & pigeonpea) and develop model input coefficients related to this trait. The link between the VPD response trait and high TE within the germplasm was assessed in lysimetric trials. Crop model simulations were run and developing maps were developed representing traits effects (response/heat response) on yield across crops/regions and giving a probability of success. The details of this study are now published in Functional Plant Biology.

Output: 1.2.1

Summary: Activity 338-2014

Conduct integrated assessments of climate change impacts on agricultural systems and food security using AgMIP protocols and simulate benefits of plausible adaptation packages at representative sites in EA, Saf, WA.
Comprehensive assessment of climate change impacts on smallholder farming systems was conducted in Eastern and Southern Africa (DFID under the AGMIP project coordinated by Columbia University). The target areas in eastern Africa include Embu county in Kenya, Wami basin in Tanzania, Adama and Adugodem woredas in Ethiopia and Hoima and Masindi districts in Uganda. Observed climate data for 23 locations from the target areas for the period 1980-2010 was collected and analysed for variability and trends. Location specific downscaled climate scenarios were generated for 20 CMIP5 GCMs for mid century (2040-69) and end century (2070-99) periods under RCP 4.5 and 8.5. In all the target areas, surveys were conducted to identify and define the farming systems in a way that can be integrated with crop simulation models. Impacts on maize crop was assessed using crop simulation models APSIM and DSSAT by setting up more than 1500 farm systems with varying climate, soil and management conditions to capture the full diversity of the systems. Using the experimental data, the models were calibrated to simulate 10 different varieties that are widely grown in the target areas. Some highlights: (i) No clear trend is discernible from the historical records of annual and seasonal rainfall; (ii) An increase in the CV of seasonal rainfall is observed when computed for 10 year moving periods (iii) The changes in temperature and rainfall in the downscaled scenarios are in agreement with the trends observed in the large scale predictions for eastern Africa reported by IPCC (iv) In several areas in Eastern Africa, a significant increase in rainfall was predicted by most GCMs; (v) An increase in the potential and farmer yields was observed in many agro-ecologies mainly due to an increase in rainfall and the temperatures remaining in the optimal

range even with the projected increase in temperature (vi). The direction and magnitude of impacts of projected changes in climate on crop growth and performance was influenced by both the current climate and the management practices employed. For example in Kenya, significant decline in yields was observed in systems using Katumani variety, higher fertilizer nitrogen and low plant populations (vii) To a large extent the negative impacts can be minimized and opportunities can be capitalized by deploying the available varieties and adjusting the management practices employed by smallholder farmers; (viii) Adaptation strategies identified from this analysis indicate that a 2-3 fold increase in productivity is possible in many agro-ecologies even under climate change.

Options improving crop and livestock production and climate change adaptation were tested for different types of smallholder farming systems in Zimbabwe, full application of AgMIP Regional Integrated Assessment. Early results showed that incremental changes in fertilizer application rates, use of adapted crop cultivars or introduction of forage production only contribute to modest income gains, and are insufficient for substantial improvement of the majority of smallholder livelihoods. This motivated the testing of more drastic systems reconfigurations, including technical, institutional and policy options. For extending the full RIA, biophysical and socio-economic parameters and approaches were compiled for the sites in Malawi and Mozambique, including representative agricultural pathways, generating climate change adaptation packages with stakeholders and multi-model components.

Activity 883-2014

Developing most appropriate protocols, geospatial analysis, and crop simulation models in yield gap assessment at local, regional, and global scales for assessment of current and future food security and potential for sustainable intensification.

The Global Yield Gap Atlas is now fully functional on www.yieldgap.org. Methodologies, protocols and data are well documented and publicly available (except weather data due to IP issues). The project provided the first scientifically credible estimates of yield gaps and yield stability of major cereal crops for the most important rainfed and irrigated production zones in 10 SSA countries and Bangladesh. This assessment allows identification of those regions with greatest opportunities for sustainable intensification due to existence of large rainfed yield gaps and low variability in potential yields due to drought, which means low risk and high potential returns from investments in yield-enhancing technologies. For example, many, but not all, maize growing regions in Ethiopia and Nigeria appear to have tremendous potential for sustainable intensification based on those criteria. The GYGA website (www.yieldgap.org) is widely used as indicated by visitors from 60+ countries in the period Jan 1 to 8 April 2014, with an average of 30 visitors and 100 page views per day. The yield gap analyses performed under the GYGA project identified rootzone depth as one of the most sensitive variables governing the magnitude of water-limited (rainfed) yield potential, yield gap, and yield stability in SSA and yet there is very little data available for this parameter. The project continues in 2015 as a CCAFS ‘bridging project’.

Activity 885-2014

Assessing the effects of climate change on pest population dynamics.

Climate change has a major bearing on the host plant resistance against insect pests. In order to study the effect of climate change on the on expression of resistance/susceptibility to insect pests in

pigeonpea and chickpea, five genotypes were grown under field conditions over four planting dates during the 2013/14 rainy seasons. In pigeonpea, temperature and relative humidity showed a considerable effect on insect incidence and diversity across planting dates on different genotypes. Under severe incidence of pod borers during Sept - Oct, all the genotypes suffered heavy pod borer damage. In chickpea, incidence of H. armigera decreased from October to December sowings, but increased in the January sowing. Population of H. armigera larvae was negatively correlated with open pan evaporation, temperature (both maximum and minimum), wind velocity, solar radiation and sunshine hours, but positively correlated with RH, except in ICCV 10.
To develop appropriate pest management strategies, it is important to understand geographical distribution of insect pests and their population dynamics across seasons. Analysis of S. litura pheromone trap data over two decades indicated large year-to-year variation in the population. There was a cyclic variation in pest incidence across the years. Pest surveillance data can be used to predict outbreaks of S. litura.

Output: 2.1.1

Summary: Activity 886-2014

Climate change and Disease and Pest dynamics: Effect of groundnut water stress and plant nutrients on aphid (Aphis craccivora) infestation, development and groundnut rosette disease transmission in the semi-arid tropics.
Groundnut is an important legume crop in SSA, providing protein, numerous vitamins and a source of oil. However, its production is constrained by Groundnut Rosette Disease (GRD), known as the most important viral disease of groundnut. Transmitted by the common aphid, Aphis craccivora Koch, GRD epidemics are known to cause up to 100% yield losses (Naidu et al., 1999). Increases in drought associated with climate change could increase the frequency and severity of insect population outbreaks and occurrence of disease epidemics. It is imperative to understand the effects of drought on plant aphid population; GRD transmission and groundnut yield performance. This study/experiment aimed to understand the effect of drought and low nutrients stress on population dynamics of Aphis craccivora and the transmission of rosette disease in groundnut. Our result indicates that water stress combines with low-phosphorus conditions could affect development of aphid and thus rosette disease on varieties sensitive to aphids. With the current breeding programs the trends is to develop drought and low P tolerant groundnut varieties. It is then necessary to also include host plant resistance to aphids/rosette traits.

Output: 2.1.3

Summary: Activity 1024-2014

Testing and promotion of effective communication methods and formats for presenting climate information, including seasonal climate forecasts in the CCAFS site in Kenya (Makueni).
This activity was conducted over three seasons involving nearly 600 farmers to test different communication methods to present the probabilistic climate information including seasonal climate forecasts in a way that farmers interpret the same and use it in planning and managing their farms. The methods tested included interpretation and presentation of forecast information in the form of

weather based advisories, training and enhancing the capacity to understand and utilize the climate information and training along with advisory. The changes in planning and conducting the farm operations were quantified by conducting surveys before providing the information and after the season. These are also compared with those by a control group that received no information. The results indicated significant differences between the control and treatment groups in the way they planned and managed the farms. The major differences were observed in the selection of crops and varieties, allocation of land to different crops and use of cash inputs. The forecast information has little or no influences on land preparation, planting and pest management. In the target area, land preparation is generally carried out well before the season starts and dry planting is a common practice. Use of pesticides is also very low. Because of these climate information has no impact on these operations. In addition, a change in attitude towards climate impacts was also noticed. The farmers in the treatment groups have understood the value of climate information in planning and managing their farms and the confidence in the information was found to be higher in the third season compared to the first season. Almost all farmers have shown interest to receive the climate information and expressed willingness to pay up to KSh 200 (equivalent to US$ 2.5) per season. The extension system has taken up this service and are currently providing forecast information through mobile network. The extension material prepared (posters and videos) were found to have made significant impact on the way extension officers tried to make farmers understand and utilize climate information. The training material, posters and videos are made available through a blog. This activity is concluded at the end of 2014 short rain season. The data is currently being subjected to critical analysis and a journal article is under preparation. This is taken up for further testing and scaling up in the Dryland Systems action site in East Shewa in Ethiopia. Additional support is provided to extension office of Wote for further refining the work they are doing especially through mobile services.
Activity 887-2014

Testing and promotion of effective communication methods and formats for presenting climate information, including seasonal climate forecasts, tailored to the end user needs in three sites across EA and SA.
This activity is partially complete.
-Capacity building of extension staff in AGRITEX so that they can train farmers and facilitate climate variability (and change) coping and adaptation planning has been done.
-15 Climate Field Schools established and seasonal forecasts (and weather updates through sms) have been delivered in 2014/15 seasons in Hwange district of Zimbabwe.
-Household surveys to be used to ascertain benefits of using climate information and these will be done in April after the 2014/15 season.
-The study should be complete and written up by July 2015.

Activity 889-2014
Participatory testing of gender-responsive M&E protocol to design, monitor and evaluate concrete outcomes from farmers' use of Climate services in three sites across WA, EA an SA.
This activity was canceled because the PIs resigned.

Output: 2.3.1

Summary: Activity 1025-2014 & 888-2014

Scaling up Climate Services: Enhancing the capacity of intermediaries and communicators (public and private extension services, media, rural radios, NGOs. CBOs and private sector) for communicating and applying climate information services , with development of two-way communication platforms and public-private partnerships for sustainable and effective delivery and tailoring of climate services to support farm-level planning, ex-ante decision-making and resilience to climate variability in smallholder agriculture systems across WA, EA and SA.

Enhancing extension services and end users capacity to use climate information to cope with impacts of climate variability and change in agriculture. Testing and promotion of effective communication methods and formats for presenting climate information including seasonal climate forecasts tailored to the end user needs.

Output: 3.3.1

Summary: Activity 890-2014

Designing climate-smart landscapes in dryland areas using the CCAFS site of Makueni as a pilot: Intensification of crop production through the introduction of climate smart agricultural practices linking to smart livestock management (ILRI, ICRAF, CIFOR).

This the PhD study that Anthony Oyoo started beginning of 2014 with fellow students at ILRI and CIFOR. Some data have been collected (see deliverables), analysis is ongoing. This project has no continued funding in next phase of CCAFS and unfortunately has to phase out.

Activity 891-2014

Assessment of greenhouse gas (GHG) emissions from maize-chickpea cropping systems in the semi-arid tropics.

This activity (with bridging funding in 2015) will be completed in the 2nd week of May 2015 with the end of dry season fallow (maize-legume-dry season fallow system). The project received bridging funding (FP 3 SA) for 2015 to complete this activity. (ICRISAT quantification and mitigation of greenhouse gas emissions-2015).

A massive dataset describing GHG emissions from a dryland cropping system rotation considering rotation and soil tillage management. This dataset has been collated and analysed in collaboration with researchers from the QUT, Brisbane, Australia and forms the basis of a Journal publication describing automated procedures for monitoring GHG in the field.

Greenhouse gas emissions were quantified from maize-legume-dry season fallow systems in Telangana, India using an automated chamber sampling system. The system allows sub-daily (n=8) datasets of N2O, CH4 and CO2 fluxes to be collected from 12 pneumatically operated static chambers, together with high resolution rainfall, temperature and soil moisture data. Twelve automated chambers were installed in the maize-chickpea rotation from June 2013 to May 2014, and were moved to the same treatments in the maize-pigeonpea rotation from the 30th May 2014 to February 2015 (ongoing). Three replicate chambers were placed in each of the following treatments: Conventional tillage: all crop residues added (CT CR), Conventional tillage: no crop residues added (CT ZR), Minimum tillage: all crop residues added (MT CR) and Minimum tillage: no crop residues

added (MT ZR).
Over 58, 000 fluxes of N2O, CO2 and CH4 have been collected and analysed from the 6th June 2013 to the 15th February 2015. Rainfall over the 2014-15 crop rotation (ongoing) was less than a third of the 1142 mm recorded in 2013-14 rotation. As such, losses from the 2014-15 year were only half to a third of emissions from 2013-14 due to the greatly reduced rainfall. Cumulative N2O emissions over the 20 months of measurement were generally low, with highest losses of just over 1 kg N from the MT treatment with residues returned. A significant influence of tillage was observed with the MT treatments emitting 55-60% higher N2O than the respective CT treatments. No significant difference in emissions following residue application was observed but losses tended to be higher from the treatments receiving crop residues. Highest losses were from the maize 2013 crop which represented 45-55% of total emissions over the 20 month experiment.
Highest daily CO2 emissions from the experiment of over 50 kg CO2-C day-1 where observed during late December 2013 when the measurements included respiration from the mature chickpea plants as well as the soil. Highest emissions were recorded in the MT CR treatment, followed by the MT ZR, CT CR and CT ZR respectively. Significant differences ($P < 0.05$) in cumulative CO2 emissions were only recorded between the MT CR and CT ZR treatments. But CO2 emissions were quite low from 2014-15 rotation, with cumulative emissions (on-going) almost half of the 2013-2014 rotation.

Output: 4.2.1

Summary: Activity 892-2014 & 893-2014
Towards the co-production of socio-economic scenarios, representative agricultural pathways, disaggregated food security assessments, and climate-smart services at the district scale: activating citizen science in support of national adaptation.
Collect and analyze bio-physical and household survey data from CCAFS sites, ICRISAT sites, ICRISAT village level studies in India and WA, and AgMIP project sites for integrated assessment of climate change impact and adaptation with the Tradeoff Analysis model TOA-MD (regional) and IMPACT (global).

This is the policy/stakeholder dimension of the AgMIP project (also reported under activity 338-2014). Socio-economic scenarios (RAPs, Representative Agricultural Pathways) have been developed in several stakeholder workshops in WA, EA and SA (in collaboration with the CCAFS scenario work). AgMIP regional research teams have been using the RAPs in combination with integrated assessment tools/models to simulate potential impacts of climate change on agricultural systems and feasible adaptation packages.
Comprehensive assessment of climate change impacts on smallholder farming systems was conducted in Eastern and Southern Africa. The target areas in eastern Africa include Embu county in Kenya, Wami basin in Tanzania, Adama and Adugodem woredas in Ethiopia and Hoima and Masindi districts in Uganda. Some highlights: (i) No clear trend is discernible from the historical records of annual and seasonal rainfall; (ii) An increase in the CV of seasonal rainfall is observed when computed for 10 year moving periods (iii) The changes in temperature and rainfall in the downscaled scenarios are in agreement with the trends observed in the large scale predictions for eastern Africa reported by IPCC (iv) In several areas in Eastern Africa, a significant increase in rainfall was predicted

by most GCMs; (v) An increase in the potential and farmer yields was observed in many agro-ecologies mainly due to an increase in rainfall and the temperatures remaining in the optimal range even with the projected increase in temperature (vi). The direction and magnitude of impacts of projected changes in climate on crop growth and performance was influenced by both the current climate and the management practices employed. For example in Kenya, significant decline in yields was observed in systems using Katumani variety, higher fertilizer nitrogen and low plant populations (vii) To a large extent the negative impacts can be minimized and opportunities can be capitalized by deploying the available varieties and adjusting the management practices employed by smallholder farmers; (viii) Adaptation strategies identified from this analysis indicate that a 2-3 fold increase in productivity is possible in many agro-ecologies even under climate change.

The AgMIP full Regional Integrated Assessment was completed for the site Zimbabwe, including multi-modeling framework, representative agricultural pathways, generating adaptation packages with stakeholder review; various outputs are available, a book chapter, poster, RIA data files. For Malawi impacts of climate change were assessed, but not yet the benefits from adaptation. Most parameters for completing the RIA in Malawi and Mozambique were assessed.

Output: 4.3.3

Summary: Activity 894-2014

Assess the impact of changing socio-economic conditions and climates on production of dryland crops, prices, food availability and nutritional security in the semi-arid regions of Africa and Asia using an integrated modeling approach (linked with CRP2, AgMIP, ILRI).

In 2014 we completed the assessment of climate change impacts on sorghum and chickpea crop yields using the crop model and integrated the results to global economic model - IMPACT 3 to assess the plausible future of those crop in different climate scenarios.

Capacities were built at ICRISAT and regional NARS partners on crop, livestock and economic modeling, by application of the AgMIP multi-modeling framework, and training of students.

3. Communications.

Media Campaigns:

http://canwefeedtheworld.wordpress.com/2012/09/28/incentives-to-mitigate-climate-change/
http://economictimes.indiatimes.com/environment/developmental-issues/icrisat-identifies-climate-resilient-germplasm-to-support-chickpea-breeding/articleshow/29305893.cms
http://www.thehindubusinessline.com/economy/icrisat-scientists-identify-climate-changeready-chickpea-germplasm/article5614320.ece
http://www.business-standard.com/article/economy-policy/icrisat-identifies-40-germplasm-lines-of-chickpea-114012400684_1.html
http://www.theguardian.com/global-development-professionals-network/2014/jun/04/subsistence-farming-precision-agriculture
http://www.icrisat.org/newsroom/news-releases/icrisat-pr-2014-media5.htm
http://www.icrisat.org/newsroom/news-releases/icrisat-pr-2014-media40.htm
http://www.trust.org/item/20150220084329-y056s/

Blogs:

http://ccafs.cgiar.org/blog/improving-adaptive-capacity-women-farmers-western-kenya#.VCp9zhbkrVG

http://ccafs.cgiar.org/blog/Intercrop-innovations-build-resilience-dryland-areas%2520#.VDeoShbkrVF
http://ccafs.cgiar.org/blog/testing-sorghum-and-cowpea-varieties-increase-farmers%E2%80%99-production-margins-east-africa#.VDepNBbkrVF
http://ccafs.cgiar.org/blog/how-can-sustainable-intensification-make-farming-climate-smart#.VEDv9hbkrVH
http://ccafs.cgiar.org/blog/new-knowledge-sharing-platform-helps-mali-rig-better-defense-against-climate-change#.VL6LehAayK1
http://ccafs.cgiar.org/blog/communicating-behavior-change-how-kenyan-tv-show-changing-rural-agriculture#.U0UOcFfWiFH
http://ccafs.cgiar.org/blog/does-climate-information-matter-innovative-tool-measure-value-climate-services-farmers#.U05ls1fWiFG
http://ccafs.cgiar.org/blog/getting-grips-how-farmers-perceive-climate-variability-and-its-impacts?utm_source=CCAFS+internal+communications+-+Monthly+update&utm_campaign=b766f661ff-Updates_from_CCAFS_January_20141_30_2014&utm_medium=email&utm_term=0_ec2b3f2725-b766f661ff-295588673
http://www.icrisat.org/impacts/impact-stories/Icrisat-impacts-60.htm
http://https://ccafsicrisat.wordpress.com/

Websites:

CALESA project web site: www.calesa-project.net/

AgMIP-Eastern Africa: http://www.agmip.org/eastern-africa
Global Yield Gap Atlas: www.yieldgap.org

Social Media Campaigns:
http://canwefeedtheworld.wordpress.com/2012/09/28/incentives-to-mitigate-climate-change/
http://economictimes.indiatimes.com/environment/developmental-issues/icrisat-identifies-climate-resilient-germplasm-to-support-chickpea-breeding/articleshow/29305893.cms
http://www.thehindubusinessline.com/economy/icrisat-scientists-identify-climate-changeready-chickpea-germplasm/article5614320.ece
http://www.business-standard.com/article/economy-policy/icrisat-identifies-40-germplasm-lines-of-chickpea-114012400684_1.html
http://www.theguardian.com/global-development-professionals-network/2014/jun/04/subsistence-farming-precision-agriculture
http://www.icrisat.org/newsroom/news-releases/icrisat-pr-2014-media5.htm
http://www.icrisat.org/newsroom/news-releases/icrisat-pr-2014-media40.htm
http://www.trust.org/item/20150220084329-y056s/

Newsletters:
http://www.icrisat.org/newsroom/news-releases/icrisat-pr-2014-media5.htm
http://www.icrisat.org/newsroom/latest-news/happenings/happenings1610.htm#5
http://www.icrisat.org/newsroom/latest-news/happenings/happenings1616.htm#3
http://www.icrisat.org/newsroom/latest-news/happenings/happenings1660.htm#1
6th Issue of CALESA news letter: http://www.calesa-project.net/news/the-final-issue-of-the-calesa-newsletter-is-out
5th Issue of CALESA news letter:
http://www.calesa-project.net/news/the-fifth-issue-of-the-calesa-newsletter-is-out

Events:
Several project meetings and workshops, mostly bi-lateral projects, not CCAFS specific.

Videos and other Multimedia:
http://ccafs.cgiar.org/shamba-shape-up#.VOIG2S4nn3h
https://www.youtube.com/embed/ZbVZqDXqCp8
http://www.agmip.org/blog/2014/12/17/southern-africa-livestock-team-video/
http://vimeo.com/114330899; http://www.iicat.org/iicat-biosphere-defense-project/
Experience of using climate information by Anna Mutheu Kyalo a farmer from Wote, Kenya in Swaheli http://youtu.be/2e95KOLCRPc
Experience of using climate information by Emily Mumo Wambua a farmer from Wote, Kenya in Swaheli with english sub-titles http://youtu.be/2XWQ_KFiyEM
Genesis Biblical story on climate variability in five parts. Genesis 1 http://youtu.be/bMtEfyz2v40

Other Communications and Outreach:

Poster on climate terms: https://ccafsicrisat.files.wordpress.com/2015/02/poster_climate-terms.pdf

Sample Agro-advisory: https://ccafsicrisat.files.wordpress.com/2015/02/agro-advisory-nthangu_sr-2013.pdf

GreenPHABLET: http://www.icrisat.org/newsroom/news-releases/icrisat-pr-2014-media40.htm

http://www.thehindubusinessline.com/industry-and-economy/agri-biz/a-greenphablet-for-small-farmers/article6739167.ece

KSIConnect: http://ksiconnect.icrisat.org/ksi-connect/

GreenSIM: http://www.krishigyansagar.com/greensim.pdf

KGS and KV: http://www.krishigyansagar.com/kgs.pdf

4. Case studies.

Case Study #1

Title: The Global Yield Gap and Water Productivity Atlas

Author: Lieven Claessens

Type: Inter-center collaboration; Capacity enhancement; Food security;

Project Description:

This project will provide the first easily accessible, transparent, reproducible, and agronomically accurate web-based platform to estimate exploitable gaps in yield and water productivity for the world's major food crops, enabling farmers, governments, policy makers, agricultural research and extension institutions, funders of agricultural research, foundations, private sector organizations and others to to identify regions with the greatest potential to sustainably increase global food supply with improved management practices.

Introduction / objectives:

Yield gap assessment provides a powerful tool for improving the efficiency of agronomic research and of research prioritization, as well as for strategic planning and policy development to ensure food security at local, national, and global scales. Yet for the major crops and crop-producing regions of the world there are no reliable estimates of yield gaps (Yg) based on robust estimates of rainfed (Yw) and irrigated (Yp) yield potential and of actual yields (Ya). The Global Yield Gap Atlas (GYGA) seeks to rectify this critical deficiency for selected countries in sub-Saharan Africa (SSA) and South Asia (SA).

Project Results:

Outputs from the GYGA project first phase (GYGA-1, 2012-2014) established scientifically robust protocols for estimating Yp, Yw, and Yg (van Ittersum et al. 2013; van Wart et al. 2013a; www.yieldgap.org), a global agro-climatic zonation scheme for upscaling results using local data for climate, soils, and cropping systems to estimates at regional and national scales (van Wart et al. 2013b), and new methods for propagation of long-term weather data specifically developed for yield gap assessment (Van Wart et al under review). Other important outputs and outcomes from GYGA-1

include: (i) a team of yield gap agronomists from 10 target countries in SSA and two in SA who understand data requirements and methods to perform yield gap assessments, and who lead efforts to identify the most suitable sources of data in their countries, (ii) the GYGA website (www.yieldgap.org) with open access to yield gap analyses and underpinning data for these target countries1, (iii) improved coordination and data sharing among major projects with related objectives (CCAFS, AgMIP, HarvestChoice,Global Futures), and (iv) significant influence on global dialogues about constraints to food security and additional funding from other donors and institutions to further develop the GYGA.

Partners:

University of Nebraska, Lincoln, USA; Wageningen University, the Netherlands; CIMMYT; AfricaRice; country agronomists in 10 countries in SSA and 2 in SA.

Links / sources for further information:

www.yieldgap.org

Case Study #2

Title: Go for sorghum, say climate smart Kenyan farmers

Author: Christine Wangari, Lieven Claessens

Type: Successful communications; Capacity enhancement; Participatory action research ;

Project Description:

Semi-arid Wote (Makueni, Kenya) faces a grim food security situation. According to a 2012 report released by the CCAFS, only 2% of the households in Wote were food secure throughout the year. A partnership of research, farmer and private organizations introduced a climate-smart sorghum-legume system to the region through participatory 'mother and baby' trials. The trials were maintained and evaluated by the farmers until harvesting. The farmers were supplied with fertilizer, pesticides and fungicides for experimentation; and they were trained on proper agronomic practices and crop protection. The project has so far reached 366 farmers in Wote, who have adopted the sorghum-legume cropping system. The project seeks to scale out the technologies to more farmers in Wote and Kathonzweni area, by planting more mother trials at Kathonzweni and increasing the baby trials in both areas.

Introduction / objectives:

Wote faces a grim food security situation. According to a 2012 report released by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), only 2% of the households in Wote were food secure throughout the year. Farmers in this area struggle to wrest a meager living from farming as they are adversely affected by drought, a situation made worse by climate change and land degradation. Through participatory trials, a group of partners introduced a sorghum-legume system as a climate smart agricultural practice to Wote.

Project Results:

A group of partners which included the Kenyan Agriculture and Livestock Research Organization (KALRO); the Ministry of Agriculture, Livestock and Fisheries, Government of Kenya; and ICRISAT introduced, through participatory trials, sorghum and two legume crops (cowpea and green gram), with inherent resilience to drought, to improve the livelihoods of poor smallholder farmers. The released sorghum, cowpea and green gram varieties were used for demonstration of different combinations of intercropping and fertilizer use. These varieties were sourced from ICRISAT and KALRO for evaluation in collaboration with the private sector. The project has so far reached 366 farmers in Wote, who have adopted the sorghum-legume cropping system.

Partners:

Kenyan Agriculture and Livestock Research Organization (KALRO); the Ministry of Agriculture, Livestock and Fisheries, Government of Kenya

Links / sources for further information:

http://www.icrisat.org/newsroom/latest-news/happenings/happenings1660.htm#1

http://ccafs.cgiar.org/shamba-shape-up#.VOIG2S4nn3h

Case Study #3

Title: Modeling crop-livestock intensification in Southern Africa in the face of climate change (CLIP)
Author: Sabine Homann-Kee Tui
Type: Innovative non-research partnerships; Policy engagement; Participatory action research ;

Project Description:

This project assesses smallholder mixed crop livestock farming systems under climate change scenarios and adaptation strategies, to identify sustainable intensification pathways and determine the potential impact on food security, income and welfare levels, by integrating multiple climate, crop, livestock and economic simulation models, and observed data, in order to provide more reliable projections and capacitate agricultural research and extension institutions, policy makers and funders of research and development.

Introduction / objectives:

AgMIP provides a framework for trans-disciplinary systems-based approach for regional scale integrated assessment of agricultural systems under future climate, bio-physical and socio-economic conditions. The case study on climate change impact and adaptation options in mixed farming systems of Zimbabwe seeks to contribute to an improved understanding of the impacts of climate change and opportunities through improved crop livestock integration, purposefully for small holder farm households at different levels of resource endowments, in an environment with low and variable rainfall, for future planning in order for agricultural production to meet food demands and contribute to improve rural livelihoods.

Project Results:

AgMIP results phase 1 (2012-2014) used robust protocols for estimating yield and production under climate change scenarios along with the economic trade-offs from commonly promoted adaptations for heterogeneous communities (Antle et al. 2013; Valdivia et al., 2013; www.agmip.org). Results lead us to postulate the need for drastic adaptation packages as follows:

A substantial number of farms lose from climate change (on average 60%), while those adopting selected adaptation packages this reduces to 20%. Low rates of fertilizers and inclusion of forage legume crops may reduce the climate change effects on crop and livestock production. Tested climate change adaptations contribute to modest income gains from intensification and diversification (< 20% increases in farm net returns and per capita incomes). Small farms will make small benefits from climate change adaptations (<200 USD farm net returns); while medium and better off farms can make up to 500 and 1200 USD higher per farm net returns, respectively but face higher risk. Adaptation can shift up to 20% of the large farms to higher welfare levels, but most small and medium size farms will remain below poverty line. This means that for the majority of rural families more drastic solutions have to be sought beyond food security and climate change, and capacitate farmers towards alternative livelihood activities. Future research should explore alternative reconfiguration pathways, as sequences of multiple component innovations.

Other outputs include: (i) teams of NARS and scientists from 3 countries in southern Africa capacitated model use and methods to generate agricultural pathways, cross country dialogue on

climate change adaptation by smallholder farmers, (ii) stakeholder engagement for defining priorities for climate change modelling and feedback; (iii) information for regional dialogues on limitations of incremental change in agriculture and need for more drastic systems interventions in order to achieve substantial improvement on smallholder livelihoods.

Partners:

Wageningen University, Wageningen, the Netherlands
University of Cape Town, Rondebosch, South Africa
Crops For the Future Research Centre, Semenyih, Malaysia
University of the Free State, Bloemfontein, South Africa
Lilongwe University of Agriculture and Natural Resources,Lilongwe, Malawi
Universidade Eduardo Mondlane, Maputo, Mozambique
Oregon State University, Corvallis, OR, USA

Links / sources for further information:

www.agmip.org

5. Outcomes.

Outcome #1:

Promoting use of climate information by smallholder farmers through training and advisories

What is the outcome of the research (i.e. use of research results by non-research partners)?

• Extension workers in Makueni and Machakos counties have a better understanding of probabilistic climate information and are actively promoting its use by smallholders
• Smallholder farmers in the counties are accessing and making use of location specific climate information in planning and managing their farms

What outputs produced in the three preceding years resulted in this outcome?

• Assessing and understanding the farmer perceptions about the climate variability, its impacts on agriculture and the way they adapted to it
• Development of forecast based agro-advisories
• Training manual and material produced to train the farmers and extension agents in understanding and utilizing probabilistic climate information

What partners helped in producing the outcome?

• International Research Institute for Climate and Society (IRI)
• Kenya Meteorological Department (KMD)
• Kenya Agricultural Research Institute (KARI)

Who used the output?

• about 50 agricultural extension officers in the two counties
• About 34,000 farmers accessed the information. It is estimated that at least 50% of them used the information. Most of the people received the information are those who voluntarily sought it based on the awareness created through radio programs

How was the output used?

• Selecting crops and varieties for that season
• Allocation of land for various crops and enterprises including total area cultivated
• Investment on inputs such as improved varieties and fertilizers

What is the evidence for this outcome? Specifically, what kind of study was conducted to show the connection between the research and the outcome? Who conducted it?

Evidence on number of extension officers promoting work based on participation in training/review meetings, number availing extension material and number of places material is displayed.
Evidence for number of farmers using information sourced from records kept by extension officers including division wise numbers of farmers accessing climate information. (www.ccafs-esa.weebly.com).

Outcome #2:

Hundreds of farmers adopting sorghum-legume climate-smart cropping system in semi-arid Kenya

What is the outcome of the research (i.e. use of research results by non-research partners)?

• At least 366 smallholder farmers have adopted a sorghum-legume cropping system as alternative for maize-beans in Wote, Makueni, Kenya

What outputs produced in the three preceding years resulted in this outcome?

• New drought tolerant varieties of sorghum, cowpea and green gram developed by ICRISAT and KALRO in collaboration with the private sector (seed) and released by the government of Kenya.
• Participatory 'mother and baby' trials.

What partners helped in producing the outcome?

• Kenya Agricultural and Livestock Research Organization (KALRO)
• CCAFS East Africa

Who used the output?

• The project reached at least 366 farmers in the Wote area; scaling out to Kathonzweni is foreseen

How was the output used?

• Through participatory trials of different sorghum-legume systems, farmers choose and adopted the Seredo Sorghum – cowpea system as an alternative to maize-beans.

What is the evidence for this outcome? Specifically, what kind of study was conducted to show the connection between the research and the outcome? Who conducted it?

http://www.trust.org/item/20150220084329-y056s/

7. Outcome indicators.

8. Leveraged funds.

There is no Leverage funds

9. Publications.