



RESEARCH PROGRAM ON  
**Climate Change,  
Agriculture and  
Food Security**



**CIMMYT**  
**2013 technical report**

## 1. Activity Reporting

### Activity 541-2013 (Milestone 1.1.2 2013 (1).)

**Title:** Improved resource use efficiency at the farm scale in cereal-based systems in different irrigated agroecologies in response to climatic change and variability in the Indo-Gangetic Plain.

**Status: Partially complete.** On-station trials on current and alternative wheat- and maize-based systems, as well as a large number (over 400) of on-farm trials across the IGP have been implemented and data collected and processed. Cropping systems based on the principles of conservation agriculture show significant advantages over currently practised systems with advantages including: increased productivity, increased water-use efficiency and improved soil fertility as well as improved economic performance as a result of lower production costs and labour saving. Farm household survey data have been analysed and typologies of farm households in relation to their resources, main livelihood activities and agronomic practices developed. A large diversity of farm households exists not only at the IGP level but also within a district. Within each district farm households can be differentiated in terms of their wealth, cropping and livestock systems, off- and on-farm activities, labour allocation and the source of food and cash. This synthesis and formalisation of cropping and farming systems is part of the methodological framework developed for the analysis of scenarios for adaptation to climate change of small scale farmers and are key elements of the delineation of recommendation domains for alternative, climate smart agricultural systems. These data and findings provide the basis for the parameterisation of cropping systems simulation models and the development of resource allocation farming systems models which form part of our main activities for 2014.

**Gender component:**

Gender-responsive surveys will be designed together with the deployment of gender-responsive field methodologies to assess gender-related differences in resource endowment and input allocation (including labour) and decision making. Further details given in output and outcome summaries as gender activities tend to relate to more than one activity.

**Deliverables:**

**Partners:**

ICAR; BARI; NARC; PARC; IRRI; ILRI; IFPRI

**Locations:**

South Asia (SAs)

### Activity 542-2013 (Milestone 1.1.2 2013 (1).)

**Title:** Improved resource use efficiency (e.g. crops and crop rotations, input allocation, crop residues/manure management, P and N fertilisation, tillage system) at the farm scale in cereal based systems in different rainfed agroecologies of East and Southern Africa (e.g. Embu, Machakos, Melkassa, Borana, Usambara, ) (suggested

sites in SA will be Monze Farmer Training Centre, Zambia, Henderson Research Station and Domboshawa Training Centre, Zimbabwe and Sussundenga Research Station, Mozambique; alternative Chitedze Research Station Malawi and Msekera Research Station Chipata).

**Status: Partially complete.** On-station and on-farm trials comparing technologies based on CA for maize- and wheat-based cropping systems in Mexico have been implemented and data is available for analysis and further use in cropping systems model parameterization. CA based systems have shown advantages in terms of the higher and more stable yields and lower costs of production and labour requirements. Widespread uptake of CA systems is taking place in some regions of Mexico where innovative farmers have realised and communicate to others the advantages. Lack of equipment and technical advice, as well as farmers' tendencies to innovate and take risks have been identified as the main barriers to wider adoption of CA based systems. The analysis of farm household survey data has enabled farm typologies to be developed in relation to farm resources, main livelihood activities and agronomic practices. Farm households differentiate in terms of their wealth and potential to invest in agriculture, cropping and livestock systems and their level of integration as well as the intensity of inputs used for cropping systems. This synthesis and formalisation of cropping and farming systems is part of the methodological framework developed for the analysis of scenarios for adaptation to climate change of small scale farmers and are key pieces in the delineation of recommendation domains for alternative, climate smart, agricultural systems. The data, and findings acquired by its analysis provide the basis for the parameterisation of cropping systems simulation models and the development of resource allocation farming systems models which are our main activities for 2014. More participatory approaches might be needed to understand the resources and resource allocation strategies of different farming systems in Mexico and the specific indicators to assess the potential of CA based cropping systems for adaptation to climate change.

**Gender component:**

Gender-responsive surveys will be designed together with the deployment of gender-responsive field methodologies to assess gender-related differences in resource endowment and input allocation (including labour) and decision making. Further details given in output and outcome summaries as gender activities tend to relate to more than one activity.

**Deliverables:**

- Sets of data soil, crop, management and weather for models parametrization /validation for each location. Data processing and data available for use in model development.

**Partners:**

**Locations:**

Global

**Activity 543-2013 (Milestone 1.1.2 2013 (1).)**

**Title:** Improved resource use efficiency (e.g. crops and crop rotations, input allocation, crop residues/manure management, P and N fertilisation ,tillage system) at the farm scale in cereal based systems in different rainfed agroecologies of East and Southern Africa (e.g. Embu, Machakos, Melkassa, Borana, Usambara, ) (suggested sites in SA will be Monze Farmer Training Centre, Zambia, Henderson Research Station and Domboshawa

Training Centre, Zimbabwe and Sussundenga Research Station, Mozambique; alternative Chitedze Research Station Malawi and Msekera Research Station Chipata).

**Status: Partially complete.** Extensive on-farm and on-station CA related research is being conducted in E&S Africa with funding from bi-lateral projects (such as IFAD, SIMLESA, Platform-Mozambique, SANREM-CRSP) and biophysical and socio-economic data has been gathered for all sites in collaboration with partners in each country. Conservation Agriculture based maize cropping systems including reduced tillage, legumes in rotations or intercropped, sufficient residue left in the field and adequate fertilisation represent important advantages in the productivity of cropping systems in S&E Africa and the maintenance of soil fertility. Input availability and heavy pressure on crop residues might be the most important bottlenecks for wider expansion of this systems. The analysis of farm household survey data has yielded farm household typologies in relation to their resources, main livelihood activities and agronomic practices developed. A large diversity of farm households exists not only at the regional level but also within district diversity. Within each district there is a differentiation of farm households (3 to 5 farm types) in terms of their assets, the presence of livestock in the farm, the kind of cropping systems and input use, as well as their off and out farm activities, their labour allocation and the source of food and cash. This synthesis and formalisation of cropping and farming systems is part of the methodological framework developed for the analysis of scenarios for adaptation to climate change of small scale farmers and are key pieces in the delineation of recommendation domains for alternative, climate smart, agricultural systems. The data, and findings acquired by its analysis, will be the basis for the parameterisation of cropping systems simulation models and the development of resource allocation farming systems models which are our main activities for 2014 by, among others, the twin post-doc positions CGIAR-CIRAD.

**Gender component:**

Gender-responsive surveys will be designed together with the deployment of gender-responsive field methodologies to assess gender-related differences in resource endowment and input allocation (including labour) and decision making. Further details given in output and outcome summaries as gender activities tend to relate to more than one activity.

**Deliverables:**

**Partners:**

**Locations:**

Other

**Activity 544-2013 (Milestone 1.2.1 2013 (2).)**

**Title:** A maize and wheat germplasm/weather data curation system developed and implemented.

**Status: Complete.** A key output is the progress made in designing a data curation system for CIMMYT. The data curation process included data control and outlier detection by examining the raw data, running single trial analyses and determining plots with standardized residuals  $> |3.5|$ . A second stage of curation involved re-computing yield from plot size and comparing values with the field book and the database, correcting both where necessary. An important part of the curation process involved checking location information using GIS tools; this will be important for analyses involving future climate scenarios. A single stage analysis was used to

produce a meta database (genotype means, trial means, genetic variance, heritability). The results from the single stage analysis were used to run a second stage analysis (genotype by environmental interaction, GxE) which produced a second generation of meta data (genotypic and environmental components, stabilities, genotypic plasticity). The genotypic response to environmental change was assessed by analysing GxE using 96 environmental covariates (combination of climatic variable x physiological stage). The results from this GxE analysis lay an important foundation for future work to identify the sensitivities of the developmental stages of CIMMYT wheat/maize genotypes to important climatic variables in different region. Patterns of change in the climatic profiles at different locations together with genotypic sensitivities to climate can help identify and refine breeding strategies for specific regions. This work is only feasible because of the expansive genotype/weather/geographic dataset held by the CIMMYT genebank. By necessity, the 2013 activities focussed mainly on data curation and preliminary analysis. We are now in a strong position for 2014 to capitalise on these activities and (i) continue mining CIMMYT Maize and Wheat genebank and identify of germplasm sources with climate adaptive potential (Heat, Drought, Cold, Frost...), (ii) confirm mega-environment's over CIMMYT's germplasm-time, (iii) use the GxE analysis to confirm mega-environment's over CIMMYT's germplasm-time, (iv) identify representative sites to establish CIMMYT phenotyping platforms and (iv) achieve an efficient parsimony site characterization methodology.

**Gender component:**

**Deliverables:**

**Partners:**

CRP 3.1 Wheat; CRP 3.2 Maize

**Locations:**

Global

**Activity 545-2013 (Milestone 1.2.1 2013 (2).)**

**Title:** Suitable international maize trial data identified, collated and relevant climate / environment data of these trials reconstructed or accessed and analysis initiated.

**Status: Partially complete.** • Hotspots of climate vulnerability were identified using the outputs of 21 global climate models (GCMs). Changes in monthly rainfall varied with location, however, in general, the rainy season will be both delayed and shorter in Southern Africa. Temperatures will increase across sub-Saharan Africa by an average of 2.1 °C, including the drought prone lowlands of Southern Africa. The outputs of this research were published in Food Security and highlighted the urgent need to develop maize varieties with tolerance to combined drought and heat stress in Southern Africa. • The outputs of crop, GCMs and economic models are being used under CCAFS to highlight both the potential impacts of climate change on crop production, identify hotspots of vulnerability and potential scope of adaptation strategies. Current options for modelling maize growth and yields were developed using temperate maize varieties. To increase the accuracy of ongoing maize modelling work DSSAT crop genetic coefficients are being calibrated with benchmark maize varieties in Eastern and Southern Africa. Three experiments were planted under optimal and drought stress conditions and these data are being used to improve modelling within Theme 4. • Based on CCAFS outputs for 2012 combined

drought and heat screening capacity was incorporated into the Eastern and Southern African regional trials network. Using this network key maize germplasm was tested for tolerance to combined drought and heat stress, heat stress and drought stress. Several key lines were identified which are now being used in breeding programs in SSA, Asia and Latin America. These lines are now undergoing testing in key hotspots within Zimbabwe.

**Gender component:**

**Deliverables:**

**Partners:**

KARI; EIAR; BMGF; BISA; YAAS

**Locations:**

Other, East Africa (EA)

**Activity 546-2013 (Milestone 1.1.2 2013 (1).)**

**Title:** Effective gender-equitable climate change adaptation strategies for rural poor small-scale maize households in East Africa.

**Status: Partially complete.** The 2013 activities and outputs focused on the SIMLESA dataset (Kenya and Tanzania) and CIMMYT-CCAFS Kenya national household and community survey of smallholder maize farmers. SIMLESA analysis on climate-related production shocks and adaptation strategies was completed for Kenya and presented at the 4th AAE conference and accepted for publication as a CIMMYT Socioeconomics Working Paper (details provided below). Cross-country comparison on factors influencing the choice of adaptation strategies to drought in Kenya and Tanzania is in progress and empirical models and analysis are currently being finalized. The CIMMYT-CCAFS Kenya national survey was completed in 2nd quarter and the database cleaned in the 4th quarter of 2013. Preliminary analysis has been carried out to support a publication for 2014. In all of the analyses on climate change adaptation, special attention is given to gender, poverty and food security. Cross-regional synthesis between East Africa and IGP is also planned for the recent CIMMYT-CCAFS datasets in both regions.

**Gender component:**

Household surveys have been designed to allow for gender analysis of coping and adaptation strategies. Further details given in output and outcome summaries as gender activities tend to relate to more than one activity.

**Deliverables:**

**Partners:**

SIMLESA; KARI; Egerton University; DRD; EIAR; Hawassa University; SAUT; DIVA

**Locations:**

East Africa (EA)

### **Activity 547-2013 (Milestone 1.2.1 2013 (2).)**

**Title:** Analysis and modeling of wheat trial data to identify climate ready traits/ideotypes, and analogue sites in climate vulnerable regions with the medium-term objective of developing phenotyping platforms with NARS collaborators.

**Status: Complete.** We also hosted a workshop on wheat response to high temperature at CIMMYT headquarters in collaboration with the AgMIP-wheat modelling group. This workshop included breeders, physiologists, agronomists and modelers and resulted in a proceedings documenting temperature algorithms for 25 major wheat models. These proceedings are available online and are being used currently by the AgMIP-wheat modelling group for their model improvement efforts. Thus far, our model evaluation has identified the need for an accelerated senescence algorithm in wheat models for APSIM and DSSAT. In 2014, the first step in model improvement will involve transferring one such algorithm (from the model NWheat) into these models and they will be further evaluated to identify other needed improvements. Pakistan was identified as a climate hot spot by New et al. (2012) and a recent report conducted by David Lobell (2013). We are connecting to a newly-initiated CIMMYT-Pakistan project (USAID-funded Agriculture Innovation Program) and have made contact with researchers from the Pakistan Agricultural Research Council, the National Agricultural Research Center, the University of Agriculture, Faisalabad, and the Wheat Research Institute of the Ayub Agricultural Research Institute. Meetings were planned for December 2013, but they had to be rescheduled to January 2014. We are offering expertise in phenotyping and crop modelling to assist in establishing phenotyping platforms (especially for heat/drought resistance traits) in Pakistan through these projects.

**Gender component:**

**Deliverables:**

**Partners:**

CSIRO; UQ; UF; BISA; Indian National Wheat Program

**Locations:**

Global

### **Activity 548-2013 (Milestone 2.1.2 2013.)**

**Title:** Identify and evaluate differential role and impact of risk management strategies in maize-legume systems on women and men using farm household bioeconomic models.

**Status: Partially complete.** The 2013 activities focussed on developing collaborations and in particular with a research team in UC Davis who have expertise in bioeconomic modelling for maize farmers in Kenya. Two technical reports have been submitted summarising previous modelling work and a model construction proposal. The recent CIMMYT-CCAFS Kenya national dataset is chosen to replace SIMLESA dataset for its more comprehensive information on household risk management strategies and national representativeness. Substantial analysis on farm household typology as an integral part of bioeconomic model has been carried out and future climate scenario will be extrapolated for each farm types to identify vulnerable farm types for model

construction with close collaboration between Socioeconomics and Global Conservation Agriculture Program. At the same time, experimental data on risk behaviour of male and female maize farmers are being analysed. Similar analysis is planned for cross-regional comparison with IGP. On-going funding uncertainty during 2013 impacted on this activity and so some deliverables were not achieved.

#### **Gender component:**

The activity will consider socially-differentiated groups, including women farmers and participants will be classified into various groups including young males, young females, adult male and adult females. Further details given in output and outcome summaries as gender activities tend to relate to more than one activity.

#### **Deliverables:**

#### **Partners:**

SIMLESA; Hawassa University; KARI; Egerton University; DRD; SUA; EIAR

#### **Locations:**

East Africa (EA)

### **Activity 549-2013 (Milestone 2.1.3 2013 (2).)**

**Title:** Participatory experimentation with risk management strategies in maize-legume-based systems in EA.

**Status: Partially complete.** Much of this activity builds on ongoing work under SIMLESA with CCAFS funding used to support complementary data collection and analysis relating to climate change risk management. In the several sites of Eastern and Southern Africa, SIMLESA has reached several hundred thousand. Priority has mainly been on CA adoption, and use of climate smart germplasm. New germplasm included varieties from other CIMMYT/partner projects, such as Drought Tolerant Maize for Africa (DTMA), that are developed to enable smallholders reduce risk related to low soil moisture. CIMMYT is also implementing a Project on Farm Mechanisation and CA for Systems Intensification (FACASI). This, along with other work have prioritised East Africa in 2013, and address wider production system constraints and their potential coping strategies to reduce climate-related risks, reduce labour constraints (especially among women and the most marginalised), increase productivity and profitability. These goals are broad, but specific activities and outputs include:

- 1) Stakeholders have been organised as Agricultural Innovation Platforms, which are critical forums for consultative meetings and action, at regional and local levels and involving strategic partners (government, private sector, insurance, key NGOs, CBOs, etc.)
- 2) Participatory experimentation with CA based technologies and new germplasm have been key to demonstrate technology-based coping strategies against climatic risks such as low soil moisture. Several surveys have been conducted to show adoption rates, and key findings will be reported in 2014
- 3) Baseline data to assess gender-related climate risk management strategies were collected late in 2013 and are being analysed. Sampling was stratified, based on three research-identified social categories in CCAFS Kenya sites. This baseline also identified communal and household approaches and practices for climate risk management. This exercise may be repeated for other countries in 2014.
- 4) Gender-disaggregated farm mechanisation data gathered in Kenya and Tanzania show lowest mechanisation among women-dominated tasks. Mechanised equipment were mostly hired and not jointly

owned, including for common small machines such as power-saws. Therefore, workable business models need to target hiring, rather than ownership.

5) The agronomic protocol commonly used across all SIMLESA sites was modified to include forage components in 2013 trials in Ethiopia. The new component includes multipurpose grain legumes that have potential for wide use, including being marketed or processed for human food.

**Gender component:**

Gender-responsive surveys will be designed together with the deployment of gender-responsive field methodologies to assess gender-related differences in climate risk management strategies. See output summary and outcome indicators for further details.

**Deliverables:**

**Partners:**

EIAR; KARI; DRD; ASARECA; ARC; QAAFI; SIMLESA

**Locations:**

East Africa (EA)

**Activity 550-2013 (Milestone 2.1.3 2013 (2).)**

**Title:** Participatory experimentation with risk management strategies in rice-wheat-based systems in the IGP.

**Status: Partially complete.** In the two CCFAS prioritized grids (Haryana and Bihar), production system constraints and potential coping strategies to reduce climate risks, increase productivity and profitability were analysed and discussed with a range of stakeholders through consultation meetings. Participatory experimentations with CA-based technologies were conducted in Haryana and Bihar to demonstrate the role of these practices on some of the climate risks such as terminal heat, excess soil moisture and terminal water stress. The data required to assess gender-related climate risk management strategies were collected through CCAFS baseline surveys and are being analysed. With an emphasis on socially differentiated farm communities in CCAFS villages, an outline of farm typologies and agronomic practices for climate-risk management have been developed. A multi-country, multi-institute learning synthesis was documented to demonstrate how community-based adaptation and risk management strategies can be mainstreamed in Govt policy. The CA-based and other related agronomic management practices that are risk averse for the range of maize- and wheat-based farming systems were synthesized and the impacts of some of the CA technologies such as zero tillage and laser land leveling in India have been documented.

**Gender component:**

Gender-responsive surveys will be designed together with the deployment of gender-responsive field methodologies to assess gender-related differences in climate risk management strategies. See output summary and outcome indicators for further details.

**Deliverables:**

- A protocol for on-farm experimentation and data management on risk management strategies at farm scale in maize-legume based farming systems in E&S Africa.

A protocol for on-farm experimentation and data management on risk management strategies at farm scale in maize-legume based farming systems in IGP.

**Partners:**

ICAR; CCS Haryana Agricultural University; IPNI; PARB; BARI; iDE

**Locations:**

East Africa (EA), South Asia (SAs)

### **Activity 551-2013 (Milestone 2.1.3 2013 (3).)**

**Title:** The role of ICT-based information delivery system on household climate risk management strategies: impact, strategy and policy recommendations.

**Status: Complete.** “Dissemination of Climate smart agro-advisories to farmers in CCAFS benchmark sites of India” was launched on 15th August, 2013 in four villages of Karnal district of Haryana and subsequently in Vaishali district of Bihar on 1st September. The project is covering 1200 male and female farmers in 8 villages and will be running for eight months on a pilot level. At present two voice messages are sent out every day to each farmer on their mobile phones along with some detailed SMS messages as and when required in Hindi language under the banner of CCAFS. These messages give weather predictions and prescriptions, information about pests and remedies, details of climate smart technologies and general awareness about climate change and solutions. A data base of farmers along with their mobile numbers has been created. Some of these farmers belong to CCAFS benchmark villages and some to control villages. In the process of building this data base, there were some hurdles to overcome such as ‘DND’ – Do Not Disturb facility subscribed by farmers that guard them against unwanted calls or messages. These are implemented by Telecom Regulatory Authority of India (TRAI). The project team worked with farmers to determine if they would be interested in being involved in the pilot study and if so obtain permission from TRAI to get these farmers out of DND. Another hurdle was to get the women to participate. Due to cultural barriers, men were not ready to share the contact numbers of their wives. Awareness and focus group discussions were organized in Karnal and CIMMYT staff met the Sarpanch (elected head) of the villages and Anganwadi workers (government women health workers) to mobilize the women farmers. All four villages in Karnal have women Sarpanch and this was helpful in reaching out to women farmers or women in male headed households. In Bihar, a women scout was appointed who has worked very closely with women farmers and has assisted them in forming womens’ groups to participate in the project. A customized feedback mechanism has been built in to the project in two ways. Firstly a helpline is created where farmers call back to give feedback and ask for responses on queries. Some queries are instantly sorted out, some diverted to other experts and some are collated and the farmer is given a call back. Statistics on these helpline calls are been collected. The feedback is also converted into voice messages the following day if they are relevant to a wider group of farmers. Recording of these voice messages and content is done just a day prior to transmission so that the most up-to-date and relevant information is sent to farmers. The second mode of feedback is through the field scouts that interact closely with the farmers, focus group discussions that will be organized at frequent intervals and detailed feedback will be collected fortnightly through a structured feedback form. In this project efforts are being made to make the information more relevant, timely, customized and

usable for the farmers. Everyday interesting feedback have been received and the research team and field team have to work very closely and pro-actively to meet the farmer's diverse request. Efforts to get farmers correct phone numbers and to make them aware of the benefits of being aware about new technologies are major challenges.

**Gender component:**

Gender-responsive surveys will be designed together with the deployment of gender-responsive field methodologies to assess gender-related differences in access and use of ICT-based information systems.

**Deliverables:**

**Partners:**

ICAR; BARI; NARC; PARC; IRRI; ILRI; IFPRI

**Locations:**

South East Asia (SEA)

### **Activity 552-2013 (Milestone 2.2.1 2013.)**

**Title:** Policy recommendations on approaches to manage market risks and create strategies to reduce vulnerability of poor households (producers and consumers) arising due to price volatility.

**Status: Partially complete.** Even though India is food sufficient there are concerns about the volatile prices of food grains. Thus it becomes important to study the recent trends in price changes in different prices received by the farmers for major staple food crops such as wheat, rice and maize in India and compare these with the international prices and its impact on food security in India. It is also important to see whether the government has taken any policies to curb the effect of these price changes which would otherwise affect food security in India. The objectives of this study were to assess recent trends in prices in the wheat markets (World, South Asia and specific to India) and whether wheat price volatility has an impact on food security; and to discuss the policy options that the government adopted to tackle price volatility of wheat. For this purpose data on Retail prices (monthly, annual, index), Wholesale prices (market wise, monthly, annual and index), Minimum support prices and Farm Harvest prices and world prices (market wise) for last 25-30 years from different sources for the crops Wheat, Rice and Maize have been collected and computed to analyze price trends, price volatility, market integration and price transmission. In addition to this trend analysis, further analysis has been undertaken to understand the reasons and causal relationship between different prices and the policies that may lead to these changes in prices, or factors responsible for a mismatch in production and consumption that may lead to temporary volatility. This analysis is in progress; data compilation has been completed and continuous updating of the data base undertaken as new data points are made available by national agencies.

**Gender component:**

See outcome indicators.

**Deliverables:**

**Partners:**

ICAR; BARI; NARC; PARC; IRRI; ILRI; IFPRI

**Locations:**

South Asia (SAs)

**Activity 553-2013 (Milestone 3.2.1 2013 (1).)**

**Title:** Analysis of the economic incentives and benefits to farmers from adoption of conservation agriculture for adaptation to and mitigating climate change.

**Status: Partially complete.** The major work in 2013 was the design of the CIMMYT-CCAFS survey in three countries of South Asia, namely, Nepal, India, and Bangladesh. The survey encompassed 2500 households with farm plot level information gathered from more than 7000 farm plots. The design of the questionnaire and the FGD guidelines began in January 2013 and it took about three months to finalize these instruments. Prior to the launch of the survey, the instrument was piloted in four locations: two in India and one each in Nepal and Bangladesh. After this, training of enumerators was undertaken. In addition to the survey, other outputs included:
 

- o Submitted paper entitled ‘The impact of laser land leveling in Rice-Wheat rotations of the North Western Indo-Gangetic Plains of India.
- o Submitted paper entitled ‘Climate change and agriculture in South Asia: Are there enough options for adaptation and mitigation?’
- o Submitted paper entitled ‘On-farm economic and environmental impact of zero-tillage wheat: a case of North-west India’.

 Ongoing uncertainty in funding during 2013 impacted on this activity in particular with delays in some deliverables as a result.

**Gender component:**

We include gender by assessing whether there are differences between male and female headed households with regard to the adoption of CA. In addition, we will look at if women farmers have equal access to information and resources to adopt CA. See output summary and outcome indicators for further details.

**Deliverables:****Partners:**

CSISA

**Locations:**

South Asia (SAs)

**Activity 554-2013 (Milestone 3.3.1 2013.)**

**Title:** Calculation of carbon footprints of maize in EA based on the SIMLESA dataset.

**Status: Complete.** A derivative of the Cool Farm Tool (CFT) was employed against the SIMLESA household dataset. We restricted the analysis to plots in which maize was grown as a sole crop to avoid issues of allocation of emissions to different crops on one plot. This resulted in a total of 376 plots from 187 households and 1433

plots from 765 households in Kenya and Ethiopia, respectively. For the analysis, outliers of nitrogen (N) application and yield were removed. These were (i) maize yield greater than 10 t ha<sup>-1</sup> and lower than 0.2 t ha<sup>-1</sup> and (ii) N application rate greater than 200 kg N ha<sup>-1</sup>. The N application rate was the sum of N from the synthetic fertilizers di-ammonium-phosphate (DAP) and Urea, as well as the organic fertilizer, farm yard manure (FYM). The maximum yield and N application were based on CIMMYT knowledge. The minimum yield threshold was determined by the minimum average seed rate of the countries, which in this case was Kenya. The analysis demonstrated that there were regional optimal N input levels which resulted in minimum greenhouse gas emissions (GHG) per tonne of product. These were associated with ensuring a balance between N input and uptake providing achievable yields under respective conditions. Yields of at least 0.75 t ha<sup>-1</sup> should be targeted to ensure GHG emissions are lower than maize planted on newly cultivated land in the region. This threshold was higher from a food security perspective ranging between 0.7 and 2.5 t ha<sup>-1</sup> depending on the average household family size and area of planted maize. Current yields in Kenya are limited by other factors as well as nutrients, whereas in Ethiopia much higher yields are already achieved. Therefore a different N optimum input, based on N balances, was determined for Kenya and Ethiopia of 60 and 120 kg N ha<sup>-1</sup> respectively.

**Gender component:**

Gender was not included as a factor in the analyses so far.

**Deliverables:****Partners:****Locations:**

East Africa (EA)

**Activity 555-2013 (Milestone 3.3.1 2013.)**

**Title:** Potential of CA to mitigate GHG emissions in cereal-based systems in different agroecologies.

**Status: Complete.** Continuation of long-term trials (eight agronomic trials equipped for GHG quantification using the static chamber method) of wheat- and maize-based cropping systems under a range of crop establishment, cropping sequence, residue management and nutrient management regimes and in different agro-ecological conditions in IGP and Mexico. As an effort to standardize the GHG quantification protocol, we reviewed the current state of knowledge and developed guidelines/protocols for chamber-based methodologies mainly focussing on the minimum requirements. We have developed a database on GHG emission for various CA-based management practices and it will be necessary to continue with the measurements for another couple of years in order to be able to reliably quantify the effect of management practices on GHG in short- to medium term. We have trained a number of students on GHG quantification methods and strengthened the laboratory capacity of different university and advanced research institutes for GHG analysis which will help to develop a critical mass and local capacity for climate change research in future. A meta-analysis of the potential of CA-based technologies to mitigate climate change through soil carbon sequestration was undertaken based on publications and data from the IGP and Sub-Saharan Africa. The general conclusion was that whilst conservation tillage practices are good for soil the potential benefits for climate change mitigation in terms of soil carbon sequestration are negligible and indeed most likely zero.

**Gender component:**

See output summary and outcome indicators for further details.

**Deliverables:**

- Two Students trained in the measurement and analysis of GHG emissions

Four students in IGP and two students in Mexico trained in the measurement and analysis of GHG emissions.

**Partners:**

IARI; ICAR; RAU; BISA; CCS Haryana Agricultural University; CSISA; SIMLESA

**Locations:**

Global

**Activity 556-2013 (Milestone 3.3.2 2013.)**

**Title:** Precision agriculture, for increasing NUE and reducing environmental impact in cereal-based systems in different irrigated agroecologies in IGP and, wheat-based irrigated and maize-based rainfed systems in Mexico.

**Status: Partially complete.** The optimum nutrient management practices for CA-based production systems are poorly understood and an opportunity exists to achieve greater yields, profits and nutrient use efficiency (NUE) through precise nutrient management. A review of NUE under various management conditions has depicted a clear picture of what has already been done, what is lacking and what opportunities exists for further research on precision nutrient management. We have established trials to evaluate NUE and measure GHG emissions under different nutrient management scenario. We have 1-2 years of GHG emission data from these trials but the measurement will need to be continued for a couple more years to come up with meaningful conclusions of the impacts of different N management strategies on NUE and GHG emissions.

**Gender component:**

Gender not included in analysis

**Deliverables:****Partners:**

BISA; CCS Haryana Agricultural University; ICAR

**Locations:**

Global

**Activity 557-2013 (Milestone 4.2.1 2013 (3).)**

**Title:** Assembling and development of data and parameters to integrate maize and wheat systems information into global models, including calibration of selected benchmark cultivars for target environments.

**Status: Partially complete.** Integrated bioeconomic modelling at fine spatial resolution is an important tool to provide insights into the impact of climate change at local level and to identify regions that are highly vulnerable

to climate change and to evaluate adaptation options. However, both the biophysical and socioeconomic models need to be calibrated and evaluated with reliable data before applying them for research and decision support. Therefore, the minimum dataset collection that was started in 2012 also continued in 2013 with additional datasets and regions. Accordingly, a database that links maize yield trial data with soil and climate data in a network of research stations in Eastern and Southern Africa (ESA) has been established. More than 30 years historical daily climate data have been collected from more than 70 principal weather stations in Ethiopia and Kenya. The CERES-Maize model was further calibrated and evaluated using benchmark drought tolerant maize varieties in ESA. By mid-2012, the database for site-specific wheat crop modelling was completed; at the end of 2013, databases for both site-specific and global scales are complete and validated.

**Gender component:**

Gender has not been integrated into this activity so far but plans are under way for 2014 to gather and integrate gender-related data into the socio-economics database. See output summary and outcome indicators for further details.

**Deliverables:****Partners:**

IFPRI

**Locations:**

Global

**Activity 558-2013 (Milestone 4.3.3 2013.)**

**Title:** Integrated assessments for estimating future impacts and identifying policy options for adaptation to and mitigation of climate change.

**Status: Partially complete.** Planning responses to climate change requires the collection and management of huge datasets at local, regional and global scales and the development and refinement of analytical frameworks for estimating the impacts of climate change and adaptation interventions. A framework that integrates biophysical models that simulate crop yields at a pixel level with socioeconomic models that provide aggregated economic impact at a global level has been validated. Using long term maize and wheat yield trial datasets with associated soil, weather and crop management data, a method of estimating the impact of current and future climate extreme events has been developed and tested. The bioeconomic modelling framework developed has been applied to study the national and global impact of the 2012 extreme weather event in the USA, the impact of climate change in maize systems in Africa and the role of adoption of drought tolerant wheat varieties in Asia. The results of these studies have been presented in international conferences and papers are submitted to peer-reviewed international journals. Necessary preparations have also been made to study the impact of climate change and its implications on cereal systems in south Asia.

**Gender component:**

See output summary and outcome indicators for further details.

**Deliverables:****Partners:**

UF; IFPRI

**Locations:**

East Africa (EA), West Africa (WA), South Asia (SAs)

**Activity 559-2013 (Milestone 4.3.3 2013.) Commissioned****Title:** CGIAR Center support to include climate change research in the "Global Futures for Agriculture" project.**Status: Partially complete.** This activity was partially completed due to the departure of the Dr Shiferaw from CIMMYT**Deliverables:****Partners:****Locations:****Activity 633-2013 (Milestone 2.1.2 2013.)****Title:** Mapping Risks and Opportunities for Targeting Appropriate Crop Adaptation Strategies in East Africa.

**Status: Partially complete.** From CCAFS baseline surveys, plausible coping strategies to climate risks were identified. However, from the surveys, there was no direct evidence that farmers had adopted new strategies in response to climate risks. This new knowledge was fed into the development of the questionnaire for the RRA and the questionnaire was adjusted to identify respondents who had changed their farming practices in response to perceived climate risks. From the literature, the key climate risks identified across the sites in eastern Africa (Kenya, Uganda, Tanzania, and Ethiopia) were:

- o Increased drought frequency
- o Decrease in rainfall amount
- o Erratic rainfall

The key coping strategies used across all sites in eastern Africa were:

- o Adoption of agroforestry practices
- o Changes in cropping practices, including the increased use of improved varieties (drought-tolerant varieties) and intercropping
- o Changes in soil management practices including increased use of rotation

In Uganda, unlike other targeted countries in eastern Africa, smallholders farmers increasingly use weather forecasts to plan farming activities

**Gender component:**

Appropriate methodologies and approaches will be used to ensure gender disaggregation of data collected during the survey work and data will be analysed with a gender lense.

**Deliverables:****Partners:****Locations:**

East Africa (EA)

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

### Output: 1.1.2

#### Summary:

Climate smart practices: CIMMYT has developed a number of wheat- and maize-based cropping systems technologies for addressing climate change challenges. Many of these technologies are based on the principle of conservation agriculture (CA) and together with key bilateral projects, CIMMYT-CCAFS has been testing these both on-station and on-farm with farmers under local conditions in East and Southern Africa (ESA), Indo-Gangetic Plain (IGP) and Mexico. CA-based technologies have shown significant advantages over currently practised systems with advantages including: increased and more stable yield, increased water-use efficiency and improved soil fertility as well as improved economic performance as a result of lower production costs and labour saving. A standard operating protocol for best practices in data management development has been developed and is available in .doc format. AgTrials metadata schema is being revised, along with metadata entry formats, for more cohesion and user friendliness. Farm household adaptation strategies: The analysis of farm household survey data has yielded farm household typologies in relation to their resources, main livelihood activities and agronomic practices developed for all three regions (see Case Study). A large diversity of farm households exist not only at the regional level but also within districts. This synthesis and formalisation of cropping and farming systems is part of the methodological framework developed for the analysis of scenarios for adaptation to climate change of small scale farmers and are key elements of the delineation of recommendation domains for alternative, climate smart agricultural systems. The data, and findings acquired by its analysis, will be the basis for the parameterisation of cropping systems simulation models and the development of resource allocation farming systems models which form the core of our activities for 2014 and will involve the twin post-doc positions funded by CGIAR-CIRAD. An analysis of household strategies dealing with drought indicated that 93% and 98% of farmers applied some adaptive measure in Kenya and Tanzania, respectively. Differences exist between farmers in their response to drought. In Kenya, a combination of drought-tolerant crops and varieties, replanting and selling of assets were identified as major adaptation strategies. In Tanzania, similar choices of adaptation strategies were found but with additional combinations including crop diversification, reduced consumption and borrowing. Factors determining the choice of specific strategy combinations including non-adaptation will be explored further in 2014. Gender: Work has continued on the integration of gender into CIMMYT-CCAFS' research portfolio wherever relevant (Farnworth, 2013) and a paper has been drafted entitled 'Gender and Conservation Agriculture in Southern Africa: towards a research agenda'. In Bihar, CIMMYT is taking steps to developing women's agency by including them in field-based training courses regarding the use of the Green Seeker. CIMMYT also actively solicits women's voice in its research and recommendations based on the findings will focus on how to strengthen women's ability to select and discuss CC adaptation strategies within farm households. CIMMYT is also taking steps to empower women in terms of structure in Bihar and has worked with women to set up a legally recognised woman's group with their own bank account. The group has been assisted to purchase a zero till drill and to rent this out to farmers within the climate smart village of Rajapakar. In Haryana, a 'Pathways of gender equity led climate smart farming: learning from stakeholders' workshop was attended by a large number of different stakeholders in CIMMYT-CCAFS work in Haryana and was organized jointly by Directorate of Wheat Research (DWR), Indian

Council of Agricultural Research (ICAR) & CIMMYT-CCAFS in Haryana on June 7, 2013. Suresh Gahalawat, Deputy Director Agriculture, Karnal, Government of Haryana, announced, following the workshop, that gender will become part of the agricultural policies of Haryana and to start with he will include gender in all schemes being operated in the district. In Addis Ababa, a workshop brought together modellers from the CIMMYT-CCAFS modelling team with IWMI modellers. First efforts to incorporate gender into modelling work at a range of scales, from household to landscape, were presented and discussed and opportunities to develop the work further will be sought in 2014. CIMMYT-CCAFS together with the WHEAT CRP has developed a unique manual on the integration of gender aspects into quantitative data collection containing key topics on gender research, tips to integrate gender in the research process and key questions around gender in quantitative surveys. This complements the FAO-CCAFS handbook on qualitative research 'Training Guide: Gender and Climate Change Research in Agriculture and Food Security for Development'. Several outputs in the form of publications etc have been produced in 2013 including:

- Beuchelt, T. (2013). Integrating gender aspects in quantitative research: A manual for researchers on agriculture, food security and climate change for rural development. CIMMYT Report.
- CIMMYT, 2013. A practical guide for comparing crop management practices. Mexico, D.F., CIMMYT. All protocols available on: <http://repository.cimmyt.org/xmlui/>.
- Farnworth, C.R. (2013). The operationalization of recommendations for the integration of gender in CIMMYT's research portfolio in CCAFS. CIMMYT Report pp.77.
- Jat, ML; Gathala, MK; Saharawat, YS; Tetarwal, JP; Gupta, R and Yadvinder-Singh. 2013. Double no-till and permanent raised beds in maize–wheat rotation of north-western Indo-Gangetic plains of India: Effects on crop yields, water productivity, profitability and soil physical properties. *Field Crops Research* 149: 291-299.
- Jat, ML; Kapil, Kamboj, BR; Sidhu, HS; Manpreet- Singh, Bana, A; Bishnoi, DK; Gathala, MK; Saharawat, YS; Kumar, V; Kumar, A; Jat, HS; Jat, RK; Sharma, PC; Sharma, PC; Singh, R; Sapkota, TB; Malik, RK and Gupta, R. 2013. Operational Manual for Turbo Happy Seeder-Technology for managing crop residues with environmental stewardship. International Maize and Wheat Improvement Centre (CIMMYT), Indian Council of Agricultural Research (ICAR), New Delhi, India, p 28.
- Lopez-Ridaura, S., and Frelat, R. (2013). Characterising the diversity of farming systems in lower Nyando and Makueni CCAFS sites in Kenya. A typology of farm households. CIMMYT-CCAFS Internal Report.
- Lopez-Ridaura, S., and Frelat, R. (2013). Characterising the diversity of farming systems in Vaishali district, Bihar, India. A typology of farm households. CIMMYT-CCAFS Internal Report.
- Lopez-Ridaura, S., and Frelat, R. (2013). Characterising the diversity of farming systems in lower Nyando and Makueni CCAFS sites in Kenya. A typology of farm households. CIMMYT-CCAFS Internal Report.
- Malik, RK; Kumar, A; Dar, SR; Sharma, R; Jat, ML and Singh, S. 2013. On-farm impacts of agronomic management optimization on wheat productivity in a rice-wheat system of eastern Gangetic plains of South Asia. *Experimental Agriculture* (In Press).
- Mkuhlani, S, Nyagumbo, I., Mupangwa, W. (2013). Susceptibility of conservation agriculture based cropping systems to rainfall variability: Implications for the sustainable intensification in Zimbabwe. Proceedings of the 4th Farming Systems Design Conferenc, 19-22 August 2013, Lanzhou, China . p 157-158.
- Nyagumbo, I, Mkuhlani1,S., Mupangwa, W., Dimes, J. and Rodriguez, D. (2013). Understanding timeliness and crop yield benefits of Conservation Agriculture technologies towards sustainable intensification in two contrasting agro-ecologies of Zimbabwe. Proceedings of the 4th Farming Systems Design Conference. 19-22

August 2013. p 123-124.

- Report on “Opportunities for Youth in Agriculture”. Haryana Kisan Ayog, Newsletter, Vol.3, No.4 2013.
- Romero-Perezgrovas, R., Verhulst, N., De La Rosa, D., Hernández, V., Maertens, M., Deckers, J., Govaerts, B., 2013. Effect of Tillage and Crop Residue Management on Maize Yields and Net Returns in the Mexican Central Highlands under Drought Conditions. *Pedosphere* (In Press).
- Tongruksawattana, S. (2013) Adaptation to climate change under poverty, food security and gender perspective of rural maize-legume farmers in Kenya. Paper presented at the 4th International Conference of the African Association of Agricultural Economists: Commercializing Agriculture in Africa: Social, Economic and Environmental Impacts, 22 – 25 September 2013, Hammamet, Tunisia.
- Van den Broeck, G., Perez Grovas, R.R., Maertens, M., Deckers, J., Verhulst, N., Govaerts, B., 2013. Adopción de la Agricultura de Conservación en El Bajío. *EnlACE* 17, 35-38. Available on: <http://conservacion.cimmyt.org/index.php/es/revista-enlace>.
- Van den Broeck, G., Perez Grovas, R.R., Maertens, M., Deckers, J., Verhulst, N., Govaerts, B., 2013. Adoption of conservation agriculture in the Mexican Bajío. *Outlook on Agriculture* 42, 171-178. [https://lirias.kuleuven.be/bitstream/123456789/421766/2/VandenBroeck+et+al++2013-CA\\_adoption\\_Bajio.pdf](https://lirias.kuleuven.be/bitstream/123456789/421766/2/VandenBroeck+et+al++2013-CA_adoption_Bajio.pdf).
- Yadvinder-Singh; Kukal, SS; Jat, ML and Sidhu, HS. 2013. Improving water productivity of wheat-based cropping systems in South Asia for sustained productivity. *Advances in Agronomy* (In Press).

### Output: 1.1.3

#### Summary:

Please note that Activity 545-2013 should be categorised under Output 1.2.1 not this one. As far as aware CIMMYT does not have any activities under this output although some under 1.2.1 relate to this.

### Output: 1.2.1

#### Summary:

A major focus of the work has been on the curation and analysis of CIMMYT’s expansive genotype/weather/geographic dataset together with parameterisation of major crop models with the aim to better inform strategies for wheat and maize improvement in the face of climate change. Good progress has been made on all fronts. A key output has been the design of a data curation system for CIMMYT. In addition, the genotypic response to environmental change was assessed by analysing GxE using 96 environmental covariates (combination of climatic variable x physiological stage). The results from this GxE analysis will lay an important foundation for future work to identify the sensitivities of the developmental stages of CIMMYT wheat/maize genotypes to important climatic variables in different geographic regions. Patterns of change in the climatic profiles at different locations together with genotypic sensitivities to climate can help identify and refine breeding strategies for different regions. This work is only feasible because of the expansive genotype/weather/geographic dataset held by the CIMMYT genebank. Maize: Hotspots of climate vulnerability

in Africa were identified using the outputs of 21 global climate models (GCMs). Changes in monthly rainfall varied with location, however, in general, the rainy season will be both delayed and shorter in Southern Africa. Temperatures will increase across sub-Saharan Africa by an average of 2.1 °C, including the drought prone lowlands of Southern Africa. The outputs of this research were published in Food Security and highlighted the urgent need to develop maize varieties with tolerance to combined drought and heat stress in Southern Africa. The outputs of crop, GCMs and economic models are being used under CCAFS to highlight both the potential impacts of climate change on crop production, identify hotspots of vulnerability and potential scope of adaptation strategies. Current options for modelling maize growth and yields were developed using temperate maize varieties. To increase the accuracy of ongoing maize modelling work DSSAT crop genetic coefficients are being calibrated with benchmark maize varieties in Eastern and Southern Africa. Three experiments were planted under optimal and drought stress conditions and these data are being used to improve modelling within Theme 4. Based on CCAFS outputs for 2012 combined drought and heat screening capacity was incorporated into the Eastern and Southern African regional trials network. Using this network key maize germplasm was tested for tolerance to combined drought and heat stress, heat stress and drought stress. Several key lines were identified which are now being used in breeding programs in SSA, Asia and Latin America. These lines are now undergoing testing in key hotspots within Zimbabwe.

**Wheat:** We hosted a workshop on wheat response to high temperature at CIMMYT headquarters in collaboration with the AgMIP-wheat modelling group. This workshop included breeders, physiologists, agronomists and modelers and resulted in a proceedings documenting temperature algorithms for 25 major wheat models. These proceedings are available online and are being used currently by the AgMIP-wheat modelling group for their model improvement efforts. Our model evaluation has identified the need for an accelerated senescence algorithm in wheat models for APSIM and DSSAT. Pakistan was identified as a climate hot spot by New et al. (2012) and a recent report conducted by David Lobell (2013). We are connecting to a newly-initiated CIMMYT-Pakistan project (USAID-funded Agriculture Innovation Program) and have made contact with researchers from the Pakistan Agricultural Research Council, the National Agricultural Research Center, the University of Agriculture, Faisalabad, and the Wheat Research Institute of the Ayub Agricultural Research Institute. Meetings were planned for December 2013, but they had to be rescheduled to January 2014. We are offering expertise in phenotyping and crop modelling to assist in establishing phenotyping platforms (especially for heat/drought resistance traits) in Pakistan through these projects. Several outputs in the form of publications etc have been produced in 2013:

Alderman, P.D., E. Quilligan, S. Asseng, F. Ewert, and M.P. Reynolds (Eds). 2013. Proceedings of the Workshop Modeling Wheat Response to High Temperature. CIMMYT, El Batán, Mexico, 19-21 June, 2013. Mexico, D.F.: CIMMYT. Available at: <http://repository.cimmyt.org/xmlui/handle/10883/32111>

Cairns, J Hellin, K Sonder, JL Araus, JF MacRobert, C Thierfelder, BM Prasanna. 2013. Adapting maize production to climate change in sub-Saharan Africa. Food Security 5, 345-360.

Cairns, J Crossa, PH Zaidi, P Grudloyma, C Sanchez, JL Araus, D Makumbi, C Magorokosho, M Bänziger, A Menkir, S Hearne, GN Atlin. 2013. Identification of drought, heat and combined drought and heat tolerance donors in maize (*Zea mays* L.). Crop Science 53, 1335-1346.

C Stirling J Hellin, J Cairns, E Silverblatt-Buser, T Tefera, H Ngugi, S Gbegbelegbe, K Tesfaye, U Chung, K Sonder, R A Cox, N Verhulst, B Govaerts, P Alderman, M Reynolds. 2013. Shaping sustainable intensive production systems: improved crops and cropping systems in the developing world. In: J Fuhrer and P Gregory (Eds). Effects of climate change on crop and livestock systems. CABI International.

## Output: 2.1.2

### Summary:

Previous bioeconomic modeling work has been reviewed and the specific model construction to be used for the current project has been proposed. Next, five groups of typical farm households were clustered with the following major characteristics and AEZ: Group 1 : Mechanized and wealthy farmers; AEZ - High tropics Group 2 : Poor farmers with no assets and livestock; AEZ - Moist Mid-Altitude , Coastal Lowland Group 3 : Specialized crop farmers; AEZ - Moist transitional Group 4 : Specialized livestock famers; AEZ - Dry Mid Altitude – no moist transitional Group 5 : Average farmers; AEZ - Dry transitional Following the initial typical farm clusters data exploration, further analysis was conducted to identify degrees of climate-related risk exposure for each farm type over the past 10 years. It appears that the clusters are evenly distributed on the climate exposure principal component. However, some AEZ seem to be more prone to climate-related risks (e.g. moist mid-altitude, high tropics, moist-transitional), while dry mid altitude and coastal lowland are more prone to drought or shortage of water, and dry transitional seems to be the region which is least prone to climate-related risk. However, there is no significant correlation between the structural farming practices and the climate-related risk exposure. Published outputs: Tongruksawattana, S. (forthcoming) Climate-related shocks and choice of adaptation for Kenyan maize-legume farmers from poverty, food security and gender perspective. CIMMYT Socioeconomics Working Paper.

## Output: 2.1.3

### Summary:

CIMMYT is working to better understand the practices that farmers currently employ to reduce exposure to climate variability and how more efficient provision of information services can enhance these risk management strategies. Participatory action research is being conducted in both the IGP and East Africa and is closely aligned with on-going bilateral projects. In the two CCAFS prioritized grids (Haryana and Bihar), production system constraints and potential coping strategies to reduce climate risks, increase productivity and profitability have been analysed and discussed with a range of stakeholders, through a series of consultation meetings. The data required to assess gender-related climate risk management strategies has been collected through CIMMYT-CCAFS baseline surveys and are being analysed. With an emphasis on socially differentiated farm communities in CCAFS villages, an outline of farm typologies and agronomic practices for climate-risk management have been developed. A multi-country, multi-institute learning synthesis was documented to demonstrate how community-based adaptation and risk management strategies can be mainstreamed in government policy (see Wright et al. below). CA-based and other related management practices that are risk averse for a range of maize- and wheat-based farming systems have been synthesized and the impacts of some of these, such as zero tillage and laser land leveling in India, have been documented (see Jeetendra et al. below). Two key risk management interventions are being tried and tested with farmers: management of terminal heat in wheat and raised bed planting (RBP).

- Management of terminal heat in wheat. This is the main risk in wheat production and can significantly lower yields. Through its programs on CA-based technologies and in collaboration with the IARI, CIMMYT-CCAFS has produced evidence that surface residue retention reduces risk of terminal heat. The fact that this work is done in farmers' fields maximises prospects for out-scaling, whilst the fact that it is done in collaboration with Krishi Vigyan Kendras (KVKs), agricultural universities and the state departments of

agriculture maximises prospects for up-scaling. Burning of crop residues is now illegal in both Haryana and Punjab and although this practice has by no means been stamped out, the legal ban provides an incentive for farmers to find alternative means of dealing with residues. Senior scientists at the Directorate of Maize Research and the ICAR reported that their institutes were favourably impressed by the fact that the CIMMYT has demonstrated that CA is showing feasible alternatives to residue management and that this improves soil cover and soil health. This constitutes evidence of Outcomes, in the form of awareness-raising.

- Raised Bed Planting (RBP). This is both a water-saving and a water-management technology. Because the land surface is raised, the crop is protected against waterlogging, which is especially problematic in eastern India. Compared to the conventional practice of flood irrigation, under RBP water is confined within the channels between the beds, thus reducing evaporation loss, and in the process reducing water requirements by 30-40 per cent. As in the case of the terminal heat stress in wheat, the KVKs and departments of agriculture have been closely involved with this work. The approach of using ICT-based information delivery systems to help manage climatic risks is not new in India. The Indian Meteorological Department (IMD) sends out simple weekly text messages advising farmers on weather variables and how they should react. At the moment various other agencies send SMS and voicemail messages to farmers along similar lines. However, no study has been conducted to establish a range of pertinent issues, such as whether such advice is received, whether it is meaningful to the recipient, whether they have taken any action on it, and whether, if they have, the agricultural impact has been positive. In the absence of such an assessment, this technology cannot be tagged as 'flagship'. CIMMYT aims to correct this inadequacy, but only after this approach has been developed, tried and tested will it be possible to assess whether or not the ICT based strategy is helping households to manage risk. Farmer groups have become more knowledgeable about climate smart options and also value the information on weather delivered to them. They have been able to quantify how precise and timely weather-based advice has helped them to take informed decision about the use of inputs during the sowing season based on which they have saved on irrigation and also on costs of pesticides and weedicides. Women farmers have become more aware about climate smart technologies and they feel empowered with access to information (see Case Study for further details). In the case of East Africa, much of the work builds on on-going activities under SIMLESA with CCAFS funding used to support complementary data collection and analysis relating to climate change risk management. In the several sites of Eastern and Southern Africa, SIMLESA has reached several hundred thousand. CCAFS-supported activities have mainly focussed on CA-based interventions, and use of climate smart germplasm. New germplasm included varieties from other CIMMYT/partner projects, such as Drought Tolerant Maize for Africa (DTMA), that are developed to enable smallholders reduce risk related to low soil moisture. Specific activities and outputs include:
  - 1) Stakeholders have been organised as Agricultural Innovation Platforms, which are critical forums for consultative meetings and action, at regional and local levels and involving strategic partners (government, private sector, insurance, key NGOs, CBOs, etc.)
  - 2) Participatory experimentation with CA based technologies and new germplasm have been key to testing with farmers technology-based coping strategies against climatic risks such as low soil moisture. Several surveys have been conducted to show adoption rates, and key findings will be reported in 2014
  - 3) Baseline data to assess gender-related climate risk management strategies were collected late in 2013 and are being analysed. Sampling was stratified, based on three research-identified social categories in CCAFS Kenya sites. This baseline also identified communal and household approaches and practices for climate risk management. This exercise may be repeated for other countries in 2014.
  - 4) Gender-disaggregated farm mechanisation data gathered in Kenya and Tanzania show

lowest mechanisation among women-dominated tasks. Mechanised equipment were mostly hired and not jointly owned, including for common small machines such as power-saws. Therefore, workable business models need to target hiring, rather than ownership.5) The agronomic protocol commonly used across all SIMLESA sites was modified to include forage components in 2013 trials in Ethiopia. The new component includes multipurpose grain legumes that have potential for wide use, including being marketed or processed for human food. Several outputs in the form of publications etc have been produced in 2013 (others listed in publications): Aryal, J; Bhatia, M; Jat, ML and Sidhu, HS. 2013. Impacts of Laser Land Leveling in Rice-Wheat Rotations of the North-western Indo-Gangetic Plains of India. *Global Environmental Change* (In Review). Aryal, J.P., Sapkota, T.B., Jat, M.L., Bishnoi, D.K. On-farm economic and environmental impact of zero-tillage wheat: a case of North-West India. *Experimental Agriculture* (In Press). Farnworth, C.R. (2013). The operationalization of recommendations for the integration of gender in CIMMYT's research portfolio in CCAFS. CIMMYT Report pp.77. Farnworth, C.R., Beuchelt, T.D., Andersson, J., Badstue, L. and Stirling C.M. (2013). Gender and Conservation Agriculture in Southern Africa: towards a research agenda. CIMMYT Internal working paper. Mittal, S. (2013). Advice by mobile - a viable model? Surabhi Mittal- My perspective, *New Agriculturalist*. Nov 2013 <http://www.new-ag.info/en/view/point.php?a=3123> Mittal, S. and M. Mehar. 2013. Agricultural information networks, information needs and risk management strategies: a survey of farmers in Indo-Gangetic plains of India. *Socioeconomics Working Paper 10*. Mexico, D.F.: CIMMYT Wright, H; Vermeulen, Sonja; Laganda, G; Olupot, Max; Ampaire, Edidah and Jat, ML. 2013. Farmers, food and finance: ensuring that community-based adaptation is mainstreamed into agricultural programmes. *Climate and Development* (In Press)

### **Output: 2.2.1**

#### **Summary:**

Even though India is food sufficient there are concerns about the volatile prices of food grains. Thus it becomes important to study the recent trends in price changes in different prices received by the farmers for major staple food crops such as wheat, rice and maize in India and compare these with the international prices and its impact on food security in India. It is also important to see whether the government has taken any policies to curb the effect of these price changes which would otherwise affect food security in India. The objectives of this study were to assess recent trends in prices in the wheat markets (World, South Asia and specific to India) and whether wheat price volatility has an impact on food security; and to discuss the policy options that the government adopted to tackle price volatility of wheat. International price volatility for major cereals was found to be greater than in India. Therefore, although food inflation is high in India and acts as a risk to urban poor, overall the poor get buffered from global price fluctuations because of the low price transmission effect in domestic market. The rural poor and urban poor also get subsidized food through several government schemes which offers some protection from market risks. Farmers have also been insured against high market risk and market fluctuations by government policies which offer a minimum support price for major cereals.

### **Output: 3.2.1**

#### **Summary:**

In 2013, CIMMYT undertook a preliminary evaluation of the impact of the laser land leveling (LLL) and zero tillage (ZT) technologies in the IGP. We examined the impact of laser land leveling technology in rice-wheat

systems of north-west India using data collected from household surveys in 2011. We compared rice and wheat yields and total irrigation time required for these crops per season between laser land leveling (LLL) and traditional land leveling (TLL). The results show that laser leveling in rice fields reduced irrigation time by 47-69 hrs ha<sup>-1</sup> season<sup>-1</sup> and improved yield by approximately 7% compared with traditionally leveled fields. In wheat, irrigation time was reduced by 10-12 hrs ha<sup>-1</sup> season<sup>-1</sup> and yield increased by 7% in Haryana and 9% in Punjab by adopting LLL. Analysis showed that LLL is a scale neutral technology, not biased towards large farmers. Farmers benefited additional USD 138 ha<sup>-1</sup> yr<sup>-1</sup> through increased rice and wheat yields in laser leveled field compared with traditionally leveled one. Adopting LLL, even in 50% of the area under RW system in the Haryana and Punjab states, can provide additional production of 699 million kg of rice and 987 million kg of wheat, amounting to USD 385 million/yr. Thus, LLL contributes to both food security and sustainable use of water resource. The economic and climate change mitigation benefits of ZT based crop production was also assessed by conducting farmers' participatory field trials at 40 sites for 3 consecutive years in four rice-wheat systems-dominated districts of Haryana state of India. In each farmer's field, zero tillage (ZT) and conventional tillage (CT) based wheat production were compared side by side for three consecutive years from 2009-10 to 2011-12. In assessing the mitigation potential of ZT, we examined the differences in input use and crop management, especially those contributing to GHGs emissions, between ZT wheat and CT wheat. We employed Cool Farm Tool (CFT) to estimate emission of GHGs from various wheat production activities. In order to assess economic benefits, we examined the difference in input costs, net returns and cost-benefit analysis of wheat production under CT and ZT. Results show that farmers can save approximately USD 80 ha<sup>-1</sup> in terms of input costs and increase net revenue of about USD 97.5 ha<sup>-1</sup> under ZT compared to CT. Similarly, benefit-cost ratio under ZT is 1.43 against 1.31 under CT. Our estimate shows that shifting from CT to ZT based wheat production reduces GHG emission by 1.5 Mg CO<sub>2</sub>-eq per ha per wheat season. Overall, ZT has both climate change mitigation and economic benefits, implying a potential win-win situation. The recent CCAFS survey collected most of the information required for such assessment. Though the results are preliminary, data from Nepal showed that female-headed households are more food insecure as compared to male-headed households. In addition, focus group discussions also revealed that female-headed households are more vulnerable to climate changes due to social barriers and their access to resources, public services and markets.

### **Output:** 3.3.1

#### **Summary:**

A derivative of the Cool Farm Tool (CFT) was employed against the SIMLESA household dataset to evaluate the effects of smallholder maize cropping systems on GHG emissions. The analysis demonstrated that there were regional optimal N input levels which resulted in minimum greenhouse gas emissions (GHG) per tonne of product. These were associated with ensuring a balance between N input and uptake to deliver achievable yields under respective conditions. The analysis suggests that yields of at least 0.75 tha<sup>-1</sup> should be targeted to ensure GHG emissions are lower than maize planted on newly cultivated land in the region. This threshold was higher from a food security perspective ranging between 0.7 and 2.5 tha<sup>-1</sup> depending on the average household family size and area of planted maize. The evidence for increased soil organic carbon (SOC) concentration in soils and hence evidence of soil carbon (C) sequestration delivering climate change mitigation in conservation agriculture-based practices was critically evaluated via a meta-analysis of data from sub-Saharan Africa and the Indo-Gangetic Plain. In IGP annual increases in SOC stock resulting from reduced tillage, crop residue return and crop

diversification were 0.22, 0.20 and 0.35 Mg C ha<sup>-1</sup> yr<sup>-1</sup> respectively with and overall standard error of difference of 0.07 Mg C ha<sup>-1</sup> yr<sup>-1</sup>. In Sub-Saharan Africa the different CA practices gave values in the range 0.34 to 1.43 Mg C ha<sup>-1</sup> yr<sup>-1</sup>, but with much greater variation. In most cases these increases are overestimates as soil was compared on an equivalent soil depth rather than an equivalent soil mass basis. It is concluded that CA practices, whilst giving benefits for soil quality, deliver only limited climate change mitigation through soil C sequestration. See Output 3.2.1 for a summary of the economic analysis of mitigation practices. Based on preliminary analysis of plot-level measurements, methane emissions were marginally higher in puddled transplanted rice than direct seeded rice but there were no differences in overall GHG emissions. Similarly, the global warming potential was not that different among tillage systems. Bellarby J., Kassie, M., Hillier, J, and Stirling, C.M (2013). GHG emissions of maize smallholder farming systems in Kenya and Ethiopia: Application of the Cool Farm Tool. SRUC Carbon management centre international conference. Sustainable intensification: The pathway to low carbon farming? 25-27 September 2013 at John McIntyre Conference Centre, Edinburgh. Bellarby J., Stirling, C.M., Hillier, J, Vetter, S.H., Kassie, M., Kanampiu, F., Sonder, K., and Smith, P. (2014). Identifying secure and low carbon food production practices: case study in Kenya and Ethiopia. Agriculture, Ecosystems and Environment (Accepted subject to revisions). Powlson D., Stirling, C.M., Jat, M.L. and Thierfelder, C. (2014). Conservation agriculture delivers only limited climate change mitigation in the form of carbon sequestration. Proceedings of the National Academy of Sciences (Submitted). Powlson D., Stirling, C.M., Cassman, K., Sanchez, P.A., Jat, M.L. and Gerard, B. (2014). Conservation tillage is good for soils but its potential role in climate change mitigation has been widely overstated. Nature Climate Change (In Preparation). Sapkota, T.B and Jat, M.L. 2013. Climate Change mitigation options in agriculture. Invited lecture delivered on Bihar Agriculture University, Sabor, Bihar. Sapkota, T.B., Jat, M.L., and Aryal, J.P. 2013. Is conservation agriculture both money and climate smart? Some examples from North-Western Ingo-Gangetic Plain. Paper presented at Frontiers in Conservation Agriculture in South Asia and Beyond, Kathmandu, Nepal, March 26-27, 2013. Sapkota, T.B., Jat, M.L., Jat, R.K., Singh, R.G.

### Output: 3.3.2

#### Summary:

The optimum nutrient management practices for CA-based production systems are poorly understood and an opportunity exists to achieve greater yields, profits and nutrient use efficiency (NUE) through precise nutrient management. A review of NUE under various management conditions has depicted a clear picture of what has already been done, what is lacking and what opportunities exists for further research on precision nutrient management (Jat et al. 2014). We have established trials to evaluate NUE and measure GHG emissions under different nutrient management scenario. We have 1-2 years of GHG emission data from these trials but the measurement will need to be continued for a couple more years more to produce results from which we can draw meaningful conclusions about the impacts of different N management strategies on NUE and GHG emissions. GHG emissions are being measured in long-term trials and a standardize measurement protocol developed. A database on these measurements has been developed for different management practices in the short- to medium term. We have trained a number of students on GHG quantification methods and strengthened the laboratory capacity of different university and advanced research institutes for GHG analysis during this period which is helping to develop a critical mass and capacity to perform such measurements locally for future research (see Case study). Several outputs in the form of publications etc have been produced in 2013

including: Aryal, J.P., Sapkota, T.B., Jat, M.L., Bishnoi, D.K. On-farm economic and environmental impact of zero-tillage wheat: a case of North-West India. *Experimental Agriculture*, (In Press). Dendooven, L., Patiño-Zúñiga, L., Verhulst, N., Boden, K., García-Gaytán, A., Luna-Guido, M., Govaerts, B., 2013. Greenhouse Gas Emissions from No-tilled Permanent Raised and Conventional Tilled Beds in the Central Highlands of Mexico. In: Kang, M.S., Banga, S.S. (Eds.), *Combating Climate Change: An Agricultural Perspective*. CRC Press, Boca Raton, FL, ISBN: 978-1-4665-6671-2, pp. 283-304. Grahmann, K., Verhulst, N., Buerkert, A., Ortiz-Monasterio, I., Govaerts, B., 2013. Nitrogen use efficiency and optimization of nitrogen fertilization in conservation agriculture. (In Press). Jat, ML; Bijay-Singh and Gerard, Bruno. 2014. Nutrient management and use efficiency in wheat systems of South Asia. *Advances in Agronomy* (in press) Jat, ML; Dagar, JC; Sapkota, TB; Yadvinder-Singh, Govaerts, B; Ridaura, Santiago L; Saharawat, YS and Stirling, C. 2014. Climate Change and Agriculture: Adaptation Strategies and Mitigation Opportunities for Food Security in South Asia and Latin America. *Advances in Agronomy* (In Review) Jat, RK., Sapkota, T.B., Singh, R.G., Jat, M.L., Kumar, M., Gupta, R.K. 2013. Seven years of conservation agriculture in a rice-wheat rotation of Eastern Gangetic Plains of South Asia: yield trends, economic profitability and carbon use efficiency. *Field Crops Research*, (In Review). Sapkota, T.B., Jat, M.L., Kapoor, P., Jat, R.K., and Stirling, C. 2014. Low carbon emission production and yield estimation of food and non-food crops. Submitted as chapter in a book "Smallholder quantification protocol" to be published under SAMPLE project. Tirol-Padre, A., Rai, M. Gathala, M., Sharma, S., Kumar, V., Sharma, P.C., Sharma, D.K., Wassmann, R. and Ladha, J. 2014. Assessing the performance of the photo-acoustic infrared gas monitor for measuring CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> fluxes in two major cereal rotations. *Global change Biology*, 20: 287-299.

#### Output: 4.2.1

##### Summary:

Integrated bioeconomic modelling at fine spatial resolution is an important tool to provide insights into the impact of climate change at the local level and to identify regions that are highly vulnerable to climate change and to evaluate adaptation options. However, both the biophysical and socioeconomic models need to be calibrated and evaluated with reliable data before applying them for research and decision support. Therefore, the minimum dataset collection that was started in 2012 also continued in 2013 with additional datasets and regions. Accordingly, a database that links maize yield trial data with soil and climate data in a network of research stations in Eastern and Southern Africa (ESA) has been established. More than 30 years historical daily climate data have been collected from more than 70 principal weather stations in Ethiopia and Kenya. The CERES-Maize model was further calibrated and evaluated using benchmark drought tolerant maize varieties in ESA. By mid-2012, the database for site-specific wheat crop modelling was completed; at the end of 2013, databases for both site-specific and global scales are complete and validated. Several outputs in the form of publications etc have been produced in 2013 including: Tesfaye, K., Gbegbelegbe, S., Cairns, E.J., Shiferaw, B., Prasanna, B.M., Sonder, K., Boote, K.J., Makumbi, D., Roberstson, R., Chung, U. (2013) Maize systems under climate change in sub-Saharan Africa: potential impacts on food production and security. Paper Presented at the First International Conference on Food Security, 29 September to 2 October, the Netherlands. Tesfaye, K. (2013). GIS and Crop Modeling for Plant Breeders: Widening the Road to Success under a Changing Climate. Training provided to national plant breeders, 16-18 July 2013, Melka Wore Agricultural Research Center, Melka Worer, Ethiopia. Addressing gender in modeling and simulations. Workshop conducted on 4 July 2013, Addis Ababa, Ethiopia: CIMMYT-CCAFS. National Workshop on Climate Change Adaptation in Ethiopian Agriculture, 19

September 2013, Addis Ababa. Organized by EIAR, CIMMYT and Rockefeller Foundation.

### Output: 4.3.3

#### Summary:

Planning responses to climate change requires the collection and management of huge datasets at local, regional and global scales and the development and refinement of analytical frameworks for estimating the impacts of climate change and adaptation interventions. A framework that integrates biophysical models that simulate crop yields at a pixel level with socioeconomic models that provide aggregated economic impact at a global level has been validated. Using long term maize and wheat yield trial datasets with associated soil, weather and crop management data, a method of estimating the impact of current and future climate extreme events has been developed and tested. The bioeconomic modelling framework developed has been applied to study the national and global impact of the 2012 extreme weather event in the USA, the impact of climate change in maize systems in Africa and the role of adoption of drought tolerant wheat varieties in Asia. The results of these studies have been presented in international conferences and papers are submitted to peer-reviewed international journals. Necessary preparations have also been made to study the impact of climate change and its implications on cereal systems in south Asia. Several outputs in the form of publications etc have been produced in 2013 including:

Chung et al. (2013) Modeling the effect of heat wave on maize production in the USA and its implications on food security in the developing world: a spatial bio-economic approach. *Weather and Climate Extremes* (submitted)

Chung, C., Gbegbelegbe, S., Shiferaw, B., Robertson, R., Jinil Y., Hoogenboom G., Sonder, K., Tesfaye, K. (2013) Response of maize to extreme heat waves and drought in the Corn Belt of USA: Analysis of biophysical and socioeconomic impacts. Poster Presented at the First International Conference on Food Security, 29 September to 2 October, the Netherlands.

Gbegbelegbe, S., Chung, U., Shiferaw, B. Msangi, M., Tesfaye, K. (2013) Quantifying the impact of weather extremes on food security in the developing world: a spatial bio-economic approach. *Weather and Climate Extremes* (submitted)

Gbegbelegbe, S., Kindie Tesfaye, Kenneth Boote, Senthold Asseng, Uran Chung, Richard Roberston, Zaidi P.H., Bekele Shiferaw (2013). Promising wheat and maize technologies: an application of a spatial bio-economic modelling. Poster Presented at the First International Conference on Food Security, 29 September to 2 October, the Netherlands.

Tesfaye, K., Gbegbelegbe, S., Cairns, E., Shiferaw, B., Prasanna B.M., Sonder, K., Boote, J.K., Makumbi, D., Robertson, R. (2013) Maize systems under climate change in sub-Saharan Africa: potential impacts on production and food security. (Submitted)

Tesfaye, K., et al (2013) Maize systems under climate change in sub-Saharan Africa: potential impacts on production and food security. Oral presentation at the the First International Conference on Food Security, 29 September to 2 October, the Netherlands.

### 3. Publications

#### Publication #1

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Jat, ML; Gathala, MK; Saharawat, YS; Tetarwal, JP; Gupta, R and Yadvinder-Singh. 2013. Double no-till and permanent raised beds in maize–wheat rotation of north-western Indo-Gangetic plains of India: Effects on crop yields, water productivity, profitability and soil physical properties. *Field Crops Research* 149: 291-299.

#### Publication #2

**Type:** Book chapters

**CCAFS Themes:** Theme 1, Theme 3

**Citation:** Jat, ML; Kapil, Kamboj, BR; Sidhu, HS; Manpreet- Singh, Bana, A; Bishnoi, DK; Gathala, MK; Saharawat, YS; Kumar, V; Kumar, A; Jat, HS; Jat, RK; Sharma, PC; Sharma, PC; Singh, R; Sapkota, TB; Malik, RK and Gupta, R. 2013. Operational Manual for Turbo Happy Seeder-Technology for managing crop residues with environmental stewardship. International Maize and Wheat Improvement Centre (CIMMYT), Indian Council of Agricultural Research (ICAR), New Delhi, India, p 28.

#### Publication #3

**Type:** Conference proceedings

**CCAFS Themes:** Theme 1

**Citation:** Alderman, P.D., E. Quilligan, S. Asseng, F. Ewert, and M.P. Reynolds (Eds). 2013. Proceedings of the Workshop Modeling Wheat Response to High Temperature. CIMMYT, El Batán, Mexico, 19-21 June, 2013. Mexico, D.F.: CIMMYT.

#### Publication #4

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** JE Cairns, J Hellin, K Sonder, JL Araus, JF MacRobert, C Thierfelder, BM Prasanna. 2013. Adapting maize production to climate change in sub-Saharan Africa. *Food Security* 5, 345-360.

## Publication #5

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** JE Cairns, J Crossa, PH Zaidi, P Grudloyma, C Sanchez, JL Araus, D Makumbi, C Magorokosho, M Bänziger, A Menkir, S Hearne, GN Atlin. 2013. Identification of drought, heat and combined drought and heat tolerance donors in maize (*Zea mays* L.). *Crop Science* 53, 1335-1346.

## Publication #6

**Type:** Working papers

**CCAFS Themes:** Theme 2

**Citation:** Mittal, S. and M. Mehar. 2013. Agricultural information networks, information needs and risk management strategies: a survey of farmers in Indo-Gangetic plains of India. *Socioeconomics Working Paper 10*. Mexico, D.F.: CIMMYT

## Publication #7

**Type:** Journal papers

**CCAFS Themes:** Theme 3

**Citation:** Tirol-Padre, A., Rai, M. Gathala, M., Sharma, S., Kumar, V., Sharma, P.C., Sharma, D.K., Wassmann, R. and Ladha, J. 2014. Assessing the performance of the photo-acoustic infrared gas monitor for measuring CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> fluxes in two major cereal rotations. *Global Change Biology*, 20: 287-299

## Publication #8

**Type:** Conference proceedings

**CCAFS Themes:** Theme 3

**Citation:** Sapkota, T.B., Jat, M.L., and Aryal, J.P. 2013. Is conservation agriculture both money and climate smart? Some examples from North-Western Ingo-Gangetic Plain. Paper presented at *Frontiers in Conservation Agriculture in South Asia and Beyond*, Kathmandu, Nepal, March 26-27, 2013.

## Publication #9

**Type:** Journal papers

**CCAFS Themes:** Theme 3

**Citation:** Sapkota, T.B., Majumdar, K., Jat, M.L., Kumar, A., Bishnoi, D.K., McDonald, A.J., Pampolino, M., 2014. Precision nutrient management in conservation agriculture based wheat production of Northwest India : Profitability , nutrient use efficiency and environmental footprint. *Field Crops Research*. 155, 233–244.

## Publication #10

**Type:** Journal papers

**CCAFS Themes:** Theme 1

**Citation:** Tina Désirée Beuchelt, Lone Badstue (2013). Gender, nutrition- and climate-smart food production: Opportunities and trade-offs. Food Security. Volume 5, Issue 5, pp 709-721.

## Publication #11

**Type:** Other

**CCAFS Themes:** Theme 1

**Citation:** Towards nutrition- and climate-smart agriculture: discussing trade-offs from a gender and intragenerational perspective” at the First International Conference on Global Food Security, September 29-October 2, 2013, Noordwijkerhout, The Netherlands.

## Publication #12

**Type:** Other

**CCAFS Themes:** Theme 1

**Citation:** “Evaluating conservation agriculture from a gender and human rights perspective”. Poster presentation at Climate Smart Agriculture: Global Science Conference, March 20-22, 2013, Davis, USA

## Publication #13

**Type:** Other

**CCAFS Themes:** Theme 1, Theme 2, Theme 3, Theme 4.1

**Citation:** Integrating gender aspects in quantitative research: A manual for researchers on agriculture, food security and climate change for rural development. Tina Beuchelt (2013). International Maize and Wheat Improvement Center (CIMMYT).

## Publication #14

**Type:** Journal papers

**CCAFS Themes:** Theme 1, Theme 3

**Citation:** Jat, ML; Satyanarayana, T, Majumdar, K; Parihar, CM; Jat, SL; Tatarwal, JP; Jat, RK and Saharawat, YS. 2013. Fertiliser Best Management Practices for Maize Systems. Indian Journal of Fertilizers. 9 (4): 80-94.

## Publication #15

**Type:** Policy briefs

**CCAFS Themes:** Theme 4.1

**Citation:** M. Misiko.,P. Mundy. and P. Ericksen. 2013. Innovation platforms to support natural resource management. Innovation Platforms Practice Brief 11. Nairobi, Kenya: ILRI.

## Publication #16

**Type:** Book chapters

**CCAFS Themes:** Theme 4.1

**Citation:** A. Agboh-Noameshie., A. Kabore., M. Misiko. 2013. Integrating gender considerations in rice research for development in Africa. Chapter: 28 (Page no: 343). In: M. Wopereis., C. S. Johnson., D. E. Ahmadi., N. Tollens., E. Jalloh. (Editors). Realizing Africa's rice promise. London: CABI.

## Publication #17

**Type:** Journal papers

**CCAFS Themes:** Theme 4.1

**Citation:** M. Misiko. 2013. Dilemma in participatory selection of varieties. Agricultural Systems 119: 35-42.

## 4. Communications

### Media campaigns:

Date	Newspaper	Web Link
06-05-2013	The Tribune	<a href="http://www.tribuneindia.com/2013/20130506/haryana.htm">http://www.tribuneindia.com/2013/20130506/haryana.htm</a>
22-01-2013	Danik Jagran	<a href="http://epaper.jagran.com/epaper/2013-172-panipat-edition-karnel.html">http://epaper.jagran.com/epaper/2013-172-panipat-edition-karnel.html</a> Karnal
21-05-2013	Danik Jagran	<a href="http://epaper.jagran.com/epaper/2013-172-panipat-edition-karnel.html">http://epaper.jagran.com/epaper/2013-172-panipat-edition-karnel.html</a> Karnal
16-02-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/16022013/page/4\$3">http://haryana.punjabkesari.in/karnal/news/16022013/page/4\$3</a>
19-02-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/19022013/page/3\$3">http://haryana.punjabkesari.in/karnal/news/19022013/page/3\$3</a>
15-03-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/15032013/page/2\$3">http://haryana.punjabkesari.in/karnal/news/15032013/page/2\$3</a> Karnal
	Amar Ujala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a> Karnal
28-04-2013	Amar Ujala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a>
05-06-2013	Danik Jagran	<a href="http://epaper.jagran.com/epaper/5-jun-2013-172-panipat-edition-karnel.html">http://epaper.jagran.com/epaper/5-jun-2013-172-panipat-edition-karnel.html</a>
22-08-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/22082013/page/2\$3">http://haryana.punjabkesari.in/karnal/news/22082013/page/2\$3</a>
18-09-2013	Amar Ujala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a>
18-09-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/18092013/page/4\$3">http://haryana.punjabkesari.in/karnal/news/18092013/page/4\$3</a>
18-09-2013	Danik Bhasker	<a href="http://epaper.bhaskar.com/karnal-bhaskar/102/18092013/cph/1/">http://epaper.bhaskar.com/karnal-bhaskar/102/18092013/cph/1/</a>
21-09-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/21092013/page/4\$3">http://haryana.punjabkesari.in/karnal/news/21092013/page/4\$3</a>
21-09-2013	Danik Bhasker	<a href="http://epaper.bhaskar.com/karnal-bhaskar/102/21092013/cph/1/">http://epaper.bhaskar.com/karnal-bhaskar/102/21092013/cph/1/</a>
26-09-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/26092013/page/4\$3">http://haryana.punjabkesari.in/karnal/news/26092013/page/4\$3</a>
29-09-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/29092013/page/2\$3">http://haryana.punjabkesari.in/karnal/news/29092013/page/2\$3</a>
28-10-2013	Amar Ujala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a>
29-10-2013	Danik Bhasker	<a href="http://epaper.bhaskar.com/karnalbhaskar/102/29102013/cph/1/">http://epaper.bhaskar.com/karnalbhaskar/102/29102013/cph/1/</a>
01-12-2013	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/01122013/page/3\$3">http://haryana.punjabkesari.in/karnal/news/01122013/page/3\$3</a>
01-12-2013	Danik Jagran	<a href="http://epaper.jagran.com/epaper/01-dec-2013-172-karnel-Page-1.html">http://epaper.jagran.com/epaper/01-dec-2013-172-karnel-Page-1.html</a>
01-12-2013	Danik Bhasker	<a href="http://epaper.bhaskar.com/karnal-bhaskar/102/02122013/cph/1/">http://epaper.bhaskar.com/karnal-bhaskar/102/02122013/cph/1/</a>
13-12-2013	Danik Bhasker	<a href="http://epaper.bhaskar.com/karnal-13-12-2013-bhaskar/Karnal/102/03122013/cph/3/">http://epaper.bhaskar.com/karnal-13-12-2013-bhaskar/Karnal/102/03122013/cph/3/</a>
15-12-2013	Amar Ujjala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a>
15-12-2013	Danik Bahsker	<a href="http://epaper.bhaskar.com/karnal-15-12-2013bhaskar/Karnal/102/15122013/cph/3/">http://epaper.bhaskar.com/karnal-15-12-2013bhaskar/Karnal/102/15122013/cph/3/</a>
15-12-2013	Karnal Bhasker	<a href="http://epaper.bhaskar.com/karnal-15-12-2013bhaskar/Karnal/102/15122013/cph/1/">http://epaper.bhaskar.com/karnal-15-12-2013bhaskar/Karnal/102/15122013/cph/1/</a>
25-12-2013	Amar Ujala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a>
03-01-2014	Punjab Kesari	<a href="http://haryana.punjabkesari.in/karnal/news/03012014/page/1\$3">http://haryana.punjabkesari.in/karnal/news/03012014/page/1\$3</a>
04-01-2014	Amar Ujala	<a href="http://epaper.amarujala.com/svww_index.php">http://epaper.amarujala.com/svww_index.php</a>
23-07-2013	Aaj	Videshi
	Vegyaniko ne krishi ke gur sikhayae	Patna
05-05-2013	Danik Jagran	<a href="http://epaper.jagran.com/epaper/2013-172-panipat-edition-karnel.html">http://epaper.jagran.com/epaper/2013-172-panipat-edition-karnel.html</a>
15-11-2013	Aaj	Mahilayaon ne zero tillage machine se ki boaiyee Patna

### Blogs:

Researchers do the crop breeding math

<http://blog.cimmyt.org/?p=11408>

Project tests new ways to deliver climate messages to farmers' cell phones <http://blog.cimmyt.org/?p=11575>

<http://blog.cimmyt.org/?tag=nutrient-expert>

Nutrient Expert™ decision support tools for maize and wheat launched.

<http://blog.cimmyt.org/?p=11575> Project tests new ways to deliver climate messages to farmers' cell phones  
<http://blog.cimmyt.org/?p=11557> Asia: Spreading conservation agriculture, developing

researchers  
<http://blog.cimmyt.org/?p=11195> Bioversity, Borlaug Institute for South Asia and CIMMYT work more closely on climate resilient farming in eastern India  
<http://blog.cimmyt.org/?p=11149> CIMMYT launches

mobile phone voice messaging for climate-smart villages in India  
<http://blog.cimmyt.org/?p=10910> Making villages 'climate smart'.  
<http://blog.cimmyt.org/?p=10712> CIMMYT/CCAFS in India: Gender, action, research.

<http://blog.cimmyt.org/?p=10484> Promoting resilient diversification options through maize and climate smart practices in India.  
<http://blog.cimmyt.org/?p=9902> Haryana Chief Minister: conservation agriculture is the way of future farming.

<http://ccafs.cgiar.org/blog/climate-smart-villages-india-show-early-signs-success#.UufNzNq6bVI> Climate smart villages in India show early signs of great reform achievements

Project tests new ways to deliver climate messages to farmers' cell phones- Surabhi Mittal and Dharini Parthasarthy, CCAFS- News Blog, Nov 21, 2013. [http://ccafs.cgiar.org/blog/project-tests-new-ways-deliver-climate-related-messages-farmers-cell-phones?utm\\_source=CCAFS+Donors+and+Partners++Quarterly+bulletin&utm\\_campaign=b94fd51809-Updates\\_from\\_CCAFS\\_December\\_2013&utm\\_medium=email&utm\\_term=0\\_31d02b497e-b94fd51809-295603057#.UtOquvQW22o](http://ccafs.cgiar.org/blog/project-tests-new-ways-deliver-climate-related-messages-farmers-cell-phones?utm_source=CCAFS+Donors+and+Partners++Quarterly+bulletin&utm_campaign=b94fd51809-Updates_from_CCAFS_December_2013&utm_medium=email&utm_term=0_31d02b497e-b94fd51809-295603057#.UtOquvQW22o)

[http://ccafs.cgiar.org/blog/project-tests-new-ways-deliver-climate-related-messages-farmers-cell-phones?utm\\_source=CCAFS+Donors+and+Partners++Quarterly+bulletin&utm\\_campaign=b94fd51809-Updates\\_from\\_CCAFS\\_December\\_2013&utm\\_medium=email&utm\\_term=0\\_31d02b497e-b94fd51809-295603057#.UtOquvQW22o](http://ccafs.cgiar.org/blog/project-tests-new-ways-deliver-climate-related-messages-farmers-cell-phones?utm_source=CCAFS+Donors+and+Partners++Quarterly+bulletin&utm_campaign=b94fd51809-Updates_from_CCAFS_December_2013&utm_medium=email&utm_term=0_31d02b497e-b94fd51809-295603057#.UtOquvQW22o)

[http://ccafs.cgiar.org/blog/project-tests-new-ways-deliver-climate-related-messages-farmers-cell-phones?utm\\_source=CCAFS+Donors+and+Partners++Quarterly+bulletin&utm\\_campaign=b94fd51809-Updates\\_from\\_CCAFS\\_December\\_2013&utm\\_medium=email&utm\\_term=0\\_31d02b497e-b94fd51809-295603057#.UtOquvQW22o](http://ccafs.cgiar.org/blog/project-tests-new-ways-deliver-climate-related-messages-farmers-cell-phones?utm_source=CCAFS+Donors+and+Partners++Quarterly+bulletin&utm_campaign=b94fd51809-Updates_from_CCAFS_December_2013&utm_medium=email&utm_term=0_31d02b497e-b94fd51809-295603057#.UtOquvQW22o)

### Websites:

A smart solution: Agricultural innovation and gender-aware approaches posted on Monday, 14 October 2013. <http://www.cimmyt.org/en/where-we-work/global-activities/item/a-smart-solution-agricultural-innovation-and-gender-aware-approaches>

<http://www.icar.org.in/en/node/7102>; Brainstorming Workshop on 'Precision Agriculture in Nutrient Management', 19th November 2013, Patna <http://www.ipni.net/article/IPNI-3349>; Workshop held on Precision Agriculture in Nutrient Management, Nov 19, 2013 at Patna, Bihar, India

[http://haryanakisanayog.org/Reports/Kisan\\_Diwas\\_Proceedings.pdf#zoom=100%](http://haryanakisanayog.org/Reports/Kisan_Diwas_Proceedings.pdf#zoom=100%), Prosperity through Diversification in Agriculture, December 22-23, 2012 at Karnal Haryana, India

### Social media campaigns:

Flickr <http://www.flickr.com/photos/44760652@N05/9737370686/in/photolist-fQsz4u> (Was also our Facebook cover photo for a week and was published in the Informa) Twitter An average of 1-2 tweets per month promoting CCAFS-related content (mostly reposted from CCAFS social media blasts)

Facebook <https://www.facebook.com/pages/Society-for-Conservation-of-Natural-Resources-Empowering-Rural-Youth/176159009186058>

### Newsletters:

Articles in both the Informa and on CIMMYT's blog Training on weed control in direct seeded rice will boost farmers' confidence <http://blog.cimmyt.org/?p=11105> CIMMYT launches mobile phone voice messaging for climate-smart villages in India <http://blog.cimmyt.org/?p=11149> Bioversity, Borlaug Institute for South Asia and CIMMYT work more closely on climate resilient farming in eastern India <http://blog.cimmyt.org/?p=11195> Climate change workshop addresses research outputs in Ethiopia <http://blog.cimmyt.org/?p=11335> Goodbye and good luck to Bekele Shiferaw (one mention of CCAFS) <http://blog.cimmyt.org/?p=11381> Asia: Spreading conservation agriculture, developing researchers <http://blog.cimmyt.org/?p=11557> CIMMYT/CCAFS in India: Gender, action, research <http://blog.cimmyt.org/?p=10712> CIMMYT-CCAFS modeling team discusses gender in Ethiopia <http://blog.cimmyt.org/?p=10830> Haryana Chief Minister: conservation agriculture is the way of future farming <http://blog.cimmyt.org/?p=9902> Global Maize Program meeting: The old and the new intersect in Kathmandu <http://blog.cimmyt.org/?p=9964> CIMMYT-India interacts with farmers at IARI Agriculture Science Fair <http://blog.cimmyt.org/?p=10219> Promoting resilient diversification options through maize and climate smart practices in India <http://blog.cimmyt.org/?p=10484> International scientists compare hot models at CIMMYT <http://blog.cimmyt.org/?p=10620> Nutrient Expert™ decision support tools for maize and wheat launched <http://blog.cimmyt.org/?p=10631> Making villages 'climate smart' <http://blog.cimmyt.org/?p=10910> The struggle of maize against climate change in Zimbabwe <http://blog.cimmyt.org/?p=10945> Are mobile phones helping farmers? <http://blog.cimmyt.org/?p=11074> Training on weed control in direct seeded rice will boost farmers' confidence <http://blog.cimmyt.org/?p=111051>. Opportunities for Youth in Agriculture <http://haryanakisanayog.org/NewsLetters/Eng.Oct-Dec%20Newsletter,2013.pdf#zoom=100%> Resilient Diversification Options through Maize and Climate Smart Practices [http://haryanakisanayog.org/NewsLetters/Eng\\_Newsletter\\_Apr-Jun\\_2013.pdf#zoom=100%](http://haryanakisanayog.org/NewsLetters/Eng_Newsletter_Apr-Jun_2013.pdf#zoom=100%) Increasing climate literacy of Indian Farmers; CCAFS' Climate Smart Agriculture Learning Platform, South Asia, January 2013 Climate Smart Villages in South Asia; CCAFS' Climate Smart Agriculture Learning Platform, South Asia, April 2013

### Events:

Workshop Modeling Wheat Response to High Temperature. CIMMYT, El Batán, Mexico, 19-21 June, 2013. Mexico, D.F.: CIMMYT. Available at: <http://repository.cimmyt.org/xmlui/handle/10883/3211.16>-18th Sept. 2013 National Travelling Seminar on Conservation Agriculture New Delhi/Karnal/Patna/Samastipur/Jabalpur. Travelling Seminar 15-17th Feb. 2013 Hands on Training on CA Machinery Karnal Training 20th May 2013 Stakeholder Consultation on Promoting Resilient Diversification Option through Maize & Climate Smart Practices CSSRI, Karnal Workshop 29th April 2013 Brain-Storming Session on Conservation Agriculture: Soil carbon changes and nitrogen responses New Delhi Workshop 22-25th Oct. 2013 Pathways of gender equity led climate smart farming: learning's from stakeholders DWR, Karnal Workshop 14th Nov. 2013 Regional workshop on Precision Agriculture-Concepts, Tools and Implementation Road Map in Smallholder systems in South Asia PAU, Ludhiana Workshop 20th June 2013 Launching of Nutrient Expert™ decision support tools for Maize and Wheat New Delhi Workshop 19th Nov. 2013 Brainstorming workshop on Precision Agriculture in Nutrient Management – Present Status And Future Need in Eastern India ICAR Complex, Patna Workshop 6th March 2013 Training of Nutrient Expert for Maize and Wheat for State Agriculture Department Patna Training 22nd July 2013 In-field stakeholder consultation on empowering gender for climate smart agriculture Bhattadashi, Vaishali, Bihar Consultation 15-18th March 2013 Wheat crop

management meeting with Farmers Bhatgadashi, Vaishali, Bihar Farmer meeting 3rd March 2013  
Kisan Mela RAU, Pusa, Samastipur, Bihar Farmers fair 16th March 2013 Kisan Mela IARI regional station,  
Pusa, Bihar Farmers fair 3rd June 2013 Gender Empowerment Awareness Meeting Bhattadashi, Vaishali, Bihar  
Consultation 16-18th August 2013 Rabi Planning meetings Bhattadashi/Rajapakar/ Mukundpur/Mahua,  
Vaishali, Bihar Farmer meeting. National Workshop on Climate Change Adaptation in Ethiopian Agriculture, 19  
September 2013, Addis Ababa. Organized by EIAR, CIMMYT and Rockefeller Foundation. Addressing gender in  
modeling and simulations. Workshop conducted on 4 July 2013, Addis Ababa, Ethiopia: CIMMYT-CCAFS.

### Videos and other multimedia:

See other sections

### Other communications and outreach:

Conservation Farming: Haryana village shows the way. Sept 25th Financial Express.  
<http://www.financialexpress.com/news/conservation-farming-haryana-village-shows-the-way/1173689>

## 5. Case studies

### Case Study #1

**Title:** Empowering women farmers in Haryana to make well-informed and timely decisions to reduce household exposure to climate risks.

**Author:** Surabhi Mittal

**Type:** Social differentiation and gender, Successful communications

#### Project description:

The project “Dissemination of Climate smart agro-advisories to farmers in CCAFS benchmark sites of India” is a pilot that which aims to provide timely, weather-based advice and information to farmers to support decision making and reduce exposure to risk and uncertainty. The pilot service, which is delivered through voice messaging, was launched on 15th August, 2013 in four villages of Karnal district of Haryana and subsequently in Vaishali district of Bihar on 1st September, in partnership with IFFCO Kissan Sanchar Limited (IKSL, as the content partner) and Kisan Sanchar (as the dissemination and implementing agency). The overall aims of this project activity are to (i) improve farmer access to information relating to climate smart technologies and (ii) measure the impact of mobile phone based knowledge dissemination on farmer decision making and adoption of new technologies. This project covers more than 1000 female and male farmers in 8 villages and two voice messages are sent out every day to each farmer on their mobile phones along with some detailed SMS messages as and when required in Hindi under the banner of CCAFS. These dynamic messages provide weather predictions and prescriptions, information about pests and remedies, details of climate smart technologies and general awareness about climate change and solutions. A data base of farmers along with their mobile numbers has been created and is continuously updated. A customized feedback mechanism has also been set up by the project through a mobile phone based helpline and also field based and telephonic feedback surveys.

#### Introduction / objectives:

Farmers face new challenges due to lack of access to relevant information to enable them to deal with the issues of climatic variability and associated risks in decision making, market uncertainty, relevant new technology etc. This widely impacts on the effectiveness of their decision making and also significantly affects farm yields and agricultural profitability. To address these constraints, CIMMYT is undertaking a study to assess the effects of climate smart agro-advisory dissemination services in treatment and control villages at CCAFS benchmark sites in India- Haryana and Bihar. The study is looking at how farmers view the usefulness of information received on mobile phones, whether it leads to farmer action and overall changes in behaviour and awareness towards climate change and climate smart technologies.

### Project results:

Although most women in rural India are directly or indirectly engaged in agricultural activities, due to cultural barriers and traditional mind sets, the general view is that little is to be gained from raising their awareness of new technologies and weather-based agro advisories. Against this background, it has been a challenge to get women involved in the pilot study. However, as the team started interacting with women farmers, elected heads of villages in Haryana (which were women in some villages) and started mobilising the educated women in male-headed households, there have been some very interesting observations. Overall the average listening rate to messages (this is defined in terms of duration (in seconds) of the voice message call) by women farmers is higher than that of men. The feedback from women farmers often report that the information they listen to on their mobile phones has helped to increase their knowledge about the climate smart technologies and improve the efficiency of input use because they are better able to make an informed contribution to household decision making. The most encouraging feedback has been in the form of an email received from a woman farmer in Anjanthali village of Haryana, who credited the project to raising her awareness of modern agricultural practices and how that they might help her family to do better in agriculture and reduce risk due to climate variability. She has also started motivating other women in the village and creating awareness towards the same goal. Most of the women participants in the CCAFS pilot study now feel they are able to discuss new approaches to agriculture with male members of the family; something they did not feel sufficiently confident to do in the past.

### Partners:

1. Kisan Sanchar- Role of disseminating voice messages in villages, collecting feedback from farmers and providing helpline support
2. IFFCO Kisan Sanchar Limited- Compiling and recording voice messages and generating weather based agro advisories

### Links/sources for further information:

1. The Email from one of the women farmer, Mrs Ruby Mehla
2. The completed feedback forms about the voice message service signed by individual women farmers
3. Media article in local language in local newspaper about interaction of project with women groups and its benefits([http://epaper.punjabkesari.in/karnal/fullstory/28860826\\_314878?fb\\_action\\_ids=10152147466889066&fb\\_action\\_types=og.likes&fb\\_source=other\\_multiline&action\\_object\\_map=%5B707713939262897%5D&action\\_type\\_map=%5B%22og.likes%22%5D&action\\_ref\\_map=%5B%5D](http://epaper.punjabkesari.in/karnal/fullstory/28860826_314878?fb_action_ids=10152147466889066&fb_action_types=og.likes&fb_source=other_multiline&action_object_map=%5B707713939262897%5D&action_type_map=%5B%22og.likes%22%5D&action_ref_map=%5B%5D)).
4. Listening rate data base

## Case Study #2

**Title:** Precision nutrient management for smallholder systems of South Asia: a dream becomes a reality

**Author:** ML Jat

**Type:** Capacity enhancement, Policy engagement

### Project description:

Conventionally, farmers in intensive systems of the IGP apply nutrients as a large area-based blanket recommendation for different cropping systems, often in high doses to ensure high productivity. Many farmers often use uniform rates of fertilizers based on expected yields (yield goal) that could be inconsistent from field-to-field (spatial) and year-to-year (temporal) variability of soil nutrient supply, thereby reducing the efficiency of fertilizer use. In season, site-specific nutrient management has the potential to greatly improve on blanket fertilizer recommendations and deliver high yields, economic profitability, nutrient-use efficiency and possibility reduce fertilizer nutrient-related environmental pollution. With 84% or more operational land holdings in India having less than 2 ha (remaining 10-15% up to 10 ha), it seems that fertilizer nutrient-use efficiency can be improved through field-specific fertilizer nutrient management because it takes care of both spatial and temporal variability in soil nutrient supply. Successful strategies comprise of management options based on location-specific fertilizer nutrient requirements of crops as per year-to-year variations in climate and spatial as well temporal variations of indigenous soil nutrient supplies due to inherent properties and management practices. Wheat and Maize Nutrient Expert (NE) decision support tools for site-specific nutrient management developed by IPNI and CIMMYT validated and released for free public use have been deployed in CCAFS target sites for precision nutrient prescriptions in contrasting management scenario in presence and absence of soil test values. Also, to attain further precision in N management, GreenSeeker hand held sensors were deployed through farmer participation. Through capacity enhancement of young farmers and extension agents, the tools and sensors are being up-scaled and out-scaled for improving NUE, enhance yield and reduce environmental foot prints.

### Introduction / objectives:

Farmers in intensive rice-wheat production systems of northwest India generally apply fertiliser nutrients in unbalanced ratios, with higher rates of N leading to low nitrogen use efficiency (NUE). This is mainly due to lack of farmer access to spatial and temporal soil fertility data and location/situation-specific crop nutrient requirements for a given targeted yield. In this study, the Nutrient Expert (NE) Decision Support tool for wheat and the handheld GreenSeeker sensors were evaluated for precision nutrient application through participatory action research with the aim of scaling up and out precision nutrient management practices relevant to smallholder farmers.

### Project results:

Precision nutrient prescription based on the Nutrient Expert Decision Support tool were compared with Ad-hoc recommendations as well as farmers' fertilizer practice (FFP) in wheat using a large number of participatory field trials across the IGP. The economic assessment of the different options indicated the value of the Nutrient Expert in enhancing wheat yield (0.5 to 1.5 t/ha) and economic profitability (US\$ 100-250/ha) over Farmers Practice and State Recommendations under both conventional and zero tillage wheat. The greater efficiency of use of nutrients when applied according to Nutrient Expert recommendations compared with Farmers Practice indicated that better targeting of N (both spatially and temporally) reduced N losses and by implication greenhouse gas emissions. The global warming potential of Nutrient Expert based prescriptions was 100-150 CO<sub>2</sub>-eq/ha lower than Farmers Practice. Moreover, Nutrient Expert supplemented with GreenSeeker sensor guided post emergent N application further improved the yield and NUE. These findings verified the potential

use of Nutrient Expert decision tool and GreenSeeker sensors for farmers, industry agronomists and government extension personnel to provide field-specific nutrient recommendations for improved yields, NUE, farm profits and reduced GHG emissions. Through on-farm trials, partnerships, capacity building and awareness in CCAFS target sites, the tools have been adopted by educated young farmers/farmer groups and extension personals for precision nutrient management. During 2013, over 600 farmers used these tools in the CCAFS grids in IGP. Discussions with key partners have resulted in the tools being advocated by the policy planners. Further research and actions are been undertaken to introduce precision nutrient management in policy guidelines as a way ahead to sustainable agriculture in smallholder systems.

### Partners:

- International Plant Nutrition Institute (IPNI): Development and validation of Nutrient Expert Decision Support tool
- International Maize and Wheat Improvement (CIMMYT): Development and validation of Nutrient Expert Decision Support tool, validation of G

### Links/sources for further information:

<http://blog.cimmyt.org/?tag=nutrient-expert>; <http://www.icar.org.in/en/node/7102>;

<http://www.ipni.net/article/IPNI-3349>;

[http://haryanakisanayog.org/Reports/Kisan\\_Diwas\\_Proceedings.pdf#zoom=100%](http://haryanakisanayog.org/Reports/Kisan_Diwas_Proceedings.pdf#zoom=100%) Sapkota, T.B., Majumdar, K., Jat, M.L., Kumar, A., Bishnoi, D.K., McDonald, A.J., Pampolino, M., 2014. Precision nutrient management in conservation agriculture based wheat production of Northwest India: Profitability, nutrient use efficiency and environmental footprint. *Field Crops Research*. 155, 233–244.

## Case Study #3

**Title:** Developing a new generation of researchers on quantification of climate change mitigation

**Author:** Tek Sapkota

**Type:** Capacity enhancement

### Project description:

A participatory strategic research platform has been established at Taraori, Karnal in addition to on-station research trials on precision-conservation agriculture in wheat and maize systems at CSSRI Karnal (Karnal), DMR, New Delhi and Rajendra Agricultural University, Pusa (Bihar) and these trails have been equipped with GHG measurement facilities. Graduate students from different agriculture universities of India were awarded a research stipend (from CCAFS W1, W2 as well as bilateral projects) to work in these trials for their PhD thesis research. Students were involved in trial management, GHG sampling and necessary data recording regularly under the supervision of CIMMYT scientists. Students were also trained on GHG analysis using GC, calculation and interpretation of emission data. In addition to students, interns and young researchers from NARS were deployed at respective locations for analysis and quantification of GHGs and C-sequestration. Periodically, we receive request from various universities to host their students as interns and to train them on GHG analysis. We

accept some of them based on their interest, strength and availability of CIMMYT staff time to supervise them. The student interns stay with us for three to six months and receive training in gas sampling, gas analysis in GC, C-sequestration and data compilation and also help us with these activities once they are trained. We pay a nominal subsistence fee for them towards the cost of living at our project sites. This has been a win-win situation for the project and for the students as they acquire important skills in quantification of the mitigation potential of different management practices whilst the project benefits from additional help with on-going research. In addition, we also organize short-term training for the young scientists from NARS who work at our project sites. We also host students from Climate Food and Farming Research Network (CLIFF) to train them on GHG quantification method.

### **Introduction / objectives:**

Quantification of greenhouse gas (GHG) emissions from smallholder production system is necessary to understand agriculture's contribution to total GHG emissions, to identify replicable, farmer-friendly mitigation options and to influence policies for investment priorities of the national and local Government. However, developing countries lack a critical mass in terms of suitably trained research personnel experienced in the quantification of GHG emissions from agro-ecosystems. Under the pro-poor climate change mitigation theme of CCAFS, university students, interns and young scientists from National Agricultural Research System (NARS) in India are being trained by CIMMYT in the measurement, analysis and calculation of GHG fluxes and C-sequestration using a range of approaches.

### **Project results:**

So far four interns, one each from Banaras Hindu University, Janta Vedic College, Maharshi Dayanand University and Bihar Agricultural University were trained on GHG measurements by using chamber methods. One PhD student from Chaudhary Charan Singh Haryana Agricultural University Hisar completed a PhD with us on "GHG emission effect of various crop establishment methods and N management techniques in rice-wheat system". Similarly, 3 more students from the same university are conducting their PhD research on resource use efficiency, carbon footprint, C-sequestration and GHG mitigation of precision and conservation agriculture based management practices in rice, wheat and maize based cropping systems. Besides, two PhD students from Climate Food and Farming Research Network (CLIFF) are currently working with us and being trained on GHG sampling, analysis in GC and calculation and interpretation of the result using chamber method. In addition, 10 young scientists from NARS have been trained through short training programs on GHG emission measurements using various techniques, C-sequestration and analysing carbon foot prints of the contrasting management practices in the cereal base systems important for the food security. By training students, interns and young researchers on quantification of climate change mitigation using various techniques, we are developing a critical mass to help quantification of GHGs from smallholder production system so as to communicate the results with policy planners and government to prioritise technologies, practices and investments through enabling policy to ensure low emission and sustainable food production system in the developing world.

### **Partners:**

1. Chaudhary Charan Singh Haryana Agricultural University, Hisar-125 004, India: Providing research Scholar and deploying researchers
2. Rajendra Agricultural University, Pusa-Bihar, India: Hosting Research

trials 3. Borlaug Institute of South Asia (BISA),

### Links/sources for further information:

Letter of agreement/intent with concerned state agricultural universities/ICAR institutes, CIMMYT informa/blog, CLIFF web

## Case Study #4

**Title:** Characterising the diversity of farming systems for better targeting of climate smart practices.

**Author:** Santiago Lopez Ridaura

**Type:** Social differentiation and gender

### Project description:

Existing farm household survey data was used to classify farming systems in terms of their resources, their livelihood activities and their cropping systems. Based on clustering of farm households and their description, within site recommendation domains for specific cereal-based cropping systems alternatives were delineated and main opportunities and bottlenecks for their adoption by different farm types identified. CCAFS baseline household surveys were used for developing typologies at two sites in India and two sites in Kenya. For Mexico, a survey conducted within the MasAgro program was used.

### Introduction / objectives:

Characterising the diversity of farming systems is essential to delineate recommendation domains for different innovations. In cereal-based systems, the successful development of alternative cropping systems requires that they are compatible with the resource endowment and the full range of activities carried out by farming households. Grouping farming systems on the basis of their resources and livelihood activities, as well as current cropping practices, provides a guideline for the development of suitable adapted innovations and better targeting in their dissemination. The objective of this project was to characterise farming systems and their within site diversity for better development and targeting of cropping systems alternatives based on conservation agriculture principles.

### Project results:

In all cases, large within-site diversity of farming systems exist. In Mexico, farm types are mainly distinguished by their wealth and possibilities for investment in agriculture, the kind of cropping and livestock systems and their level of integration as well as the intensity of inputs used. In Kenya, their assets, the presence of livestock, the type of cropping systems, input use, off- and out-farm activities, labour allocation and the source of food and cash are the main factors differentiating farms. In India, the resources available, their access to irrigation and to loans or credits, the types of cropping and livestock systems and the main off- and out-farm activities are the main determinants. In general terms, better-off farmers have multiple on-farm activities for food and cash production, they intensify production and have other stable sources of off-farm income in the form of

businesses or paid jobs. These groups of farmers might be a target group for sustainable intensification of cropping systems based on the principle of conservation agriculture as they have access to inputs and mechanical ploughing. Conservation agriculture option might reduce their need to hire agricultural labour, however these farmers are also characterised by having large livestock and the competition for crop residues might be high. Nonetheless, appropriate rotations and crop management might allow these farmers to step up from their current food insecurity levels. At the other extreme of the wealth gradient, there are groups of farm households that could be considered the resource poor non-livestock farmers. These groups are normally the more food insecure with less land, mostly dedicated to food crops. They use few inputs for crop production and obtain cash from off-farm agricultural labour. Because of the absence of livestock activities, these groups of farmers may be able to implement alternative cropping systems based on residue retention for increased soil fertility and resource use efficiency - imperatives for these resource-limited farm households. However, options for mechanisation and higher intensification of the cropping systems seem difficult. Options for farmers with little land and few assets might be based on rotations and intercropping systems of food crops with cash crops (including fodder for other farmers).

**Partners:**

MasAgro Partners for Mexico, CIMMYT regional researchers for Kenya and India

**Links/sources for further information:**

See CIMMYT-CCAFS 2013 reports.

## 6. Outcomes

### Outcomes #1

#### Title:

CIMMYT-CCAFS research informs the Ethiopian government's Climate Change Adaptation Strategy (CCAS).

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

The Ethiopian government's Climate Change Adaptation Strategy (CCAS) is informed by CIMMYT-CCAFS research outputs.

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

The major research outputs include the following: EIAR and CIMMYT (2012) Past and future intra-seasonal climate futures in maize- and wheat- based systems in Ethiopia. Research Report, Addis Ababa. EIAR and CIMMYT (2012) Past and projected drought occurrence and frequency in maize- and wheat- based systems in Ethiopia. Research Report, Addis Ababa. EIAR and CIMMYT (2013) Temporal and spatial distribution of climate extremes in Ethiopia. Research Report, Addis Ababa. National Workshop on Climate Change Adaptation in Ethiopian Agriculture, 19 September 2013, Addis Ababa. Organized by EIAR, CIMMYT and Rockefeller Foundation.

#### What partners helped in producing the outcome?

The Ethiopian Institute of Agricultural Research (EIAR) Melkasa Agricultural Research Centre (MARC) National Meteorology Agency (NMA)

#### Who used the output?

The outputs of the research were used by federal climate change experts and advisors in the Ministry of Agriculture and Ethiopian Environmental Protection Authority, the international consultant tasked to develop the draft climate change adaptation strategy and, and representatives from regional states who participated in consultative meetings.

#### How was the output used?

The Ethiopian Agricultural Institute (EIAR) is considered as a major provider of research evidence for many of the issues that need policy intervention by the Ethiopian Government. The Biometrics, GIS and Agrometeorology (BGA) directorate of EIAR has been a member of the national taskforce that developed the Climate Resilient Green Economy (CRGE) and subsequent climate change initiatives. CIMMYT-CCAFS collaborated with EIAR (BGA) to generate information on past and future climate in Ethiopia. The research analysed past and future climate from 50 stations distributed in the different agro-ecological zones of the country. The research showed distinct spatial and temporal variations in the studied regions and their policy implications. These results were presented to several stakeholders and once feedback was incorporated, the BGA used the outputs to advise those tasked to develop the adaptation strategy. The outputs were also used by CIMMYT researchers in more than two

consultative meetings held to provide constructive inputs to the draft strategy. The research also helped develop an integrated national climate electronic database at EIAR with a display capacity of raw data, results, scenarios and summary outputs which are relevant for future policy implementation..

**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? Please provide a reference or source.**

The research was conducted by EIAR (contact person Andualem Shimelis) and CIMMYT-CCAFS (contact person Kindie Tesfaye) and was based on past daily climate data (1970-2010) of 50 weather stations within Ethiopia and future climate data in 2030s and 2050s. Evidence of the contribution of the outputs of the research can be traced from the draft climate change policy. Results of the research will be published in peer reviewed journals in 2014. A further source of evidence is the CIMMYT-CCAFS project monitoring report (CIMMYT-CCAFS monitoring report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. November 2013).

## Outcomes #2

### Title:

Government breeding institute introduces a screening program for extra resilience in maize to climate change.

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

The outcome of this research is to increase adaptation of maize systems in Zimbabwe to impacts of increasing temperatures in drought-prone regions through sensitization to the fact that drought tolerance per se does not confer drought tolerance under conditions of elevated temperatures. Through raising awareness of the potential impacts of climate change in Zimbabwe and the need to ensure breeding pipelines incorporate screening for drought and heat tolerance the national program and seed companies are started developing

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

The products of CIMMYT's research into climate projections for Zimbabwe and Research products included: Downscaled climate projections for Zimbabwe at the maize mega-environment level including temperature and monthly rainfall projections (Cairns et al. 2013a) Relationship between drought, heat and combined drought and heat stress (Cairns et al. 2013b) Paper presented at 6th International Crop Science Congress, 6-10 August 2012, Bento Goncalves, Rio Grande do Sul State, Brazil. "Progress in breeding for drought stress tolerant maize in Eastern and Southern Africa" JE Cairns, GN Atlin, T Abate, W Mwangi, P Setimela, B Raman, C Thierfelder, PH Zaidi, S Nair, B Das, C Magorokosho, A Tarekegne, J Crossa, G Mahuku, B Masuka, J MacRobert and BM Prasanna Presentation to the FAO Agriculture Coordination Forum on "Future climate scenarios in Zimbabwe and its implications for maize production" JE Cairns and K Sonder. 25th July 2013. Presentation at the Agricultural Research Trust, Zimbabwe "future climate for Zimbabwe" JE Cairns and K Sonder. 25th February 2013.

### What partners helped in producing the outcome?

Crop Breeding Institute, MAIZE CRP

### Who used the output?

Crop Breeding Institute (Zimbabwe), Ministry of Agriculture (Zimbabwe), Progene, AgriSeeds, SeedCo, Pannar

### How was the output used?

The Crop Breeding Institute is the national breeding institute within the Department of Research and Specialist Services in Zimbabwe. The Crop Breeding Institute is the only public maize breeding institute within Zimbabwe and has developed several key maize hybrids in Zimbabwe. Its research focus is on developing maize with resistance to foliar diseases (grey leaf spot, maize streak virus and turcium leaf blight) and ear rots (Diplodia, Fusarium, Aspergillus), insect resistance (stem borers, maize weevil and large grain borer), drought and low nitrogen tolerance, low soil pH and high nutritional quality (QPM). Based on discussions and presentations summarising the outputs of CCAFS research to maize breeders within the Crop Breeding Institute the institute sought external funding to develop screening capacity to initiate breeding for drought and heat stress. The Crop Breeding Institute was awarded a MAIZE competitive grant to “Screening maize germplasm for tolerance to combined heat and drought stress in Zimbabwe”. The total budget for this project is 50,000 USD and the project duration is 3 years. The Crop Breeding Institute is also a partner in a second MAIZE CRP grant lead by the University of Barcelona on “Affordable Field Based HTPs” to develop high throughput phenotyping capacity using remote sensing techniques to increase breeding efficiency for combined drought and heat stress phenotyping. Zimbabwe historically has a strong maize seed sector. Seed Co is a regional seed company based in Zimbabwe. Recently several new seed companies have emerged including Progene and AgriSeeds which are focusing on the smallholder farmers within the drought-prone regions of Zimbabwe. Presentations and discussions with seed companies have submitted pre-release hybrids for screening under combined drought and heat stress to eliminate unsuitable hybrids from their pipeline and/or avoid promoting unsuitable hybrids. Inbred lines have a lower temperature threshold than hybrids and thus seed production of hybrids is likely to be adversely affected in Zimbabwe where seed companies rely on contract farmers with no irrigation facilities. Progene and AgriSeeds also requested to have inbred lines screened under heat stress..

### 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? Please provide a reference or source.

Interviews between Gerry Gill (external consultant) and Crop Breeding Institute, AgriSeeds and ProGene confirmed the influence of CCAFS outputs on influencing their research strategies. A list of MAIZE competitive grants is available at the following link <http://maize.org/competitive-grants-initiative/> (document: CPG List 2012). The Crop Breeding Institute has two grants the primary institute.

## 7. Outcome Indicator

### Outcome indicator #1

#### Outcome indicator:

One to five flagship technical and/or institutional approaches identified and developed with farmers, key development and funding agencies (national and international), civil society organizations and private sector in three regions, which would directly enhance the adaptive capacity of the farming systems to the climate change conditions

#### Achievements:

One of the output-to-outcome pathways is already in place in the shape of influence on national level institutions. In East Africa, a range of partners is involved with CIMMYT-CCAFS and the NARS in Ethiopia and Kenya have already adopted a conservation agriculture approach. Other partners are national NGOs and, in the case of Zimbabwe, the private sector. At the regional level CIMMYT in Southern Africa works with a number of partners. The Center is a member of the regional CA task force (based in Pretoria, South Africa), which has been promoting adoption of a CA approach by Ministries of Agriculture in the region, and this has now been successful in at least one other case, Malawi, which has reportedly adopted a CA strategic framework broadly similar to that now seen in Zimbabwe. The policy environment for addressing the impact of climate change on agriculture and food security in India is highly conducive to the adoption of many of the outputs from CIMMYT-CCAFS. Following CIMMYT-CCAF's demonstration that maize can replace rice as part of a crop diversification effort, the government has allocated Rs. 5 billion for crop diversification in both Haryana and Punjab in the current year, and has now introduced a support programme for maize similar to existing support for wheat and rice. The plan is for this money to become an annual grant. This policy development was reported by the Central Soil Salinity Research Institute (CSSRI) to have been an Outcome of the Project's work. In Karnal District, Haryana, where the Project has a relatively large number of intervention villages, the Deputy Director of Agriculture reported that perhaps as much as 30 per cent of the land is now under CA as a direct result of the Department's partnership with CIMMYT-CCAFS. Crop diversification, it was reported, has played a key role in this, with 2,000 hectares of maize already having replaced rice, while the target for the Department's current year's Crop Diversification Programme (CDP) is 4,000 ha under maize. The Deputy Director of Haryana's Department of Agriculture reported that the state's CDP had benefited from the findings of CIMMYT-CCAFS work on maize, and that Haryana now had a target of diverting 60,000 ha of paddy land into maize, as a means of addressing the twin problems of deteriorating soil health and unsustainable drawdown on groundwater resources through excessive use of irrigation. The Deputy Director also noted that CIMMYT-CCAFS had been close partners in developing the state's policy on promoting conservation agriculture, and that the ten member Working Group on Conservation Agriculture, which effectively drew up the state's CA policy, included three CIMMYT staff members (including the present leader of the IGP CIMMYT-CCAFS team). He also noted that they did not work with any other international institutions on CC issues, so that the above policy influence can be attributed exclusively to CIMMYT and CIMMYT-CCAFS. Agricultural subsidies are an important policy instrument

in India, and in Haryana CA has been encouraged by the decision of the Chief Minister, after visiting CIMMYT-CCAFS intervention villages, to eliminate the subsidy on rotavators and the divert this funding to the machinery used in CA. In Bihar too, the government recently began taking a close interest in CA, as a result of which it introduced subsidies on direct seeders and other CA equipment. The state's Director of Agriculture reported that over the past three to four years zero tillage (ZT) has become widely used on winter wheat, and according to official estimates covered more than 82,000 acres in 2011-12, while the number of ZT machines in the same year is put at 2,555 against a target of 882.17 The Bihar State Director of Agriculture reported that ZT saves at least 15 days between paddy and wheat – a crucial consideration, as farmers want to sow their wheat crop as early as possible to avoid problems of lack of soil moisture. He also reported that CIMMYT has been supporting ZT in Bihar since 1995, but that this had had little effect until a recent change in state government policy. Another resource conservation technology supported by both the GoB and the Government of India (GoI) is laser land leveller.

### Evidence:

Interviews with senior staff in EIAR and KARI indicate that the agricultural research and extension services in both Ethiopia and Kenya are involved in promoting CA through Innovation Platforms. 2013 Monitoring Report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. Monitoring Consultant. CIMMYT.

## Outcome indicator #2

### Outcome indicator:

Breeding strategies of regional and national crop breeding institutions in three target regions are coordinated, informed by CCAFS-led crop modeling approaches that are developed and evaluated for biotic and abiotic constraints for the period 2020 to 2050

### Achievements:

See also Outcome case study. In Ethiopia, CIMMYT-CCAFS has created capacity inside the EIAR to develop heat-tolerant maize varieties. This has been a three stage process, which entailed: (i) Facilitating EIAR staff to identify the most suitable locations for heat-screening sites; (ii) Funding EIAR to develop these sites to the point at which they could be used for the trials in question, and (iii) Further building on earlier training by providing on-site comprehensive mentoring to develop techniques for:- conducting trials to develop varieties with heat tolerance, and- evaluating heat tolerance in currently available commercial germplasm. This effort has resulted in the development of human and physical capital at a key national development agency to develop flagship technologies which can enhance the adaptive capacity of maize-based farming systems to climate change conditions. In Zimbabwe, interviews with senior staff of the Zimbabwe government's Crop Breeding Institute (CBI), which is one of the project's key development partners, confirmed that CIMMYT-CCAFS work has sensitized the Institute to the fact that drought tolerance per se does not confer drought tolerance under conditions of elevated temperatures. As a result, the CBI last year started its own varietal assessment programme in order to identify those that are both drought- and heat-tolerant. The Institute is now screening its elite products for tolerance to both drought and heat stress – the conditions which climate change is expected to worsen – in order to be able to eliminate products/varieties that are susceptible to heat stress. Removing

drought-tolerant varieties that are not effective under high temperature in water-limited environments will facilitate targeting of varieties to the climatic conditions that are expected to emerge in the medium term. CIMMYT-CCAFS work in both countries is automatically coordinated by the fact that the same CIMMYT maize physiologist is doing the work in both countries, and that the approach adopted in both is broadly similar. In both countries the work is informed by CIMMYT-CCAFS modelling approaches. Crop models were used from the outset to identify hot spots of vulnerability to future climate conditions in order better to target breeding efforts. The main difference between the approach in the two countries is that it was not found necessary to do any capacity building in terms of infrastructure in Zimbabwe. Indeed the fact that capacity building was necessary in one country but not in the other, and that the deficit was filled, is in itself evidence of coordination, as it creates a more level playing field between them.

#### **Evidence:**

2013 Monitoring Report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. Monitoring Consultant. CIMMYT. Interviews with government officials.

### **Outcome indicator #3**

#### **Outcome indicator:**

One to five flagship risk management interventions evaluated and demonstrated by farmers and agencies at benchmark locations in three regions

#### **Achievements:**

The 'flagship' risk management strategies will be developed on the basis of the national survey undertaken this year in Kenya. Activities are highly sequential, and the trajectory is therefore end-loaded, so that few Outcomes can be expected in terms of adoption of policy recommendations until relatively late in the process. That said, some Outcomes have already begun to be achieved in the shape of various forms of capacity building, particularly of partners within KARI's Socio Economics Programme (KARI-SEP). According to the senior staff of KARI who were interviewed during the field visit, the experience of working with CCAFS on conducting a national survey has changed the way the KARI-SEP intends to collect farm level data in future. It has now been decided that in future all KARI socio-economic studies projects will be based on the approach of conducting a baseline survey followed by focus group discussions and biannual collection of panel data from a subset of the sampling frame, which is the approach of CIMMYT-CCAFS. This constitutes a contribution to the PI/IDO. In India, two risk management interventions are under development: management of terminal heat in wheat and raised bed planting (RBP). Senior scientists at the Directorate of Maize Research and the ICAR reported that their institutes were favourably impressed by the fact that CIMMYT-CCAFS has demonstrated that CA is showing feasible alternatives to residue management and that this both improves soil cover and sequesters carbon instead of releasing it into the atmosphere. This constitutes evidence of Outcomes, in the form of awareness-raising.

#### **Evidence:**

2013 Monitoring Report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. Monitoring Consultant. CIMMYT. Interviews with government officials.

## Outcome indicator #4

### Outcome indicator:

Three food crisis response, post-crisis recovery, and food trade and delivery strategies tested and evaluated with partner crisis response organizations at benchmark locations in three regions

### Achievements:

The process of producing Outputs under this Outcome is sequential in nature and the trajectory is end-loaded, so that it is too early to report on Outcomes at this stage.

### Evidence:

## Outcome indicator #5

### Outcome indicator:

Decision-makers in three regions better informed re options and policy choices for incentivizing and rewarding smallholders for GHG emission reductions

### Achievements:

The requirement that decision-makers will be “better informed regarding options and policy choices” by the end of the Year 3 is ambitious. However, in its work on CA-based technologies, CIMMYT-CCAFS is promoting interventions which have clear economic benefits for farmers while simultaneously producing CC mitigation effects. While CA-based technologies are showing much promise on large mechanized farmers in ‘green revolution’ states like Haryana, it could potentially produce similar results with smallholder farmers in areas like Bihar, Bangladesh and the Nepal Terai, where smallholding and animal-powered cultivation predominate. There are, however, two major challenges to be met in realizing this potential. One is that, unlike the situation on mechanized farms, where crop residues are presently of little or no economic value, on smallholder farms they are of high value, having alternative uses as fuel and/or fodder. This is an important set of trade-offs which must be taken into account when policy recommendations are made. The second challenge relates to land tenure. Smallholder farms in the areas in question are often under tenancy arrangements characterized by short-term leases, share cropping and little or no security of tenure. In such circumstances the incentive for farmers to adopt climate smart practices such as CA is greatly reduced because the cultivator will be unable to capture the benefits of longer term improvement in soil health and quality, which is a major benefit of this system.

### Evidence:

The Bihar Government’s Agricultural Road Map notes the need for land reform, and plans to use such measures as Land Possession Certificates and ‘land reforms through re-distributive justice and other measures’, but it also notes the many challenges in the way of achieving such measures.

## Outcome indicator #6

### Outcome indicator:

Project design and monitoring guidelines for smallholder agriculture in developing countries produced and contributing to global standards

### Achievements:

Many agencies, both national and international, have a strong interest in measuring CC mitigation and are expected to become the primary adopters of innovative technologies for measuring changes in emission levels. During interviews with senior officials in both Haryana and Punjab strong interest was expressed in ensuring that their staff of their agricultural research institutes and agricultural universities should learn from the approaches developed by CIMMYT-CCAFS. In a number of cases postgraduate students from state agricultural universities are conducting the experiments, indicating interest on the part of these institutions also. This involvement of key local stakeholders translates into encouraging prospects for the achievement of Outcomes at the national and state levels. At the international level, the IGP team, in collaboration with colleagues in Mexico, is developing a manual and set of field guidelines on emission monitoring. These will constitute the CA component of the work presently being conducted by the global CCAFS team which is developing improved protocols for measuring GHG emissions across the spectrum of agricultural practices. ICRAF is coordinating the effort to develop standard protocols, and CIMMYT-CCAFS work on Output 3.3.1 is feeding into a common protocol, namely Standard Assessment of Mitigation Potential and Livelihoods in Smallholder Systems (SAMPLES). Significant progress has therefore been made towards developing design and monitoring guidelines, but it is as yet too early to assess the extent to which these will eventually contribute to global standards, as required by the PI/IDO. In Mexico, the mitigation work is being incorporated in the policy formation. The government is currently working on the development of the Special Climate Change Program (Programa Especial de Cambio Climático, PECC) 2013-2018. This is the second phase of the PECC 2009-2012, created by the previous government. The PECC was created as part of the Mexican federal government's commitment to fight climate change. This program consists of a series of mitigation and adaptation goals undertaken by various federal agencies. Their monitoring is done by the Technical Secretariat of the Interministerial Commission on Climate Change (CICC), which falls under the Ministry of Environment and Natural Resources (SEMARNAT). In order to develop the actions for the Agricultural Section of the document, the Vice Minister of Agriculture requested CIMMYT's input to develop CC mitigation recommendations based on the measurements done under CCAFS in the long-term trials and the related publications. These recommendations include:

- Reduction of N based trace gas contamination through the use of the NDVI GreenSeeker sensor extension in the high input irrigated regions of Mexico (Wheat and Maize production).
- The variable "Carbon sequestration to reduce the greenhouse effect" has been changed to "net effect of reduction in greenhouse gasses (global warming potential)" and the promotion and monitoring of CA based systems is included in the plan.

### Evidence:

2013 Monitoring Report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. Monitoring Consultant. CIMMYT. Programa Especial de Cambio Climático 2013-2018. Interviews with government officials.

## Outcome indicator #7

### Outcome indicator:

Global database and set of tools for climate-smart agriculture established and used by key international and regional agencies

### Achievements:

There are three components. The first is development of a regional database, and completion of this task will by definition meet the regional component of the Year 3 PI, so that the Research Uptake pathway is straightforward in this particular case. It is, however, difficult to see how achievement of this goal can be described as an Outcome. The second component, dissemination of findings in the region is a necessary, but not a sufficient, condition for achieving the Outcome. Effective dissemination would include training programs and media such as workshops, reports, policy briefs, the CCAFS website, field demonstrations, steering committees and sector/ subsector working groups, and implementation of such activities will form a key step in the uptake process. Towards this end, the CIMMYT-CCAFS Theme 4 team has been planning to host a workshop in 2014 tentatively entitled 'Past and Future Climate Risks for Crop Production in Eastern and Southern Africa'. The third component is adoption of the database and set of tools for climate-smart farming systems by key international and regional agencies. Achievement of this would indeed represent an Outcome. There are two important issues here. The first is that the O-O trajectory for Output 4.2.1 is likely to be quite heavily end-loaded, yet the PI/IDO requires that, not only should the set of tools have been developed by the end of Year 3, but that by that same time these tools should already be in use among 'key international and regional agencies'. This allows no time for the necessary intermediate stages of assessment, evaluation and trialling by these same agencies, and is hence not entirely realistic. The second level of concern relates to the nature of the O-O pathway implied by the combination of the PI/IDO and the Year 10 Outcome statement. While the latter mentions improvements at national, regional and international levels, the former mentions only the second and third of these levels. The implication is that the O-O pathway will be from the Project to regional and international agencies, and that only after they have passed through this conduit will innovations reach the national level. However, as was noted earlier, the closest partners of CIMMYT-CCAFS – and CIMMYT more generally – are the NARS. This is also the case with Output 4.2.1: for example under Output 4.2.1 in Ethiopia meetings are held twice a month by EIAR and CIMMYT-CCAFS to evaluate progress to date – i.e. the technical validity of the work and progress being made. In sharp contrast to this, we are not clear as to the identities of the international and regional agencies with which they might work. CIMMYT is presently working with Global Futures, but for the most part the international partners are other CG centres, particularly IFPRI and the team already works with their modellers. The adoption pathway at this level will be to communicate the outputs to IFPRI, and it is reasonable to assume that if they find these useful they will use them. However it is unclear what other international agencies might be involved.

### Evidence:

2013 Monitoring Report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. Monitoring Consultant. CIMMYT.

## Outcome indicator #8

### Outcome indicator:

New knowledge on how alternative policy and program options impact agriculture and food security under climate change incorporated into strategy development by at least 3 national agencies, and 3 key international and regional agencies

### Achievements:

See Outcome Case Study

### Evidence:

2013 Monitoring Report for Eastern & Southern Africa and the Indo-Gangetic Plain. Gerard J. Gill. Monitoring Consultant.CIMMYT.Interview with Ato Andualem Shimelis, Director, Biometrics, GIS and Agro-meteorology Research Directorate, EIAR.

## 8. Leveraged funds

### Leveraged fund #1

**Title:**

Establish temperature thresholds for tropical maize modelling and determination of hot spots of vulnerability to changing climate

**Partner name:** Maize CRP - competitive grants

**Budget:** \$100000

**Theme:** T1

### Leveraged fund #2

**Title:**

Establish temperature thresholds for tropical maize modelling and determination of hot spots of vulnerability to changing climate

**Partner name:** Crop Breeding Institute (CBI) and Maize CRP

**Budget:** \$189800

**Theme:** T1

### Leveraged fund #3

**Title:**

Government of Haryana creates special funds for competitive projects and of the 16 priority areas they have identified, more than half are on the themes CCAFS have been working and advising on.

**Partner name:** Haryana Farmers Commission

**Budget:** \$2000000

**Theme:** T1

### Leveraged fund #4

**Title:**

CIMMYT-CCAFS staff consulted by the MoA, Government of India to identify target research areas for a call for proposal by the National Food Security Mission.

**Partner name:** Government of India

**Budget:** \$40000000

**Theme:** T1