FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Conservation Agriculture
Experience Sharing and Networking Workshop

Jointly organized by *the Agricultural Knowledge, Learning, Documentation and Policy (AKLDP) project, AgriProFocus and the Canadian Food Grains Bank (CFGB)*

2nd June 2017, Addis Ababa, Ethiopia

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Agricultural Knowledge, Learning, Documentation and Policy Project (AKLDP-Ethiopia)

Cover photo from CFGB: Conservation agriculture harvest in Amhara regional state

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The AKLDP project undertakes a set of structured learning and coordination activities based on policy and programming issues that have been prioritized with USAID and the Government of Ethiopia. Specifically, the AKLDP provides coordination and technical support to guide improvements in USAID agricultural programming and to support national development policies and strategies—particularly those geared towards assisting poorer households to benefit from agricultural and food security investment.

A key task of the AKLDP project is the organization of regular meetings, field visits and information sharing events for collaborative learning groups, whilst ensuring the mainstreaming of these networks within government structures. The AgroEcology Network was established 2016 to promote sustainable solutions to improved agriculture production and productivity in Ethiopia. These proceedings provide a record of the one-day 'Conservation Agriculture Experience Sharing and Networking Workshop' held on 2rd June 2017.

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List of Acronyms

2WT	Two-wheel tractor
ACE	African Center of Excellence
ACT	African Conservation Tillage Network
AKLDP	Agricultural Knowledge Learning Documentation and Policy project
BoA	Bureau of Agriculture
CA	Conservation Agriculture
CFGB	Canadian Food Grains Bank
CIMMYT	International Maize and Wheat Improvement Center (Spanish)
CRGE	Climate Resilient Green Economy
CSA	Climate Smart Agriculture
FTCs	Farmer Training Centers
GHG	Greenhouse gases
HU	Haramaya University
IYS	International Year of the Soils
MCC	Mennonite Central Committee
MoANR	Ministry of Agriculture and Natural Resources
MSCFSO	Migbare Senay Children and Family Support Organization
SHF	Smallholder farmers
SMART	Sustainable Management of Alternative and Renewable Technologies

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Contents

Summary

Tufts University/Agricultural Knowledge Learning Documentation and Policy project (AKLDP) together with AgriProFocus have initiated the Agroecology platform for knowledge exchange on Agroecology topics during 2016 and 2017. The Agroecology platform is a multi-stakeholder platform that seeks to bring together stakeholders from government, NGOs, private sector actors including farmers, and research institutions to share knowledge and experience.

The Agroecology platform is interested in linking, learning and sharing knowledge and experience on issues of agroecology and sustainable, location appropriate agriculture. For more information on the platform, see: http://agriprofocus.com/ethiopia-agroecology-platform

Conservation Agriculture (CA) is one of the topics the Agroecology platform aims to mainstream. CA is a technique for maximizing soil health and fertility, through minimum tillage, intercropping with various legumes, and maintaining permanent soil cover with mulch. CA has proven potential to improve yields, while also improving the long-term environmental and financial sustainability of farming.

The partners of the AgroEcology platform, including AKLDP, the Canadian Foodgrains Bank (CFGB) and AgriProFocus, organized a Conservation Agriculture Experience Sharing and Networking Workshop on 2nd June 2017. Held at the Golden Tulip Hotel, Addis Ababa, the objectives of the workshop were to:

- **Share conservation agriculture research and experience in Ethiopia**
- **Undertake interactive and participatory conservation agriculture learning**
- **Promote networking to support the scaling-up of conservation agriculture in Ethiopia**

CA has proven potential to improve yields, while also improving the long-term environmental and financial sustainability of farming

Sarah Assefa of AgriProFocus moderated the first half of the workshop that focused on experience sharing. She began by welcoming the participants and presenting an outline of the purpose, agenda and expected outcomes of the meeting. After self-introductions by the participants, Adrian Cullis, AKLDP's Chief of Party made an opening address. This was followed by a brief introduction from Ms Theresa Rempel-Mulaire, Program Manager of CFGB CA. Mr Teferra Solomon from the Soil Fertility Directorate at the Ministry of Agriculture and Natural Resources (MoANR) then provided the keynote address. During the morning session, eight presentations were given on Conservation Agriculture Experience in Ethiopia, followed by a question and answer session with a panel of presenters. After lunch there was time set aside for networking by the participants over expositions, demonstrations and refreshments.

Dr. Wegayhu Bekele of ATA moderated the afternoon session of the workshop, which looked at the Conservation Agriculture research projects in Ethiopia and other countries in Africa. After a final question and answer session the workshop came to a close. The workshop program is included at Annex 1.

1. Introductory Session

Opening Address, Mr Adrian Cullis

Adrian Cullis, AKLDP's Chief of Party, formally opened the meeting with reference to the key messages conveyed during the 2015 International Year of the Soils (IYS) events; including the historic loss of soil from Ethiopia that created the Nile delta, and that as recently as the turn of the Millennium Ethiopia 'exported 1billion MT of soil at a cost of 4% GDP. Other messages from the IYS were the progress being made in land tenure, soil and water conservation, blended fertilizers and learning institutes. Adrian stated that this workshop would build on the 2015 Conference, in particular through the importance of sharing experience, learning and best practice in Ethiopia on Conservation Agriculture—an approach that is gaining credence around the world as a sustainable solution to improved soil management and agriculture cropping.

Adrian highlighted how farmers concerned about rising costs, and declining productivity as their soils got 'tired', have developed a number of CA techniques here in sub-Saharan Africa. Techniques include minimum tillage, use of cover crops, improved rotations and use of crop residues to build soil fertility and health. There are also benefits of CA to carbon capture and hence to global climate change. Adrian reminded participants of the opportunity not only to learn about the progress made to promote Conservation Agriculture in rural smallholder farming communities, but also in research and at policy level with a view to encourage each other that progress is being made. He emphasized the need to identify gaps and challenges in order to accelerate progress and promote the associated benefits of Conservation Agriculture.

Introduction, Ms Theresa Rempel-Mulaire

Ms Rempel-Mulaire from the Canadian Foodgrains Bank (CFGB) then provided a brief introduction. CFGB is a relief and development network based in Canada. CFGB started working on Conservation Agriculture over 10 years ago with partners in Zimbabwe. Since then CFGB have expanded and are working with partners across Southern and Eastern Africa on CA. Currently they are implementing a Government of Canada funded program on Scaling-Up of Conservation Agriculture in East Africa, aiming to reach 50,000 farmers through 11 partners in Ethiopia, Kenya and Tanzania. In Ethiopia CFGB are with FH Ethiopia in Beneshengul-Gumuz, MSCFSO (Migbare Senay Children and Family Support Organization) in Amhara, and TDA (Terepeza Development Association) in Wolita. The Scaling-Up program focuses on a farming systems approach to CA – promoting farmer led experimentation, creating an enabling environment with extension services, markets, and input suppliers. The program is also partnering with ACT (African Conservation Tillage Network) to promote an enabling policy environment for CA, and with Farm Radio to promote CA thorough the three regions. Ms Rempel-Mulaire concluded by saying they are excited to see the development and promotion of CA happening currently in Ethiopia and thanked everyone for their coordination and support.

CA techniques include minimum tillage, use of cover crops, improved rotations and use of crop residues to build soil fertility and health.

Keynote Address, Tefera Solomon, MoANR Soil Fertility Directorate

Ato Tefere welcomed all the participants and requested their active participation. He stated that so far the experience of MoANR has shown that crop production is highly dependent on chemical fertilizers, but that it is not possible to attain sustainable crop production by depending on chemical fertilizer only. Increasing crop production in a sustainable manner requires integrated soil fertility management, which is why MoANR is now working to establish soil fertility departments at all levels. For instance, the soil fertility unit establishment has been completed in Oromia region and the other regions are also in the process. They will help the effective flow of information and reporting to the fertility directorate, and promote integrated soil management.

Ato Tefere explained that whilst soil fertility training used to be given as part of agricultural extension packages for extension workers every October, three years ago the Ministry was forced to pend it. (One directorate was promoting continuous tillage and the other was promoting minimum/zero tillage while both under the same Ministry). The soil fertility department has however been intensively working to incorporate CA into extension packages since 6 months ago. Of course, at the beginning the participation of concerned stakeholders was very poor, but a strong and participatory CA workshop was held at Debrezeit last month at which various institutions shared their experiences. Following this event, guideline and policy brief working groups were established, of which CFGB and ACT are both members. The fertility directorate is planning for the team to be together from July 15-16 to finalize draft CA guidelines and policy briefs on selected topics. The final output will then be presented to decision makers. Lastly, Ato Tefere wished all the participants to have a very fruitful time at the workshop.


Panellists of the morning

2. Conservation Agriculture Experience in Ethiopia

CA Experience of Sasakawa Global 2000

Sasakawa Africa Association (SAA)

The first presentation, by Melese Liyhe, began by outlining three key principles of conservation agriculture that SAA use in their demonstrations to farmers: 1 - Minimum soil disturbance; 2 - Permanent soil cover with crop residues and live mulches; and 3 - Crop rotation and inter-cropping. After identifying farmers' technological knowledge and skills gaps, SAA provides hands-on training as well as technological inputs; including the small-scale affordable 'Berken Maresha' plow for reduced tillage. Crop rotation training, participatory field monitoring and gathering feedback from farmers is important. Beginning with maize, the program has expanded to cover wheat and teff, with yield and profitability now shown to be higher in locations with CA than without.

The presentation highlighted the relevance of CA in terms of: reduced soil erosion and run-off; improved soil health/fertility/infiltration/aeration and increased carbon sink; savings in terms of labor and costs; and the value of the provision of alternate technology for resource poor smallholder farmers (SHFs) -especially women farmers - and for those in trypanosomiasis affected areas. The level of practical experience and adoption by farmers is now high (2016 data). Nonetheless there are challenges in promoting CA, namely: awareness of Ethiopia's CRGE Strategy is still limited among officials and extension workers; and the existence of free grazing and shortage of livestock feed impacts the availability of crop residue, which is also used for fuel. Roll-out challenges include the fact that the extension system has not consider the comparative advantage of CA (reduced vs. repeated tillage), the poor linkage between Research-Extension-Farmers with respect to CA, the limited technologies available for different agro-ecologies, poor documentation and loose follow-up, and the overall poor supply chain.

CA Implementation Experience of Terepeza Development Association

Terepeza Development Association

The second presentation, by Mesfin Mathewos, looked at the experience of CA since 2012 in Wolaita Zone, SNNPR. Implemented in four districts, CA is highly relevant given the area's high population density (very small farm sizes, continuous cropping/no fallow), low soil fertility (repeated tillage, soil erosion) and recurrent drought/moisture stress. Targeting 300 farmers, the project's approach has been to use Farmer Training Centers (FTCs), CBOs and animators (farmers training farmers). There has been no external input provision (farmers provide their own seeds, fertilizers etc.), a strong focus on the use of local resources, work relations and networking with Zonal & district line offices, as well as support from University researchers and soil labs. The uptake by farmers has gone from 40 farmers in 2012 to 4140 in 2016, despite a number of challenges. These include the need to change mindsets at the beginning (of farmers, experts and leaders), insufficient mulch material (competition with livestock and for fuel use), and resource limitations. The project has demonstrated the increasing interest of farmers in CA, that there is strong support and cooperation at local levels, as well as CA's significance in the policy environment and its climate change effects.

CA increases variable costs to farmers, but the benefits are higher and labor is lower.

CA Experience of FH Ethiopia in Benishangul Gumuz Region

Food for the Hungry Ethiopia (FHE)

Operational since December 2015, the FHE CA project is funded by CFGB and Mennonite Central Committee (MCC) and covers 39 kebeles in Assosa and Bambasi woredas. It is targeting farmers in 10,700 HHs (83,500 family members) over a five-year period. FHE strategies include: conducting a familiarization workshop with stakeholders; training kebele leaders, development agents, agriculture experts at woreda level—and community workers on CA principles (min. tillage, mulching & crop rotation/association); the preparation of demonstration plots within FTC compounds to train farmers practically on CA principles; conducting model farmers training (1589 model farmers were trained in 2016); conducting follower farmers training; and experience sharing among farmers with field days conducted on demonstration plots for practical learning of CA principles. Training is ongoing for an additional 5000 farmers and more than 3500 farmers are expected to practice CA in 2017 on areas from 400 – 2500 square meters.

Key successes and lessons learnt were that 100% of the mulched plots were then weed free; mulching CA plots 1 to 2 months ahead of planting season showed better results in crop stands and yields due moisture conservation; CA practice reduced the work load of male and female farmers (specially in weeding and cultivation); innovative farmers would practice CA beyond the lessons they acquired (i.e. mulching teff fields and agro-forestry fields); and non-target farmers were learning CA farming techniques from their relatives and neighbors (the number of spontaneous adopters is increasing). In addition it has been found that: the decomposition of mulches increases the fertility of the soil, which further contributes to increase in crop yields; the intercropping of beans (nitrogen fixing crops) contributes to the fertility of the farmlands in addition to the economic value of bean production; soil erosion is minimized by 100% mulch cover of the CA plots; farmers in the target areas discussed and agreed to control burning of crop residues, grasses and bushes, which contributed to environment protection. This CA experience is being shared with experts of other woredas and Assosa University for practical learning of students.

Intercropping maize with beans

Indigenous CA Experience of SMART Ethiopia in SNNPR

Sustainable Management of Alternative and Renewable Technologies (SMART) Ethiopia

The fourth presentation by permaculture trainer Asmelash Dagne explained how CA is an indigenous farming technique, with one of the best examples being the farming technique of the *Derash* community. The SMART Ethiopia project builds on the Indigenous experience of the community and scales it up in different ways. Techniques used to transform local knowledge include: mulching, soil and water conservation practices, composting, use of green manure, and companion planting. The project builds community garden using solar wells, tests different techniques and plants, and then scales up the most appropriate ones. Neighboring farmers become curious to learn and to copy the techniques being used onto their plots of land, so these interested farmers are provided with training. The training centers provide theoretical as well practical training. The project is a success, with farmers copying and implementing techniques in their backyards. The SMART Ethiopia approach is a silent revolution challenging the fast growth of conventional farming.

Testing different techniques and plants

CA Experience of MSCFSO in East Gojam, Amhara region

Migbare Senay Children and Family Support Organization (MSCFSO)

In the fifth presentation the MSCFSO project on scaling up CA to improve food security and sustainable livelihoods for smallholder farming households was introduced. The 4-year project funded by MCC/CFGB follows a set of core principles - minimum soil disturbance, permanent soil cover, crop rotation and/or association– for the estimated 5620 HH beneficiaries. The project's extension approach is a farmer-to-farmer one and uses government extension approaches**.** Animators (1 model: 20 followers), training, farmer field days, the use of GO and NGO networks to help stakeholders know about CA, **e**xperience sharing from one woreda to the other, CA radio transmissions with Farm Radio International (FRI), women's empowerment in all of the approaches, and CA demonstration plots established in the target kebele schools and FTCs have all been used as well.
For the 2016 /2017 crop season, 336 farmers planted maize, 58 planted wheat (with 44 using lupine as a cover crop while the rest used mulch), and 4 planted Faba beans. Average yield increased 17% for maize, 14% for wheat and 23% for faba bean. To address the ongoing

challenges of CA cover crops are used as mulching material. The project is also promoting controlled growth by aligning with the watershed to address free grazing practices, whilst continuous awareness and training is used to impact the mind-set of farmers. In terms of lessons learned, the project found that: CA is practiced easily by female headed household farmers—thereby encouraging them to use their land rather than giving it up for rent; CA require less labor for land preparation, weeding and other agronomic practices—making replication more easy by farmers; and CA technology can be integrated with soil and water conservation.

Experience of CFGB with livestock integration and CA

Canadian Food Grains Bank

The sixth presentation by Frew Beriso (CA Technical Specialist for Ethiopia) looked at how competition for crop residues between livestock feeding and soil cover is a major CA challenge in mixed farming in Ethiopia and other African countries; and how we can more synergistically integrate livestock and CA. With Ethiopia the first in Africa, and the tenth in the world, in terms of livestock population, it is very important to plan how to address the demands for mulch to satisfy soil needs and also feed livestock. Competition for crop residues between livestock feeding and building organic matter is a major challenge in Ethiopia and one that will need to be resolved at the farm-level if CA is to be taken to scale. After identifying the 3 principles of CA, a possible fourth was also suggested – incorporating farmyard manure, synthetic fertilizer, green manure cover crops and compost.

There are many ways to promote integration of CA and livestock. E.g., multipurpose cover crops provide fodder for animals and meet the requirements of CA.

The CA-livestock integration strategies proposed in the presentation were: crop residues as 'the best for livestock and the rest for the soil'; Multipurpose Cover Cropping; Integrating NRM-CA-forage development; Cut and Carry System; Promoting Farmer to Farmer Learning; Efficient Land Use Planning; Using various promotional approaches; Collaborating with concerned stakeholders; and Valuing the contribution of livestock for soil fertility. Successes achieved to date with CA-livestock integration include: interactive radio programming; better networking and collaboration from woreda up to federal levels; working with watershed committees; and the inclusion of cover cropping, wild fire, bund planting, cut & carry system into existing bylaws. A promising synergistic integration of crops and livestock is observed, although ongoing challenges remain including the loose integration between stakeholders, wild fires, a high livestock population over farm carrying capacity, overgrazing/free grazing.

Global and Ethiopian Experiences on CA/CF for Climate Resilience

Tigray Agricultural Research Institute (TARI)

The detailed seventh presentation made by Abbadi Girmay Reda, Director and Senior Researcher at TARI, provided information on the background and context of CA, the experience with on-farm research on Conservation Farming (CF), the challenges of promoting CF in Ethiopia, and the actions needed for it to be adopted as a component of Climate Smart Agriculture (CSA). After introducing CA as a sustainable agricultural production system that conserves the environment, optimizes yield and profit, is labor saving, and enhances soil stability through biological process above and below ground, Dr Abbadi explained why CA is not universally applicable. Innovative approaches are need for its promotion among small-scale farmers, as although CA can increase yields in the long term, farmers may need to wait 3 to 7 years to see such increases. The three principles and practices of CA all improve soil formation, climate resilience, agricultural productivity and sustainability, and in Ethiopia CA

has been practiced in Tigray, Eastern Shoa, Eastern Hararghe and the Southern nations. Its future prospects are bright given the policies for agricultural transformation and CSA in Ethiopia, and as CA is vital and pivotal for sustaining agriculture in the face of climate change variability. CA can be promoted both in moisture deficit areas and in the vertisols of Ethiopia, based on drainage of excess water and returning it back during moisture deficit periods.

Details were provided on the Conservation Farming Drylands Coordination Group (CF-DCG) Project. CF is promoted in combination with tested scientific technologies in agricultural production—keeping the soil covered (>30% residue), minimal soil disturbance (reduction in tillage) and mix and rotate crops. CF practices enhance soil fertility and structure, conserve soil moisture and organic matter content, and maintain soil biological health. CF is also a strategy for mitigating climate change and an adaptive mechanism. Emphasis is on maximum use of available water resources and minimal disturbance to the soil surface, with legumes included in rotation with other crops. In terms of up-scaling CF practices in the drylands of Ethiopia, CF is a promising technology for sustainability. It is also appreciated by farmers, zonal administration and agriculture departments, and adds value to farmers existing knowledge. Future considerations for CF are the need for a more integrated approach (between farmers, Bureaus of Agriculture and research); the use of cluster-based approaches with adjacent farmers; for technologies— mechanization (tillage), weed controls, soil and crop—all to be integrated; and for guidelines to be produced on CF extension. The presentation concluded with details on the research and actions still needed.

How climate-smart is Conservation Agriculture (CA)?

GIZ

CSA is not only about doing different things but also about doing things differently

Georg Deichert of GIZ continued the theme of climate-smart agriculture in the eighth presentation, looking at the differences and commonalities between sustainable agriculture, agro-ecology, CSA and CA. Dr Deichert provided an explanation of sustainable agriculture, identified the six agro-ecological principles of agro-ecology, and presented four key statements on conservation agriculture. In comparing the definitions of sustainable agriculture, agro-ecology and CA it is clear there are more commonalities than differences, but there are also different system boundaries or perspectives, e.g. sustainability, ecology, eco-system, conservation, biodiversity, climate. Basically however all definitions point in the same direction: Increasing productivity without short and long term negative effects on the environment and natural resources.

Using a series of diagrams the presentation than addressed the question of how to identify, integrate, measure and value environmental effects, ecosystems and ecosystem services. In terms of building CSA combinations within CA it was concluded that combinations are: necessary in order to overcome trade-offs within and between single measures; basically land use based, but can combine measures from different land use types and livestock—although using more than 5 single measures might result in adoption constraints (complexity); should be balanced with hardware (inputs) and software (practices); and should have at least 2 key interventions and optional measures added (farmland based with soil fertility). It was concluded that CA is highly climate-smart when all three principles are practiced together but there is a significant trade-off effect with the use of chemical herbicide.

Questions/Answers/Comments

A representative from Makubo Enterprises attended the meeting and was added into the program. He did not make a formal presentation but talked briefly about Makubo and answered questions. Makubo Enterprises is an importer and supplier of agricultural inputs, representing Monsanto, and work closely with FAO. They supply herbicides including Roundup, which can be used in weed management in the practice of minimum tillage.

1. Will there be a time where we can gradually exit from herbicide application in the CA system in Ethiopia?
   The practice of CA is area specific. Exiting from herbicide can be achieved gradually depending on the area where it is practiced. Many people observe a series of phases in the transition of from conventional agriculture to conservation agriculture on one plot of land – in early years inputs like weed management support may be more helpful; in later years less required.

2. How is the issue of mulching and crop residues viewed in an integrated manner?
   Crop residue is used primarily for immediate moisture conservation. In time these residues breakdown and add fertility to the soil. Additional organic matter can be added therefore in the form of mulches which further help to improve the soil fertility.

3. What does “silent revolution” mean?
   The dissemination of CA system is best done through showing results instead of theoretically disseminating its benefits.

4. Concerning the extension system, how is it more efficient to target women headed households (WHH) instead of men headed households (MHH)?
   The existing agricultural system is marginalizing WHH, as most of them are forced to rent out their lands. CA intends to reverse this situation by prioritizing WHHs. WHH have also proved to be fast learners. Furthermore, women model farmers have shown to be much more influential than men model farmers.

   Women stand to benefit significantly from CA: lower labor required to till the land and in weeding is of great benefit, the first particularly for WHH, and the second for communities where women are responsible for weeding work, which takes their time from other important activities (eg in Benishangul Gumz).

5. What is being done to fill the gap in terms of CA technology? Are the technologies for CA area specific?
   Currently CA is being promoted for small-scale farm implementation through the establishment of hidden terraces built inside the soil to avoid erosion. A number of technologies for reduced tillage have been developed. Appropriate crop integrations are area specific. Technologies for CA should focus on key elements including the reduction of greenhouse gas emissions.

6. Has the impact of CA on farmers' profitability been measured?
   Farmers mentioned the following points when talking about the benefits of CA:
   - Time saving
   - Improvement of soil health
   - Empowerment of women
   - Increased productivity

   The main challenge for farmers that are practicing CA remains weed control.

7. Can CA practice be applied for different cereals and root crops as the available guideline is only for maize?
   CA can be applied for different crops. However, there are specific recommendations for each crop type. A guideline for different crops is now available.

8. With reference to CRGE – is there an opportunity to use that framework for CA as an extension strategy?

9. What lessons can be drawn from improved plowing?

10. Why is the increase of conventional farming seen as a challenge?

11. How many years before the pace of CA taken by extension workers will meet increasing urbanization?

12. What is the reason behind CA implementation going slow – despite the Task Forces and the different researches?

13. The majority of countries practicing CA are in Latin America as its practice depends on soil temperature, soil organic carbon content and power sources – how are these indicators being included when determining the suitability of CA in Ethiopia?
    CA can be applied everywhere as long as the specificity of the location is taken into account. When determining CA suitability in one area, prioritization can be done based on different indicators including rainfall, soil texture etc. Nevertheless, it is evident that additional indicators such as soil temperature can be included to refine the research tools.

14. How pertinent is the economical analysis done over just a year? Any evaluation of ecological services of CA included in the researches?
    Evaluation of ecological services of CA is to be included in future researches.

Comments

- CA needs a multidisciplinary approach (economical, pro-gender equality etc.) that is area specific, in order to optimize the use of the natural resource base of the locality. The main questions around CA should be how to make it affordable and easily adaptable by farmers. The critical challenges to promote CA include:

a) Weed control
b) Selection of mulch material/ crop residue

- The practice of CA in Ethiopia started more than 20 years ago, hence CA is nothing new for the country and its importance has already been proved. CA experts should focus more on how to disseminate the latter to extension workers.
- The 3 principles of CA can have different benefits. The long-term benefit includes the increasing moisture retention capacity of the soil. Yield improvement and increase in income are also amongst the demonstrated benefits of CA.

3. Demonstrations of Conservation Agriculture Mechanization

Demonstrations of locally appropriate mechanization to complement CA, promoted by Melkassa Agricultural Research Center and CYMMIT. The photographs show various types of minimum tillage seeders and planters.

4. Conservation Agriculture Research

Research Evidence and Potential Recommendation for CA in Ethiopia

International Maize and Wheat Improvement Center

In the highlands, yield benefits don't come for the first few years – but eventually the benefits of increases soil fertility and reduced soil erosion becomes evident.

The presentations during the afternoon session focused on Conservation Agriculture research, beginning with the ninth presentation of the day provided by Kindie Tesfaye, Scientist - Foresight and Targeting, at the International Maize and Wheat Improvement Center (CIMMYT). After introducing the challenging context of agriculture in Ethiopia and how CA might be a way out, Dr Tesfaye looked at experimental evidence from Ethiopia in terms of on-station and on-farm experiments from 2010-2016. The evidence has highlighted six key findings:

1: CA may not significantly increase yield over conventional plots in the first few years but it improves soil health

2: The yield benefits of CA increase over time and during drier than wet years (on-farm experiments, Bako Western Ethiopia)

3: Retention of crop residue/mulch over a certain level on the field does not necessarily increase crop yields—it is context specific

4: CA increases both total variable costs and gross return on investment as compared to conventional plots (Gross margin analysis in maize production by tillage from Gojam)

5: Current adoption is higher for CA components than the full set of CA (farmers had a preference for adopting specific agronomic practices in project target districts)

6: CA recommendation domains can be developed at national level using biophysical and socioeconomic factors.

CA yield benefits are greater over time and during drier years

The presentation then went into more detail on proposed recommendation domains. CA faces a number challenges, namely: the heterogeneity of growing environments and farming systems; trade offs (i.e. over crop residue); population pressure (land size); and market access (input-output). The impact of CA in small-scale mixed farming systems crucially depends on the underlying biophysical and socioeconomic factors that influence the farming system, and the performance and adoption of CA systems. Understanding these factors could allow for proper targeting of CA technology to places where it works well and could be adopted quickly. Accordingly, the cultivated areas of Ethiopia have been stratified into nine recommendation domains based on biophysical suitability and high CA adoption potential. Targeting at least the High Suitability - High Adoption areas in the near term, with appropriate CA technologies and extension systems, could increase the area coverage and benefit of CA in the country. Benefits from CA are location and condition specific however, and hence there is a need to consider local challenges and opportunities in a participatory manner with farmers before pushing the technology as a standard practice.

Photo credit: CIMMYT

Improving Productivity, Resilience and Sustainability through Conservation Agriculture Based Systems in the Ethiopian Highlands

Department of Dryland Crop and Horticultural Science, Mekelle University

CA immediately increases moisture retention in soils. Soil fertility naturally improves with CA after some time. Fertility amendments are important in the beginning of CA.

The tenth presentation, from Dr Tesfay Araya, began with an introduction to the problems and limitations with agricultural production in Ethiopia. Food shortages are major concern in Ethiopia due to: climate variability and climate change (insufficient and erratic nature of precipitation); imbalanced soil hydrology (high runoff and evaporation); cropland degradation (↑tillage → ↓soil organic matter→ ↑runoff and soil loss). Over a 10 year period the research determined the impacts of CA-based systems on: building resilience against climate change; runoff and soil loss; soil rainwater storage; and crop productivity and food security in the Ethiopian highlands. Field experiments were carried out in a sub humid area and compared different soil treatments/tillage practices: 1. Conventional tillage (CT) plowing pattern similar to local practice, at least three times per year, crop straw completely harvested. 2. *Terwah+ (TER+)* at least 3 tillage per cropping, typically for teff, furrows made at 2-4 m intervals along the contour; and Modified terwah+: furrows made at 1.5 m intervals along the contour, practiced for all experimental crops, tillage was done only once at sowing, 30% the crop residue was left as standing stubble, 2 l/ha glyphosate was applied to control pre-emergent weeds. And 3, *derdero+* (DER+) local practice, furrows and raised beds (35 cm), typically on vertisols for fenugreek, lentil, wheat and teff; and Modified *derdero+*: no tillage on the top of the raised bed, tillage done once at sowing by refreshing furrows, 30% crop residue left as standing stubble, 2 l/ha glyphosate herbicide applied starting in 2007.

The practice of 'aftermath overgrazing' by livestock on remaining crop residues after harvest, impacts the soil.

The research measured runoff and soil loss; with the results determining how CA treatments affects runoff coefficient, how CA builds erosion resistant soils during either drought or water logging, and how CA affect soil fertility. Graphics were presented of the results, for example a graph of the % of soil organic matter accumulated from 0-10cm soil depth over 10 years shows the role of CA in adaptation and mitigation to climate change; and a wheat yield (t/ha) graphic showed how CA can increase food security. The presentation stated the scaling up challenges for CA to include: the need to abandon repeated plowing and the free grazing system, and the need for willingness to leave crop residues in the field. Recognition that improvements in soil fertility and crop yield are also long term, with weed infestation often at early stages of CA implementation, is also necessary. The conclusions from the research highlighted the positive effects that CA planting systems have however, namely: Minimum tillage + residue retention + crop rotation + *in situ* SWC→ More soil organic matter→ Improved soil physical, chemical and biological properties→ Reduced runoff and soil loss→ Reduced land degradation→ Increased resilience to climate change→Improved crop productivity and food security.

Farm Mechanization and Conservation Agriculture for Sustainable Intensification

Ethiopian Institute of Agricultural Research

All machines require calibration [so that they work best in their specific environment]

The eleventh presentation came from Bisrat Getnet, and focused on research that is looking at how to address the issue of declining farm power in Ethiopia through either increasing power supply (mechanization) or by decreasing the demand for power (conservation agriculture). The aim of the research was to evaluate and demonstrate two-wheel tractor (2WT) based technologies to support CA systems, using expertise and implements from Africa, South Asia and Australia. Specific tasks were to: test site-specific commercial systems to deliver 2WT-based mechanization; identify improvements in national institutions and policies for wide adoption of 2WT-based mechanization; and improve capacity and create awareness of 2WT-based technologies in the sub region.

We need to move from technology push to market pull approach

During the project, six of the 'best bet' 2WT-based technologies were evaluated on-station and on-farm, and were continuously refined. The types of CA planters were the Fitarelli2Row, VMP, Nat.Agro, Danyang 2BFG-100, Fitarelli1Row and J.Morrison. They were field tested for variables including turning time, steering difficulty, soil engagement, seed rate, fuel consumption, compaction etc. for maize planting and wheat seeding. They were then compared with conventional treatments in terms of the weeding time needed and grain yield at field sites in Hawassa and Assela. To build capacity, exposure visit to India and Bangladesh were conducted for key members of the project research team. Practical training on farm mechanization, precision agriculture and controlled traffic farming was also carried out for 8 key project team members (2 from Ethiopia) at the University of Southern Queensland, Australia. Two field days were also conducted, one at each site and one on station, with a total of 120 farmers, DAs, microfinance institutions, NGO members, machinery importers, and local farm implement manufacturers, researchers and mechanics in attendance. A participatory evaluation and demonstration of best bet 2WT-based technologies was conducted on 10 farmers fields (five at each site). The viability of the technologies as a business options was also determined.

Stepped Tillage for Herbicide Free Conservation Agriculture

Aybar Engineering plc

In long distance running we [Ethiopia] are the champions. In the number of times the land is ploughed we are also the champions.

In the introduction to the twelfth presentation, Melesse Temesgen provided an overview of CA's global distribution; the key factors that vary its uptake — soil organic matter, soil moisture, soil temperature and power source; and provided a definition based on objectives — any tillage that conserves soil, water and energy (J. Rockstrom). Dr Melesse explained that the areas with highest potential in Ethiopia include Gambella, Benishangul and parts of SNNPR (high mulch availability, high soil organic content, high temperatures), and how a major cause of land degradation in Ethiopia is the repeated cross plowing by the traditional Maresha plow, which creates a V-shaped furrow. Using a Maresha plow contour plowing is impossible, whilst plowing along the slope accelerates soil and water losses. It was stated that a different type of tillage is needed to reduce the time and energy currently wasted on repeated plowing.

The *Berken Maresha* plow allows a new approach to plowing: stepped tillage. The *Berken Maresha* avoids the need for repeated cross plowing; allows contour plowing; promotes ripping at the center to break the hardpan, improves infiltration and root growth; provides efficient weed control; creates invisible barriers (*Siwur Erken*) to retard water movement; saves time and energy; and is easier to use in fields with soil conservation structures. Other advantages are the reduced draft power requirement, reduced clod formation and reduced soil inversion (less SOC and moisture loss). Graphics of the positive field-test results in terms of cutting performance, surface runoff, soil loss and yields for the *Berken Maresha* plow were presented from sample plots, using published and unpublished data.

African Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation

Haramaya University (HU)

Professor Nigussie Dechasa provided the thirteenth presentation, with details of the forthcoming establishment of the African Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation. After explaining some of the priorities for teaching, research and extension activities in Ethiopia, and presenting some of the research and extension activities that have been achieved by HU, Professor Nigussie explained the overall objective for establishing the Center. The ACE is to produce skilled human power for the East and Southern Africa region through research-based quality post-graduate programs and by developing skill-based short-term training courses. Specific objectives are to

- Produce high quality skilled MSc and PhD graduates
- Generate new knowledge and quality research output as well as promoting technological and institutional innovations
- Enhance the knowledge and skills of faculty and technical personnel to consolidate efficient and result-oriented quality training and research
- Upgrade teaching and research facilities (laboratories, ICT services, greenhouses, lath houses, meteorological stations, research farms, etc.)
- Strengthen national, regional, and international collaborations and partnerships to enhance exchange of science and technology skills, experiences and expertise

- Foster specialization and collaboration with emerging higher education institutions
- Solicit funding for sustaining high quality postgraduate training and cutting edge research in climate-smart agriculture and biodiversity conservation

New M.Sc. programs will be established in Climate Smart Agriculture and Biodiversity and Ecosystem Management.

Educational banners provided by ACT

African Conservation Tillage Network

ACT

The fourteenth presentation was made by Peter Kuria and Meaza Melkamu and provided details of three research projects that have been undertaken by the African Conservation Tillage (ACT) Network: Project 1-Agro-ecology Based Aggradation-Conservation Agriculture (ABACO); Project 2-Conservation Agriculture for Food Security & profitability (CA4FS); and Project 3-Conservation Agriculture for Sustainable Agriculture and Rural Development (CA-SARD). Targeting innovations to combat soil degradation and food insecurity in semi-arid Africa, the ABACO project undertook CA action research with rural communities (co-innovation), participatory and model-based scenario analysis and evaluation trade-offs. Over 8,000 farmers were involved in on-station and on-farm field experiments. The CA4FS project involved over 20,000 farmers in researcher-designed and farmer-managed treatment trials testing variations in seeding practice, fertilizer use and residue retention, and generated extremely positive results.

The involvement of farmers and other agricultural actors and their networks in this process is key, and requires building their capacity so that they can seek knowledge either in the form of information or new findings and process into innovations."

One of the purposes of the ACT network is to share and serve African's conservation agriculture knowledge and information needs. It does this via online platforms, producing materials and through conferences and symposiums, amongst other means. Information sharing products available online include a CA manual, CA Case studies, CA toolbox, documentaries and scientific publications. Experience of CA practices, technology and approaches have been imparted to more than 1000 research and extension officers, with ACT working with national governments to develop CA training materials. The ACT's view is that the future of CA lies in:

- From Technology Push to Market Pull
- From Farmer Groups to CA Communities Approach
- CA Hire Service Provision by Farmers for Farmers

- Building the Future of Farming – Soil Health Amendments through CA
- Crop-livestock integration

In addition CA mainstreaming by Governments, Academia and researchers is long overdue.

Carbon Sequestration and Greenhouse Gas Emissions in Agroforestry

Wondo Genet College of Forestry and Natural Resources, Hawassa University

The final presentation, made by Dong-Gill Kim, explored how important agroforestry is for the mitigation of greenhouse gases (GHGs) in Ethiopia. The benefits of agroforestry include the growing of crops with various tree species integrated with animal production; the provision of food, fuel and cash income; and the protection soil and biodiversity. The question being asked in the presentation was whether agroforestry is also a sink for greenhouse gases, namely the sequestration of carbon (C) and for the emission of non-carbon dioxide greenhouse gases (CH_4 & N_2O). In terms of the global potential of mitigation in agroforestry, unproductive agricultural lands that can be converted to agroforestry worldwide are estimated at 630 million ha; and the mitigation of greenhouse gas from new agroforestry worldwide is estimated at 19-billion t CO_2 eq y^{-1}. In Ethiopia, converting forest to coffee agroforestry would see no significant change in soil carbon, whilst converting agroforestry to mono-cropping would see soil carbon and nitrogen loss of 18 to 30%. The implications for Ethiopia of this recognition of agroforestry's importance are: the potential for carbon trading of existing indigenous agroforestry practices; and the conversion of degraded lands to agroforestry resulting in restoration, increased agricultural productivity, carbon sequestration and greenhouse gas mitigation.

Combining hi-tech solar development and conservation agriculture principles

Questions/Answers/Comments

1. What is the scale of expansion of *Berken Maresha*?
   Berken Maresha was marketed in 2016 for the first time. So far, it has only been manufactured in Addis Ababa. Although farmers' feedbacks are positive, the rate of expansion of the tool remains very slow. In order to make it accessible to a wider number of farmers, the Ministry of Agriculture and Natural Resources has to include it in the extension package through local agricultural offices. Moreover, the scarcity of input shops in the country has been a real challenge in the dissemination process.

2. Isn't a moldboard plow more appropriate for CA than *Berken Maresha*?
   Moldboard plow does a complete plowing, implying high soil disturbance. Moreover, it necessitates high draft power compared to *Berken Maresha,* which is much lighter to carry and does semi plowing.

3. How do you evaluate the value of crop residue for livestock?
   As the grain yield and biomass increase and animals benefit from it. Nevertheless it is necessary to cut the vicious circle of free grazing system.

4. Do the machines used in CA fit in the actual agricultural system *e.g* row planter?
   Experience shows that farmers prefer easier CA technologies, although easiness comes through practice and intensive training is required for all technologies. Currently, experts are working to make the planter adaptable for *teff*, as it is already works for maize and wheat.

5. How are lessons learnt being used in CA for different AgroEcologies?

6. What makes CA different from soil conservation?

7. Conventional tillage, residue burning how to justify the increase in SOM?

   Comments:

- The existing definition of CA is conceptually obsolete – experts should think of a new definition that has to have a systemic perspective.
- Mechanization should be encouraged as long as it uses renewable energy as it helps reduce greenhouse emission.
- The socio economic losses from using mulches should be studied.

8. How are you influencing neighboring countries with the promotion of CA? How does the use of mobile telephones work?
   In order to influence neighboring countries, works have been done through:
   - regional offices
   - policy makers
   - stakeholder engagements

Moving a step further, a CA center of excellence is being established in the different countries.

Although the mobile telephone service has not yet started, the idea is to keep farmers informed as much as possible. Basically, farmers can send an SMS and express their needs on markets for example, and they will get back a response through the mobile telephone service.

9. In terms of integration, research centers in Ethiopia are rather weak compared to those in Tanzania and Kenya. How do you address this challenge?
   Today we consider that we are living in a global village; therefore to address this challenge we try to network through the Internet and disseminate as much information as needed.

10. Is there a standard – number of trees needed etc. – when talking about agro forestry? Is the potential in carbon trading realistic in Ethiopia? Are farmers benefiting from it?
    These questions regarding the standard for agroforestry and carbon marketability are a work in progress. There is no definite answer for now.

11. How is CA being integrated in the curriculum? Have you linked the technologies to the extension system?
    Although this is not the case, the curriculum is supposed to be updated every 4 years. Moreover, it is widely recognized that the latter is either Euro/Americano centric and very detached from our own needs. For example, the current curriculum does not mention any of the indigenous/ local tools used for farming; hence, the establishment of the African Center of Excellence. The latter will work in addressing the above-mentioned challenges, and deal with climate change issues.

    In order to link technologies to the extension system, agricultural bureaus should work extensively to promote the technologies by producing manuals and creating partnerships, with primarily national, and then international, research institutes that work on CA.

5. Closing Remarks from Sarah Assefa, AgriProFocus

The organizers of this workshop extend our thanks to all of you, as you have contributed your time, passion, knowledge and connections for conservation agriculture today. We are very hopeful for an enabling and contextualized policy for CA integration in agricultural extension in Ethiopia. We also hope for strong multi-stakeholder collaborations in its implementation.

We still have more to learn, as indeed agro-ecology and conservation agriculture are knowledge intensive. Many questions that arose from our conversations over the course of the day are as yet unanswered. So let us keep learning from our practice and research, and sharing the insights that we gain with others who can use them.

In parting, sets of publications on CA practice, mechanization and conferences provided by ACT will be given to the following organizations: MoANR, CFGB, MARC, Smart Ethiopia, Haramaya University and Mekele University. Others in the room might contact the relevant organizations to access these publications.

Annex 1 Program of Events

Time			Activity
8:30	-	9:00	Registration
			1. Welcome and Introductions
9:00	-	9:05	Introduction to the Agroecology Platform and Overview of the day's Program
9:05	-	9:25	Self-introductions: Name, Organization, Location
9:05	-	9:10	Adrian Cullis - Chief of Party, Tufts University AKLDP
9:10	-	9:15	Ms.Theresa Rempel-Mulaire, Program Manager CFGB CA
9:15	-	9:30	Mr. Teferra Solomon, MoANR Soil Fertility Directorate
9:30	-	9:40	Q&A session (everyone to introductory presenters)
			2. Presentation of Conservation Agriculture Experience in Ethiopia
9:40	-	9:52	Dr. Abera and Mr. Melese: Conservation Agriculture Experience of SG 2000
9:52	-	10:04	Mr. Bereket & Mr. Mesfin: Conservation Agriculture Experience of TDA, Wolaita, SNNP
9:52	-	10:04	Mr. Sahle and Mr. Daniel Gebeyehu: Conservation Agriculture Experience of FHE, Benishangul Gumz Region
10:04	-	10:16	Mr. Asmelash Dagne: Indigeneous Conservation Agriculture Experience with SMARTEthiopia
10:16	-	10:46	*Tea break*
10:46	-	10:58	Mr. Sisay: Conservation Agriculture Experience of MSCFSO, East Gojam, Amahara
10:58	-	11:10	Mr. Frew Beriso: Livestock integration with conservation agriculture - Experience from CFGB
11:10	-	11:15	Dr. Abbadi Girmay Redda: Global and Ethiopian Experience on CA/CF for Climate Resilience
11:15	-	11:27	Dr. Georg Dichert: CA as a strategy of CSA of GiZ's SLMP
11:27	-	12:30	Q&A session with panel of presenters

12:30	-	1:30		*Lunch break*

Time			Activity	Lead Participants
12:30	-	1:30		*Lunch break*
			3. Networking over exposition demonstrations and refreshments	
1:30	-	2:15		Demonstrations from EARI/Melkasa, ACT and Aybar Plc
			4. Presentations of Conservation Agriculture research	
2:15	-	2:27		Kindie Tesfaye – CYMMYT
2:27	-	2:39		Dr. Tesfay Araya - Mekelle University
2:39	-	2:51		Bisrat Getnet - EARI/Melkasa
2:51	-	3:03		Melesse Temesgen - Aybar PLC
3:03	-	3:33		*Tea break*
3:03	-	3:15		Prof. Nigussie Dechasa - Haramaya University CSA Center of Excellence
3:15	-	3:27		Peter Kuria – ACT
3:27	-	3:39		Dong-Gil Kim - Wondo Genet University
3:39	-	4:39		Q&A discussion with panel of presenters
4:40	-	5:00	**5. Workshop Closing**	

For more information on the presentations including print outs, please contact Sarah Assefa sassefa@agriprofocus.com or Frew Beriso fberiso@foodgrainsbank.ca.

Annex 2 Participating Organizations

The workshop was attended by 62 participants from the following organizations:

ACT
AgriProFocus
Aybar PLC
Beaureau of Agriculture
Canadan Embassy
Canadian Food Grains Bank
CRS
CST
CYMMYT
EARI/Melkasa
EIAR (MARC)
EKHC
EMWACDO
FHE
FRI
GAA
GiZ SLM
Haromaya University
Hawassa Univerisity - Wondo Genet College of Environment and Forestry
Helvetas
ICRAF
Macobu Enterprises
MCC Ethiopia
Mekelle University
Ministry of Agriculture and Natural Resources - Soil Fertility Directorate
Ministry of Environment, Forest and Climate Change
Ministry of Livestock and Fisheries
Mintesenot Farm
MSCFSO
Oromiya Regional Bureau of Agriculture and Natural Resources
SARI
SCORE Ethiopia
SG 2000
SLMP – MoANR
TDA
Tigray Agricultural Research Institute
Tufts University AKLDP
WHH

Annex 3 Contact Details of Presenters

Conservation Agriculture Experience of SG 2000
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Livestock Integration with Conservation Agriculture - Experience from CFGB
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Global and Ethiopian Experience on CA/CF for Climate Resilience
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CA as a strategy of CSA of GIZ's SLM

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Research Evidence and Potential Recommendation for CA in Ethiopia

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Improving Productivity, Resilience and Sustainability through Conservation Agriculture Based Systems in the Ethiopian Highlands

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Farm Mechanization and Conservation Agriculture for Sustainable Intensification

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Stepped Tillage for Herbicide Free Conservation Agriculture

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Carbon Sequestration And Greenhouse Gas Emissions In Agroforestry

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