WORLD CONGRESS 6 on CONSERVATION AGRICULTURE

JUNE 22-25, 2014

WINNIPEG CONVENTION CENTRE
WINNIPEG, MANITOBA

WCCA6.ORG

Session 8: Conservation Agriculture and the Changing Climate

ORAL ABSTRACTS

Conservation Agriculture: A Critical Adaptive Management Strategy

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The leaders of the 25x'25 Alliance and Solutions from the Land dialogue project are very concerned about climate change. While they do not unanimously agree on the core causes of changing climatic conditions, they do believe what science is telling them– climate change is real, and it will pose major challenges, as well as opportunities, for U.S. farmers, ranchers, and foresters.

Though the causes of climate change are debated, its impacts will need to be addressed in order for agriculture to continue meeting the world's growing needs for food, feed, fiber, and fuel. Recognizing this, the 25x'25 Alliance, in 2011, formed an Adaptation Work Group composed of agriculture, forestry, business, academic, and conservation leaders. Together, these leaders have been exploring the impacts of a changing climate on the agriculture and forestry sectors and developing a prioritized series of recommendations for actions that should be taken by government agencies, universities, and business partners, as well as farmers, ranchers, and forest land managers to address adaptation challenges in the coming decades.

The first step our leaders took was to examine current and anticipated shifts in climate and weather patterns that the agriculture and forest sectors will need to address in order to maintain and enhance future productivity and the delivery of ecosystem services. We did this by meeting with climate scientists, agronomists, economists, sociologists and other experts and by studying peer reviewed scientific studies and reports. We then synthesized the information we had gleaned on this subject and published a report in January 2012 entitled "Agriculture and Forestry in a Changing Climate: The Road Ahead." The report highlighted our literature review findings and revealed a number of important trends and impacts that farmers, ranchers, and foresters should be aware of.

Our real world observations and experiences producing food, feed, fiber, and fuel, confirmed what science was forecasting and propelled us to move into a second phase of work: developing a prioritized series of recommendations for actions that should be taken by government agencies, universities, and business partners, as well as farmers, ranchers, and forest land managers to address adaptation challenges in the coming decades.

In a second report released in April 2013 entitled "Agriculture and Forestry in a Changing Climate: Adaptation Recommendations," the 25x'25 Adaptation Work Group concluded that while the impacts of changing weather patterns vary by region, producers need to be prepared for higher temperatures; changing precipitation patterns; new threats from weeds, pests, and diseases; increased humidity; and stronger storms. They also concluded that our nation is not solely at the mercy of these trends, and they identified options available to address this uncertainty and mitigate risks, while strengthening productivity, cutting input costs, and improving the quality of the land.

25x'25's adaptation strategies fall into three major categories: actions to increase *resistance* to changes in climate in order to maintain existing practices; actions to improve *resilience* by investing in steps that preempt disasters and restore systems in the wake of them; and actions to *transform* operations.

25x'25's adaptation recommendations present a variety of pathways for building and strengthening resilience to climate change in our nation's agriculture and forestry system in the areas of research, production systems and practices, risk management, decision tools, and outreach. Rather than offering them as the last word, however, the Work Group produced its report to trigger a national dialogue on steps needed to prepare for an uncertain future.

The following conservation practices for building and preserving the soil have been identified by the Adaptation Work Group for consideration by producers:

a) ***Increase the soil's water-holding capacity by improving soil organic matter content –*** With heavier rainfall events creating problems for many producers, the implementation of practices to increase soil organic matter will help to prevent erosion and loss of valuable nutrients. It will also make crops more resilient to drought by retaining additional water.

b) ***Engage in conservation tillage practices to improve soil quality*** – For many farmers, conservation tillage has become a standard practice for dealing with erosion, runoff, soil compaction, and declining organic matter. In addition to reducing input costs, conservation tillage can protect soils from heavier rainfalls and/or prolonged drought.

c) ***Plant cover crops to provide additional soil protection*** – Like conservation tillage, cover crops are becoming a popular tool for increasing soil organic matter and preventing erosion and runoff, especially during winter and early spring. An example of this technique and its advantages can be found on page.

d) ***Explore the use of conservation buffers to prevent runoff and enhance ecosystem services*** – In addition to preventing runoff, conservation buffers filter water, create habitat, offer shade for livestock, reduce water temperature, increase dissolved oxygen, and prevent algal blooms in waterways. Research even suggests that buffers, such as those composed of miscanthus or switchgrass, can protect against chemical drift.[i]

e) ***Utilize wetlands and new field drainage practices*** - Heavy rainfalls and changes in the timing of precipitation may require new drainage networks. A number of options exist to meet this need, including buffer strips that scavenge nutrients and wetlands for additional filtration. Controlled drainage techniques, such as using a flashboard riser to allow water in a drainage outlet to be raised or lowered, can improve production and maximize nutrient use.

f) ***Diversify and lengthen cropping systems that enhance soil structure*** – Longer crop rotations can help break up pest and weed cycles, thereby reducing input costs and enhancing the soil's productive capacity.

g) ***Consider biochar to improve soil health*** – Biochar is a charcoal byproduct created by burning biomass at slow and low heat. Though additional field research will be needed, biochar has been demonstrated to have a number of benefits as a soil amendment, including improving nutrients, tilth, and water management. In addition, it is a means of sequestering carbon into the soil.[ii]

h) ***Engage in irrigation practices that improve water-use efficiency*** – In many regions that already rely on irrigation, the climate is expected to become drier and create new demand for water-saving irrigation practices. In addition to conducting regular maintenance and audits on existing systems, many producers are recycling water, changing to drip systems, and using precision irrigation to target specific areas of their fields with the exact amount of water needed.

Quantifying Farm-Scale Greenhouse Gas Fluxes in the U.S.: Methods, Challenges and Data Gaps

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Background

Emerging environmental markets have the potential to incentivize additional conservation on the land. Land managers require tools that will enable them to quickly and easily assess these opportunities under various management scenarios. Provisions of the Food, Conservation, and Energy Act of 2008 directed USDA to "establish technical guidelines that outline science-based methods to measure the environmental services benefits from conservation and land management activities in order to facilitate the participation of farmers, ranchers, and forest landowners in emerging environmental services markets" with an initial emphasis on methods for greenhouse gas (GHG) emissions and carbon sequestration.

USDA enlisted the help of 40 scientists to author, and 30 experts to provide scientific review of, the resulting technical methods report. In all, four rounds of review by federal and academic experts were conducted to ensure validity and transparency of the contents, followed by a public comment period. The report is a first step toward providing land managers with standardized and vetted GHG assessment tools.

Results

The objective was to create a standard set of GHG estimation methods for USDA, and to provide a framework for development of a tool that would help landowners estimate the GHG impacts of their management decisions. The methods presented in the report address GHG emissions and carbon sequestration for the entire farm, ranch or forest operation, and also provide the opportunity to assess individual practices or management decisions. A co-objective was to demonstrate the scientific basis for farm-scale estimation of the GHG impacts of land management decisions. It is important that the report reflect scientific rigor and transparency. From the findings in the report, a web-based tool will be developed that will facilitate estimation of annual emissions and sequestration at the local scale. It is critical that the tool demonstrate accuracy, completeness and ease of use.

Anticipated uses of the methods report and tool include aiding: (i) Landowners, NGOs, and other stakeholders in assessing increases and decreases in GHG emissions and carbon sequestration associated with changes in land management, (ii) USDA in assessing GHG and carbon sequestration increases and decreases resulting from current and future conservation programs and practices, and (iii) USDA and others in evaluating and improving national and regional GHG inventory efforts. In the process of developing the report, the authors noted many significant areas where research and/or available data are lacking. Filling these research and data gaps will enhance our ability to provide reliable farm-scale estimates of changes in GHG emissions and carbon storage.

Applications and Implications for Conservation Agriculture

Crop and grazing land management influences greenhouse gas emissions. Often emissions can be reduced, or carbon storage increased, by adopting conservation practices. Operators of cropland systems use a variety of practices that have implications for GHG emissions. Considering changes to management in areas such as nutrient additions, irrigation, liming applications, tillage practices, residue management,fallowing fields, forage and crop selection, set-asides of lands in reserve programs, erosion control practices, water table management in wetlands, and drainage of wetlands can result in reduced GHG emissions and increased carbon sequestration. Operators of grazing systems also have a variety of management options that influence GHG emissions, such as stocking rate, forage selection, use of prescribed fires, nutrient applications, wetland drainage, irrigation, liming applications, silvopastoral practices and manure management. The guidance described here focuses on methods for estimating the influence of land use and management practices on greenhouse gas emissions (and sinks) in crop and grazing land systems. Methods are described for estimating biomass and soil C stocks changes, and changes in emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) that result from changes in management of cropland, grazing land, managed wetlands, and animal manure. The report also provides methods for estimating changes in enteric methane emissions from livestock and changes in carbon stocks and GHG emissions on managed forest lands, but these are not discussed here.

Results and Discussion

This presentation highlights the methods presented in the report (a portion of which are presented in the table below) and USDA efforts to implement these methods into user-friendly management tools. Also presented are some of the challenges that had to be overcome in assembling the methods into a transparent, comprehensive and scientifically vetted approach to local scale accounting, including some of the strategic research and data gaps that need to be addressed to allow for more complete and accurate local-scale GHG inventory.

	Basic Estimation Equation (cf., IPCC Tier 1)	Inference (cf., IPCC Tier 2)	Modified IPCC or Empirical Model (cf., IPCC Tier 2 or IPPC Tier 3)	Processed-Based Model (cf., IPPC Tier 3)
Croplands/Grazing Lands	• CO_2 from Urea Fertilizer Application • CH_4 Emissions from Rice Cultivation • Direct N_2O Emissions from Drainage of Organic Soils	• Soil Organic Carbon Stocks for Organic Soils • CO_2 from Liming • N_2O Emissions from Rice Cultivation • Non-CO_2 Emissions from Biomass Burning • Indirect N_2O Emissions	• Biomass Carbon Stock Changes • CH_4 Uptake by Soils • Direct N_2O Emissions from Mineral Soils	• Soil Organic Carbon Stocks for Mineral Soils
Wet-lands	—	—	—	• Biomass Carbon • Soil C, N_2O, and CH_4
Animal Manure Management		• Poultry-Manure • Aerobic Lagoon – CH_4, N_2O • Temporary Stack and Long-Term Stockpile – CH_4 • Composting	• Temporary Stack and Long-Term Stockpile – N_2O • Anaerobic Lagoon, Runoff Holding Pond, Storage Tanks • Combined Aerobic Treatment Systems • Anaerobic Digester – CH_4 • Manure in Housing Areas – CH_4, N_2O • Manure from Barn Floors and Bedded Pack – CH_4	—

The Development of Middle/Small Size No/Minimum-Till Seeder in Asia

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Abstract：
Although conservation agriculture (CA) has been adopted in many parts of the world, some factors limit the widespread adoption of CA in Asia. One prominent limited factor is the lack of a suitable CA seeder for the small and middle size area farmer. This paper summarizes the currently available middle to small zero and minimum-till seeders in Asia, and classifies these seeders as hand operated units, animal traction seeders, 2-wheel tractor and 4-wheel tractor seeders. Some typical CA seeders for middle/small size farms are described. Also, this paper puts forward the future development of CA seeder for small/middle size farms for Asian conditions in the future.

Keywords: Conservation agriculture, CA seeder, tractor, anti-blockage, Asia

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Conservation Agriculture: An Option to Overcome Agricultural Crisis in Kerala

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Background

In the tropical state of Kerala (Fig. 1) in India, demands in food are rising with growing population, whereas availability of reliable water and farm land are fast decreasing. The state with heavy rainfall and fertile soil depends on neighbouring states for rice and vegetables. Conservation agriculture becomes highly significant to maintain food security in the state. More than 50% of the paddy fields in the state was lost in the past three decades. Paddy fields were widely encroached for residential complexes, economic expansion zones, roads and mining. Unfortunately, implementation of environmental laws fails due to vested political interests and high levels of corruption. A survey showed that 80% farmers have already left the agricultural sector since 1950 because of Land Reforms Act that limited the area of ownership of land, heavy financial losses due to various issues including labour problems, natural calamities, hurdles in getting loans and compensation, non-availability of farm machineries in time and delay in the procurement of products by the marketing agencies (CEREM, 2013).

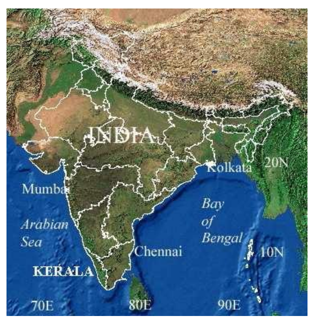

Fig. 1. Location of Kerala

Results

In addition to the socioeconomic issues, climate extremes also have a significant role in reducing agricultural production and affecting the existence of farmers in Kerala (Nair, 2013). Climate extremes lead to severe water scarcity and floods, causing tremendous loss in agriculture. Several farmers committed suicide because of heavy loss in agriculture. The State recently experienced hike in food price unaffordable to the poor and also a shortage of cereals and vegetables. Government is now promoting conservation agriculture to overcome the crisis. This has produced positive results.

Applications and Implications for Conservation Agriculture

Introduction of conservation agriculture has proved the sustainability, economic benefits and increase in production, especially in rice farming (Ajith & Nair, 2012). Low cost, locally available traditional technologies in soil and water conservation were implemented in most of the cases. Government has made agreements with banks for agricultural loans with low interest and with liberalised formalities. Promoting agriculture through self help groups (SHGs, mostly women), schemes for land protection and agriculture through rural employment schemes, arrangement subsidised supply for seeds and fertilizers produced good results. Recently, environmental protection has been adequately included in the curriculum. Modern agricultural technologies that minimises the use of water and new concept of utilising inexpensive biofertilizers are being popularised.

Experimental Approach

This paper analyzes the various socio-economic and environmental issues associated with agriculture, especially in rice farming in the State of Kerala and examines the possibility of conservation agriculture in overcoming the crisis. Impacts of climate change, environmental degradation and the changing government policies on agriculture have been assessed. The concept of conservation agriculture has been mainly experimented for rice and vegetable cultivation. Universities and research institutes are conducting new in experiments in field. Data and information for the present study have been collected from various national institutes, government departments, agricultural universities and NGOs. Changes in rainfall characteristics over Kerala have been statistically analysed. Change in water availability under an altered climate has been assessed using hydrological model based on the outputs from climate models.

Results and Discussion

Extremes in climate have become a major threat to agriculture. There is an increasing trend in the development of convective clouds in the eastern hills where all rivers in the state originate. Large rain drops and intense rain erode topsoil which is already degraded due to deforestation, which is then deposited in rivers, adding to water scarcity and creating floods. Another trend in rainfall is the increasing seasonality that makes the dry season longer. Loss of soil moisture adds to the fall in production. Changing rainfall characteristics, droughts, floods and untimely rainfall during the harvesting period cause tremendous loss in agriculture. Vagaries in monsoons and rise in temperature affects the crop cycle and yield. Water conservation is an integral part of conservation agriculture. Though the state receives an annual rainfall of more than 3000 mm, it experiences seasonal water shortage because of typical topography and improper management. Groundwater level is receding at an alarming rate of 1 metre per decade because of high rainfall seasonality and unsustainable use. Model study predicts a considerable fall in water availability in near future. Recent hike in food price and shortage of cereals and vegetables have compelled the authorities and general public to consider the possibility of extending conservation agriculture. Implementation of conservation agriculture, though in developing stage has produced expected results of more production with small investment. The state needs a comprehensive policy for agriculture, water resources, environment and climate change adaptation and a strong mechanism for its implementation. Traditional, low cost methodologies in soil and water conservation, pest control, weed control and production of bio fertilizers are to be initiated from the level of farmers holding small farm area. Special economic package and technical assistance should be provided to small and marginal farmers. Better storage facilities for seeds and grains, timely procurement of products and emergency assistance during crop failure due to extreme climates are necessary. Proper public awareness can help minimising the intensity of protests during the introduction of new varieties and new policies. Encouraging conservation agriculture may attract a new and young generation of farmers and control the internal migration as employment opportunities are decreasing. New crop varieties and crop calendar is necessary to cope with environmental changes and to reduce GHG emissions. Certain initiatives such as cooperative farming and incentives for farmers have been taken to rescue agriculture. But the progress is slow because of the typical bureaucratic and political set-up. Development of an appropriate policy is possible with the cooperation of scientists, representatives from the agricultural community, NGOs and the technicians and officials from the government departments.

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Carbon: The Synergy Element in No-Tillage and Cover Crops

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Background

Global food security is critical for the entire population, not only for the next generation or two, but for the next 20-30 generations. While conventional agriculture has provided increasing yields, the environmental degradation and consequences of this intensification are not generally being addressed. As new technology and concepts appeared, conservation agriculture meaning permanent no-tillage and cover crop mixes have evolved as a sustainable production system that can lead to food security with additional ecosystem services and environmental benefits. This form of agricultural production is the only way to assure sustainable production with resource preservation, protection and efficient utilization. No-tillage farmers are doing society a huge favor by ensuring food security for future generations in developing and utilizing this new technology to protect our resources (sun, soil, water, air). The presentation will address soil carbon (C) management through the synergistic interactions between no-tillage and cover crops that lead to improved soil health.

Earth's climate is complex, and highly variable. Climate change may be the first "domino" to fall setting off a series of crises related to soil degradation and loss of food security. We have had several "one in 1000 years" rainfall events in the last few years contributing to the observed climate extremes. In the end, it doesn't matter one bit if climate change is a natural cycle or a man-made problem; we all have to deal with it. We in agricultural will have to learn to mitigate and adapt to these extreme changes if we're going to maintain sustainable production systems. With the recent extreme weather, we have outgrown our "traditional conservation" practices. Since the dust bowl days in the U.S., grassed waterways, contour strips, erosion control structures, and terraces all have served a useful purpose and have help protect our valuable soil resources. We must now reconsider these soil conservation practices in view of climate extremes.

Efforts to control land degradation and soil erosion can be traced over millennia. Although some local successes have been achieved, on a global level results have not been significant. History is a parade of civilizations that have arisen and then vanished. Montgomery, (2007a, b) explains the effect of poor soil management and erosion on several past civilizations. Many once thriving civilizations eventually collapsed due to erosion, salinization, nutrient depletion and other types of soil degradation. Degradation has continued unabated, in fact, it has increased severely over the past century, sometimes to the point that it has threatened the continuation of agriculture in some countries.

Keeping the soil covered and growing with living roots is a critical component of erosion control and improving the health and function of the soil in all farming operations. Diverse rotations enrich the soil with plant-available nitrogen and organic C, break disease and weed cycles, and diminish erosion by putting living roots in and cover on the soil surface. Diverse rotations also provide multiple environmental benefits including reduced synthetic nitrogen use, effective weed control with less herbicide, and lower herbicide-related issues, all these characteristics point to increased system resilience. Erosion control, increasing organic matter, nitrogen fixation, increasing water infiltration, better soil structure and improving the soil micro flora, all derived from cover crops aid in sustaining or increasing yields through healthier soils. Deep rooting cover crops enhance the ability for the economic crop to follow those bio-pores deeper. Using diverse annual cropping rotations and cover crop mixes increase soil organic matter (carbon) which increases water holding capacity and available nitrogen.

Applications and implications for conservation agriculture

Conservation Agriculture (CA) will be used to describe the intended production system. This term will imply the use of continuous no-tillage systems that incorporate diverse crop rotations and multi-species cover crops with emphasis on C management. The no-till system (also referred to as direct seeding, zero tillage, and sometimes conservation tillage) is the only strategy and farming technology to protect the soil while at the same time enabling seeding for subsequent crops (Friedrich, et al.,2012). The no-till system described here is **not** to be confused with other forms of conservation agriculture, conservation tillage, mulch tillage, strip tillage, reduced tillage, etc. The three key components in CA are: 1) continuous crop residue cover, 2) minimum soil disturbance, and 3) diverse rotations and the use of cover crops. Conservation Agriculture and Soil Health system concepts are closely related. Soil health (SH) includes the first three components (expressed a little differently) of CA and adds a fourth component, keep living roots in the soil as long as biologically possible.

Conservation is more about plant and C management than soil management. It is evident that "C"arbon is the chemical symbol "C" that starts true "C"onservation. The interest in cover crops and C input stems from the potential for "drought proofing" a landscape. Soil organic matter absorbs moisture like a sponge, then releases it and decomposes enhancing nutrient cycling. The acceptance of the synergistic simplicity of no-tillage (minimizes C and soil loss) and the use of diverse cover crop mixes (maximizes soil coverage and C input) for soil diversity protection and regeneration. With less intensive tillage, there are more environmental benefits accrued with fewer input costs. A few farmers are finding the environmental and economic benefits are going hand-in-hand with this systems approach for food security. By using cover crops, no-till and diverse crop rotations, some farmers are finding that their soil actually has more available water for their cash crops when those crops really need it.

Results and Discussion

We must take the "really long view" for food and national security. With increased recognition that by using no- tillage combined with diverse rotations and cover crops, we can protect and improve the health and function of our soil. The principles of building healthy soils are the same everywhere; minimize soil tillage and switch from a monoculture crop rotation to one with a diversity of crops that includes cover crops. These principles serve to create diversity required for the habitat for soil microbes to flourish, enabling the rejuvenation of the soil. The synergistic combination of no-till as a unique seeding method combined with diverse crop rotations and cover crop mixes implicate the role of C in our ecosystem services directed at food security. We must transition towards improved C management systems linking bio diverse genetic resources to low external input/high C input farming systems that come from conservation agriculture systems using no-tillage and cover crop mixes.

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