Policy and Institutional Support for Conservation Agriculture in the Asia-Pacific Region

Food and Agriculture Organization (FAO) of the United Nations
Regional Office for Asia-Pacific (RAP)
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Foreword

FAO Regional Office for Asia-Pacific (FAO-RAP) in cooperation with the national institutions and counterparts in the Asia-Pacific region[1] as well as international organizations including CIMMYT, ICARDA, ICRAF, CIRAD, SANREM and ACIAR organized a Regional Expert Consultation Workshop in collaboration with the Conservation Tillage Research Centre (CTRC), MoA, in Beijing, China, from 20 to 22 November 2013 to: (i) promote awareness of Save & Grow concept of FAO as a basis for sustainable production intensification, and of CA as an integral farming system component of Save & Grow; (ii) share experiences and knowledge on CA based on cases in the region and from outside; and (iii) promote the mainstreaming of CA as a basis for sustainable production intensification through policy and institutional support strategy. The Workshop was hosted by the China Agricultural University, Beijing.

This working document includes the summary of the proceedings and outcome of the Workshop. The documents was reviewed and finalized taking into account the contributions made by the Workshop participants in general, and in particular the two Working Groups that reviewed the current status of CA in the region and suggested possible ways forward for the promotion of CA.

The term "Save and Grow" comes from the title of a publication that was launched by FAO in July 2011 (FAO, 2011). It represents as "a new paradigm: sustainable crop production intensification, which produces more from the same area of land while conserving resources, reducing negative impacts on the environment and enhancing natural capital and the flow of ecosystem services." While the publication is "A policymaker's guide to the sustainable intensification of smallholder crop production", the principles and concepts are scale neutral and apply to all ecologies where agriculture can be practiced.

In the first edition of Save and Grow, the Foreword by the FAO Director General states:

"The present paradigm of intensive crop production cannot meet the challenges of the new millennium. In order to grow, agriculture must learn to save. Consider, for example, the hidden cost of repeated ploughing. By disrupting soil structure, intensive tillage leads to loss of nutrients, moisture and productivity. More farmers could save natural resources, time and money if they adopted Conservation Agriculture (CA). It aims at sustainable production intensification that can enhance agricultural output and productivity as well as ecosystem services."

The Workshop recommended that: (a) an CA Alliance for Asia-Pacific (CAAAP) should be established with its Secretariat to be hosted initially at the Conservation Tillage Research Centre (CTRC), MoA, China; and (ii) the Alliance should facilitate the preparation and

[1] Asia-Pacific region comprise of Iran, Afghanistan, countries of South Asia, South-east Asia and East Asia, and the South Pacific Islands.

implementation of a Business Plan for CAAAP to promote the mainstreaming of sustainable production intensification through CA at the national and regional level, involving a multi-stakeholder partnership strategy.

Given the heterogeneous nature of the land resource base, agricultural production systems, socio-economic condition, limited but growing experiential and research knowledge about CA in the Asia-Pacific region, CAAAP should develop a broad regional strategy for the promotion of CA, and facilitate the development of individual sets of policy support guidelines for each country in the region, as well as country-specific CA development strategies and action plans. Consequently, this document should be seen as a first step in the process of formulating country-specific policy guidelines, institutional strategies and action plans for the promotion of CA in the Asia-Pacific region.

Many individuals including the Workshop participants and the CTRC team helped, directly and indirectly, in compiling this working document which was overseen by Amir Kassam with support from Li Hongwen. Special thanks are expressed to them all. Yuji Niino, Li Hongwen and Amir Kassam, with support from Theodor Friedrich and Josef Kienzle as well as staff from FAO-RAP and CTRC helped in the organization and administration of the Workshop. Sincere thanks are expressed for their many contributions and support.

Grateful thanks are also expressed to CTRC and to College of Engineering of CAU for providing the facilities and logistical support for the Workshop, to CAU President KE Bingsheng, CAU Vice president WANG Tao and Mr. Percy Misika, FAO Representative for China, DPR Korea and Mongolia, for their support and personal involvement at the workshop. The guidance and support rendered by China Ministry of Agriculture (the Department of Agricultural Mechanization Management and the Department of International Cooperation) is highly appreciated.

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Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AIT	Asian Institute for Technology
APAARI	Asia Pacific Association of Agricultural Research Institutions
BISA	Borlaug Institute for South Asia
CA	Conservation Agriculture
CAAAP	Conservation Agriculture Alliance for Asia-Pacific
CA-CoP	Conservation Agriculture Community of Practice
CANSEA	Conservation Agriculture Network for South East Asia
CAU	China Agricultural University
CIMMYT	International Wheat and Maize Improvement Centre
CGIAR	Consultative Group on International Agriculture Research
CIRAD	La recherche agronomique pour le développement, France
CTRC	Conservation Tillage Research Centre
DRM	Disaster Risk Management
ECAF	European Conservation Agriculture Federation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAO-RAP	FAO Regional Office for Asia-Pacific
FAO-TCI	FAO Technical Cooperation Investment Centre Division
GCAP	Global Conservation Agriculture Programme
GHG	Green House Gas
GM	Genetically Modified
ICARDA	International Centre for Agricultural Research in Dry Areas
ICRAF	International Centre for Research in Agroforestry (World Agroforestry Centre)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agriculture Development
IRRI	International Rice Research Institute
M&E	Monitoring and Evaluation
MoA	Ministry of Agriculture
NGO	Non-Governmental Organization
SACAN	South Asia Conservation Agriculture Network
SANREM	Sustainable Agriculture & Natural Resource Management
SOM	Soil Organic Matter
SLM	Sustainable Land Management
TCI	FAO Technical Assistance Investment Centre
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development

Recommended Action Points

The following are the recommended action points for policymakers in Asia-Pacific countries based on the outcome of the Regional Consultation Workshop on Conservation Agriculture (CA) in Beijing, China:

- Launch the establishment of CA Alliance for Asia-Pacific (CAAAP) with its Secretariat hosted initially at the Conservation Tillage Research Centre (CTRC), MoA, China.
- The CAAAP and FAO should jointly facilitate the preparation and implementation of a Business Plan for CAAAP to promote the mainstreaming of sustainable production intensification through CA at the national and regional level, involving a multi-stakeholder partnership strategy. The Business Plan should elaborate the further development of the CAAAP to coordinate and facilitate regional and national level actions. In this regard, an outline regional strategic framework is provided in the Annex III.
- CAAAP and FAO should facilitate the formulation of national strategies and action plans for the mainstreaming of CA in each country in Asia-Pacific region as the preferred production paradigm for agricultural development, including the formation of national CA stakeholder task forces to coordinate and facilitate national level actions. The outline regional strategic framework in the Annex III and the material in section 4 of this report serve as a 'road map' for the formulation of national strategies and action plans.
- Establish clear and verifiable guidelines, policies and protocols for agricultural production systems which qualify as sustainable intensification, including as integral elements Conservation Agriculture, Integrated Pest, Nutrient, Weed and Water management and other desirable practices.
- Institutionalize the new way of farming as officially-endorsed policy in public sector education and advisory services.
- Establish a conducive environment to support this new kind of agriculture, including the promotion of CA farmer associations, provision of suitable technologies, and of inputs through the commercial supply markets.
- Establish incentive mechanisms such as justifiable payments to eco-effective land users for environmental or community services.
- As adoption levels increase and the sustainable intensification becomes an accessible option to every farmer, introduce penalties for polluting or degrading ways of agriculture as additional incentive for late adopters.

1. Introduction

In Asia and the Pacific region, the rate of increase in crop yields has slowed and yield gains are becoming difficult to maintain because of the degradation of land and water resources upon which agriculture is depends. In the region, agriculture in general has been changing from traditional subsistence farming to 'modern' commercial farming at different rates in different nations. This has led to specialization in commercialized farming with mechanization, intensive tillage and increased agrochemical use, leading to destruction of soil health and soil ecosystem functions. The use of high levels of external inputs and labour-saving technologies has resulted, in some cases, to abandoning some of the important ecologically-based practices such as crop rotation and diversified cropping.

Soil erosion, loss of soil organic matter and soil structure, and soil health resulting from soil tillage and exposed soils compels us to look for alternatives to reverse the process of soil degradation and decreasing productivity. The natural approach to this is no or minimum mechanical soil disturbance and maintaining soil cover in a diversified cropping system. This produces many benefits, and has led to movements promoting what has become generally known as Conservation Agriculture (CA)[2]. This involves no tillage and direct seeding, protection of the soil with an organic mulch cover, and crop diversification through crop rotations or associations or sequences. Practices such as the precise placement of agrochemicals, and application of animal manure, crop residues and green manure crops, can enhance the positive effects of CA. The controlled movement of farm vehicles on permanent tracks facilitates reducing or eliminating soil compaction from excessive use of heavy machinery for field operations also in CA systems.

Conservation Agriculture aims to conserve, improve, and make more effective use of natural resources through the integrated management of available soil, water, and biological resources, combined with purchased external inputs. It contributes to environmental conservation and enhances and sustains agricultural production. It can also be referred to as resource-efficient/resource-effective type of agriculture.

Natural ecosystems, in their altered states, have always been relied upon to support continuity of agriculture production and ecosystem services such as flood and erosion control, mediation of water quality, stream flow regulation, microclimate regulation, and biodiversity in its various forms. Improper agricultural practices can reduce the ability of ecosystems to provide food and other services. But efforts to promote food security and environmental sustainability can often reinforce each other and enable all farmers to adapt to and mitigate the impact of climate change and other stresses. Some of these efforts would be based on appropriate technologies such as CA and practices that restore natural ecosystems and improve the resilience of farming systems, thus enhancing food security. This is why CA is considered to be an ecologically suitable basis for sustainable production intensification.

[2] The definition and description of CA adopted for this Regional Consultation and document are those from FAO, available at: www.fao.org/ag/ca

Issues and challenges

Agricultural practices can reduce the ability of ecosystems to provide goods and services (also known as ecosystem services). For example, high applications of fertilizers and agrochemicals can increase nutrients and toxins in groundwater and surface water, resulting in health and water purification costs, and decreasing fishery and recreational values. Agricultural practices that degrade soil quality contribute to eutrophication of aquatic habitats and higher costs for increased fertilization, irrigation, and energy to maintain the productivity of degraded soils. Practices that change species composition or reduce biodiversity in non-agricultural systems may also diminish ecosystem goods and services, because the ability of ecosystems to provide some services depends both on the number and type of species in an ecosystem.

Conservation Agriculture is based on the principles of rebuilding the soil and maintaining its productive health, optimizing crop production inputs and labour as well as productivity and profit gains. It advocates that the social and economic benefits gained from combining production targets and protecting the environment, including reduced input and labour costs, are greater than those derived from targeting production alone. CA involves the integration of ecological management of the natural resource base with scientifically modern agricultural production.

Conservation Agriculture has been practiced for more than three decades now in different locations worldwide. Field results show that the introduction of no-tillage, mulch cover and crop rotation is economically and environmentally viable, and that CA has the ability to control weeds and retain soil moisture, providing better conditions for crop development.

Despite the obvious benefits of CA, it does not spread automatically unless it is promoted for wide adoption. The constraints that hinder adoption must be understood and addressed for specific situations. These can include a combination of intellectual, social, financial, biophysical, technical, infrastructure constraints, or policy related support. Knowing what the bottlenecks are is important in developing strategies to overcome them. Crisis situations that are likely to become more frequent as a result of climate change, and the political pressure for more sustainable use of natural resources and environment protection, provide opportunities to harness international, national and local support for Conservation Agriculture.

CA is still a relatively new and unknown concept in Asia whereas the majority of the world's farmers practice conventional tillage-based farming. The primary constraints are intellectual - the CA concept can appear to be counterintuitive and contradicting the culture of the common tillage-based farming experience. There can also be a lack of locally generated experimental data on CA but this constraint is now not as severe as it used to be a decade or two ago because some 10% of the global cropland is now being managed using CA systems and successful experiences are now available from most agro-ecologies across all continents.

CA practice must always be developed locally, depending on the specific farming and agro-ecological conditions. Long-term experience with CA globally has shown that it does not give more or fewer problems for the farmer, but different ones like, for example, the completely

new dynamics of CA systems that require a different set of management skills and learning by doing process for the farmer. Nevertheless, it should be noted that such needs can be facilitated. . For instance, in order to adopt CA, a farmer would need access to a zero-tillage direct seeder, which may be unavailable in the neighbourhood. Buying one without knowing the system or without even having seen the system is a risk that few farmers will take. Machinery dealers might not wish to promote CA, if not supported by extension trials, and also because the technology will reduce machinery sales, particularly of large tractors that would not be needed with CA.

Before a significant number of small farmers can adopt CA practices, they will need access to competent technical assistance and long-term credit at affordable rates to purchase or share a minimum set of equipment and machinery. However, CA can be practised successfully as a manual system as well as with simple and affordable animal-drawn equipment. In mechanized situation on smallholdings, CA can be practiced using CA equipment mounted on two wheel tractors.

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This document presents: some of the generic policy opportunities that exist for the adoption and uptake of CA; a summary proceedings and outcome of the Regional Expert Consultation Workshop which describes the status of CA in the Asia-Pacific region; the challenges to CA adoption and uptake; and the conditions that need to be taken into account in designing and promoting policy and institutional support strategies for up-scaling CA.

At the Workshop in Beijing, it was agreed that Conservation Agriculture Alliance for Asia-Pacific (CAAAP) should be established with its Secretariat to be hosted initially at the Conservation Tillage Research Centre (CTRC), MoA, China; and (ii) the Alliance should facilitate the preparation and implementation of a Business Plan for CAAAP to promote the mainstreaming of sustainable production intensification through CA at the national and regional level, involving a multi-stakeholder partnership strategy. Thus, there was a need to facilitate follow-up work on the formulation of country-specific policies, strategies and action

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plans for the promotion of CA. As a guide to this follow-up work, a regional strategic framework for CA in the Asia-Pacific region has been included as an Annex to be used as a ‘road map’ (Annex III).

2. Policy and Institutional Support Opportunities for Conservation Agriculture in Asia-Pacific

Major changes in ecological awareness and knowledge have been occurring globally during the past three decades in the understanding of the root causes of agricultural land degradation and sub-optimal agricultural performance. This understanding has increasingly become a basis for the promotion of sustainable production intensification, sustainable agricultural land management, and rehabilitation of degraded agricultural land. Experiential knowledge from the farming communities and formal scientific knowledge from research community have been accumulating from all continents regarding the role of CA in sustainable agriculture intensification, improving food security and enhancing livelihoods and the environment. This is why FAO is promoting CA as a 'Save and Grow' production system. These developments serve to strengthen policy-related opportunities for promoting the testing, adaptation, adoption and dissemination of CA to address the following five major challenges faced by the Asia-Pacific region, as well as internationally, namely:

(1). The concerns regarding pervasive food insecurity and poverty, high prices for food, production inputs and energy, wide-spread degradation of agricultural land resource base, resource scarcity, and climate change;

(2). The continuing high environmental impact of tillage-based agriculture, leading to economically and environmentally sub-optimal productivity in rainfed and irrigated agriculture, soil and agro-ecosystem degradation, pollution of water systems due to water erosion and leaching of agrochemicals, salinization and vulnerability to climate change;

(3). The short-comings of the relatively high-cost tillage-seed-fertilizer-pesticide-credit approach to agricultural development and sustainable livelihoods for the resource-poor small farmers trapped in a downward spiral of land degradation, fragile economies and ineffective policy and institutional support;

(4). The increasing preference for agro-ecologically-based production systems that are environmentally more benign, offer improved productivity from less inputs as well as greater environmental services, and are 'climate-smart' in terms of adaptation and mitigation;

(5). The natural and man-made disasters and crises which often lead to emergencies involving large rural populations whose agriculture systems and livelihoods have to be rehabilitated through relief and development measures.

Much has been written about the above concerns and situations (McIntyre *et al*., 2008; Foresight, 2011; UNEP, 2012). These concerns and situations are creating opportunities for transforming tillage-based agriculture that is increasingly being recognized to be ecologically

and economically unsustainable into CA system (Shaxson *et al*., 2008; Friedrich *et al*., 2009; Kassam *et al*., 2009; FAO, 2011).

Conservation Agriculture enables producers to intensify production sustainably, improve soil health and minimize or avoid negative externalities. CA is able to support and maintain ecosystem functions, and services derived from them, while limiting agro-chemical and mechanical soil interventions - required for intensifying the production - to levels which do not disrupt these functions. Thus, intensification with CA can allow harnessing efficiency (productivity) gains as well as producing ecosystem benefits. CA offers these potential benefits to all producers, whether they operate on small or large scale of farm size, and to all types of soil-based systems of agricultural production, and to society at large (Pretty, 2008; Friedrich et al., 2009; Kassam *et al.*, 2009; Pretty *et al*., 2011):

(i) Higher stable production, productivity and profitability with lower input and capital costs;
(ii) Capacity for climate change adaptation and reduced vulnerability to extreme weather conditions;
(iii) Enhanced production of ecosystem functions and services;
(iv) Reduced greenhouse gas emissions.

CA principles translate into a number of locally-devised and applied practices that work simultaneously through contextualized crop-soil-water-nutrient-pest-ecosystem management at a variety of scales. According to FAO (2008, 2012), the adoption of CA has resulted in savings in machinery, energy use and carbon emissions, a rise in soil organic matter content and biotic activity, less erosion, increased crop-water availability and thus resilience to drought, improved recharge of aquifers and reduced impact of the variability in weather associated with climate change. It can also result in lowered production costs, leading to more reliable harvests and reduced risks.

CA has been transforming tillage-based agriculture over large areas, especially during the past 20 years or so in North and South America, and in Australia. In the last ten years CA has been spreading in Asia and Africa, as well as in Europe. In 2011, there were some 125 M ha of arable crop land under CA, corresponding to about 9% of the global crop land, spread across all continents and agro-ecologies (Table 1) (Friedrich et al., 2012), with some 50% of the CA area being located in the developing countries.

During the past decade or so, CA has been spreading at the annual rate of some 7 M ha, as more development attention and resources are being allocated towards its dissemination by governments, public and private sector institutions, international research and development agencies, NGOs and donors (Kassam *et al*., 2010; Friedrich *et al.*, 2012). As described in the following sections, CA is now taking-off in the Asia-Pacific region. In China in 2011 there is some 3.1 M ha of wheat-based system under CA, and the area is much larger today. China serves as a good example that shows that accelerated transformation from tillage-based system to CA is possible if policy and institutional support can be provided to farmers.

Table 1: Extent of Adoption of CA Worldwide in 2011 (countries with > 100,000 ha)

Source: Friedrich *et al.* (2012); www.fao.org/ag/ca

Country	CA area (ha)	Country	CA area (ha)
USA	26,500,000	South Africa	368,000
Argentina	25,553,000	Venezuela	300,000
Brazil	25,502,000	France	200,000
Australia	17,000,000	Zambia	200,000
Canada	13,481,000	Chile	180,000
Russia	4,500,000	New Zealand	162,000
China	3,100,000	Finland	160,000
Paraguay	2,400,000	Mozambique	152,000
Kazakhstan	1,600,000	United Kingdom	150,000
Bolivia	706,000	Zimbabwe	139,000
Uruguay	655,100	Colombia	127,000
Spain	655,000	Others	409,440
Ukraine	600,000		
Total			124,794,840

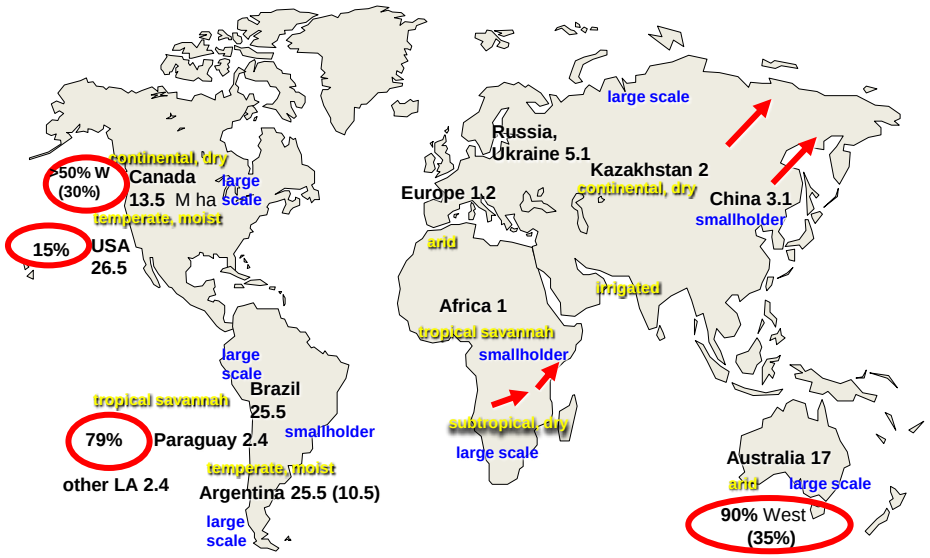

Figure 2: The spread of Conservation Agriculture globally in 2011 -- 125 million ha

3. Proceedings of the Regional Expert Consultation Workshop on CA Policy and Institutional Support

A Regional Expert Consultation Workshop on Conservation Agriculture (CA) for Formulation of CA Policy and Strategy for Asia-Pacific Region was held in Beijing, China from 20-22 November 2013. The Food and Agriculture Organization (FAO) Regional Office for Asia-Pacific FAO-RAP) Region and China Agricultural University (CAU) co-sponsored the Workshop, in close collaboration with Conservation Tillage Research Centre (CTRC), MOA, China. More than 30 experts including researchers, policy makers, extension specialists and entrepreneurs from the Ministries of Agriculture, agricultural research institutes, academia and universities, agricultural machinery management, extension services, enterprises and the private sector from 16 member countries (China, Mongolia, India, Vietnam, Cambodia, Laos, Philippines, Sri Lanka, Bangladesh, Pakistan, Thailand, Indonesia, Timor-Leste, Malaysia, Australia, Uzbekistan) and several and international organizations (CIMMYT, ICARDA, ICRAF, SANREM, ACIAR) and Food and Agriculture Organization (FAO) participated in the event. Yuji Niino, Land Management Officer, FAO-RAP, and Amir Kassam, Consultant, FAO-RAP, facilitated the Workshop with support from the CTRC team led by Li Hongwen.

Focusing on the status of CA in Asia, the participants shared experience and progress in promoting CA practices, reviewed the current status of CA in the region, analyzed the economic and environmental benefits from CA and exchanged ideas on how to enhance the application of this generic farming system in the member countries in the Asia-Pacific region.

Field visits to view the demonstration of CA machinery and equipment developed in China were arranged by China Agricultural University and Shandong Yuncheng Gongli Ltd. of China.

Field Visits

During the concluding session, the participants focused on policy recommendations, strategies and program formulations for promoting the uptake and spread of CA in the

member countries in the Asia-Pacific region. The Workshop proceedings, conclusions and recommendations are summarized below.

3.1 Opening Ceremony

Han Lujia, Dean of the College of Engineering of China Agricultural University hosted the opening ceremony. President of China Agricultural University, Ke Bingsheng, FAO Representative for China, DPR Korea and Mongolia, Percy Wachata Misika, and Deputy Director General of Department of Agricultural Mechanization Management, MOA, China, respectively introduced the development history of CA in China, the development and challenges of CA in the Asia-Pacific region and in China. They expressed a desire for cooperation to be strengthened between international organizations, universities and government agencies, for CA policies and strategies formulation for the promotion and spread of CA in Asia-Pacific region.

Opening Ceremony

3.2 CA Status in Asia-Pacific region at the national and regional/sub-regional level

After the opening ceremony, Yuji Niino introduced the Workshop programme (Annex I) and highlighted the objectives which were to: (1) promote awareness of CA and its benefits; (2) share experiences and knowledge on CA based on cases in the Asia-Pacific region and from outside; and (3) promote the mainstreaming of CA as a basis for sustainable production intensification in agriculture development through formulation of CA policy and strategy for the Asia-Pacific member countries. More than 30 CA experts from different countries and organizations in the Asia-Pacific region and outside the region attended the Workshop, and more than 20 experts made presentations on the status of CA and related activities at the national level. There were presentations also at the global and regional level, including from ICARDA on Central Asia, CIRAD on Southeast Asia and ACIAR on Australia and Asia, CIMMYT on Asia, and BISA on South Asia.

Presentation

3.2.1 "Save and Grow" and the Status of Conservation Agriculture in the world

Amir Kassam made a presentation of the book "Save and Grow" published by FAO in 2011 as a guide to policy makers for sustainable production intensification by smallholder producers. The challenge proposed in the book is that to feed a growing world population we have no option but to intensify crop production. But farmers and development community face unprecedented constraints including high cost of production, land degradation, sub-optimal production paradigm, inadequate policy and institutional support and resource scarcity. In order to grow, agriculture must learn to save. The Save and Grow book is FAO's guide to sustainable crop production intensification in line with its Strategic Objectives, and (ahead of) international thinking – EU Food Security Thematic Programme "ecological intensification"; IFAD Rural Poverty Report, 2011; Rio+20 (the SCP agenda); and aims to be technically correct, and quick to read for policy makers. The book includes six technical chapters (farming systems, soil, water, plant protection, etc) in plain language, and there is no silver bullet – there is no single solution for sustainable intensification but all agriculture production solutions need to be based on Conservation Agriculture principles which, based on locally formulated CA practices, is able to mobilize the whole agro-ecosystem for

resilience rather than fight or degrade it, and for more efficient use of inputs which can create "win-win" situations.

Consequences of tillage-based agriculture included: (1) loss of SOM, porosity, aeration, biota (=decline in soil health -> collapse of soil structure -> compaction & surface sealing -> decrease in infiltration); (2) water loss as runoff & soil loss as sediment; (3) loss of time, seeds, fertilizer, pesticide (erosion, leaching); (4) less capacity to capture and slow release water & nutrients; (5) less efficiency of mineral fertilizer: "The crops have become 'addicted' to fertilizers"; (6) loss of biodiversity in the ecosystem, below & above soil surface; (7) more pest problems (breakdown of food-webs for micro-organisms and natural pest control); (8) falling input efficiency & factor productivities, declining yields; (9) reduced resilience, reduced sustainability; (10) Poor adaptability to climate change & mitigation; (11) Higher production costs, lower farm productivity and profit, degraded ecosystem services; (12) Dysfunctional ecosystems, water cycle, suboptimal water provisioning & regulatory water services. More of this 20th century paradigm is not going to meet the needs of the 21st century.

So a new production paradigm of sustainable production intensification is needed whose technical objectives include: (1) enhancement of agricultural land productivity as well as of the natural capital base and the flow of ecosystems services; (2) enhanced input-use efficiency; and (3) the use of biodiversity – natural and managed (and carbon) to build farming system resilience. In addition it must contribute to multiple outcome objectives at farm, community & landscape scales of the food and agriculture system; and it must be able to rehabilitation degraded agricultural land and agro-ecosystems from past abuse. But how can these objectives be realized? In terms of production system, it corresponds to CA. The pattern of impact of CA included: (1) Increase yields, production, profit (depending on prevailing yield level and land degradation); (2) less energy, labour and machinery costs (up to 70%); (3) less mineral fertilizer use (up to 50%); (4) less pesticides (up to 20% in high output situations, and being able to do without pesticides in poor smallholder situations); (5) reduced water needs (-30%); (6) more stable yields – lower impact of climate (drought, floods, heat, cold) – climate change adaptation; (7) climate change mitigation (through C sequestration and lower fossil fuel use); (8) Lower environmental cost (water, infrastructure).

And then typical CA machines of Pakistan, India, Kazakhstan, China and North Korea were introduced. At the end Amir highlighted opportunities and constraints to CA uptake and scaling, emphasising that a more organized approach needs to be promoted at national and regional level by all stakeholders working together and helping to establish policy and institutional support needed to accelerate the mainstreaming of CA concepts, practices and benefits.

Next, Amir presented another overview presentation of the status of CA in the world. The presentation included: (1) the notion of sustainable crop production intensification, which includes highest possible production and environmental footprint lower than the recovery capacity of the ecosystem, and focuses on soil and ecosystem functions which means that healthy soil is a basis for sustainable crop production; (2) CA system which involves a set of

three inter-linked core components necessary to make "no-till" sustainable. CA in practice is characterized by three locally formulated linked practices, namely: continuous no or minimum mechanical soil disturbance; maintenance of permanent organic soil cover; and diversification of crop species grown in sequences, associations and rotations. This translates into following practices: permanent no-till (disturbance <15cm/25%), mulch cover or cover crops/crops (soil cover >100%, min. 30%), and crop rotations, associations, sequences (>3 different species).

Amir then outlined the history, development and regional experiences of CA in the world. CA had been adopted over 125 million ha of arable cropland in 2011. CA adoption was distributed across all continents - Latin America, North America, Europe, North Africa, Middle East, Sub Saharan Africa, Australia and New Zealand and Asia. Drivers for CA adoption include erosion and loss of productivity, drought and loss of productivity, increasing production costs; and demand for ecosystem services from agricultural land use. Impacts of CA include yield improvement, less fertilizer use, less pesticides, less machinery, energy, labour cost, high profit, and low environmental cost. Today there are many organizations and networks that are promoting CA at national and international level.

3.2.2 Status of Conservation Agriculture in China

Li Hongwen, Head of CTRC, MOA, presented the background, development, machines and tools, government policy of CA and barriers to adoption and promotion of CA in China. Li pointed out that, in China conservation tillage equals to Conservation Agriculture. In China, the total population is 1300 million but only 130 million ha of land can be used for agriculture, which means that there is on average 0.1 ha of agricultural land per person. Drought, soil and wind erosion, stubble burning, all provide a justification for the application of CA in China. CA was started in 1992, and has been developed for 20 years. The history and development of CA can be divided into two stages: stage 1 (1992-2002), to prove China can use machinery to practice CA, and to test whether mechanized CA gave good benefits. During this period, CTRC was set up in 1999; stage 2, demonstration. During this period, the first national field meeting was held in 2002 and the area of CA increased to more than 6 million ha. The machines and tools of CA have developed considerably in China, and more than 100 factories at different levels exist in China. Typical CA machines and tools contain hand planter (Li Seeder), no till seeder for 2 wheels tractor, middle and small no-till seeders (wheat strip rotary hoe seeder, rice strip rotary hoe transplanter, etc.).

Until now, many policies of CA have come, such as the Central Document No. 1 which stressed CA for 8 years, and the Ministry of Finance supported MOA to extend the spread of CA from 2002 and beyond. However, there are still barriers that exist to adoption and promotion of CA in China, such as lack of cheap and easy used CA machines, farmers' traditional thoughts, and some scientists and governmental officials worry about yields, too much herbicide use and so on. At the end, Li recommended that there was a need to establish ACAA (Asia CA Alliance or Cooperative Research Centre or Training Centre) or a platform for CA information sharing in Asia.

3.2.3 Industry and Agriculture Sector of Mongolia

G. Nandinjargal, Head of Administration Management Department for Ministry of Industry and Agriculture, Mongolia, presented an overview of the industry and agriculture sector of Mongolia. The presentation covered a general background on Mongolia, purpose and brief introduction of the industry and agricultural sector, and an introduction of the crop production sector. Mongolia is a landlocked country located at the heart of Asia. It borders Russia in the north and China in the south, east and west. The mission of industry and agricultural sector is to provide healthy food to the population, develop industries, increase growth of all sections of the national economy, to successfully use national raw material resources, and to implement successful policy to increase value addition. The vision is to develop the industry sector, facilitate sustainable development of the industry and agriculture sector and of the Mongolia economy. In 2012, industry and agricultural sector of Mongolia covered 40% of Gross Domestic Products, and 64.8% of total labour force. Industry and Agricultural sector comprises: heavy industry, light industry, food industry, animal husbandry, and crop production. The structure of crop production consists of seed, potato, vegetable, and storage system.

3.2.4 Status of Conservation Agriculture in India

Yashpal Saharawat from IARI and ICAR introduced the status of CA in India. India has the 2nd largest agricultural land area in the Asia region, and has more than 140 million ha under cultivation, 63.3 million ha net irrigated area and engages 58% of total workforce. Indian population has tripled in the last 40 years but food-grain production quadrupled in spite of the fact that 78% of the farmers cultivate less than 2 ha. The Green Revolution was a great achievement in the mid-sixties, which was attributed to policy support, institutional infrastructure and trained human resources. But there are still future food security challenges existing, and the largest paradox is the same land area, with less water, nutrients, fuel, labour and in changing climatic conditions must now produce more. That is the background of CA development in India. CA began with on-farm testing of ZT drill in 1990, and did a rapid development with many initiatives still in place after more than 20 years. There are many benefit of CA in India, however, there are still some challenges, such as: over all potential wheat yields are decreasing; decrease is more than 1.5 t/ha if the date of sowing is December 1 from 1981 to 2009, and November end to December 1st sowing was fine up to end of 2000, but with terminal effect November 3 to November 17 sowing performed better, so the future trends suggest that date of sowing may shift a bit ahead to end October and therefore short duration rice varieties are needed.

In a recent review of the CGIAR impact has reported that India CA programme has saved USD 164 million with an investment of USD 3.5 million with internal rate of return of 66%, highest amongst all the CGIAR programmes. Suitable machinery, mind-set and variable results are the major issues in the adoption of CA in India. Future pathways in India includes: design and develop CA machinery suited to diverse farmer typologies and ecologies; studies on crop-livestock interactions and crop residue management for multiple use; environmental

foot prints of CA systems; define institutional arrangements and developmental needs for scaling-up and scaling-out of CA systems; capacity building at different scales and levels; and new course in CA system at University level.

3.2.5 Status of Conservation Agriculture in Vietnam

Dr Duong Ngoc Thi from Institute of Policy and Strategy for Agriculture and Rural Development introduced the status of CA in Vietnam. First, he presented the agriculture context: after 25 years reforming, Vietnam agriculture has achieved many successes: food security; agro-products export; poverty alleviation; and rural development etc. Now Agriculture share 20% of total GDP, and 25% of export value in Vietnam. Directions to develop agriculture until 2020 include ensuring food security at national and household level; development of commodities that have good potential to offer high value products, and increase agro-product competitiveness; applying technical and technology-based solutions in agro-production and business, applying intensification and mechanizations; applying farming systems to adapt to and mitigate climate change, using sustainable resources; developing both small scale and large scale models; change institutions to cooperate among farmers and link enterprises to farmers, attracting investment from private sector; and directions on techniques to include replacing crop varieties tolerant to flood, drought, diseases and with shorter maturity period; rotating rice with annual crops in area that specialize in rice cultivation; changing relation of crop, livestock and aquaculture in farming systems; applying technical measure to reduce fertilizer, pesticide and herbicide application; and applying technical measure to reduce water use; and reduce glasshouse emission.

CA in Vietnam has developed in a wide range of agro-ecological conditions in the cooler northern part, warmer southern parts and the mountainous agro-ecology; the crops comprise maize, soybean, potato, rice-shrimp and others. In Vietnam, the process of applying CA on the field (rice-growing land) include harvesting rice, cleaning the field and cutting straw, maintaining soil humidity, and a network of furrow drains around the field and between beds-to create beds-sowing-covering ground by straw-taking care of the young seedlings and fields. CA has been evaluated highly by farmers and local administrations on a number of aspects. On economics: it minimizes expense for tillage (60-70%); uses waste products (using 90% straw); economizes on fertilizer cost; no need of strong farmers, the older farmers can work easily; farmers can grow larger area; grow crops that have been carried in time; farmer's expense is reduced, and income is increased. On environment: using straw, reduces pollution of fresh air due to burning straw; minimum soil disturbance or zero tillage has contributed to reducing greenhouse gas emission; reducing chemical fertilizer => reducing chemical surplus in the soil, water and products, contributing to protect the environment and ensure food safety. The opportunities of CA in Vietnam are: government set a target to reduce 20% GHE in each decade, so they pay more attention to apply GHE - reduced agriculture system; government set a target programme to use sustainable resources; CA on potato production had been recognized by MARD as an advanced technique and encourages farmer to apply; price of material chemical and industrial input has increased, and some farmer try to use least amount of industrial inputs and rely more on their own sources;

consumers and others stakeholders pay more attention to food safety, so that they support the CA systems.

The challenges to CA adoption are: no agency in the agriculture sector has been assigned responsibility for promoting CA; awareness of producers and administrators about CA is limited; farmers are implementing CA based on their own experience because there has been little training available to develop skills on CA; database and information on CA is scarce; CA systems have been competing with other systems specially the intensive input Green Revolution systems; there is no detail policy to support CA while many policies are in place to support others programmes and systems; the price of products from CA system has not been higher than ones produced by other systems. So Dr Duong Ngoc Thi put forward some suggestions: Strategy suggestions – (i) CA should be developed on rice fields rotated with other annual crops, in coastal areas and sloping lands; (ii) CA can be applied with minimum soil disturbance with annual crops and zero tillage with CA system involving rice-shrimp fish; (iii) it is not only small households but large producers can apply CA systems; (iv) should combine applying CA system with organic products or products safety; (v) CA should be planned and maintain with other programmes. Policy suggestions – (i) there should be an agency assigned to study and develop CA systems; (ii) agriculture sector should evaluate and recognize CA systems as a set of advanced techniques; (iii) the environmental benefits of CA should be evaluated comprehensively; (iii) advocate for government policy support in order to issue policy to support and disseminate CA systems; (iv) illustrate and persuade the consumers to accept to pay higher price for products from CA systems.

3.2.6 Status of Conservation Agriculture in Cambodia

Sovuthy Pheav from DALRM of Cambodia introduced the status of CA in Cambodia. He said, rice is the most important crop, and major constraints in agricultural production intensification include soil resources, water, variety, seed quality, pests and diseases, socio-economic conditions, labour and knowledge, and marketing. At present land degradation in Cambodia is serious, because the inherent low soil fertility in substantive portions (> 50%) of agricultural lands; disaster risk and climate change primarily through increased intensity and frequency of floods, drought and sea water intrusion and human-induced activities such as overgrazing, and down slope land cultivation. To solve the problems, some possible solutions in policy, regulations and technical options were put forward, and CA is one of the proposed solutions. Some policies and strategies promoting CA include: currently, Cambodia does not have national policy and strategy specifically for CA promotion but the existing ones somehow contribute directly and/or indirectly to food security, SLM and CA; the on-going policy and strategy implementation should involve the alignment and empowering of research, extension, education and training institutions; the public, private and civil sectors are generally aligned to the current norms of tillage-based agriculture in agricultural development. Thus, scaling up of CA adoption means a change in the mind-set of those who practice agriculture and in the very culture of agriculture; the effective sequences of strategic actions could be as follows: identify the limiting factors that hinder farmers to improve their livelihoods; identify factors limiting crop yields and what could be done to alleviate them;

identify one or more farmers already practicing CA and demonstrate its agronomic, financial and livelihood benefits, and set up study visits; set up demonstrations for researchers and advisory staff and farmer groups leaders, to catch their interest; initiate 'learning by doing' such as through participatory forms of investigation and learning; determine the optimum means of achieving CA's benefits for different situations of farm size and resource endowments through on-site research and benchmark demonstration, observation, farmer field schools and field days on farms already attempting CA; importing or producing suitable samples of equipment (e.g., jab planters, direct seeders for animal or tractor power, knife rollers, walking tractors with no-till seeder attachments) to be able to demonstrate their use at the beginning; interact with any already established farmers' groups, e.g. farmer cooperatives, to gain interest and support. However, there are still barriers to adoption and promotion of CA: From the pilot extension experiences, the proposed CA-based cropping systems need to couple with measures to facilitate production factors such as access to credit, cover crop seeds, specific mechanization services; at this stage, it seems clear that acceptance of or dropout from CA is largely dependent on credit and specific mechanization services (no-till seeders), too heavy herbicides used, cover crop seeds; institutional aspects such as the setting up of farmer group organizations and cooperatives.

3.2.7 Status of Conservation Agriculture in Laos

Somvang Phanthavong, Deputy Director of Planning and Cooperation Division, Department of Agriculture, Ministry of Agriculture and Forestry, introduced the current status of CA in Lao PDR. Lao PDR covers area of 236,800 km2 and mountainous areas account for 80%, and about 20% is lowland area. Cultivated land covers about 1.2 million ha (5%), rice is occupying 60-70% of the total crop area. CA principles in Laos consist of minimum mechanical soil disturbance, permanent organic soil erosion (cover), and crop diversification (through crop rotation). Crop rotation includes maize-red bean rotation, maize-pigeon pea intercropping, and rice-maize-soybean rotation. It is said that in Laos "CA is a "basket" of agricultural practices. Farmers choose what is best for them. It is not "prescriptive" and it represents current "best advice" to achieve long-term land sustainability, to obtain more reliable harvests and higher farm profits". However, there are constraints and challenges in scaling up CA: equipment accessibility for farmers; farmer and technician CA knowledge level; credit accessibility for farmers; CA extension system; farmers group organization for CA adoption and application; marketing information provision for farmers; stakeholders coordination; introduction of CA to the agricultural college and university courses. So suggestions are that government interventions should be strengthened in these aspects: CA application contributing to achieving the goals of the Agricultural Development Strategy to 2020 and the Master Plan 2010-2015; strengthening the capacity building and supporting the accessibility to CA equipment; marketing information provision for farmers; strengthening the public-private partnership and stakeholders coordination; international and regional Cooperation in CA R&D; fund support from donors and financial institutions.

3.2.8 Status of Conservation Agriculture in Philippines

Samuel M. Contreras, Head of Soil Conservation and Management Division, made a country report on Philippines. He first presented an overview of the proportion of different types of land and the situation with Philippine agriculture, e.g., the ecological status of top five agricultural crops, the importance of agriculture to the Philippine economy and the disaster losses in agriculture. He pointed out that agriculture is highly sensitive to climatic conditions and the related data indicated the challenges of climate change. Then he introduced the researches on different soil and crop management practice, ways of soil conservation extension and programmes such as DA National Corn Program to advocate CA. At the same time, the barriers on CA adoption are as follows: 1) technology-related factors, 2) tenure insecurity, 3) policy-related factors, and 4） institutional factors. The presentation ended with a conclusion and a recommendation that CA should be examined in the general framework of sustainable development goal, and according to the goal, information and advocacy campaign, more technology demonstrations and enabling local policies are needed to broaden the implementation of CA at the local level.

3.2.9 Status of Conservation Agriculture in Indonesia

Seta R. Agustina from Indonesian Agency for Agricultural Research and Development Ministry of Agriculture made a representation about CA in Indonesia. The distribution of the population across the archipelago is highly asymmetric and agriculture plays an important role in economic growth. Issues and challenges in national agriculture development included: the low land-people ratio for food crops compared with that of some other countries', the area of degraded land is relatively large, and there is an existence of high erosion risk due to inappropriate land use system such as land clearing, deforestation and conversion. Aimed at this situation, policy and strategy are made to revitalize national agricultural development which means taking measures such as keeping self-sufficiency in key commodities and natural resource sustainability. In the meantime a lot of research on component of CA has been done. According to the research, the best practices consist of integrated crop management, integrated cropping calendar information system and integrated crop-livestock system. It was noted that the national extension system includes three stages of agriculture technology transfer: one is research activities, second is assessment activities, and third is extension activities. During the adoption stage there are lessons learned as well, e.g., insecure tenure, additional cost and intangible returns, and limited exposure of some farmers to CA technologies.

3.2.10 Status of Conservation Agriculture in Malaysia

Mohd Abidin Mohd Afiffin from the Department of Agriculture of MoA Malaysia made a presentation of CA in Malaysia by first making a brief introduction about land use and the background of agriculture in Malaysia. Then the present practices of CA were shown, pointing out that the key principles in CA are: 1) practicing minimum mechanical soil disturbance, 2) protecting the soil with mulch cover, 3) crop rotation with more than two

species. In the meantime, it is necessary to deal with marginal soil, sloping land and degradation soil during the development of CA. Therefore, corresponding strategies are designed which include policy, guidelines and legislations. The presentation concluded with the statement that extension programs are the effective tools to create high awareness among farmers in the aspects of utilizing and managing soil, flora and fauna, air, water and energy to sustain the CA, and Good Agriculture Practice and Best Management Practice initiatives are the thrusts for practicing CA in Malaysia.

3.2.11 Status of Conservation Agriculture in Timor-Leste

Adalfredo Do Rosario Ferreira from ministry of agriculture & fisheries in RDTL gave us a country report of status conservation agriculture in Timor-Leste. Timor-Leste situated in Southeast Asia. It has 14,916 sq km and generally topography is mountainous. He briefly introduced the general situation of agriculture in Timor-Leste. As a conclusion, he said that Timor is at the beginning of using CA, with at least one indigenous option. He also pointed that farmers need access to tractors for field preparation on flat areas as well as options to keep animals away from cropping areas.

3.2.12 Status of Conservation Agriculture in Thailand

Thongchai Tangpremsri made a representation of Thailand country report on CA. Thailand is a food exporter and its main crops are rice, rubber, sugarcane, cassava and maize. Soil degradation is an important factor leading to fluctuations in agricultural production particularly in the northeast, and as a consequence, Thai government is trying to manage sustainable agriculture by CA. Five case studies on the main crops were shown. According to the studies, the implementation of CA can offer a lot of benefits, e.g., improve the soil properties of soil structure and organic matter, ultimately resulting in higher yields. At the same time, the government has made policies to promote the development of CA.

3.2.13 Status of Conservation Agriculture in Bangladesh

Md. Abu Taleb, Deputy Secretary of MoA of Bangladesh, presented the status of CA based technology for sustainable crop production by first showing the basic features of Bangladesh agriculture and the listing the sustainability issues that have existed during the development of Bangladesh agriculture. A view held in Bangladesh is that successful crop production is a combination of practices of less soil disturbance, beneficial crop rotation and residue management. A series of studies have shown that CA practices are preferred as they offer a lot advantages including less irrigation water requirement, less soil erosion, comparatively higher yield and so on. However, there are still problems and challenges during the adoption of CA technology. Based on these problems and challenges, it was pointed out that a multi-disciplinary, system-based approach is key for sustainable crop production and for corresponding future plans.

3.2.14 Status of Conservation Agriculture in Pakistan

Mushtaq A. Gill from SACAN, Pakistan made a presentation of the status of CA in Pakistan. The situation of land utilization and yield gap in Pakistan was shown. It was also noted that the challenges that need to be faced include energy security, poverty alleviation, climate and environmental change, etc. CA practice was then compared with traditional planting practices, and it was shown that implementation of CA can save land preparation time, reduce diesel consumption and increase yield. It was mentioned that a pilot project, a kind of integrated crop and resource management in the rice-wheat CA system, had been conducted with good result. Finally, barriers to adaption of CA had been analysed and some concrete advice with respect to farmers, policy makers, private sectors and research have been formulated.

3.2.15 Status of Conservation Agriculture in Sri Lanka

WMW Weerakoon, Director of Field Crops Research & Development Institute in Mahailluppallama, Sri Lanka, made a representation on achieving food security through CA in Sri Lanka. Analysing the basic situation of agriculture in Sri Lanka, it was pointed out that the greatest challenge is to achieve more food production from less land, water, degraded land, labour and agrochemicals. There are still problems that need to be solved, such as soil erosion, lower fertility and reduction of the reservoir capacity due to siltation. Cascade system was established as an answer to drought hazards. It is a unique system in Sri Lanka on which research has been done to prove that this kind of system can benefit a lot. The presentation ended with a discussion on the question "why CA is still not popular in Sri Lanka" and on the need to formulate policy and strategy to improve the situation.

3.2.16 Status of Conservation Agriculture in Australia/Asia

Richard Bell from ACIAR introduced the status of CA in Australia and Asia. Erosion control, timely sowing, moisture, fuel and labour saving lead to the initial development of CA. Many seeders have been developed in Australia but there are many factors blocking adoption: farmer attitudes and aspirations, cost of machinery conversion or replacement; build-up of soil- and stubble-borne plant disease; concern that residual herbicides may limit crop options; livestock with cropping may require tillage to remove forage or pasture phases; herbicide resistance and build-up of hard-to-kill weeds, associated with frequent use of herbicides; soil disturbance may be needed in some situations; environmental and health concerns about the effects of herbicides on and off site. It was suggested to facilitate further adoption of CA in the following ways: ongoing machinery modifications for greater flexibility in the cropping systems; refinement of controlled traffic farming and precision agriculture; resistance or greater tolerance to plant diseases associated with stubble retention; availability of more crop options and rotations; broader spectrum of effective herbicides for use in fallow weed control; genetic modification technologies increasing the efficiency and flexibility of the system (e.g. herbicide-resistant crops); and role of stubble in evaporation component of the water balance.

From the history of CA in Australia, what can be learned is that: development and widespread adoption of CA in Australia has taken several decades; local circumstances affect rates of adoption; adaptation is required for particular soils, crops, and climate; continuous improvement is needed in each region in practice or machinery or to accommodate changes in agronomy (e.g. weed populations, varieties); excessive soil erosion, fuel saving, opportunities for more timely operations and saving in soil moisture at sowing have been the principle drivers behind adoption of CA in Australia; disadoption is almost zero once farmers are convinced to start CA and implement it; partnerships between growers, input suppliers, machinery manufacturers and researchers have been crucial to the development of effective CA. Challenges for CA includes herbicide resistance, increasing costs of weed control, climate variability and diverse rotations. Now Australia (ACIAR) has several projects and seeders developed in Southeast Asia, South Asia, Africa and Mexico.

3.2.17 Status of Conservation Agriculture in Central Asia

Aziz Nurbekov from ICARDA presented the development of CA in Central Asia. Central Asia consists of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. Current and emerging challenges for CA include: growth of population followed by increasing demand for food and feed; expanding area under irrigation; declining arable land per capita and increasing competition for land and water; rising prices of inputs and land degradation, and CA can address these challenges. Effectiveness of CA has been shown in several ways: better development of crops and higher rates of return from agricultural investments and less erosion in the irrigated areas. In addition, crop residues can slow evaporation of soil moisture because residues are slower to degrade, and no-tilling also conserves soil moisture, so more organic matter is produced, outweighing the initial loss of feed. Moreover, CA can reduce farm power and energy for field production, number and size of tractors, mineral fertilizer use, and mitigate climate change. Research has shown that except in Kazakhstan, the adoption of CA is very little in other countries of Central Asia. The barriers includes: (i) mind-set – overcoming the culture of the plough, and there are more difficulties for researchers who have expounded the need for intensive tillage; (ii) more effort is needed in dissemination and local manufacture of the adapted equipment; (iii) lack of extension services throughout the region and lack of farmer expertise; (iv) competition for crop residues. Smallholder farmers generally manage mixed crop-livestock systems where crop residues are used as animal feed.

3.2.18 Status of Conservation Agriculture in Southeast Asia

Jean-Claude Legoupil from CIRAD presented an introduction of CA status in Southeast Asia. The thought “doing together what can’t be done in isolation” is very important. Introducing the overall context of agriculture in South East Asia, it was pointed out that CA is: alternative to intensive commercial agricultural systems based of high chemical input; solutions to restore soil fertility and degraded environment (acidic or salty or polluted soils; erosion both at plot and landscape levels); and solutions to intensify and diversify agriculture in mountainous areas. CA is based on three principles: (i) minimum mechanical soil

disturbance; (iii) permanent organic soil cover; (iii) crop rotations. There are many projects in Southeast Asia, including Cambodia, Laos, Thailand, Vietnam, China and Philippines. There are still some regional challenges identified as priorities for agricultural development as follows: (1) restoration of soil fertility in degraded areas; (2) intensification and diversification of agriculture in mountainous areas, and alternatives to "slash & burn" practices; (iii) development of capacity for "Human Resources Development" to address the needs of all CA development and dissemination actors. In addition, the CA Network for South East Asia (CANSEA) was introduced. The network started in 2009, and the objective is to work together what cannot be done alone. There are six core members in the network: China, Vietnam, Thailand, Cambodia, Laos, and Indonesia. The generic activities of the network include supporting exchanges of experience, results and training, and communication and dissemination of results.

3.2.19 Status of Conservation Agriculture in South Asia

Harminder Singh Sidhu from BISA made a presentation of recent advances in CA machinery in India. India has a large development programme in CA mechanization, because CA can increase farmers' income, address labour shortages, improve natural resources, and mitigate climate change. However, there are still some challenges like land holding size, economic condition, seasonal use, size and shape of fields, terrain, machine, labour and mind-set etc. Some achievements in CA machinery were elaborated such as laser levelling, rice direct seeders, residue management technology, and some new CA seeder prototypes. There are more than 19000 machines in India. The following lessons have been learned and there are opportunities: good Liaison with manufacturer; global market for need/farm size based machinery/technology; custom hiring single window service is emerging for small and marginal farmers; government should come forward to provide subsidies (with qualifier) on all new CA machinery; capacity building of scientists manufactures, farmers is necessary; CA machinery needs to be managed as a business model.

3.2.20 Conservation Agriculture by CIMMYT in Asia

Allen McHugh gave a general introduction of CA on behalf of CIMMYT in Asia. CIMMYT was founded in 1966, with success in South Asia in the mid-1960s. It works through the following five global programmes: genetic resources, wheat, maize, socioeconomics and conservation agriculture (GCAP). Currently, CIMMYT has 1500 staff and 22 regional offices, with staff of CA programme distributed in India, Bangladesh, Nepal, Pakistan, Afghanistan and China. An example of CIMMYT activities in India and China was presented. There are some challenges as following: mind-set, weed control, residue management, nitrogen management, zero-till planters, socio-economic issues, climate change, irrigation, and RD&E modalities.

3.3 Working Groups to review and discuss possible guideline for policy and strategy for promotion of CA

The discussion was divided into five aspects: 1. conduciveness for CA in each country; 2. factors against CA in each country; 3. challenges for CA that need to be addressed in each country; 4. factors needs to be uptake and spread CA in each country; 5. suggestions for CA policy and strategy to move forward.

Participants were divided into two groups for discussion: Experts of Group I included members from Southeast and East Asia, experts from Sri Lanka, Bangladesh, Pakistan, India, Uzbekistan and China. Their discussion led to the following output:

(1) In Sri Lanka, minimum soil disturbance is preferred than other treatments, and water and erosion is the conducive for CA, however, CA appear to need more herbicides than conditional tillage to control weed, which can hinder CA development; another challenge for CA development is machinery availability, suitable machineries were still not adequate. In Sri Lanka, the awareness of farmers on CA still needs to be improved through demonstration.

(2) In Bangladesh, CA has been developed and researched since 1995. Up to now, more than 50000 two wheel tractors are used in the country and large numbers of organizations have been developed. Constraints and challenges include: availability of quality is a problem, conflicts of residue between CA and livestock feeding, and some CA technologies for rice are not ready, such as safe and effective use of herbicide. So CA needs active farmers and providers as leaders; in addition, knowledge sharing should be strengthened, such as weed control, therefore, networking is needed for such exchange at regional level, and value adding supply chain creation is necessary: from manufacturer to farmers to market, credit facility for smallholder farmers, training program for farmers and service providers.

(3) In Pakistan, four cereal based cropping systems are using CA, with partial success in wheat crop systems, and water scarcity is the most conducive factor for CA adoption. The barriers and challenges of CA development in Pakistan embodies in the following aspects mainly: mind-set is the biggest problem, so the awareness at all levels should be enhanced; in addition, machinery is a major issue, and lack of institutional support and policies, so right policies are needed to accelerate adoption and dissemination of technology, and international collaboration should be strengthened.

(4) CA has a huge growth potential in India due to machinery availability, reduction in cost of production and existence of partial policy support. However, there are still some issues such as weed control, mixed views of scientists, no business model for CA, policy mismatches and CA leaders are not available. So India should establish standardization of package of practices according to local situations, establish national networks on CA, and develop CA engagement at all stakeholder levels.

(5) In Central Asia, water erosion promotes the adoption of CA, because CA improves land use efficiency. But mind-set is still a big issue during CA development, and lack of CA

equipment; another issue is that there are no private manufacturers for CA machineries, which means CA machines used in Central Asia rely mainly on imports. In the future, Central Asia should be emphasized in countries which have not yet adopted it, promote knowledge on CA at all levels such as success stories, and update ICTs on CA and its sharing, field days and field training.

(6) In China, CA has gone through rapid development, but smallholder farmers care more about yield increase than other factors such as climate change. In addition, machinery unavailability, non-conducive policy and lack of inter-ministry support to promote CA, all serve as constraints to the development of CA. Therefore, making policy makers believe that CA is a reality and so is the need to support its adoption for sustainable production intensification.

(7) Considering the above national situations, the working group put forward that sub-national, national and regional CA networks should be established, and form partnerships to promote exchange visits, machinery, seeds, information, etc. FAO should lead the networks and governments should own the networks.

Working Group II included experts from Southeast Asia -- Philippines, Thailand, Indonesia, Vietnam, Cambodia, Timor-Leste, Malaysia, and Laos. They discussed five aspects and formulated conclusions as follows:

(1) What is in each country conductive to CA? This question was discussed in three ways: First is research. Some countries have advanced CA research, but some countries have just initiated CA research. Second is policy. Polices are still weak across all countries in promoting CA, and national and local level policies as well as organizational structure differ for each country. Third is extension system. Extension system is still weak across all the countries, and includes the lack of capacity of extensionists on CA, sound methodology to promote CA and research on extension linkage, and demonstration network with qualified people such as farmers, and education institutions with CA integrated into the curriculum.

(2) Constraints to CA uptake and spread. The factors that restrain CA uptake and spread include: overlapping functions between ministries and departments, not clear responsibilities; lack of funding within R&D; lack of awareness about CA across all levels -- farmers, policymakers and government line agencies; conflicting policies between large scale farming and smallholders for CA adoption.

(3) Solutions should be devised to create opportunities for CA uptake and spread in the following aspects: good advocacy at policy level, efficient science, sound organization for arrangements and awareness at all levels, capacity building at all levels including at school, extension of policy support for CA, CA policy oriented towards smallholders, suitable machineries for landscape like sloping and flatlands, and more integrated approach on production systems at the field and landscape level.

(4) Discussions on how to move CA forward focussed on two aspects: First, at the national level CA should have a strong national focal point; national programmes on CA in each

country should be recorded and consolidated; and strong national CA priority and public-private partnership including civil society should be developed. Second, at the sub-regional level networks between countries and institutions should be represented by national focal points. The objectives of the networks should aim at synergies, to identify topics which can be useful to all countries, facilitating information exchanges and mobilizing funding through proposal formulation with strong support from all countries and with strong involvement of country focal persons.

(5) Based on the sub-regional networks already in existence, the working group put forward a CA Asian Network Structure to be named CA Alliance for Asia-Pacific (CAAAP), and include the sub-regional networks of South Asia, Central Asia, Pacific Islands and Southeast Asia. The objectives of CAAAP should be: synergies, support for resource mobilization, advocacy at international level, and exchanging information, experiences, research results and resources. CAAAP should focus on addressing common issues of national, regional and global context, and comparing issues across agro-ecosystems would be scientifically interesting such as education and capacity building, adequate agricultural equipment, national program support through competitive grant systems, soil fertility management and international partnership with IARCS, public-private partnership and civil society.

CAAAP could operate in following ways: rotating designation and election of secretariat among sub-regional (SR) networks, steering committee that elects two representatives from each SR network, and being chaired among SR members and conduct annual meeting, exploring existing facilities to promote CA adoption, and FAO playing the role of welcoming members for legal purposes, network recognized by FAO, supporting in resource mobilization and communication and dissemination. FAO should provide financial support at the initial period for the secretariat, steering committee and chair and other operating expenses.

Group Discussion

3.4 Workshop Conclusions

In the end of the workshop, Amir Kassam, one of the workshop organizers, presented the consensus-based conclusions of the workshop. First, Amir talked about the CA Alliance for Asia-Pacific (CAAAP), a network put forward by Group II, and accepted by all. He noted that there was full agreement on the establishment of the CAAAP. Then he requested experts

sharing the existing networks, and the expert from Philippine to introduce the network *Asia Soil Conservation Network for the Humid Tropic*s *(ASOCON)*.

After that, Amir summarised the outcomes of the workshop. He said that the workshop was a success, and that everyone was in agreement regarding the need to promote CA as a basis for sustainable production intensification, and that all participants have agreed to work together to share the achievements, experiences, and technologies etc. and to discuss how to organize to work together. FAO may consider providing support to facilitate the establishment of CAAAP for the promotion of CA at the national and regional level, initially to be hosted at the CTRC.

Amir highlighted the importance of multi-stakeholder associations involving farmers, corporations and service providers, researchers and others in moving forward with CA adoption and spread. Amir then elaborated on the importance of the role of CA in harnessing ecosystem services at the landscape level which are not available with tillage-based agriculture. Amir reminded everyone about the development of CA globally, and that there had been huge progress in the adoption and spread of CA during the past 20 years. Until ten years ago, there were no real solutions available to address land degradation, sustainable production intensification, climate change and other issues, but now solutions are available based on CA. However, there are many challenges for CA adoption and scaling, but policies and government support remains a big issue for CA development everywhere. In Asia, a major limitation is the poor availability of CA equipment and machinery for the different agro-ecologies and farm sizes, and limited experience about how to adapt CA to local conditions and scale it. CAAAP is an excellent outcome of the workshop, and it was suggested that FAO should facilitate the establishment of CAAAP which should formulate a business plan through electronic consultation and organize a regional meeting towards the end of 2014 to review progress and future plans.

4. Policy and Institutional Support Implications for Conservation Agriculture[4]

This section elaborates the policy and institutional conditions that appear to be necessary to support the introduction, adoption and widespread uptake of CA at the national level.

4.1 Adoption and uptake of CA

Shifting from tillage-based agriculture to no-tillage CA systems removes unsustainable elements in the current tillage-based systems and replaces them with CA elements that make the production systems ecologically sustainable. The individual CA principles have been practiced by farmers for a long time (Derpsch, 2004; Montgomery, 2007) and many of the advantages arising from the individual CA practices have been known for many years. What is new and unique about the modern concept of CA is the bringing together of all three interlinked CA principles that are applied simultaneously through locally devised and tested practices as part of a production system with other good management practices, particularly: (i) use of well adapted good quality seeds; (ii) enhanced and balanced crop nutrition, based on and in support of healthy soils; (iii) integrated management of pests, diseases and weeds; and (iv) efficient water management. In many respects, this represents a fundamental operational change in agricultural production systems and to the producers.

Thus, sustainable crop production intensification based on CA is the combination of all improved practices applied in a timely and efficient manner. The approach offers farmers many possible combinations of CA-based practices to choose from and adapt, according to their local production conditions and constraints. The benefits of CA provide an indication why many farmers worldwide are adopting CA systems and why CA is receiving attention from the development and research community as well as from government, corporate and civil sectors. However, not all synergistic interactions in CA systems are fully understood nor fully recognized. In general, scientific research on CA lags behind farmers' own discoveries (Derpsch, 2004; Bolliger *et al*., 2006; Goddard *et al*., 2008). Similarly, knowledge and service institutions in the public and private sectors tend to be aligned to supporting conventional tillage-based systems. Further, there is limited policy experience and expertise to assist in the transformation of conventional tillage-based systems to CA systems for small and large farmers in different ecologies and national contexts (Friedrich & Kassam, 2009; Milder *et al.*, 2011; FAO, 2011).

On a few occasions, such as in southern Brazil in the 1970s-1980s (Bolliger *et al.*, 2006) problems with conventional tillage-based farming practices became so severe that spontaneous change to no-till system and its widespread evolution towards CA practices occurred (Mello & Raij, 2006). At the time, it was severe water erosion combined with poor profit margins that encouraged uptake (Derpsch *et al*., 1991). Similarly, it was wind erosion

[4] Reproduced from Kassam et al. (2014)

in the mid-west USA and the Canadian Prairies that led to the adoption of reduced tillage systems in North America (Montgomery, 2007).

Generally for early adopters there are many hurdles as is often the case with new systems requiring significant behavioural change. Further scaling up of CA practices to achieve sub-national and national impact will thus require enabling policies and institutional support (including training, access to knowledge and research) to both producers and input supply chain service providers (including equipment and machinery) (Friedrich & Kassam, 2009; FAO, 2011).

The typical adoption process for new technologies follows an 'S' curve, with a relatively slow start to adoption, possibly preceded by farmers' own trials on just parts of CA principles and/or parts of their land, leading then into fast or even exponential growth, and slowing towards a plateau (Alston *et al.*, 1995; Rogers, 1995). In some contexts, for example in Paraguay and Western Australia, this had led to complete adoption, with tillage almost completely disappearing over the past decade (Derpsch & Friedrich, 2009; Crabtree, 2010). In others, when conditions for adoption are less favourable, the initial phase of the 'S' curve can be drawn out , sometimes lasting many years such as in Brazil (Bolliger *et al*., 2006; Junior *et al*., 2012) or Argentina (AAPRESID, 2010). To date, some 10% of the world's arable cropland is farmed under CA (although more is farmed with reduced tillage systems). In most countries CA is being introduced as an "unknown" new concept and thus neither the agronomic knowledge base nor the policy and institutional support environment is necessarily favourable to adoption.

4.2 Necessary conditions for the CA adoption

CA is both management and knowledge intensive and complex to practice, requiring more planning than tillage-based systems. It cannot be reduced to a technology package, adoption requiring both change and adaptation based on experiential learning (Derpsch, 2008; Friedrich & Kassam, 2009). The following sections elaborate the *necessary conditions* for the introduction of CA and transformation of tillage-based systems. The support to foster these necessary conditions must be mobilised at the individual, group, institutional and policy levels within the private, public and civil sectors so that the behaviour patterns of all stakeholders involved in the CA innovation system are mutually reinforcing to induce the development of the *sufficient conditions*, or the enabling environment, for adoption and spread. In cases where the learning process is missing or the benefits to the farmer are not obvious, then non-adoption or disadoption can occur.

4.2.1 Reliable local individual and institutional champions

Wherever CA has successfully spread, there have been local champions whose own examples have encouraged adoption. Those champions are then supported by research and development groups, and private sector service providers in equipment and machinery, seeds and agrochemicals. More recently the international research community and development organizations including NGOs have shown interest in this farmer-driven adoption process,

bringing the promotion and dissemination of CA to international attention. In this way, local national champions, whether individuals or institutional, are now increasingly being supported by international champions.

4.2.2 Dynamic institutional capacity to support CA

CA is a dynamic system in constant development and adaptation. The institutions that are set up to support CA need to be similarly dynamic so that they can respond to farmers' changing needs. As well as policy making departments, these institutions include the research and development programmes on which much of the technical knowledge of CA is based. Whatever technological combinations are used by farmers, R&D activities must help to assure that good husbandry of crops, land and livestock (Shaxson, 2006) can occur simultaneously for CA to function well.

Biophysical, ecological, agronomic and social sciences must be aligned with the views of stakeholders to develop systems that can be adapted to varied conditions facing farm family adopter of CA. This means that self-organizing innovation networks of diverse providers of information need to be involved in broad programmes to develop the science and technology adaptation for CA (Ekboir 2003; Cernea & Kassam, 2006; Rajalahti *et al.*, 2008; World Bank, 2012). Such institutions include international agencies, multi-donor programmes, NGOs, national government staff, academic institutions, commercial organisations and agribusiness with their diverse points of view. One way to support integration would be to develop common indicator sets to assess progress towards the environmental, economic and social benefits of CA.

4.2.3 Engaging with farmers

Support for any production systems should be oriented towards solving farmers' problems that inhibit productivity. However, when the transformational change occurs with the adoption of CA by farmers who have only known and practiced tillage agriculture, a new challenge is created. Farmers need support to understand new concepts and principles, enable an intellectual change in mind-set, commit to a longer-term process of change in their production system, test and adapt new practices, and change equipment and machinery. In establishing different cropping systems and farm operations, they also need to manage new production input and output relationships involving crop, soil, nutrient, water, pest, and energy management practices. Thus, engaging with farmers and providing them with the necessary support is critical for successful adoption and uptake of CA.

Though the principles of CA remain the same across contexts, how they can be best applied depends on how individual farm families make decisions. This emerges from how each farm family can respond to specific combinations of environmental conditions, farmers' resource-availability, production system, market opportunities and transport availability, and support, encouragement and guidance (Wall, 2007). Farmers can be ingenious in problem-solving, and if they pick up the conceptual part of CA, they often innovate and adapt the practices to their own conditions (WOCAT, 2007; Borsy *et al.*, 2013).

4.2.4 The Importance of farmers' organizations

Farmers tend to believe trusted peers more than their formal advisers when discussing innovations, making it easy for them to exchange ideas and experiences helps strengthen their own linkages and reinforce recommendations (Pretty, 2003). Social capital is used as a term to describe the importance of social relationships in cultural and economic life. The term includes such concepts as the trust and solidarity that exists between people who work in groups and networks, and the use of reciprocity and exchange to build relationships in order to achieve collective and mutually beneficial outcomes. Social capital is thus seen as an important pre-requisite to the adoption of sustainable behaviours and technologies over large areas (Cernea & Kassam, 2006). Where social capital is high in formalized groups, people have the confidence to invest in collective activities, knowing that others will do so too. Farmers' participation in technology development and extension approaches has emerged as a response to such new thinking (Pretty *et al*., 2011).

Interested farmers may have already coalesced into informal groups with common interests. Such groups can form the basis for Farmer Field Schools (FFS), with guidance from experienced advisors, for 'learning by doing' (e.g. Mariki *et al.*, 2011). Farmer groups, which may comprise associations, clubs, co-operatives or other organizational arrangements, derive confidence from mutual support and exchange, which can accelerates innovation and adoption (e.g. Silici *et al.*, 2011; Marongwe *et al*., 2011). The fastest development of suitable technologies is usually achieved through groups of innovative and pioneer farmers who are part of a community and exchange their experiences through their networks, thus building social capital (Pretty, 2003).

Small informal groups of farmers may evolve into co-operatives and other larger bodies. If such bodies already exist, they may embrace the CA ethic and actions, and draw in new members. Such groups and organisations also develop bargaining power with buyers and sellers, traders, equipment related service providers, transport agencies, and others: and this benefits all the members of the group. If sufficiently well-organised, they may be able effectively to pressure national and local governments and institutions for necessary reforms and services, including research and extension, to aid the CA cause. The development of such groups can then become a powerful means of encouraging others to join the movement. Mentoring programmes, where experienced CA farmers assisted newcomers during the first year of adoption have resulted in immediate yield increases and significantly higher profitability during the first year of adoption compared to farmers who had to learn on their own, mainly because mistakes could be avoided (Meyer, 2009).

4.2.5 Providing knowledge, education and learning services

CA involves a fundamental shift in the way agricultural production is conceived and how it relates to environmental stewardship (Kassam *et al*., 2009). There is a need to think differently about how knowledge is spread to farm families, to professionals in the public and private sectors, and to society at large. One opportunity lies in educating schoolchildren – and

then right up through graduate and postgraduate education – for a broader focus on ecologically-based, resource conserving agriculture based on the core CA principles in all settings for sustaining the production of crops and water from all landscapes.

A second change will be to ensure that people working in specialised areas of agricultural science and policy are informed of emerging CA successes from the field and the implications for their disciplinary specialisations. Both researchers and advisory staff need to be kept up to date with the different ways by which the principles of CA are put into practice, their effects on the resource base and the environment, and the socio-economic outcomes. This means having the capacity to work across the traditional science disciplines and to work closely with farming communities. Recognizing the realities of CA technical education and vocational training in universities, colleges and schools will include CA principles and benefits in their curricula.

In addition, while the greatest impact will come from fully applying all three principles of CA, farmers' constrained socio-economic situations may mean that some are gradually introduced responding to the individual conditions. Thus research and extension need to be able to operate at different scales simultaneously. They need to be able to assess the landscape-scale benefits of adopting CA whilst also providing evidence of how well CA performs on individual farms and farming communities. A key function of the tertiary education system in both developed and developing countries would be to research and validate the science underpinning CA techniques and practices.

Third, international national, regional and international networks covering all levels of development management and geographical regions are required to acquire, evaluate, share and disseminate robust evidence about the principles, practices and impacts of CA. These networks should devise specific encouragements for larger-scale and more advanced CA practitioners to advise and mentor those at earlier stages of adaptation and uptake. It could also monitor the results of CA projects and programmes, at all levels, and disseminate them across the international community. A global communication platform for all CA community of Practice (CA-CoP) stakeholders was launched in January 2009 and is hosted by FAO (FAO, 2008). However, establishing more regional and national CA networks would assist in completing the multi-level coverage of CA stakeholders. Establishing a global network of CA farmer associations would help to facilitate exchange of information amongst farmer groups who could also provide constructive feedback into policy and input supply sector.

4.2.6 The need for scientists and extension agents to recognise and characterise the problems related to CA adoption and facilitate problem solving

It could be argued that what is expected of scientists and extension agents in the promotion of CA adoption may not fundamentally differ from that required for conventional farming practice. The focus should be on recognising, characterising and solving problems related to CA adoption and dissemination. However, there is a difference in that CA is relatively new and therefore problems can arise for which locally-based experience and knowledge does not exist. Thus, in support of CA scientists need to: (a) respond to unsolved technical problems

(e.g. cover crops, and crop combinations for different situations), systems development in ecologies that are too dry or too wet, biomass management across competing demands ; (b) explore new potentials and possibilities based on what is already known and observed; (c) clarify basic soil conditions regarding the significance of organic-matter effects and related interactions with respect to soil productivity and its changes over time under different treatments and adapt knowledge on nutrient levels and fertilization; (d) advance knowledge about pest, disease and weed interactions under CA conditions; (e) design new mechanization concepts for CA systems including aspects such as compaction management and promotion of no-till seeders for small farmers; (f) undertake 'blue-sky' exploratory research with possible relevance to CA.

Also, too little ex-ante analyses have been carried out to better understand how specific policies will work and what impact they might have. Systems research aimed at linking and supporting change policies with potential environmental benefits that may accrue, and quantifying such relationships, is definitely a priority area for research. However, these benefits might not be equally applicable for all agro-ecosystems; important variability and system trade-offs could limit the expansion and adoption of these technologies in smallholdings. Risk coping mechanism for potential adopters and more importantly effective technical assistance are key elements for uptake of CA under difficult biophysical conditions. The competing uses for crop residues could be potentially resolved through local by-laws that reduce free access to residue grazing and promote better area and on-farm integration of crop-fodder-tree-livestock systems involving community-based approaches to the effective management of functional biomass and stocking rates. The dynamic functioning and evolution of these integrated systems and their long-term impacts on the potential productivity of agro-ecosystems also deserve a sustained research attention in the future.

Advisory staff also need to be trained as facilitators of knowledge-expansion and information-exchange, of problem-solving, as 'travel-agents' for study visits and interchanges, and of linkages between farmers and their groups with service-providers, and with government. As with any innovation system, there is a need for linkages and feed-back loops between researchers, extension staff, and farmers, so that all sides engaged in CA can remain well-informed about needs and achievements of the farmers, results of research, and of possibilities to be explored.

4.2.7 The need to build up a nucleus of knowledge and learning system for CA in the farming, extension and scientist community

The Latin American experience with CA has shown that, by providing institutional and financial support, government can play a crucial role in creating incentives for adoption (FAO, 2001a; Derpsch, 2004; Bolliger *et al*., 2006; Borsy *et al*., 2013). The studies also point to the importance of financing for the purchase of new no-till machinery. Smallholders have been a special target as they lack the capacity to raise funds and retrain on their own. The World Bank reiterated these observations in its review of a project in Brazil promoting sustainable agriculture, modern forms of land management, and soil and water conservation

(FAO, 2001b). It considered rural extension to be a pivotal element in the project. In addition, monetary incentives were highly successful in motivating group formation among farmers, leading to an increase in cooperation and social capital. It recognized rapid paybacks and government financial incentives and support as key influences on adoption.

Elsewhere, in Sub-Saharan Africa, CA plus the FFS approach to assisting and informing small and larger farmers creates a form of insert into community, sub-national and national governance and development efforts. Such collective agro-ecological efforts can implicitly or explicitly underlie and enrich 'watershed management' as a practical concept for sustainable improvement of livelihoods, landscapes and ecosystem services (Pretty, 2003; Pretty *et al*., 2011), and facilitate the reconnecting of people, land and nature (Pretty, 2002).

Sustainable forms of agriculture such as those based on CA principles, which are identifiable in biological, social, environmental and economic terms, must be maintained in all agro-ecosystems, and therefore must be supported by appropriate operational and policy changes. Most importantly, a practical knowledge and learning system for CA should be built up in the farming, extension and research community and should always be put out and demonstrated to stakeholders as evidence of relevance and feasibility, and used for hands-on training students, researchers, extension agents and farmers as well as sensitizing institution leaders and decision-makers. Such knowledge and learning systems are emerging in Brazil, Argentina, Alberta (Canada), Andalucia (Spain) and Western Australia (Kassam *et al.*, 2013) and include following elements.

i. *Demonstration areas:* Once initial 'benchmark' demonstrations of CA have been established among interested farmers themselves, it will become important to catch the interest of other potential supporters. For this reason it will be desirable to work with innovative and capable farmers who are prepared to describe and share their experiences with a wider range of people, beyond the farming community. Such demonstrations would need to be clearly visible (e.g., alongside public roads) and offer ease of access to people from e.g., commercial organisations, different branches of government, potential financiers who might assist broader expansion, and others.

ii. *Staff training:* Key to success of participatory approaches is that the advisers and lead farmers should be fully conversant with the ethos, changed mind-set, agroecologic and socioeconomic principles, and modes of application of CA. Dedicated training courses for this purpose are needed, to generate a commonality of understanding among the trainees. On this they can base understanding of what they encounter among farmers and in the field, and provide consistent information. The training institution should maintain close links with the fieldwork and experiences to gain feedback and make appropriate adjustments to the programme for the refining of future courses which cover both theory and practice.

iii. *Field days and study-visits:* Much relevant experience is passed from farmer to farmer. Field days enable many farmers to get together to see new things and exchange views. Specifically-arranged study visits to unfamiliar areas within their own country, and/or different countries and among farmers in very different

circumstances, can be powerful means of engendering new ideas. On return home, these may become the focus of further innovation by the farmers.

iv. *Participatory and interdisciplinary learning process:* For the development of CA in the field, active feedback loops for intercommunication between farmers, researchers and advisers are helpful. In this way information can be shared within and between the farming, advisory and scientist communities. A participatory process should be the basis for the analysis of socio-economic and agro-ecological factors which determine problems at farming system level and the methodology to identify practical solutions, which can be managed by farmers. This has certain implications for policy-makers. On the one hand, an assumption that CA will spread on its own in some desirable fashion is not appropriate. On the other hand, a uniform policy prescription to fit many locations is not realistic either, whether it consists of direct interventions or more indirect incentives stemming from research and/or development. Designing successful policies to promote CA starts with a thorough understanding of farm-level conditions. This understanding includes farmers' management objectives, attitudes to risk, willingness to make trade-offs between stewardship and profits. The next step is the careful design of location-sensitive programmes that draw on a range of policy tools. Flexibility is likely to be a key element in policy design to promote CA.

v. *Operational research:* A type of research which can pay dividends for good interactions between farmers and advisors is 'Operational Research'. It is aimed at investigating, in the field, and with farmers, how improved practices and their interactions with overall systems, and *vice-versa* actually have their effects in the field, and how farmers perceive and manage them. Farmers and researchers become partners in such investigations, to the mutual benefit of both. Other criteria of success than profit alone, suggested by farm-families themselves, become part of the 'stock-in-trade' of such collaborative teams. This approach is similar to the concept of multi-stakeholder innovation network performing different and vital activities to make farmer adoption work (Ekboir, 2002, 2003; Rajalahti *et al.*, 2008; World Bank, 2012)

4.2.8 Mobilizing input supply and output marketing sectors for CA

With farmers grouping together into associations, potential suppliers of inputs and technical advice will become aware of potential commercial opportunities, and can be encouraged to join, and provide supplies to the farmers themselves. Usually some 'kick start' is necessary to break the deadlock of farmers not adopting because of lack of available technologies and equipment and the commercial sector not offering these technologies for lack of market demand. Policies facilitating procurement with credit lines, promoting technologies with technical extension programmes and introducing supportive tax and tariff policies are important for building up the long term commercial development of suitable input supplies for CA. To prevent disadoption, incentive mechanism must be clearly directed to specific adoption hurdles and must be separated from the conceptual components of CA. Whereas CA should never be promoted as blueprint technology package in the first place, production inputs such as fertilizers, if provided as incentives, can be part of the CA message.

4.2.9 Accessibility and affordability of required inputs and equipment

Real costs arise during the transition from tillage-based agriculture to CA. The farming patterns which preceded a farmer's decision to switch production techniques may not have produced enough saved resources to allow the farmer to accept all the potential risks associated with the change-over. Nor may it be possible for the farmer to make the necessary investments in unfamiliar seeds (e.g. of cover crops) or to hire or procure new equipment such as direct seeders. However, once CA has become established on a farm, its lowered operating costs and the generally higher and more stable yields then begin to generate sufficient resources to pay the full commercial costs of these new inputs (Bolliger *et al*., 2006; Baig & Gamache, 2009; Crabtree, 2010; ECAF, 2012; Junior *et al*., 2012).

CA can be used with many types of production inputs, including seeds of traditional or modern cultivars, at any level of agricultural development and farm power, manual, animal assisted or mechanised. This flexibility allows CA to target inputs (e.g. fertilizers, seeds, equipment) and using them regardless of the source which may be organic or mineral in the case of fertilizers, and GM or non-GM in the case of seeds.

4.2.10 Financing and enabling the initial stages

Risks attend any changeover from one way of making a livelihood to another. All farmers, regardless of size and resources, will be subject to such risks, and will make their own decisions on how best to minimise or avoid them. In recommending that governments give appropriate support at all levels to CA and other forms of sustainable intensification, it is assumed that this will also include whatever may be necessary to reduce and ameliorate any extra risks to farmers arising from the process of change during the transition until a new system of CA has become established. Such assistance to farmers could be appropriately in the form of sharing costs of any additional start-up credit, of purchase of suitable equipment, of extra insurance premiums (for perceived greater risks attending an unfamiliar set of procedures), or as incentive payments justified by the positive environmental services expected to result from adopting CA.

However, incentives in the form of subsidies carry the risk of encouraging farmers to adopt practices and technologies they do not believe in. However, with CA, the economic benefits improve over time and in general evidence suggests that large mechanised farmers do not revert to old practices once they switch to CA (Sorrenson, 1997; Filleccia, 2009; Baig & Gamache, 2009; Lindwall & Sonntag, 2010; González-Sánchez *et al.*, 2010; Crabtree, 2010). In the case of small farmers in Sub-Saharan Africa, there have been contexts where farmers reverted to old practices once the support for inputs including advisory services became ineffective (FAO, 2008). However, during the past five years, with greater policy support and institutional attention being paid to CA by governments, national research and extension institutions, NEPAD (New Partnership for Africa's Development), international research and development agencies and donors, over 500,000 ha have been brought under CA by small

farmers in Zambia, Malawi, Mozambique, Zimbabwe, Tanzania and Kenya (Friedrich *et al.*, 2012).

Zimbabwe, Zambia, Malawi and Mozambique also now include CA as a core element of their national agriculture development policy and strategies. NEPAD has integrated CA as a key element if it's agricultural development framework. In Zimbabwe and South Africa, CA is being integrated into the education system. In Zimbabwe, in response to domestic emergency, CA has been a core element in agricultural rehabilitation and development programmes that involve public-private partnerships for linking farmers with service providers including inputs. Most countries in southern Africa region have established multi-stakeholder national task forces to facilitate the promotion of CA in response to any new development opportunities that may arise.

Having made a commitment, it is also important for a government to make a policy that will ensure that sufficient and appropriate support to farmers' efforts be provided and maintained, to share costs and risks taken by small farmers during the period of changeover. This period might be up to five years in each instance of uptake to farmers having developed full confidence in managing the new system. Because uptake would not all occur at the same time, such assistance would necessarily be on a 'rolling' basis. Further to this adoption phase, extension and research need to address the specific needs of the CA farmers on a permanent basis. Such temporary support mechanisms are being successfully piloted in Spain, Germany, Italy and Switzerland (ECAF, 2012).

The period of changeover to a new system may thus require cost-sharing for inputs, equipment, and travel as a means of minimising both risks and a temporary dips in yields which could result from inexperience during the learning and adaptation phase. The need for credit can be foreseen, and suitable arrangements made, whether with a banking system or informal community savings schemes. Temporary investment might be also needed for CA-specific equipment, and its repair/modification for farmers' use from communal or commercially operated equipment pools. Lack of availability of such equipment at critical times for the farmers who need them has been found to be a strong disincentive to making further progress with CA, because loss of timeliness or precision then prejudices expectations of yield. Finance should be available for study tours, field days and other opportunities for farmers to meet each other and discuss CA matters of mutual interest as a potent way of stimulating innovations.

Although it is not possible to distil a generic set of guidelines that could constitute initial interventions for promoting the transformation towards CA systems, we suggest an effective sequence is as follows:

1. Identify what are the limiting factors to farmers making improvements to their livelihoods (which may not always primarily be financial) to catch their attention.
2. Identification of factors limiting crop yields and what could be done to alleviate these.
3. Identify one or more farmers already undertaking CA and demonstrating its agronomic, financial and/or livelihood benefits, and set up study visits.

4. Or: set up demonstration for researchers and advisory staff and farmers' groups leaders, to catch their interest.
5. Initiate 'learning by doing' e.g., through participatory forms of investigation and learning. Gain insight into what farmers know already and how they would tackle the apparent problems in the light of new knowledge introduced.
6. Determine what are optimum means of achieving CA's benefits for different situations of farm size, resource-endowments, through on-station and on-farm research and benchmark demonstration, observation, FFS etc. and Field Days on farms already attempting CA. Record-keeping, analysis and feedback loops, Operational Research, are all important
7. Importing suitable samples of equipment (e.g., jab planters, direct seeders for animal or tractor power, knife rollers, walking tractors with no-till seeded attachments, etc.) to be able to demonstrate their use at the beginning.
8. Interact with any already-established farmers' groups, e.g., co-operatives, to gain interest and support.

4.3 Designing and implementing policy and institutional support

Adoption of CA can take place spontaneously, but where it is not supported by policy and public and private sector institutions, it usually takes a long time until it reaches significant levels as in the case of Brazil and Argentina where it took some 20 years before CA began spreading. Policy and institutional support is crucial for the introduction and accelerated adoption of CA based on all stakeholders working together for a common goal as has happened for example in Brazil, Argentina, Paraguay and more recently in western Canada and in western Australia (Derpsch, 2004; Kassam *et al.*, 2010). In essence, the role of policy and institutional support is to ensure that the above-described necessary conditions are met for the introduction and subsequent widespread adoption of CA systems in various agricultural land use sectors.

Adequate policies and institutional support can shorten the adoption process considerably, mainly by removing the constraints mentioned earlier. This can be through information and training campaigns, suitable legislations and regulatory frameworks, research and development, incentive and credit programmes. However, policy makers often are not aware of the relevance of CA as a basis for sustainable intensification and thus many existing policies work against the adoption of CA. Typical examples are commodity-related subsidies, which reduce the incentives of farmers to apply diversified crop rotations, mandatory prescription for soil tillage by law, or the lack of coordination between different sectors in the government.

There are cases where countries have legislation in place which supports CA as part of the programme for sustainable agriculture, and yet within the same Ministry of Agriculture also have a programme to modernize and mechanize agriculture, introducing tractors typically equipped with ploughs or disk harrows. This not only gives the wrong signal, but it works directly against the introduction and promotion of CA, while at the same time an opportunity is missed to introduce tractors with no-till seeders instead of the plough.

Countries with their own agricultural machinery manufacturing sector also often apply high import taxes on machinery to protect their own industry. This industry commonly has no suitable equipment for CA available in the short term, but due to the high import taxes the importation of equipment from abroad is made impossible to the farmers who wish to adopt CA. In other cases the import tax for raw material might be so high that the local manufacturing of CA equipment becomes unfeasible. Policy makers and legislators will need to be made aware of CA and its ramifications to avoid such contradictory outcomes.

With farmers who own land but also rent other land, there are additional problems with the introduction of CA: the build-up of soil organic matter under CA is an investment into soil fertility and carbon stocks, which so far is not recognized by policy makers, but increasingly acknowledged by other farmers. Farmers who still plough know that by ploughing up these lands the mineralization of the organic matter acts as a source of plant nutrients, allowing them to "mine" these lands with reduced fertilizer costs. This allows them to pay higher rent for CA land than the CA farmer is able to do. Such cases can be observed in some developing countries in Africa as well as in industrialised countries in Europe.

To avoid this, policy instruments are required to hold the land owner responsible for maintaining the soil fertility and the carbon stock in the soil, which in absence of agricultural carbon markets is difficult to achieve. Generally, farmers with secure land tenure are more likely to take care of their land and maintain or increase the carbon stock in the soil. Mechanisms that encourage good land stewardship within a land rental situation are provided within the CAP which applies the same rules to farmers who own their land and farmers who do not (ECAF, 2012). Similarly, in Alberta, Canada, the carbon offset scheme, which is in its sixth year of compliance, encourages all farmers including those who do not own their land to adopt CA protocol to enhance soil carbon stocks for which they get paid (Haugen-Kozyra and Goddard, 2009).

Effective demand in the market and the value chains beyond production are also important in ensuring that farmers can receive an attractive return for their effort to produce safe and nutritious food and other ecosystem products using sustainable practices such as CA. Policies and institutions that encourage and enable the integration and verification of CA practices and their products into practical programmes in which farmers can receive monetary benefits for delivering certain ecosystem services have been established recently (Kassam *et al.*, 2013).

These include CA farmers in the Alberta carbon offset scheme selling carbon off-sets to industry emitting GHG (CCC, 2011); farmers participating in the Itaipu Dam *Programa Cultivando Água Boa* ('cultivating good water') in the Paraná basin III in Brazil qualifying for payments and development assistance for supplying water of good quality into the Itaipu dam (ITAIPU, 2011); olive farmers in Andalucia, Spain, receiving financial and technical support for adopting CA practices to control soil erosion (Franco and Calatrava, 2006). Such schemes do help farmers to transform their tillage-based production systems to CA-based systems. Likewise it could also be argued that farmers ploughing land should pay a carbon tax similar to other emitting industries.

4.3.1 The need to sensitise policy-makers and institutional leaders

Both the field demonstrations and technical discussions generated by the growing spread of CA methods and successes, as told by farmers and others, will also make government department heads, policy-makers, institutional leaders and others aware of benefits, and of the desirability of backing the initiatives. It is important that policy makers come to a better understanding of the implications of CA. This makes it easier for them to justify supportive policies, which in the end are beneficial not only for the farming community but for everyone and hence for the policy makers and their constituency. On the other hand it is important for policy makers to think in long term developments and in integrated approaches, even across sectors and ministries (Pieri *et al.*, 2002).

4.3.2 Formulating enabling policies

A facilitating policy environment can be an important determinant of whether CA is adopted and how fast. In cases where policy has been weak or ineffective, much of the successful diffusion of CA has occurred because of support from the private sector, farmers groups or other non-government organisations. In some countries, existing policies have both encouraged and discouraged CA at the same time. In spite of this, successes can be seen in the decoupling programmes in Europe in which financial support to farmers is defined in terms of income support for environmental management (ECAF, 2012), and in farmland stewardship programmes such as Australia's Landcare (Flower *et al.*, 2008; Llewellyn *et al.*, 2009).

While CA so far has spread mostly without policy support, it would need a supportive policy environment for accelerated spread. However, there is no 'one size fits all' policy in support of CA: whether this comprises direct interventions, indirect incentives via research and development activities, or a mix of the two. Since the principles of CA are based on an understanding of: farm-level biophysical and socio-economic conditions, farm management objectives, attitudes to risk and complementary relationship between stewardship and profits, policies in support of CA need to be formulated on a similar appreciation.

The main implication of this is that most policies to support CA adoption and spread must be enabling and flexible, rather than unitary and prescriptive. Allowing the design of location-sensitive programmes which draw on a range of policy tools would ensure that policies are designed which both accommodate and promote the location-specific nature of CA. It can be argued that the location-specific nature of CA-related polices is not unique as this would also apply to policies related tillage-based production systems. This is not so because the main difference between the two production paradigms is that many of the ecosystem services for environmental sustainability cannot be harnessed effectively with the currently dominant tillage-based agriculture (Pretty, 2008; Kassam *et al.*, 2009; FAO, 2011; Pretty *et al.*, 2011). Thus, CA-related policies would not only enable the transformation of production systems into ecologically more sustainable and less degrading systems, but also sustain the on-farm

and landscape level harnessing of environmental services from agriculture land use (ECAF, 2012; Kassam *et al.*, 2013).

However, one area where a more uniform policy may be appropriate is in the development of social capital to promote the precursor conditions for collective action by farmers (Cernea & Kassam, 2006). This would include the development of group extension approaches (FAO 2001b) when dealing with smallholders who are operating in poverty stricken situation with degraded resource base and poor access to markets.

We suggest five key issues policymakers need to consider:

(i) Policy coherence

CA is compatible with existing approaches to promoting agricultural and environmental sustainability, such as watershed management. Any policies regarding (for example) existing laws on water use, health, the use of pesticides and other inputs, and the burning or incorporation of crop residues, can influence the adoption of CA. A first step in creating legal rules for the protection of natural resources may be to establish a national framework whose responsibilities are shared between the land users and the executing organizations. However, the interdisciplinary nature of CA means that policies will cut across traditional government departmental boundaries. This means that there is a clear need to co-ordinate the adoption of a CA approach across departments to reduce the likelihood of conflicting policies being implemented. Agriculture-related incentives or subsidies must be examined to ensure that they do not jeopardise farmers' ability to adopt CA practices. Ultimately, skill levels and reward systems in the public sector may need to be adjusted so that government staff provide conservation-effective advice to all farmers, all of the time. This could be accomplished by decentralising a CA programme to a regional capacity within the existing governmental organisation, avoiding the need to create a new entity to execute new laws or regulations. A particular aspect where government policy coherence is needed is in the area of sustainable mechanization to avoid the simultaneous promotion of tillage equipment as well as no-till equipment.

(ii) Policies to actively encourage knowledge sharing

For farmers to take the leading role in implementing CA, there is a need for policies that encourage knowledge-sharing amongst stakeholders at all levels. This could be accomplished by developing appropriate local, national and regional CA networks and task forces to facilitate capacity building and active mutual learning. Part of the mission of these networks and task forces would be to build a good shared awareness of positive opportunities and constraints for CA within policy environments.

(iii) Basing 'macro' policies on 'micro' understanding

National policy needs to be framed in the full understanding of how micro-level issues (technical, socio-cultural, economic and environmental) are significant to the broad macro-scale features of agriculture and the environment as a whole. At the farm level, micro-level

changes (such as raising the OM content of the soil) give rise to macro-level effects such as increased yields and profits as well as ecosystem services as groundwater recharge, flood prevention, and improved water quality. This relates as much to policy formulation as it does to the provision of technical advice. For example, a community comprising a group of small farmers may decide to develop their own local bye-laws – as for instance to regulate open grazing of post-harvest residues. Any national policy must be supportive of these sorts of local initiatives within the national legal framework.

(iv) Policies relating to farm-level risk management

Adopting CA may, in the short term, involve costs and risks. Switching to CA quickly may appear too risky. Farmers may start with 10% of their land under CA, and move forward with the rest of the land as they gain experience with the new management system. If CA is to be a national priority, governments need to recognise the public good value of the environmental benefits generated by widespread adoption of CA practices. This means that appropriate policies and incentives need to be put in place to share costs and risks. From the review of CA-related experiences and 'live' cases examined and cited for this paper earlier, it would appear that the potential productivity, socio-economic and environmental benefits of such policies and incentives are likely to exceed the cost in most if not all cases. This is an area where more environmental economic research needs to be supported and strengthened to establish the nature of the cost:benefit relationships involved in CA-based policies and programmes.

Whether CA is adopted by large or small-scale farmers, wider society gains in a number of ways:

- Reduced erosion and runoff, resulting in less downstream sedimentation and flood-damage to infrastructure;
- Better recharge of groundwater, more regular stream-flow throughout the year, and better replenishment of wells and boreholes;
- Cleaner civic water supplies with reduced costs of treatment for urban/domestic use;
- Cleaner air during times of land preparation (dust from tillage) or harvest (burning of residues);
- Increased stability of food supplies due to greater resilience of crops in the face of climatic drought;
- Better livelihoods on farms with the potential to reverse rural-urban migration trends.

(v) 'Sustainability' as justification for policy support for rapid up-scaling

The capacity of CA specifically to address the improvement of sustainability – through improved functioning of its biological components – should spur innovative thinking and action at government levels in the search to revitalise agriculture on all degraded lands of any degree, where increasing expenditures are required just to maintain yields at a level average. After CA has been promoted in Kazakhstan by CIMMYT and FAO in the early 2000s it has had a rapid development as a result of farmers' interest, enabling and facilitating policies, and

an active input supply sector. While the total CA area in the country in 2004 was less than 1,000 ha, it grew until 2007 to 600,000 ha and in 2008 to 1.3 million ha, placing Kazakhstan in only four years among the top ten CA adopting countries worldwide. Besides a general policy support for CA, which encouraged public and private extension services to take up this message, the government provided initial subsidies for locally produced herbicides to decrease the initial costs and credit lines for purchasing no-till seeding equipment to overcome problem of capital availability for investment. Further, the country was open for importation of no-till seeding equipment, despite having one of the main seed drill manufacturing facilities from the Soviet times (Suleimenov, 2009).

4.4 Conclusions

A number of reasons have been suggested for farmers not spontaneously adopting CA, despite the acknowledged advantages. Knowing these hurdles and problems allows developing strategies to overcome them. Crisis and emergency situations, which seem to become more frequent under a climate change scenario, and the political pressures for more sustainable use of natural resources and protection of the environment on the one hand and for improving and eventually reaching food security on the other provide opportunities to harness these pressures for supporting the adoption and spread of CA and for helping to overcome the existing hurdles to adoption. In this way, the increasing challenges faced around the world, from the recent sudden global crisis caused by higher food and energy prices and input costs, and increasing environmental concerns to issues of climate change, facilitate the justification for policy makers to introduce supportive policies and institutional services. Thus, the actual global challenges are providing at the same time opportunities to accelerate the adoption process of CA and to shorten the initial slow uptake phase. However, with the exception of few catastrophic events, changes occur gradually and hence the need for a fundamental change is not recognized. As a result wrong answers, providing window dressing rather than addressing the root causes might actually divert the attention and further delay adoption of CA.

First national and international knowledge systems must increasingly align their work in research, education and extension to helping to understand the root problems and the role CA systems and practices can play to then facilitate policies for accelerated adoption. Research in particular must help to solve farmer and policy constraints to CA adoption and spread, requiring research comparing CA with conventional systems to generate scientific evidence along with empirical evidence for policy makers to invest into CA. Additionally new research knowledge on CA systems generated on-farm and on-station is also required to advance their further development and adoption.

People and institutions, both public and private sector, everywhere have everything to gain from adopting CA as a basis for sustainably increasing agricultural production and ecosystem services. The greater impact that can result from the adoption of CA as a matter of policy and good stewardship is that agriculture development in the future everywhere can become part

of the solution of addressing national, regional and global challenges including resource degradation, land and water scarcity, climate change.

There is growing evidence from farmer fields, landscape-based development programmes and scientific research in tropical, sub-tropical and temperate agro-ecologies across all continents that CA can be positive for productivity, farm profit and environment. As full benefits of CA take several years fully to manifest themselves, fostering a dynamic CA sector requires an array of enabling policy and institutional support over the longer term, including the availability of necessary inputs and equipment, and the fostering of farmer-driven innovations. The lack of knowledge about CA as well as a supportive enabling environment for its promotion, and the fact that the national institutions, public and private, are mainly serving tillage-based agriculture, are the main reasons for CA not spreading faster in Africa, Asia and Europe. However, the evidence of increased adoption and uptake in these continents during the recent years indicates that the situation is changing, and the uptake of CA is expected to continue over coming years.

5. Prospects for Conservation Agriculture in the Asia-Pacific Region

Prospects for CA in the Asia-Pacific region are now better than ever before because most countries in the region not only are keen to transform their agriculture onto a sustainable base, but also some countries such as China, India, Pakistan, Bangladesh, Laos, Vietnam, Cambodia, Philippines and north Korea now have research and extension activities on CA and some countries such as China and India have a significant area already under no-till crops. In addition to FAO, there are several international organizations such as CIMMYT, IRRI, ICARDA, ICRAF, ICRISAT and CIRAD as well as some aid agencies such as IFAD, ADB, ACIAR and USAID who are seriously promoting CA research and development activities in the region. There are some regional networks such as APAARI, SACAN and CANSEA and institutes such as BISA, AIT and SANREM who have a strong research and development interest in CA. Thus overall there is an emerging strong interest in promoting CA in the Asia-Pacific region. This will require all stakeholders in the public, private and civil sectors to increasingly work together in support of promoting CA.

CA is one of the most promising agricultural land use options that has been developed in our times to serve as a basis for sustainable production intensification. CA is more a system's approach to agriculture production management than a single technology because it offers a way to produce more with less while at the same time preserves and enhances many of the ecological functions a natural soil has to offer in a natural ecosystem. CA also offers economic benefits to farmers who apply it. Generally, an immediate cost reduction due to reduced cultivation and machinery operations can be felt right after the introduction of CA. There are a number of challenges that CA faces throughout the largely agricultural region of Asia-Pacific including lack of crop diversification on small and large-size farming areas, knowledge about CA systems among extension and technical staff, knowledge about CA at decision-making levels, farmers' ability to decide on diversified crop rotations, and the implements needed for use in the CA. Nevertheless, farmers in the Asia-Pacific region are now becoming increasingly aware of CA as a new, promising technology. Awareness comes in the form of accepting no-till as a viable system in growing crops as opposed to the earlier total rejection of agriculture without tillage. Usually manufacturers, importers and dealers are proactive with the objective of increasing the demand for CA implements. Yet, the present political systems in Asia-Pacific region indicate that the public rather than the private sector is now being called upon to initiate and lead such efforts.

Agriculture in the Asia-Pacific region is diverse, and has a great potential to revitalize the agricultural economies of the countries in the region via improved productivity (efficiency) and higher total output through CA-based agriculture development. CA will have to shoulder the largest burden of making sustainable intensification of production systems a reality for food, fodder and fibre crops and livestock in Asian-Pacific countries.

The demand for food and fodder production will continue to grow in the region, and several countries have the potential of becoming significant grain exporters at the regional and

international level. Wheat, rice, maize, cotton, several pulses and livestock are the most important agricultural commodities in the region, and with a trend to diversification, oil crops such as rapeseed, sunflower, safflower and soya could likewise become even more important commodities than they are now. In addition, most if not all of the perennial tree systems, including those in plantations, lend themselves to becoming CA systems such as is the case with oil palm, cocoa and rubber in Malaysia. Similarly, irrigated cropping systems also can benefit from adopting CA principles as seen in South Asia region.

Minimal soil disturbance or no-till is one of the principles of CA. No-till fields act as a sink for CO_2; and the CA applied on a global scale could provide a major contribution to control air pollution in general and global warming mitigation in particular. Given the importance of agriculture for most of the regional economies and for the rural livelihoods, there is a need for research on what may be the role of CA and adaptation and mitigation options to climate change in agriculture in the region. CA also can assist in the adaptation to climate change, by improving the resilience of agricultural cropping systems, and hence by making them less vulnerable to abnormal climatic situations.

To reduce climate change impact, tillage agriculture should be assisted to transform into CA. The transformation can deliver climate-smart agriculture, producing profitable food, feed and fibre as well as other ecosystem services. Adapting to climate change requires a robust agricultural system, which can deal with the changes in climate and in its variability, and in pest dynamics. Integrated production technology such as CA is a hardy system which deploys preventive measures as a priority and is the best choice for preparing for adaptation to climate change. Climate-friendly agricultural practices focus on increasing the carbon and water content in soil (e.g., by using cover crops, farming with perennials, reduced soil disturbance or rotational grazing), minimizing the need for chemical fertilizers (responsible for nitrous oxide emissions) and managing livestock systems to reduce methane emissions. Low-Greenhouse (GHG)-emission farming systems include all systems that incorporate the three principles of CA including CA-based arable systems, CA-based crop-livestock systems as well as CA-based organic farming systems.

Within a CA-based crop rotation, different root systems influence different soil horizons and improve the efficiency of soil nutrient use. In general, the soil structure becomes more stable and soil functions in CA systems can support a range of ecosystem services. The evidence from Asia-Pacific countries shows that CA practices are suitable for the existing major cropping systems. Most of the results come from collaborative projects largely initiated and funded by international organizations but increasingly national systems are also expanding research and extension activities on CA. CA is not a single or uniform technology that can be immediately applied anywhere in a standard manner. Rather, it represents a set of principles that encourage the formulation of locally adapted practices, approaches and methods, which need to be tested, evaluated and then adopted or implemented under various biophysical and socio-economic conditions. Further research is necessary, for instance to study in details the effects of various CA crop rotations and mulch cover on weed management, nutrient, pest and water management, on residue levels, sowing depth, dates, density, and on fertilizer and

irrigation rates; and impact assessment on livelihoods and environmental conditions. To make results applicable on a wider scale, state programmes should become more active in conducting research and extension.

Considerable knowledge has been generated about CA practices in the Asia-Pacific region, in both rainfed as well as in irrigated areas, and more recently for plantation crops. In fact, the potential of CA for sustainable agricultural development has been demonstrated in the region, and outside the region with similar environments (e.g., see regional reviews in Jat *et al*., 2014). Building the technical and scientific capacity of national partners will be essential for moving to large-scale CA adoption and uptake. Researchers, extension workers and farmers will continue exchanging experience and knowledge about the new CA methods. Consequently, for the foreseeable future, facilitating national development strategies for up-scaling of CA, conducting training courses with national partners remain a high priority in the efforts undertaken by FAO, CIMMYT, IRRI, ICRAF, ICRISAT, ICARDA, CIRAD and other international organizations and programmes such as IFAD, ADB, ACIAR, SANREM, USAID and national donors, to promote CA in the region.

6. Concluding Remarks

From global evidence, as well from evidence within Asia-Pacific region as well from the deliberations of the Regional Consultation Workshop, CA potentially represents a more-secure paradigm of agriculture than that which is based on tillage of the soil. Consequently, CA does deserve close attention because of its wider socio-economic and environmental implications and possibilities for faster spread.

The lack of general knowledge and understanding about CA as well as a supportive enabling environment for its promotion, and the fact that the national institutions, public and private, are mainly serving tillage-based agriculture, are the main reasons for CA not spreading faster in the Asia-Pacific region. However, the evidence of increased adoption and uptake in other regions and continents during the recent years for example in China and in South Asia indicates that this situation can change, and the uptake of CA can be expected to accelerate over the coming years.

As seen already, there are a number of good reasons for farmers not immediately/spontaneously adopting CA, despite the acknowledged advantages. Farmers have to first overcome a number of hurdles. Foreseeing/knowing these hurdles and problems allows developing strategies to overcome them. Crises and emergency situations, which seem to become more frequent under a climate change scenario, and the political pressures for more sustainable use of natural resources and protection of the environment on the one hand, and for improving and eventually reaching food security on the other provide opportunities to harness these pressures for supporting the adoption and spread of CA and for helping to overcome the existing hurdles to adoption. Thus, actual regional challenges are providing at the same time opportunities to accelerate the adoption process of CA and to shorten the initial slow uptake phase.

In this regard, it is vital that all national knowledge systems in the Asia-Pacific region must increasingly align their work in research, education and extension to helping to understand the root problems and the role CA systems and practices can play to then facilitate policies for accelerated adoption. Research in particular must help to solve farmer and policy constraints to CA adoption and spread (rather than comparing CA with conventional systems which is often of academic value and not advancing the further development of knowledge to facilitate the introduction and spread of CA).

There is growing evidence from farmer fields, landscape-based development programmes and scientific research in most agro-ecologies across all continents that CA is very largely positive for productivity, profit and environment. As all the benefits of CA take several years to fully manifest themselves, fostering a dynamic CA sector requires an array of enabling policy and institutional support over a longer term time horizon, including the availability of necessary inputs and equipment, and the fostering of farmer-driven innovations. Undertaking these improvements will enable governments, civil institutions and farmers to progress together.

What Needs to be Done Now?

The core agro-ecological elements of sustainable intensification systems are the practices that implement CA's three principles, plus other best practices dealing with crop management, as well as the integration of pastures, trees and livestock into the production system and supported by adequate and appropriate farm equipment and power. This concept and the practical implications must be placed at the centre of any effort to intensify production at any farm scale.

The following are the recommended action points for policymakers in Asia-Pacific countries based on the outcome of the Regional Consultation Workshop in Beijing:

- Launch the establishment of CA Alliance for Asia-Pacific (CAAAP) with its Secretariat hosted initially at the Conservation Tillage Research Centre (CTRC), MoA, China.
- The CAAAP and FAO should jointly facilitate the preparation and implementation of a Business Plan for CAAAP to promote the mainstreaming of sustainable production intensification through CA at the national and regional level, involving a multi-stakeholder partnership strategy. The Business Plan should elaborate the further development of the CAAAP to coordinate and facilitate regional and national level actions. In this regard, an outline regional strategic framework is provided in the Annex III.
- CAAAP and FAO should facilitate the formulation of national strategies and action plans for the mainstreaming of CA in each country in Asia-Pacific region as the preferred production paradigm for agricultural development, including the formation of national CA stakeholder task forces to coordinate and facilitate national level actions. The outline regional strategic framework in the Annex III and the material in section 4 of this report serve as a 'road map' for the formulation of national strategies and action plans.
- Establish clear and verifiable guidelines, policies and protocols for agricultural production systems which qualify as sustainable intensification, including as integral elements Conservation Agriculture, Integrated Pest, Nutrient, Weed and Water management and other desirable practices.
- Institutionalize the new way of farming as officially-endorsed policy in public sector education and advisory services.
- Establish a conducive environment to support this new kind of agriculture, including the promotion of CA farmer associations, provision of suitable technologies, and of inputs through the commercial supply markets.
- Establish incentive mechanisms such as justifiable payments to eco-effective land users for environmental or community services.

- As adoption levels increase and the sustainable intensification becomes an accessible option to every farmer, introduce penalties for polluting or degrading ways of agriculture as additional incentive for late adopters.

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Annex I: Workshop Programme

20 November 2013	
07:00 – 08:00	**Breakfast**
08:30 – 09:00	Registration
09:00 – 09:20	Opening Statements: *Percy MISIKA, FAO Representative, China* *China Agricultural University (CAU)*
09:20 – 09:30	Introduction to the Workshop – *Yuji NIINO, FAO-RAP*
09:30 – 09:50	Introduction of the Participants
09:50 – 10:20	"Save and Grow" and Conservation Agriculture – *Amir KASSAM, FAO*
10:20 – 10:40	**Coffee-Break**
10:40 – 11:10	Status of Conservation Agriculture in the world – *Amir KASSAM, FAO*
11:10 – 11:30	Status of Conservation Agriculture in China – *Prof. Hongwen LI, China Agricultural University*
11:30 – 11:50	Status of Conservation Agriculture in Mongolia – *Ms. D. Nandinjargal*
11:50 – 12:10	Status of Conservation Agriculture in India – *Dr. Yashpal Saharawat*
12:10 – 12:30	Questions and discussion – *Moderator Y. NIINO, FAO-RAP*
12:30 – 13:30	**Lunch**
13:30 – 13:50	Status of Conservation Agriculture in Vietnam – *Dr. Duong Ngoc Thi*
13:50 – 14:10	Status of Conservation Agriculture in Cambodia – *Dr. Sovuthy Pheav*
14:10 – 14:30	Status of Conservation Agriculture in Laos – *Mr. Somvang Phanathavong*
14:30 – 14:50	Status of Conservation Agriculture in Philippines – *Dr. Agustin Mercado* (SANREM)
14:50 – 15:10	Status of Conservation Agriculture in Indonesia – *Ms. Seta Agustina*

15:10 – 15:30	Status of Conservation Agriculture in Malaysia – *Mr. Mohd Abidin Mohd Afiffin*
15:30 – 15:50	**Coffee-Break**
15:50 – 16:10	Status of Conservation Agriculture in Timor-Leste – *Mr. Adalfred Ferreira*
16:10 – 16:30	Status of Conservation Agriculture in Thailand – *Mr. Thongchai Tangpremsri*
16:30 – 16:50	Status of Conservation Agriculture in Bangladesh – *Mr. Md. Abu Taleb*
16:50 – 17:10	Status of Conservation Agriculture in Pakistan – *Mr. Mustaq Gill* (SACAN)
17:10 – 17:30	Status of Conservation Agriculture in Sri Lanka – *Dr. W.M.W. Weerakoon*
17:30 – 17:50	Questions and discussion – *Moderator Y. NIINO, FAO-RAP*
19:00	**Dinner**
After Dinner	**Shopping (The holy city mall 8 nearby Jinma by students)**
21 November 2013	
6:20	Gather in the hotel lobby on the 1th floor
6:30	Start for Beijing South Railway Station by bus
8:00-10:06	Take the high-speed rail G11， from Beijing South Railway Station to Qufu East Railway Station
10:20-12:20	From Qufu East Railway Station to Shandong Yuncheng Gongli Company Limited
12:30-14:00	Lunch (at Qixing Hotel)
14:30-16:30	Visit the Shandong Yuncheng Gongli Company Limited/field visit
16:40-18:40	From Yuncheng Gongli Company Limited to Qufu East Railway Station by bus
20:11-22:16	Take the high-speed rail G22, from Qufu East Railway Station to Beijing South Railway Station
22:00	Return to Jinma Hotel by bus

22 November 2013	
07:30 – 08:30	**Breakfast**
09:00 – 09:20	Status of Conservation Agriculture in Australia/Asia – *Dr. Richard Bell* ACIAR
09:20 – 09:40	Status of Conservation Agriculture in Central Asia – *Dr. Aziz Nurbekov* ICARDA (Uzbekistan)
09:40 – 10:00	Status of Conservation Agriculture in Southeast Asia – *Dr. Jean-Claude Legoupil* CIRAD-CANSEA (Laos)
10:00 – 10:20	Status of Conservation Agriculture in South Asia – *Mr Harminder Singh Sidhu* Borlaug Institute for South Asia (India)
10:20 – 10:40	Conservation Agriculture by CIMMYT in Asia – *Dr. Allen Jack McHugh* CIMMYT (China)
10:40 – 11:00	Questions and discussion – *Moderator Y. NIINO, FAO-RAP*
11:00 – 11:20	**Coffee-Break**
11:20 – 11:50	Guidelines for policymakers on promotion of Conservation Agriculture in Asia - *Amir KASSAM, FAO. Y. NIINO, FAO-RAP*
11:50 – 13:20	Working Groups to Review the reports presented on the status of CA in Asia and discuss possible Guidelines for Policy and Strategy for the Promotion of CA
13:20 – 14:20	**Lunch**
14:20 – 16:00	Presentations of the working groups on the promotion of CA
16:00 – 16:30	**Coffee-Break**
16:30 – 17:00	Summing up and follow up actions to prepare a regional policy and strategy for the promotion of CA – *Amir KASSAM, FAO. Y. NIINO, FAO-RAP*
17:00 – 17:30	Final remarks and closure of the workshop
19:00	**Dinner**
Departure of participants	

Annex II: List of Participants

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Annex III: A Strategic Framework Template

Conservation Agriculture for the Asia-Pacific Region:

A Strategic Framework for Regional and National Action

1. Introduction

This strategic framework[5] presents the relevance of CA to sustainably increasing agricultural output, productivity and profit whilst enhancing both the resource base and ecosystems. It presents the vision, goal, mission and strategy for CA in Asia-Pacific region[6] over some 15-year time horizon, and also the key elements upon which the strategy is based. In developing the strategy, FAO and regional stakeholders have identified the development opportunity provided by CA as well as the constraints that must be overcome to mainstream CA in a targeted manner involving all stakeholders who have a role in ensuring success. The document discusses ways to improve and measure outcomes over the longer-term.

The purpose of the strategic framework is to serve as a 'road map' or a template to the formulation of country-specific strategies and action plans for the promotion and up-scaling of CA. To achieve this, it was recommended and agreed at the Beijing Regional Workshop on Policy and Strategy for CA in Asia-Pacific Region that a regional CA Alliance for Asia-Pacific (CAAAP) should be constitute to coordinate and facilitate the promotion and up-scaling of CA at national and regional level in order to enhance sustainable increases in production and reduce risks. The framework aims to:

- Develop a common understanding on CA.
- Outline an action plan for expanding CA in Central Asia
- Elaborate approaches to sustain and institutionalize CA through national structures
- Define stakeholder role for achieving the spread and impact of CA.

The document presents stakeholder's vision, mission and goal for CA in Asia-Pacific over a period of some 15-year time horizon. It underscores the relevance of CA towards achieving sustainable production, food security and increased farm profitability levels, while enhancing the resource base and conserving ecosystems.

In developing the strategic framework, FAO and its partners (e.g., national programmes, CIMMYT, ICARDA, ICRAF, SANREM, ACIAR) and other stakeholders in the region have identified opportunities provided by CA as well as the constraints that must be overcome by stakeholders to mainstream CA in relevant national, sub-regional and regional plans, programmes and policies. The document discusses ways to improve and measure impacts in the short to long term. Because FAO operates at the national, sub-regional and regional level,

[5] Based on the earlier work on the FAO Conservation Agriculture Strategy for Sub-Saharan Africa and Central Asia.

[6] Asia-Pacific region under FAO-RAP comprise countries of South Asia, Southeast Asia, East Asia, the Pacific Islands, and Iran and Afghanistan.

the strategic framework is based on a corporate approach to formulation and implementation, and has attempted to be inclusive in capturing region-wide organizations. The regional strategic framework for Asia-Pacific provides a 'road map' for the formulation of national strategies for the promotion of CA involving policy and institutional support to farmers.

The national strategies will provide the FAO country and regional offices and CAAAP with a mechanism to ensure that governments, civic society, sub-regional and regional bodies, donors and international agencies are aware of FAO's capacity and comparative advantage in promoting CA in Asia-Pacific region. The strategy and the associated action plan for each nation reflect the diversity of experience and progress that exists in the different parts of the region. For example, China is relatively more advanced than the other nations in the adoption and spread of CA, followed by India and Pakistan with no-till wheat in the wheat-rice cropping system in the Indo-Gangetic Plain. The rest of the countries have no significant area under CA as yet but have been taking serious interest in testing the performance of CA. Thus, the pace at which the different nations would move forward would reflect the current diversity in experience, expertise and stakeholder awareness.

2. Why Conservation Agriculture?

The agricultural resource base of Asia-Pacific region comprises a range of agro-ecologies. On its western parts are the arid and semi-arid sub-tropical climates with winter rainfall in Iran, Afghanistan and northern and western parts of Pakistan, with strongly continental thermal regime with hot summers and cold winters. In South Asia, the lowlands have tropical and sub-tropical climates with summer monsoon rainfall ranging from arid and semi-arid moisture regime in the western, northern and central parts to sub-humid and humid monsoon rainfall in the eastern and southern parts. The Himalayan highlands of South Asia have sub-tropical summer monsoon rainfall regime that is sub-humid to humid on the windward side and arid and dry semi-arid on the rain shadow side. In Southeast Asia and the Pacific islands, the climate is mainly tropical with sub-humid and humid monsoon rainfall regime. In East Asia, the climate ranges from tropical and sub-tropical with summer rainfall in the southern parts of China and Korea to temperate winter rainfall climate in the northern parts of China and Mongolia.

In the rainfed semi-arid, sub-humid and humid areas, key climatic constraint is a high within season and between season rainfall variability, and often excessive rainfall. In the irrigated arid areas as well as in the semi-arid areas with dry season irrigation, the main constraint is water scarcity and salinity. The production potential of these agro-ecological zones in the lowlands and highlands for arable production and for livestock has been further reduced by inappropriate agricultural land use practices and poor management including nutrient mining and high mechanical soil disturbance. Conventional tillage has exacerbated the decline in soil fertility and biodiversity, soil loss, degradation and compaction. This is also true for the irrigated production where crops such as rice, wheat, cotton are produced under tillage systems.

The increase in populations of both people and livestock, droughts and floods and poor access to yield enhancing technologies and low marketing opportunities for agricultural produce, has also caused reduction and/or stagnation in agricultural productivity and worsened food insecurity and malnutrition. This situation will only worsen, unless drastic changes in farming practices are adopted by farmers for sustainable production, and for reducing risks linked to climate change.

There are many technical options available to improve agricultural productivity, for example with high quality seeds, fertilizer and pesticides. However, under the above described scenario, such improvements will neither be sustainable, nor economically feasible in the long term. The FAO Strategic Objective aims to combine sustainability with intensification as elaborated in its 'Save and Grow' publication. Since it minimizes or eliminates soil degradation and builds a foundation for a functioning ecosystem, CA is considered to be *the* entry point in making the intensification sustainable, as well as rehabilitates degraded and abandoned rainfed and irrigated agro-ecosystems.

Livestock is an integral component of the production systems in many of the agro-ecological zones of Asia-Pacific region. The potential of crop-livestock integration in CA systems has not been adequately exploited and competition for crop residues for livestock feed and mulching is high because of low biomass production in these systems. CA provides an opportunity to increase *in situ* biomass production to integrate crop-livestock systems for increased productivity and resilience. For small scale farmers, the integration of livestock and trees into the CA farming systems is considered to strengthen livelihood and resilience.

Given the present knowledge and circumstances, CA is the most appropriate sustainable option available to increase productivity, income and food security in the region. It offers an opportunity for commercialised production and substantially improves resource use efficiency. It can be practiced by any farmer and offers a viable solution for poor farmers to address their productivity constraints, particularly high labour costs and tillage constraints. Further, CA will help farmers to adapt to and mitigate the effects of climate change and variability.

CA has been shown to be relevant and appropriate at all levels of farm power and mechanization, from manually operated hand tools to equipment drawn by animal traction to operations performed by heavy machinery. CA is not only for vulnerable small farmers but also for small or large scale commercial farmers whose ecological as well as economical risks can be lowered by CA. Benefits of CA to the farmers relate to improved yields and input use efficiency, greater profit, improved soil characteristics, reduced soil erosion and increased resilience to climate variability and change. CA has been shown to work successfully in most countries in the Asia-Pacific region. However, most if not all countries in the Asia-Pacific region have a desire to initiated programmes to support the introduction and spread of CA. While CA represents innovative systems for agricultural development and sustainable livelihood, rapid spread of CA also needs to be supported by policy and institutions, including the availability of affordable locally manufactured or imported CA equipment and machinery including animal drawn or tractor drawn direct seeders.

3. What is Conservation Agriculture?

Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely (www.fao.org/ag/ca):

1. Continuous minimum mechanical soil disturbance (no-till, direct seeding).
2. Maintenance of permanent soil cover (residues and cover crops).
3. Diversification of crop species grown in sequences and/or associations and/or rotations (a diversified cropping system).

CA is more than no-till. The above three principles are universally applicable, in combination with other good agricultural practices, to all agricultural landscapes and land uses with locally adapted practices that address local opportunities and constraints. CA enhances biodiversity and natural biological processes above and below the ground surface. Soil disturbance from mechanical tillage is reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with, or disrupt, the biological processes. Critical to this is the increase in the quantities of organic matter on and in the soil, so as to provide the surface-protection, energy and nutrients required by soil-inhabiting flora and fauna that constitute the 'life' of a soil, playing a vital role in maintaining its porosity, enhancing its moisture holding capacity and extending the availability of nutrients to crops.

CA facilitates good agronomy, such as timely operations, and improves overall land husbandry for rain-fed and irrigated production. Complemented by other known good practices, including the use of quality seeds, and integrated pest, nutrient, weed and water management, sustainable mechanization approaches, etc., CA is a base for market-driven sustainable agricultural production intensification. It opens increased options for integration of production sectors, such as crop-livestock integration and the integration of trees and pastures into agricultural landscapes.

The successful spread of CA requires that a number of constrains – including the widespread perception amongst farmers that inversion tillage is an essential part of crop production processes – have to be overcome. Moreover, the design of any CA effort should consider the needs of the communities and farming systems and the market context, and be cognizant that CA should be pursued as a permanent undertaking, ideally with a five year initial investment period. CA practices may be applied incrementally, starting with minimum-tillage on a small area and at high standards of management.

4. Vision, Mission and Goal

CA is linked to FAO's Strategic Objectives which aim at sustainable crop production intensification as a means to eradicate hunger, reduce rural poverty, improve food and agriculture systems, and increase livelihood resilience, and CA is seen as a main mechanism for sustainable agriculture development including in Asia-Pacific region. CA is also part of FAO's Disaster Risk Management Strategy where it is an option for disaster risk prevention and mitigation.

Vision
A region free of hunger and malnutrition where increased access to food and increased productivity of agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner.

Mission
Within the framework of the above vision and FAO's operational strategy, the CA strategy for Asia-Pacific region aims at helping to build a food-secure region for present and future generations.

Goal
CA up-scaled and mainstreamed in national, sub-regional and regional policies and programmes contributing to the achievement of the Millennium Development Goals

Key outcome
Increased and sustained agricultural productivity, production and profitability in Asia-Pacific region for farmers as key beneficiaries.

The achievement of the above key outcome will be determined by the Plan of Action of each nation implemented at the country level whose formulation and implementation will be facilitated by the national stakeholder task forces or working groups.

5. Critical Success Factors for CA Adoption and Up-scaling

The following are considered to be the critical success factors or strategic focal areas for CA adoption and up-scaling:

- Coordination and cooperation
- Policy support for CA in national programmes
- Targeting CA interventions
- Partners and stakeholders participation
- FAO's technical capacity
- Private sector participation
- Farmer-centered participatory adaptive research
- Monitoring and evaluation
- Communication and advocacy
- Defined roles and responsibilities

- Availability of adequate financial resources

Details on each strategic focal area are elaborated in the ensuing sections of the strategy, and these will be further elaborated in each national strategy.

5.1 Coordination and Cooperation

The key elements of CA development and scaling-up are coordination and flexibility in, implementation and supporting innovative approaches. FAO will facilitate the coordination of CA development and rolling out by partners and stakeholders. The coordination will ensure harmonized implementation of CA principles and approaches as well as monitoring. Where appropriate, FAO will support the establishment or strengthening of national and regional multi-stakeholder task forces that are responsible for promoting and implementing CA. FAO, through its unique intermediary position, and being lead organisation for food and agriculture will continue to support the establishment and/or strengthening of CA coordination mechanisms that incorporate all relevant stakeholders at the country and sub-regional levels. The national coordination platforms will facilitate the development of CA implementation plans based on this strategy and the integration in national policies and frameworks/platforms. This will require the building of capacity at the national level to establish country specific work plans.

5.2 Policy Support for CA in National Programmes

One of the key elements of successful adoption and up-scaling of CA is policy support in national programmes. This means that there must be proactive buy-in at the policy level backed-up by significant institutional support in a range of services from both public and private sector before CA can be embedded in national programmes. Such policy support would be reflected through mainstreaming appropriate CA interventions in policies of relevant developmental sectors which include agriculture, environment, education, commerce, trade and industry. A key area related to resource mobilisation and requiring national policy-level intervention is the provision of necessary support for appropriate engagement of national CA practitioners (representing the public and private sector) in the development of national action plan process to ensure that CA interventions are adequately covered in all national plans. In particular, FAO and CAAAP as well as sub-regional CA networks will work to mobilise policy support for CA in terms of research and extension, supply of CA related equipment and machinery, linking input subsidies with adoption of CA. Investments in agriculture intensification will have to be allocated increasingly towards the adoption and up-scaling of CA and FAO would provide policy guidance and support to governments as well as ensure that politicians and decision-makers are made adequately aware and convinced of the large range of benefits that can be harnessed for the producers and the society though the large scale adoption of CA.

5.3 Targeting CA Interventions

In designing CA interventions, FAO, CAAAP, sub-regional CA networks and the collaborating stakeholders will consider the characteristics of agro-ecological conditions and farming systems in each nation. FAO will promote CA to strengthen production system sustainability and intensification within its Disaster Risk Management (DRM) framework that links emergency and rehabilitation activities to longer-term development and technical assistance activities.

Support to CA will be tailored to the requirements of different small farmer categories. FAO and CAAAP will support policy development that addresses the needs of all CA stakeholders. Technical support will be provided to potentially productive farmers for increased household food security and income generation. Where needed, vulnerable farmers will be provided with material and technical support, with an emphasis on productivity and profitability. Across all levels the focus will be on community level engagement to ensure buy-in by all stakeholders.

The corporate strategy recognises the different target levels of implementation and coordination. At the regional and sub-regional level, the focus will be on building coordination and cooperation backed-up with an effective communication and advocacy effort as well as support to operational planning, monitoring and resource mobilisation activities. Networking and information sharing will be an important activity at the regional and sub-regional level and so will the identification of some of the service providers in the key areas such as equipment and machinery, training, etc. The regional and sub-regional targeting will be formulated by the respective sub-regional working groups.

The targeting of beneficiaries, particularly the small farmers, can only be done at the national level taking into account the potential demand for sustainable intensification and need for CA, readiness to adopt CA as reflected by the national policy and institutional capacity to support CA interventions, including the support from the private sector on the input supply. In general, national level targeting of beneficiaries and geographical areas will be facilitated by the national working group on CA in each country, consistent with the country's sector and national development plans. In those countries where CA does not have an explicit policy support in the production intensification strategy, then the national policy-makers and institutional and corporate/business leaders will be a special advocacy target group.

Each sub-region has its own particular resource endowment, socioeconomic conditions, range of production systems, and agricultural and economic development opportunities. Each sub-region has its particular level of adoption and spread of CA with its particular national level commitment towards CA. Further, FAO's own experience with CA in each sub-region in Asia-Pacific is at different levels. Thus, the strategy calls for flexibility and adaptability according to the specific situation in each sub-region and in each country.

5.4 Partners and Stakeholders

Successful development and scaling-up and out of CA requires flexibility and participation of various stakeholders and partners. Collaboration between FAO and stakeholders will be guided by principles of good (true) partnership (transparency, mutual trust, respect, commitment, continual consultation/communication, accountability, knowledge and benefit sharing).

FAO will work with partners and stakeholders at the regional and national level, including governments, private sector, farmer organizations, civil society, NGOs, and research and development partners in generating and mobilising support for the implementation of CA in the sub-regions, facilitating the integration of CA into national and regional agricultural plans, programmes and policies, including training, research, education, markets, extension and budgeting.

FAO will engage stakeholders at regional (e.g., ICARDA, CIMMYT, ICRAF, ICRISAT, IRRI) and national (e.g., MoA) platforms for problem analysis, programming, planning, resource mobilization, implementation, monitoring and evaluation, and lessons learning and dissemination. FAO's engagement with stakeholders will build on their respective comparative advantages, geographic and sectoral coverage.

FAO and CAAAP will work closely with existing CA networks to maximize exchange of information and expertise for capacity development of stakeholders.

5.5 FAO's Technical Capacity

FAO, as a leading agricultural organization, has made CA part of its strategy for agriculture development to achieve the FAO strategic objective of sustainable intensification of crop production in the Asia-Pacific region and is advocating for CA support. FAO will realign and strengthen its technical capacity needed to generate and respond to opportunities to promote CA as part of its sustainable production intensification strategy. To achieve this, expertise will be mobilized for national and regional coordination and technical assistance. FAO with its multi-disciplinary approach will provide technical and policy support and advice when needed at every stage of any CA-based initiatives.

CA is not a single technology but a set of complementary practices that are implemented simultaneously by the farmers to obtain full benefits. These practices cover a large range of expertise from equipment and mechanization to cover crops and residue management to pest (weeds, pathogens and insects) management to nutrient and water management. In addition, there is crop and cropping system management expertise that is also required to support the development of good quality CA. Thus, the need for multi-disciplinary teams with CA expertise is essential for the success of this strategy and FAO-RAP and country offices will make certain the required expertise is added to the various teams as appropriate to successfully implement this strategy. At the same time, FAO will strengthen its in-house

collaboration and facilitate the greater sharing of in-house expertise across the sub-region and countries.

5.6 Private Sector Participation

Development and up-scaling of CA must be supported by access to inputs (seeds, agrochemicals, equipment, implements), finance, research and knowledge, and training. Inputs such as soil additives (fertilizer, lime), seeds, herbicides and pesticides are generally more available under the existing input support systems. On the other hand, access to CA equipment and machinery and other inputs, such as herbicides and cover crop legume seeds, may not be readily accessible. FAO and CAAAP will facilitate the creation of an enabling environment for timely access to quality inputs and CA equipment, where possible. In the short-term, there may be a need for importation and adaptation of equipment through existing regional and global capacities and suppliers. In the medium to long term, private sector is expected to import and manufacture equipment. FAO and CAAAP will particularly facilitate access to essential inputs of equipment and cover crop seeds. CA equipment hire services providers will be provided with technical and training support so that they provide farmers with timely and high quality services that are economically viable. Here, the role of private sector is particularly important and FAO and CAAAP will seek the greater involvement of private sector. Additionally, the CA-based farming value system is much more sensitive to environmental concerns and soil health so that improved factor productivity with CA corresponds to lower use of agrochemicals. In many instances, good quality seeds of local adapted varieties can also offer excellent performance under CA. FAO and CAAAP will ensure that in promoting the spread of CA due care will be taken to optimise the use of purchased inputs and where possible local adapted varieties and local cover crop species will be encouraged. This will require the promotion of public-private partnership in input/output markets. Farmer access to input/output markets is critical for sustainable CA adoption and up-scaling. While markets for staple crops and export crops are better developed, there are major challenges with respect to other crops which are used in crop rotations (legumes, oilseeds). FAO and CAAAP will also support partnerships that link farmers to output value chains and markets.

Beyond equipment and inputs, FAO sees an important role for private sector in research, training, extension and finance. This will be encouraged as appropriate.

5.7 Farmer-Centred Participatory Adaptive Research

CA is knowledge and management intensive and requires the support of both research and extension agents working together with farmers. Participatory approaches to testing and sharing experiences is an important part of up-scaling. This occurs through different mechanisms such as Farmer Associations, farmer networks with lead farmers, farmer co-operatives, lead farmer-based producer groups, or farmer clubs, in which generation of site specific knowledge and experience is key to successful adoption and spread of CA. Links with CGIAR centres and national programmes operating in specific agro-ecological zones

will be established and strengthened to ensure that recommendations within the realm of CA can be discussed with and tested by the farming community. It is also important for research and extension to undertake short-term and longer-term on-farm benchmark applied and adaptive research that can help identify solutions regarding constraints to CA adoption by the farmers as well as serve as hubs for convergence of innovations and inputs from different stakeholders. Research and extension must also be able to demonstrate the relevance and feasibility of CA in different parts of the country and between countries. FAO and CAAAP will strengthen its linkage with research and extension in line with adequate policy support and facilitate their greater participation in up-scaling of CA. Research on critical issues, selected in cooperation with relevant stakeholders for obtaining evidence on the benefits of CA and also to understand the technical and policy constraints to CA uptake and spread will be supported.

5.8 Monitoring and Evaluation

FAO along with national institutions and international organizations will establish a comprehensive Monitoring and Evaluation (M&E) system from the sub-national and national levels to the sub-regional and regional levels. Its purpose is to measure the status of CA implementation, quality of activities and processes, development of information and, to provide evidence of change and impact on livelihoods resulting from CA interventions. It also aims to provide a synthesis of resource materials and information on lessons learned for programme planning, advocacy and communication, and for decision-making by a range of stakeholders in public and private sectors. The M&E system will be a critical and integral component of FAO's and CAAAP CA mainstreaming strategy and incorporated from the outset in the programme design.

Through sub-national and national coordination mechanisms, M&E will focus on changes in productivity, socio-economic and, livelihood changes as well as on environmental impacts. Through national coordination mechanisms, short, medium term and long term CA verifiable and measurable targets will be established. They will be based on the status of capacity, existing and planned projects and the constraints that exist particularly in terms of training expertise. Targets will be formulated with a focus on sustainable impacts, taking into account both quantity and quality of interventions. Country specific targets would be amalgamated and updated to form consolidated regional targets. The information gathered as such will be used to create advocacy products for influencing strategic direction and form the basis of accountability. The national M&E strategies will contribute to M&E systems at the sub-regional and regional level.

Baseline benchmarks of livelihood circumstances, productivity, soil quality and health, cost-effectiveness etc., will be established for individual countries and within each sub-region. In the short term, the M&E would focus on rates of productivity and, its effects on food security and income generation. In the long term, the focus would be on changes in socio-economic and livelihood conditions and on institutional and environmental parameters. FAO and CAAAP will be cognizant of the fact that CA interventions will have different time frames

for realizing results. The M&E system will also establish a result-based justification for up-scaling and establishing outreach and, through feedback mechanisms opportunities to readjust regional and/or country specific action plans.

The adoption of CA will be measured by changes in the application of production practices which in turn is expected to lead to measurable changes in input use, derived outputs and factor productivity, profitability and risks. For such changes to be ecologically sustainable, they are expressed in ecosystem service parameters at farm and at landscape level and, in the state of economic, social and environmental circumstances. Thus, the strategy would imply measurements of change at both, the micro (field plots) as well as macro (landscape) level. The M&E is expected to bring out the pattern of adoption of CA's core principles. This process of change can be monitored to assess the impact both during the transition stage e.g. changes in runoff and erosion, in soil moisture conditions and impact of dry spells on production, etc. and at the time when all expected benefits have been realized.

To establish result-based impact pathways, FAO, CAAAP and national and international stakeholders propose a 15-year planning and implementation horizon to guide overall direction of interventions and to show commitment to the long term nature. This horizon will show how CA links to national and regional strategic agricultural development plans. Within this framework FAO will implement projects through rolling national and regional action plans each with their own M&E system. Some will be in the realm of shorter term emergency interventions while others in the medium and longer term development interventions. The main value of this approach is to provide evidenced based information to improve project planning and target formulation through feedback linkages.

5.9 Communication and Advocacy

The objectives of the communication and advocacy strategy will be to facilitate effective internal as well as external communication, information sharing and awareness creation, and catalyse and support the desired changes consistent with the goal of this CA strategic framework for Asia-Pacific region and the countries within it.

For internal communication the focus will be on information sharing, including lesson learned, good practices, technical and policy briefs, to enable the different FAO programmes and units to work better together as One FAO and strengthen FAO and CAAAP CA strategy and pool of expertise.

FAO and CAAAP will communicate to increase stakeholder knowledge and awareness of CA and its benefits, facilitate lesson learning and sharing of best practices, and advocate for resource mobilization and an enabling environment. For external communication, FAO will communicate its role as one of the lead CA organization working alongside CAAP and international organizations in the Asia-Pacific region and the national programmes. The communication messaging and vision will be formulated to address different target audiences and delivered through different mediums (print and electronic) and processes.

The national communication strategies will be developed through the national coordination mechanisms and the national communication strategies will feed into the regional communication strategy.

5.10 Roles and Responsibilities

For the successful implementation of CA, all structures of FAO including CAAAP will support the common goal. The responsibilities of FAO will be addressed and coordinated at various levels – sub-national/national, sub-regional, and regional/headquarters in emergency and rehabilitation activities and in regular development activities, as well as in linking emergency programme phase with development phase. However, in essence, activities will reach across the various levels because of their nested relationships. Each level has its specific competency but within each level FAO has clearly defined mandates that must be implemented in a complementary manner. The country units are supported and back-stopped by interdisciplinary teams at the sub-regional level who in turn are supported by the Regional Office for Asia-Pacific and by Headquarter staff from regular programme as well as from TCI. The FAO country level staff work in an integrated and inter-disciplinary manner with a range of national ministry staff and staff from national institutions and harness the synergies within FAO across country, sub-regional and regional/HQ level as well as with all the stakeholders who are engaged in up-scaling CA.

The following list illustrates the roles and responsibilities of FAO at various levels:

Headquarters/Regional Level

- Advocacy, publicity and promotion in the short and long term
- Provide link to relevant international global agreements, conventions and protocols
- Standardization and harmonization
- Resource mobilization
- Support innovation and spread relevant information
- Operational support to programmes and projects

Sub Regional

- Monitoring and evaluation, documentation and dissemination of lessons and best practices
- Advocacy, publicity and promotion
- Coordination –facilitation, standardization, harmonization
- Capacity building at all levels of implementation
- Resource mobilization
- Support and communicate innovation
- Technical support to programmes and projects

Country Level

- Advocacy, publicity and promotion
- Coordination –facilitation, standardization, harmonization

- Capacity building at all levels of implementation
- Monitoring and evaluation, documentation and dissemination of lessons and best practices
- Resource mobilization
- Support innovation, e.g., input delivery mechanisms and carbon trading and communicate to other levels
- Technical support to programmes and projects

5.11 Financial Resources

FAO will advocate a common resource mobilization strategy involving systematic approach complemented by a communication and advocacy strategy. The key objective will be to mobilise resources for partners at the national level who are involved in mainstreaming CA in national programmes.

Implementation and development of CA in each of the sub-regions will require appropriate funding if it is to make a significant impact in the sub-region in the near future. To date, many countries have only undertaken small-scale projects but if wide-scale promotion and adoption is to be achieved then it will require relatively high levels of funding over the next fifteen years. FAO and CAAAP will emphasize dialogue and contact with donors, governments and regional bodies that are promoting CA. At both regional and country level FAO will focus on its key roles of coordination, networking, information collation and dissemination, and policy. One of the coordination functions would be to develop a costed country CA plan with stakeholders. This plan would be the basis for joint resource mobilization and allocation.

FAO and CAAAP will focus on ensuring the effective implementation of country level programmes where there is an emphasis on directing resources to district and village levels, where the impact at farm level, and