What is the goal of Conservation Agriculture?

Conservation Agriculture (CA) aims to conserve,improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource-efficient and resource-effective agriculture.What is the goal of Conservation Agriculture? Conservation Agriculture (CA) aims to conserve,improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource-efficient and resource-effective agriculture.

What are the characteristics of CA?

CA maintains a permanent or semi-permanent organic soil cover. This can be a growing crop or a dead mulch. Its function is to protect the soil physically from sun, rain and wind and to feed soil biota.The soil micro-organisms and soil fauna take over the tillage function and soil nutrient balancing. Mechanical tillage disturbs this process.Therefore, zero or minimum tillage and direct seeding are important elements of CA. A varied crop rotation is also important to avoid disease and pest problems.
Rather than incorporating biomass such as green manure crops, cover crops or crop residues in CA this is left on the soil surface. The dead biomass serves as physical protection of the soil surface and as substrate for the soil fauna. In this way mineralization is reduced and suitable levels of soil organic matter are built up and maintained.

What are the elements of CA?

Residue management: crop and weed residue management is an essential element of CA. For example, slashing a cover crop or weed cover before flowering or seed set, or rolling to flatten crop residues, reduces weed pressure, increases infiltration of rainwater and protects the soil water against evaporation.The residue cover also protects and feeds the soil fauna that produces and maintains an open pore system in the soil.
Crop rotations: crop rotation is necessary in CA in order to avoid the built-up of pest, weed or disease pressure, and to ensure that root systems explore the soil to different depths. It also entails a more balanced extraction of plan nutrients from the soil.

Zero tillage: zero tillage is a technical component used in CA but not everyone carrying out zero tillage is practising CA. CA not only avoids tillage by placing the seed into the soil with direct drills, it also improves the structure of the soil by maintaining a soil cover. This facilitates direct planting. CA uses biological tillage. Zero tillage can also be applied as a stand-alone technique in conventional agriculture under certain circumstances.
Conservation tillage: conservation tillage practices leave some crop residues on the surface,which increases water infiltration and reduces erosion. They are used in conventional agriculture to reduce soil erosion on bare soils. However, some conservation tillage practices such as zero tillage can be elements of CA.

Direct planting/seeding: this is a technique of seeding or planting without prior cultivation to prepare a seedbed. Equipment or tools that place the seed in the soil through a mulch or residue cover are used in CA. However, the term direct seeding can also refer to implements used in conventional agriculture that combine primary and secondary tillage and seeding in one machine/tractor operation.

Organic farming: organic farming practices can be elements of CA, but organic farming still relies on tillage in many cases. Conversely, CA is not necessarily organic farming, although it is based on natural processes. CA does not prohibit the use of farm chemical inputs. For example, herbicides are an important component in CA,particularly in the transition phase, until the new balance of weed populations is managed. However, in view of the importance of the soil life for the system, farm chemicals, including fertilizer, are carefully applied and, over the years, quantities applied tend to decline.

What is wrong with tillage?

1. Regarding the overall fertility,including soil structure, virgin soils are usually more fertile than soils following decades of cultivation.
2. Nature shows that plant growth is possible without any soil tillage; otherwise all virgin lands would be deserts.
3. There is scientific evidence that water infiltration is highest on non-tilled soils with a continuous cover of vegetal material.

Explanation:

The accumulation of a mulch cover on an undisturbed soil protects and feeds intensive soil life, which then provides a stable and favourable soil structure and sufficient continuous deep macropores for improved water infiltration. This process of biological tillage is building up in the absence of mechanical tillage and it is reduced or inhibited by mechanical tillage.

Why did humankind till in the first place?
The first agricultural intervention was a kind of no-till within a slash-and-burn agriculture, using a planting stick to make a hole for the seed.

As agriculture became more intensive the technologies available for weed control at that time allowed only a clean tillage approach to large scale farming.

In temperate climates the detrimental effects of tillage are not as pronounced as in the tropics.

Tillage produces an aeration and thus rapid mineralization of organic matter in virgin soils. This mining of soil organic matter makes available plant nutrients for the next crop, albeit only for a limited number of years. This is the origin of the misconception that tillage increases soil fertility.

Once the fertilizing function of soil organic matter had been taken over by mineral fertilizer,the achievement of soil structure had to be taken over by more intensive tillage.This mechanical soil structure formation does not last very long and calls for ever-increasing tillage efforts. Over the years these reduce the content of soil

organic matter, which aggravates the problem. Tractor power required for conventional tillage has been steadily rising.

Consequences:

- On most agricultural soils it is impossible to grow a crop without tillage because of a general soil degradation process.
- Soil tillage is understood as a purely mechanical problem.
- Many farmers and the general public cannot imagine how a crop can be grown without tillage.

Is CA compatible with IPM?

CA is compatible and actually works on Integrated Pest Management (IPM) principles. CA, like IPM, enhances biological processes. It expands the IPM practices from crop and pest management to land husbandry.Without the use of IPM practices the build up of soil biota and the consequent biological tillage would not be possible.

What is the role of animal husbandry in CA?

Livestock production can be fully integrated within CA, by making use of the recycling of nutrients. This reduces the environmental problems caused by concentrated intensive livestock production. Integration of livestock into CA enables the farmer to introduce forage crops into the crop rotation, thus widening it and reducing pest problems. Forage crops can often be used as dual-purpose crops, for fodder and soil cover. However, in arid areas with low production of biomass, the conflict between the use of organic matter to feed the animals or to cover the soil still remains to be resolved.

What are common prejudices?

"It is only for large mechanized farms" – Today technologies are also available (and used) to practise CA on small farms with animal traction and on very small farms with hand tools.
"Disease problems increase due to the residues left in the field" – This will depend largely on the adoption of sound crop rotations. Monocropping under zero tillage is possible but not recommended because, just like monocropping in conventional farming, it creates pest problems and therefore would not be considered as CA.
"It only works for grain crops" – The system has been adapted for vegetables and root crops.Now, not only grain crops and pulses but also a wide range of other crops such as sugar cane, vegetables, potatoes, beets and cassava can be grown. Perennial crops such as fruit and vines can also be grown using CA techniques.
"It only works in certain climates or on certain soils" – CA is practised in many agro-ecological zones, from the humid tropics to cold temperate climates, and on all kinds of soils. So far the only areas where the concept has not been successfully adopted are arid zones with extreme water shortages and low production of biomass.In these areas both humans and animals compete with the soil for crop residues.

What are the downsides of CA?

CA is generally a win-win situation.That does not mean that there are no problems. CA may require the application of herbicides in the case of heavy weed infestation, particularly in the transition phase from conventional agriculture.
During the transition phase certain soil-borne pests or pathogens might create new problems because of the changing biological equilibrium. Once the CA environment has stabilized it tends to be more stable than conventional agriculture. So far there has been no pest problem that could not be overcome in CA.

Why can't we do CA without soil cover?

Only in very few soil and climatic conditions is the soil able to maintain its structure on its own. No-till systems such as CA rely on soil life to build and maintain an open pore structure in the soil.This biological tillage replaces mechanical tillage in CA. The soil life consists of macro- and micro-fauna and flora such as earthworms, insects, bacteria, fungi and plant roots. These have to be fed and protected.Soil cover provides protection for the living environment of soil life and the substrate to feed it. In addition the soil cover plays an important role for weed control. No-till agriculture without soil cover is only successful in a few cases and invariably runs into weed problems requiring large amounts of herbicides.

Why can't we carry out CA without crop rotation?

CA without crop rotations may be possible, but it is very difficult, especially if the use of pesticides is to be reduced to a minimum. Any crop which is grown repeatedly on the same field accumulates pests and diseases over time.Under CA the crop residues remain on the soil surface and are neither burnt nor ploughed in and the infection chain to the subsequent crop can only be broken by leaving sufficient time between similar crops. In addition, the different crops in a rotation have other rooting systems and exploit or develop different parts of the soil profile or have different nutrient requirements. Crop rotations not only allow diversified production but also make use of synergy effects between different crops in pest control,nutrient availability and rooting environment.

What are the attractions of CA?

CA attracts different people for different reasons:

Farmers:
Reduction in labour, time, farm power.
Reduction in cost.
In the case of mechanized farmers: longer lifetime and less repair of tractors, less power and fewer passes, hence much lower fuel consumption.
Better trafficability in the field.
More stable yields, particularly in dry years.
Gradually increasing yields with reduced inputs.
Increased profit, in some cases from the beginning, in all cases after a few years.

Communities/Environment/Watershed:
More constant water flows in the rivers, re-activation of wells.
Cleaner water due to less erosion.
Less flooding.
Less impact of extreme climatic situations (hurricanes,drought,etc.).
Less costs for road and waterway maintenance. Better food security.
At global level:
Carbon sequestration (reduction of greenhouse effect): in some places CA farmers start to receive carbon-grant payments; the global potential of CA in carbon sequestration and reduced energy (fuel) use could equal the human-induced increase in CO_2 in the atmosphere.
Less leaching of plant nutrients and less pollution of surface water and groundwater.
Practically no erosion (erosion is less than soil build-up). Recharge of aquifers through better infiltration.

Can CA be used to recover degraded soils?

CA is based on soil life.Therefore soils have to be brought up to a condition where life can develop. This refers to nutrients, pH, organic matter and moisture. On extremely degraded soils some investment in amelioration might be necessary to recover them, such as ripping a compacted layer, liming, use of green manure and fertilizers to correct extreme nutrient deficiencies. Soils under CA are usually improving, which means the rate of degradation and erosion is lower than the rate of soil build-up. For that reason even degraded soils will improve and become productive under this system. A good example are the Brazilian Cerrados, which were considered degraded land unsuitable for farming, and which have been converted by CA into a highly productive area.

Is CA real?

Elements of CA are being practised on about 45 million ha, mostly in North and South America. CA is growing exponentially on small and large farms in South America, due to economic and environmental pressures. Farmers practising CA in South America are highly organized in regional, national and local farmers' organizations, and are supported by institutions in North and South America. In Europe the European Conservation Agriculture Federation (ECAF), a regional lobby group, has been founded.This body unites national CA associations in the United Kingdom, France, Germany, Italy, Portugal and Spain.

Country Area	**under No-tillage (ha) 2004/2005**
USA 1	25.304.000
Brazil 2	23.600.000
Argentina (*) 3	18.269.000
Canada 4	12.522.000
Australia 5	9.000.000
Paraguay 6	1.700.000
Indo-Gangetic-Plains (**) 7	1.900.000
Bolivia 8	550.000
South Africa 9	300.000
Spain 10	300.000
Venezuela 11	300.000
Uruguay 12	263.000
France 13	150.000
Chile 14	120.000
Colombia 15	102.000
China 16	100.000
Others (Estimate)	1.000.000
Total	**95.480.000**

Source: 1) John Hassel CTIC, 2005; 2) FEBRAPDP, 2005; 3) AAPRESID, 2004; 4) Dr. Doug McKell, Soil Conserv. Council of Canada, 2004; 5) Bill Crabtree, WANTFA, 2005, 6) MAG - DEAG, Soil Conservation Program, 2005; 7) Dr. Peter Hobbs & Raj Gupta 2005; 8) Carlito Los, 2005, 9) Richard Fowler, 2003; 10) ECAF Homepage, 2005; 11) Rafael E. Perez, 2004; 12) Miguel Carballal AUSID, 2005; 13) ECAF Homepage, 2005; 14) Carlos Crovetto, 2005; 15) Fabio Leiva, 2005; 16) Li Hongwen, 2005; (*) Preliminary information based on 40% of data collection for 03/04 (**) Includes four countries in South Asia, India, Pakistan, Bangladesh and Nepal

What are the issues?

Despite its advantages, for a number of reasons CA has so far spread relatively slowly. First, there is greater pressure to adopt CA in tropical than in temperate climates.As a result in Latin America it is gaining in popularity. It has taken a long time, but over the past 20 years the establishment of a local knowledge base has ensured its spread. In some states of Brazil it is official policy and in Costa Rica the Ministry of Agriculture has a Department for Conservation Agriculture – so in these cases the policy-makers have been convinced.The adoption of CA in the United States was probably due to a mixture of public pressure to fight erosion and the financial incentives of reduced tillage. Europe is slowly waking up; farmers still do not feel sufficient pressure and environmental indicators (erosion, flooding) are not yet taken seriously enough. CA has great potential in Africa owing to its ability to control erosion, give more stable yields and reduce labour. There are a number of ongoing initiatives promoting different practices, from conservation tillage up to CA. However, the are still some significant problems.

Another vast area where the adoption of CA would be extremely beneficial is Central Asia. In the countries of the former Soviet Union conventional agriculture is in great difficulties because of environmental problems and because of a lack of farm machinery, which has to be replaced. Unless CA is adopted, the investment in new machinery will have to be very high.
Converting to CA needs higher management skills.The first years might be very difficult for the farmers, therefore they might need moral support – from other farmers or from extension services – and perhaps even financial support to invest in new machinery such as zero-tillage planters.
Necessary technologies are often unavailable: in order to try CA, the minimum a farmer needs is a zero-tillage planter, which might not be locally available. Few farmers take the risk of buying new machinery without knowing the system or even having seen it. Machinery dealers might not wish to promote CA as long as it is not supported by extension, since the widespread adoption of CA will reduce machinery sales,particularly of large tractors and tillage equipment.

Why is CA not yet widely recognized and applied?

There is no simple answer to this question; it depends on the specific circumstances.In many cases the system and its benefits are not well known and the culture of tilling the soil or even ploughing is so deeply rooted that people have difficulties in taking CA seriously as long as they do not see successful examples. In temperate zones the climatic conditions allow conventional farming without producing disasters in terms of erosion that are known in tropical climates.The environmental pressure is not yet high enough for farmers to reconsider their production systems, and national and regional agricultural policies are often biased against certain practices needed under CA, such as sound crop rotations. Besides these factors,which result from a lack of knowledge and awareness, there is also some resistance to CA from groups with different agendas or interests, for example commercial companies living mainly from technologies that might become obsolete with a massive adoption of CA.

What is the role of GMOs in CA?

The possible merits or dangers of genetically modified organisms (GMOs) are a distinct issue, without direct relation to CA. As in conventional agriculture, some CA farmers use them; others not. Some people believe that CA would depend on herbicide-resistant varieties. This is not true. Most instances of CA are carried out without herbicide-resistant varieties. In fact, if the weed situation is managed through an adequate crop rotation and cover crop management, herbicide-resistant varieties do not provide any advantage over other varieties. Many farmers therefore consider them as superfluous and even potentially dangerous in a properly established CA system, as they might induce an overuse of herbicides, with consequent damage to the soil life and the possible creation of herbicide-resistant weeds.

What is FAO doing on CA?

Because of its close links with food security, biodiversity, land and water resources, carbon sequestration and sustainable development, CA is a major opportunity to implement the international conventions such as Convention on Sustainable Development (CSD), U.N. Convention to Combat Desertification (UNCCD), U.N. Convention on Bio-diversity (UNCBD) and U.N. Framework Convention on Climate Change (UNFCCC).
FAO has been promoting the CA concept for more than ten years, particularly in Latin America. As it is becoming a success story in Latin America, FAO has been expanding the programme to other regions,such as Africa and Central Asia. An interdisciplinary project on CA has been formulated within the Agriculture Department of FAO.