Towards sustainable agriculture:
Direct seeding on plant cover

In the face of climatic, economic and social changes, agronomists are examining world-wide new ways for agriculture production. The aim is to develop, for and with farmers, specific and appropriate solutions which can be adopted rapidly, particularly by the poorest farmers.

Various practices of minimum or without tillage, cover crops and direct seeding have been studied all over the world. However, Cirad and its partners, lead by L. Séguy in France, are testing systems that simulate a temperate forest ecosystem while increasing crop production. In these systems, the soil is never tilled but permanently kept covered by a dead or living mulch. The mulch comes from plants that are used as "biological pumps" in cropping systems to contribute to nutrient recycling and to improve soil structure and fertility.

Towards sustainable agriculture:
Direct seeding on plant cover

For more than 20 years Cirad and its partners have been developing alternatives to conventional cropping systems in southern countries. Agriculture based on soil tillage is now being questioned as it seems unable to face the main challenges of soil and water conservation, environmental protection, food safety and cost reduction. Attractive, economically profitable, environmentally friendly and sustainable cropping systems have been developed and extended on a large scale, based on direct seeding on permanent plant cover without soil tillage.

A world-wide network and the Agro-ecology action plan Cirad / AFD / FFEM / MAE

Together with its various partners, Cirad developed a research network to adapt these techniques to a wide range of bio-physical and socio-economics conditions. These situations range from very poor to rich soils, from temperate areas to tropical and equatorial conditions, from dry areas (450 mm rainfall in Tunisia) to very humid tropics (areas over 3000 mm rainfall in Amazonia), from sea level to high altitude (e.g. Madagascar highlands), and from flat land (including poorly irrigated paddy fields) to very steep slopes (e.g. northern Vietnam). They also range from highly economic (low-cost agriculture for the poorest) to very intensive agriculture (with high capital investment and returns), from areas integrated in the world market (Brazil) to isolated mountains (Vietnam), and from regions with very high population density to deserted areas.

French donors (AFD - Agency for Development, FFEM - Fund for World Environment and MAE-Ministry of Foreign Affairs) combined their efforts to support a world-wide Agroecology Action Plan (AAP), funding research and development programmes in five pilot countries (Laos, Cameroon, Mali, Madagascar and Tunisia).

Cropping systems are tested in matrices (system trials in which several key factors are combined) on representive toposquences in the experimental units. New systems are developed by gradually including other production factors. Based on matrix construction rules, direct and cumulative effects of cropping system components can be interpreted over a period. Reference farms matrices are sites of action, innovation and training. They also provide a field-monitoring laboratory for scientists and are a cropping system vivarium where tillage techniques and new direct seeding systems (simple to highly complex systems, with diversified crops, livestock production and agro-forestry) can be showcased.

For the past two decades, Cirad and its partners have been developing alternatives to conventional cropping systems in southern countries. Agriculture based on soil tillage is now being questioned as it seems unable to face the main challenges of soil and water conservation, environmental protection, food safety and cost reduction. Attractive, economically profitable, environmentally friendly and sustainable cropping systems have been developed and extended on a large scale, based on direct seeding on permanent plant cover without soil tillage.

PRINCIPLES OF DIRECT SEEDING ON PERMANENT PLANT COVER

Young soybean on Eleusine coracana mulch, Brazil

For more than 20 years Cirad and its partners have been developing alternatives to conventional cropping systems in southern countries. Agriculture based on soil tillage is now being questioned as it seems unable to face the main challenges of soil and water conservation, environmental protection, food safety and cost reduction. Attractive, economically profitable, environmentally friendly and sustainable cropping systems have been developed and extended on a large scale, based on direct seeding on permanent plant cover without soil tillage.

A world-wide network and the Agro-ecology action plan Cirad / AFD / FFEM / MAE

Together with its various partners, Cirad developed a research network to adapt these techniques to a wide range of bio-physical and socio-economics conditions. These situations range from very poor to rich soils, from temperate areas to tropical and equatorial conditions, from dry areas (450 mm rainfall in Tunisia) to very humid tropics (areas over 3000 mm rainfall in Amazonia), from sea level to high altitude (e.g. Madagascar highlands), and from flat land (including poorly irrigated paddy fields) to very steep slopes (e.g. northern Vietnam). They also range from highly economic (low-cost agriculture for the poorest) to very intensive agriculture (with high capital investment and returns), from areas integrated in the world market (Brazil) to isolated mountains (Vietnam), and from regions with very high population density to deserted areas.

French donors (AFD - Agency for Development, FFEM - Fund for World Environment and MAE-Ministry of Foreign Affairs) combined their efforts to support a world-wide Agroecology Action Plan (AAP), funding research and development programmes in five pilot countries (Laos, Cameroon, Mali, Madagascar and Tunisia).

Cropping systems are tested in matrices (system trials in which several key factors are combined) on representive toposquences in the experimental units. New systems are developed by gradually including other production factors. Based on matrix construction rules, direct and cumulative effects of cropping system components can be interpreted over a period. Reference farms matrices are sites of action, innovation and training. They also provide a field-monitoring laboratory for scientists and are a cropping system vivarium where tillage techniques and new direct seeding systems (simple to highly complex systems, with diversified crops, livestock production and agro-forestry) can be showcased.

For the past two decades, Cirad and its partners have been developing alternatives to conventional cropping systems in southern countries. Agriculture based on soil tillage is now being questioned as it seems unable to face the main challenges of soil and water conservation, environmental protection, food safety and cost reduction. Attractive, economically profitable, environmentally friendly and sustainable cropping systems have been developed and extended on a large scale, based on direct seeding on permanent plant cover without soil tillage.

PRINCIPLES OF DIRECT SEEDING ON PERMANENT PLANT COVER

Young soybean on Eleusine coracana mulch, Brazil

For more than 20 years Cirad and its partners have been developing alternatives to conventional cropping systems in southern countries. Agriculture based on soil tillage is now being questioned as it seems unable to face the main challenges of soil and water conservation, environmental protection, food safety and cost reduction. Attractive, economically profitable, environmentally friendly and sustainable cropping systems have been developed and extended on a large scale, based on direct seeding on permanent plant cover without soil tillage.

A world-wide network and the Agro-ecology action plan Cirad / AFD / FFEM / MAE

Together with its various partners, Cirad developed a research network to adapt these techniques to a wide range of bio-physical and socio-economics conditions. These situations range from very poor to rich soils, from temperate areas to tropical and equatorial conditions, from dry areas (450 mm rainfall in Tunisia) to very humid tropics (areas over 3000 mm rainfall in Amazonia), from sea level to high altitude (e.g. Madagascar highlands), and from flat land (including poorly irrigated paddy fields) to very steep slopes (e.g. northern Vietnam). They also range from highly economic (low-cost agriculture for the poorest) to very intensive agriculture (with high capital investment and returns), from areas integrated in the world market (Brazil) to isolated mountains (Vietnam), and from regions with very high population density to deserted areas.

French donors (AFD - Agency for Development, FFEM - Fund for World Environment and MAE-Ministry of Foreign Affairs) combined their efforts to support a world-wide Agroecology Action Plan (AAP), funding research and development programmes in five pilot countries (Laos, Cameroon, Mali, Madagascar and Tunisia).

Cropping systems are tested in matrices (system trials in which several key factors are combined) on representive toposquences in the experimental units. New systems are developed by gradually including other production factors. Based on matrix construction rules, direct and cumulative effects of cropping system components can be interpreted over a period. Reference farms matrices are sites of action, innovation and training. They also provide a field-monitoring laboratory for scientists and are a cropping system vivarium where tillage techniques and new direct seeding systems (simple to highly complex systems, with diversified crops, livestock production and agro-forestry) can be showcased.

For the past two decades, Cirad and its partners have been developing alternatives to conventional cropping systems in southern countries. Agriculture based on soil tillage is now being questioned as it seems unable to face the main challenges of soil and water conservation, environmental protection, food safety and cost reduction. Attractive, economically profitable, environmentally friendly and sustainable cropping systems have been developed and extended on a large scale, based on direct seeding on permanent plant cover without soil tillage.
PRINCIPLES OF DIRECT SEEDING ON PERMANENT PLANT COVER (2)

The permanent plant cover:  
- prevents erosion  
- increases infiltration 
- reduces evaporation 
- buffers temperature 
- creates favourable environment for development of biological activity 
- control weeds 
- increases soil organic matter content and provides nutrients to the plants

Plants with strong root systems and intense biological activity:  
- improvement of soil structure  
- increase soil organic matter content  
- recycle nutrients which have been leached in deeper horizons, especially nitrate  
- use water stored in deeper horizons for biomass production during the dry season.

As a consequence, water and nutrients use and efficiency and yields of the main crops are increased and stabilised. For example, on acid ferralsic soils in the Cerrados of Brazil (without irrigation) yields up to 7 tonnes/ha of upland rice, 5 tonnes/ha of cotton and 4.5 tonnes/ha of soybean, with a 30-50% reduction of mineral fertilisation as compared to conventional practices.

Diversified production systems  
Sustainable cultivation based on direct seeding with vegetal cover is not possible without crop rotations and diversified productions, which contribute to biodiversity (especially the fauna, from micro-organisms to macro-fauna).  

These types of cropping systems allow an integration with livestock systems as most plants used for soil structure improvement and mulch production also are excellent forages. Finally, association between crops or forages and trees is possible.

2/ Environmental considerations  
This agro-ecological agriculture proposes solutions for the following major challenges the world will have to face in the near future:  
- soil preservation and recovering of soil fertility  
- carbon sequestration and reduction of the greenhouse effect  
- reduction of water consumption by agricultural production and production of rainfed crops in marginal dry areas  
- reduction of fertiliser and pesticide use, and thus reduction of pollution and improvement of food quality and safety  
- buffering of water flows and reduction of risks on flooding  
- stabilisation of agriculture and reduction of deforestation loss.

All the experts agree that, in 10 years, Brazil with more than 13 million ha of land cultivated with direct seeding, has preserved over a billion tonnes of arable land, spared eleven billion US$ and 1.3 billion litres of fuel, and has sequestered more than 500 million tonnes of CO2 (Borges et al., 2002, Especial 10 anos retrospectiva dos principais fatores que foram noticia revisão plantio direto, edição n°29, 09 10 2000).

J. Landers and the “Associação de Plantio Direto no Cerrado” (2002) indicated that thanks to direct seeding, 18 tonnes per ha and per year of soil are preserved (reduction of 76 % in erosion losses as compared to conventional systems in Brazil), and rainfall run-off is reduced by 69 %.

3/ Economic and social aspects  
A major advantage of these cropping systems is that, apart from technical and environmental benefits, they are particularly attractive from an economic point of view, as they allow reduction of labor and drudgery. Optimisation of work organisation is easier thanks to access to fields, there is reduced fuel consumption in the case of large scale farming, less inputs (fertilisers and pesticides), and smaller investments (tractor, plough, etc. are needed). As a consequence, these systems provide higher land, capital and labour profitability than conventional systems while they respect the environment.

From a social perspective, preservation of soil is fundamental: when loosing his soil the farmer is doomed. The adaptability of these systems to various agro-ecological conditions, production means and input levels, also makes them accessible to a broad range of farmers, including the poorest. Furthermore, direct seeding on plant cover is the first credible and practical way towards the development of biological agriculture for the less advantaged farmers who can then add value to their products on the world market, in accordance with consumers’ requirements.