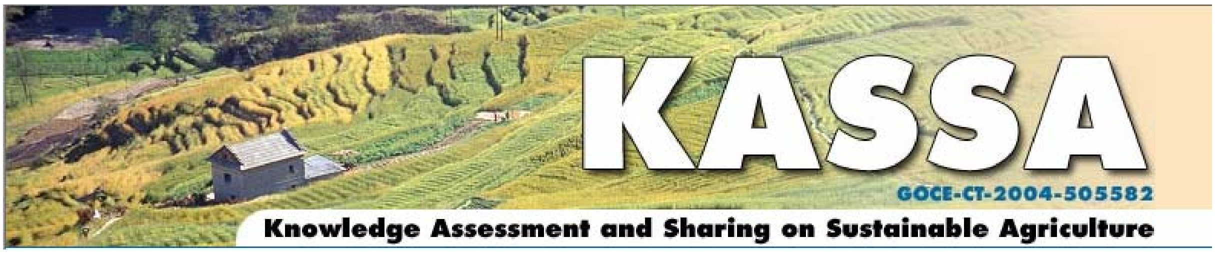

Knowledge assessment and sharing on sustainable agriculture

Main results, gaps in knowledge and challenges in the Mediterranean platform

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THE MEDITERRANEAN PLATFORM

Mediterranean agroecosystems

KASSA addressed agroecosystems where rainfall, which ranges between 250 and 700 mm annually, is variable and erratic, and is often concentrated in high-volume, high-intensity storms. Drought is endemic and unpredictable. Soils in the Mediterranean region typically have medium to poor fertility. They often have calcareous horizons close to the surface that limit water-holding capacity and root development. Frequently, they are stony, alkaline or saline. They are characterized by low levels of organic matter, partly because limited rainfall restricts biomass production, and partly as a legacy of more than 2000 years of human cultivation.

The most important crops in Mediterranean areas are winter cereals, especially wheat and barley. Where there is adequate soil moisture during summer months, tree crops (olives, almonds, nuts) and vineyards may accompany winter cereals. The presence of irrigation allows the cultivation of fruit trees, e.g., apples, peaches, pears, olives and citrus. Other crops may include grain legumes (peas, faba bean, lentils, chickpea); forage legumes (alfalfa, vetches); and a miscellany of others (sunflower, potatoes, sugar beet, cotton). Multiple cropping is not possible without irrigation. In fact, long bare fallow periods of up to 18 months (to accumulate soil moisture) are traditional “dry farming practices” in some areas. Recently, however, continuous cultivation of adapted crop rotations has become more common. Some areas are devoted to grazing of livestock (cattle, sheep, goats) on dryland permanent pastures. Crop-livestock interactions are important: livestock graze on the stubble of barley and wheat fields and sometimes straw is baled and used for livestock feeding and bedding.

Ecological and environmental issues are different in dryland and irrigated areas. In the dry lands, the main problems are water scarcity and land degradation by soil erosion associated with lack of soil cover, high rainfall intensity and overgrazing. Stubble burning and lack of organic residue incorporation exacerbate these problems. There is a strong need -and relevant opportunity- to improve the agroecosystem functioning by stressing the importance of covering soils with crop residue. The ultimate issue, of course, is the stark prospect of irreversible desertification.

In irrigated lands, important issues include excessive and inefficient water and chemical use, resulting in environmental pollution and, in places, further salinization of agricultural lands. Pollution may also arise from excessive applications of manures and organic slurries.

An important social and economic issue lies in the marked differences in agricultural activity between southern and northern Mediterranean countries. Relative to southern countries, agriculture in the north is more advanced. Driven by more rapid processes of economic growth, the proportion of the population in northern Mediterranean countries that are still directly engaged in agriculture is relatively low, while new technologies have led to substantial increases in agricultural labour productivity. Apart from this, social and economic issues are similar to those in temperate climates – the need to reduce production costs, improve competitiveness, and (for European Mediterranean countries) comply with evolving CAP regulations and policies.

Conservation Agriculture in the Mediterranean agroecosystems

Conservation agriculture is not widespread around the Mediterranean. Adoption in European Mediterranean countries has been greater than in North African countries. Reduction of intensive tillage in the region begun in the 1960's, and later tentatively in North African Mediterranean countries, with variable impact and mainly driven by the necessity for a reduction in different inputs (fuel, machinery and labour). No-tillage and cover crops are used between rows of perennial crops such as olives, nuts and grapes. Conservation agriculture is occasionally used for winter cereals in traditional rotations with legumes, sunflower and canola.

Researches undertaken

In the Mediterranean dryland areas, attention has been paid to technologies for soil and water conservation, most of them also aiming to facilitate the introduction of conservation agriculture practices, especially no-tillage.

In irrigated areas, technology development has included cover crops between rows of fruit trees; practices to optimize irrigation system management to conserve water, energy and soil quality; and practices to increase fertilizer use efficiency. Information on the extent of adoption of such practices, however, was not provided.

Acquisition of knowledge started by the design and setting of field experiments for research and transfer of conservation agriculture technologies to the farmers by public organisations, such as Universities and Agricultural Research Institutes. In some areas and countries, private companies, co-operatives and farmers associations played an important role for the later conservation agriculture development and expansion.

In **Spain**, one of the objectives of the Spanish Conservation Tillage Research Network was to identify those research and experimentation groups and teams working on conservation agriculture across Spain. In the 1996-1998 period, 22 groups belonging to different research organizations and Universities were identified. From the mid 1970's, in perennial crops, and the late 1970's in annual crops, a large number of conservation agriculture field studies have been carried out across Spain. Most of these studies have been either short- or long-term specific-site tillage experiments within experimental farms of agricultural research institutes or collaborative farms. Only a very limited number of experiments could be qualified as on-farm trials. The research approach used in the different trials has been both basic and applied in most of the studies. Only in a very few cases, the field experimentation has been implemented as a farmer's initiative. A total of 137 field conservation agriculture experiments conducted across Spain from 1981 have been inventoried. A significant number of these experiments ended after a few years of trial (4 years on average). It is estimated that about 20-25 experiments are still active as long-term experiments.

In **Greece**, some field experiments were conducted to determine the effects of tillage systems on plant growth and yield. A method establishing wheat crop after cotton under no-till was studied under Greek conditions in comparison with conventional tillage.

In **Morocco**, INRA scientists began, in the early 1980s, research on the effects of crop rotations, tillage and residue management on the productivity and quality of cropped soils. Twenty two years of no-tillage research were confined to two soils of INRA experiment stations in semiarid Morocco. In subhumid areas, research on no tillage was carried but in a discontinuous way (wheat-sunflower rotation with a combination of direct seeding and fertilization). The first years' research was confined to experiment stations. Lately, research on no-tillage was performed in farmer's fields as on-farm studies or research & development. In the development of trials at farmer fields, the various regional and local agricultural authorities were involved.

In **Italy**, the investigations about more sustainable practices have been mainly developed for Organic Farming, but some topics concerning conservation agriculture have been studied as crop associations, cover crops, rotation systems, and different tillage systems.

Main Results

For the Mediterranean Platform, where adoption of conservation agriculture has occurred, impacts are said to have been favourable and significant. The major driving forces regarding shifting from conventional to conservation agriculture are:

- A better economy at farm level (reduction of costs in machinery and fuel and time-saving in the operations that permit to develop other agricultural or non agricultural complementary activities);

- o More flexible technical possibilities as flexible and early times for sowing, fertilizer application and weed control, yield increase (10% to 15% higher), greater yield stability, and faster crop establishment and development (e.g., better emergence observed in crops sown in autumn due to warmer soil conditions in October and November);

- o Soil protection against erosion by rainfall-runoff and wind (in Spain, it has been shown that reduced tillage, with chiselling as primary tillage, could be a viable alternative to conventional tillage (mouldboard ploughing) for wind erosion control;

- o Greater nutrient-use efficiency (less use of fertilizers); and

- o Greater water economy in dryland areas through a higher accumulation and infiltration of water in the soil profile and lower water losses by evaporation and runoff.

Gaps in knowledge

In the past, research has been conducted on ways to increase the production and optimize the management of crop residues; establish cover crops between rows of tree crops (olives, nuts, grapes); increase fertilizer use efficiency; and increase crop diversification and improve weed control through the introduction of new crop rotations. Future research may address the management of crop/livestock interactions and fertilizer use to optimize the production and allocation of crop residues; germplasm to increase production of crop residues; and drought-tolerant germplasm with better transpiration and water use efficiencies.

The adoption of conservation agriculture leads to the necessity to revise the whole management process. Yet, it appears that gaps in knowledge in crop and soil management under conservation agriculture are still permanent:

- o Most data are gathered from experimental plots and hence extrapolation or out-scaling stays difficult in countries where no-tillage is still at experimental or R&D stage;

- o Little specific data or other evidence was provided on the extent to which conservation agriculture helps conserve soil water in water-scarce ecosystems. Further research on this theme is clearly needed;

- o In rainfed agroecosystems, residue management questions are significant. Residue scarcity emerges when biomass production is relatively low - or when the use of residues for mulch competes with their use for livestock fodder;

- o Farmer use of conservation agriculture practices is constrained by changes on the pattern of development of weeds, pests or diseases associated with the new practices. The Mediterranean platform team recognized knowledge gaps concerning integrated strategies for their management, and particularly noted that rodents and slugs become more troublesome with no-till direct sowing.

There is a generalized gap in knowledge on ways to introduce conservation agriculture into irrigated agriculture.

Researches in other fields could be deepened:

- o The use of conservation agriculture is constrained when suitable implements are not available (e.g. special drills or harvesters, and equipment for weed and pest control);

- o A lack of farmer information and knowledge regarding these technologies can be an important constraint, e.g. lack of information and technical advice taking into consideration site-specific social, economic and environmental aspects; lack of information on the time needed to reach a complete adaptation or stabilization of the conservation agriculture based cropping system (transition phase); and on crop rotations performance;

- There is little research conducted to date solely on sociological and economic factors concerning the evolution and the social impact of conservation agriculture systems;

- There is a gap in knowledge regarding methods for helping policymakers arrive at prudent, sensible decisions on topics touching on conservation agriculture.

Challenges

One of the main challenges in the Mediterranean is to develop alternatives to the current dry farming practices that are leading to many resources degradation issues, including soil organic Carbon and fertility decline and soil losses by water and wind erosion, which favour desertification. Attractive and adapted conservation agriculture practices may contribute to face this challenge. These practices should aim at:

- Enhancing the maintenance of soil cover in order to reduce erosion and water losses and to improve soil fertility. These should be addressed through a better integration between crop and livestock. Some combination of the following practices might be used to increase the amount of biomass:

    - The use of drought-tolerant varieties that allow better transpiration and water use efficiency, or soil fertility management practices;

    - The introduction of new drought-tolerant cover crop species or specialized fodder species;

    - Improved crop residue management, social control of stubble grazing, or substitution of fodder crops for crop residues as livestock feed.

- Improving water productivity in water-scarce rainfed agroecosystems, and thereby improving food safety and quality. These are systems where rainfall, in the range of 250-700 mm annually, is variable and erratic; where soils have medium to low fertility, limited water-holding capacity, and low levels of organic matter; and where the main problems are water scarcity and land degradation by soil erosion associated with lack of soil cover, high rainfall intensity, stubble burning, and overgrazing of livestock. These environments should be more carefully identified and “recommendation domains” defined. A better water economy and efficient water use is possible through a higher accumulation and infiltration of water in the soil profile and lower water losses by evaporation and runoff.

Another challenge is the development of innovation systems. Stakeholders will need to learn how to guide their respective efforts in light of what is learned from farmers during participatory research. Information dissemination and training of farmers and technicians is of prime importance. Some compensation to farmers for long-term social and environmental benefits might be in order. Subsidy and credit programs for implement purchase may serve as drivers of conservation agriculture adoption particularly by small-scale farmers. Policies should be reshaped to explicitly support conservation agriculture research and development.