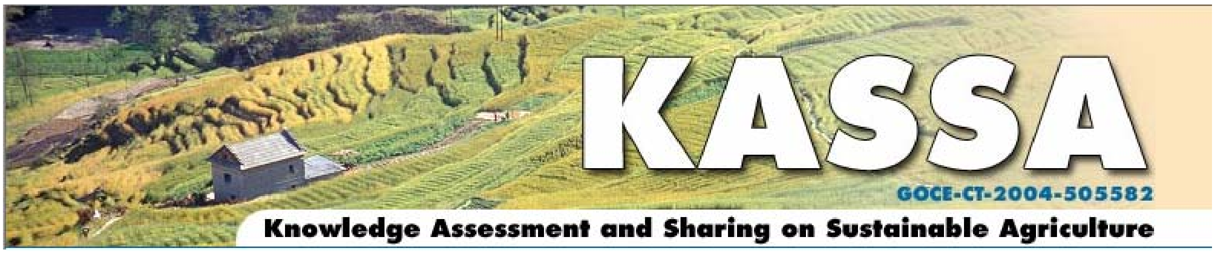

The Mediterranean platform comparative critical analysis. Learning from KASSA platforms'reports

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I. Introductory general comments

Reports **R1.1** (**European Platform** report), **R.1.3** (**Asian Platform** report) and **R.1.4** (**Latin American Platform** report) were analysed in depth by the Mediterranean Platform partners (WP1.2). Partner opinions on particular aspects were largely discussed and shared during the Second Mediterranean Platform Meeting (Meknès, Morocco, 27-29 June 2005) (WP2.2). In this section, a series of general comments attained from this critical analysis is presented. These comments are aimed to refine both the R.3.x platform reports and the final KASSA document.

European Platform report

The European Platform report is well structured and clear. It is precisely focused on the objectives of Work Package 1.1 of KASSA. Section I-1 contains interesting definitions on *Conservation Agriculture* (CA) that can be used in the introduction of the KASSA final report.

As it has been stated in other country and platform reports, it is very difficult to collect reliable data on the actual extension of land where CA and *Organic Farming* (OF) are practiced. This fact has to be taken into account for a consistent assessment of actual surface under CA in the world, except probably in the USA and Australia. An interesting methodological aspect in the report is the use of qualitative assessment tables by countries (see section I-2).

For the analysis of section II, the information was distributed between European partners. Though in each sub-section it is mentioned the partner or partners that did the work, this could be confusing because it might be understood that the analysis corresponds to the knowledge (scientific and technical information) generated only by those partners.

The main problem with this report is that a general pedoclimatic description of the region where the information comes from is missing. It would be of interest providing with this description and also where the gathered information is applicable. It would be also useful a general description of the cropping systems and their management. All this information should be followed by the general limiting factors for agriculture and agricultural products in the area. The analysis of knowledge on crop yield and its variability would have to be related with climatic pattern or tendency. As it occurs in other platform reports, the information on OF research is very scarce. It would be interesting to devise a different, particular analysis for this production system.

Asian Platform report

This report constitutes a very interesting document explaining in a comprehensive way the rice-wheat production system in the platform areas, in which the assessment of knowledge in CA has been focused. The cropping system management and its limiting factors and drawbacks are well explained and the potential role of CA for the development and sustainability of the agricultural systems in the area is described. Knowledge reported for the Asian Platform would be highly valuable for learning in wet and irrigated systems. In this sense, it is very interesting the bed planting system and the system rely on water management and water quality.

The general description of the area where the partners come from is good, but there is a lack of information for the dryland systems in the region. The report concentrates only in the rice-wheat system. This lack of wider scope information can be a problem.

The main problem with the report relates to its length and structure. Firstly, the report is too long. Secondly, it is structured more as a review for publication (e.g. references to studies conducted outside the platform) than as a scientific-technical report for study. This makes difficult its analysis and comparison with other platform reports as requested by the WP1.2. Another important concern about the report is the doubt expressed by all the Mediterranean partners attending the meeting, on whether the report has been really focused on CA or just on general agricultural management aspects.

Duplication of some ideas and paragraphs has been found in different sections of the document. Section 12 (e.g. Table 5) appears to be related more with general research gaps and needs and not with CA.

Latin American Platform report

This report is well structured and easy to read for the understanding of the current situation of CA in the Latin American Platform countries, particularly on no-tillage. It is mainly focused on knowledge gathered in Brazil and Argentina where there are important sources of information and experiences. It is interesting the scale of information provided by contrasting partners: Brazil and Argentina describe the CA performance on the production system for large-scale farmers, while Bolivia describes the performance for small-scale farmers.

The report includes an interesting discussion on no-tillage in which there are mentioned studies from authors presumably working not under the Latin American Platform conditions. This makes difficult to understand the real knowledge available in the area on certain CA aspects. In some sections there is a lack of scientifically-based information supporting the statements made or just missing references.

The main problem with this report is the absence of specific conclusions and proposals for the area. There is a mere list of CA aspects that must be considered.

General comments for all platforms

Careful attention has to be paid to what is knowledge coming from scientifically contrasted information and knowledge based on qualitative information coming just from field observations.

It was pointed out that clear definitions for CA systems are needed. For example, references to conventional tillage or traditional tillage are confusing because there is a large variability of meanings for those terms among countries given the changes in soil management occurred in the last 30 years. Conventional tillage has been related with intensive tillage systems that were also traditional and continued to be in some areas. However, in other areas conventional tillage is now a minimum tillage system that has become traditional because most of the farmers are using it.

II. Features regarding shifting from conventional agriculture to sustainable agriculture. Common aspects and differences among platforms

II-1. Driving forces and constraints for the development and dissemination of conservation agriculture and organic farming

The main driving forces for the adoption of ***Conservation Agriculture*** (CA) in the different platforms are summarised in **Appendix 1**. From this summary we can conclude the following:

- A better economy (savings on production costs) derived from CA, is a driving force in all platforms.
- Soil erosion (and related aspects such as soil protection, soil crusting, fertility, pebble raising…) is another common driving force, although this has not specifically mentioned for Bolivia.
- More flexible technical possibilities (labour organisation, cropping diversification…) except for Brazil and Argentina (Latin American platform) and Asian platform countries.
- Human factors (in general, public and private sectors: farmer associations, political measures, subsidies…) except for Mediterranean platform.
- Yield increase/stability (with livelihood improvement) except for Argentina and Bolivia (Latin American platform).
- Developing technologies and technical facilities (except Bolivia; not clearly specified for the Mediterranean platform).
- A better water economy is only specified for the Mediterranean platform.

In **Appendix 2** we have summarised the constraints for the dissemination and development of CA in the four platforms. In the *Asian Platform report* there is not a clear description of the constraints. Only in Section 9 we can suppose that some of the strategic conceptual issues could be some constraints. This is only a speculation because only the authors of the report know what they want to say. In the Appendix 2 we have included an example.

The following comments apply only to the Mediterranean, Latin American and European platform reports:

- Crop residue management and use is a general constraint (straw burning is only specified by the European platform).
- Pests, diseases and infestations is a common constraint for the Mediterranean, European and Latin American Platforms.
- Technical difficulties (support, investment, education, lack of capital…) (except for Argentina in the Latin American platform).
- Human factors (psychological factors, marginalization, religious beliefs...) (except for the Mediterranean platform and Brazil).
- More time to adaptation, except for the Latin American platform.
- Soil constraints (except for Latin American platform; decrease in yield is only specified by the European platform).

The driving forces and constraints for the development and dissemination of ***Organic Farming*** (OF) are summarised in **Appendix 3** and **Appendix 4**, respectively. Favourable soil and climate conditions (e.g. in Greece), the demand of OF products of quality and high price, seed control and certification and subsidies from the European Union appear to be major driving forces for OF adoption in the Mediterranean and European Platforms.

Lack of information about OF techniques (i.e. methods based on scientific knowledge), lack of money, economic risk during the transition period, management issues such as weed and pest control (e.g. in the European Platform) and even the new rules for seed certification are main constraints for OF adoption.

II-2. Agronomic, environmental and socio-economic impacts

Knowledge available in the four platforms on the agronomic, environmental and socio-economic impacts of ***Conservation Agriculture*** (CA) has been in some way synthesised through the statements included in **Appendices 5, 6 and 7**, respectively, which have been extracted from the R.1.x reports.

With regard to the **agronomic impacts** of CA, in general crop yields increase under CA systems in all platforms and is very positive under dry conditions. In particular, crop yields depend on climate, soil properties, cropping systems and farmers. Crop emergence may be affected by agricultural systems.

Conservation agriculture increases water infiltration into the soil and improves water use efficiency, especially in rainfed farming areas. Likewise, CA increases soil nutrient retention, improves nutrient use efficiency and reduces the use of fertilisers. In general, soil fertility increases in CA and, particularly under no-tillage as it occurs in the Latin American platform areas. Soil organic mater and some macronutrient contents are higher under conservation tillage than under conventional tillage. Crop residue management is the basis of CA and improves soil protection, fertility and humidity.

A change in weed population and weed inversion can be a problem under conservation tillage. In some cases, however, CA may be a tool for weed control. A permanent vegetal cover in CA systems favours, in general, a higher incidence of pests compared to conventional agriculture.

In some platforms, crop response to nitrogen fertilisation is higher under CA than under conventional agriculture. A positive impact of crop rotation under CA is mentioned in all platform reports. It improves and stabilises yields and is beneficial for weeds, pest and disease control. Fallow management with CA systems increases soil water storage and has a positive effect on weed control.

Regarding the ***environmental impacts***, in general, CA improves soil physical properties and fertility through an improvement of soil structure, an increase in soil water-holding capacity and a reduction of direct water evaporation from soil. As mentioned above, CA increases soil organic mater. Likewise, CA improves enzymatic activity and increases biological activity and microbial biomass. The persistence and mobility of herbicides and pesticides are lower in CA systems. The practice of CA decreases the emission of CO_2 to the atmosphere and reduces soil erosion in all platforms.

From a ***socio-economic impact*** point of view, in all platforms CA implies a reduction in the cost of direct inputs. The cost of labour, energy and time in farming operations is lower under CA than under conventional agriculture. However, CA needs a higher investment in new machinery. Depending on the agricultural system and the local conditions, in general, farm profitability is higher under CA than under conventional agriculture.

A synthesis of knowledge available on the agronomic, environmental and socio-economic impacts of ***Organic Farming*** (OF) is presented in **Appendix 8**.

III. Priorities and proposals for the Mediterranean Platform

A synthesis of the proposals contained in the R1.x platform reports regarding technical changes, innovation processes and policies for Conservation Agriculture and Organic Farming is presented in **Appendix 9** and **Appendix 10**, respectively.

III-1. Knowledge gaps in conservation agriculture and organic farming. Common aspects and differences among platforms

The load of information and research results is different among countries in the same platform as well as among platforms. With the exception of the Mediterranean platform, there is not a special section on *Conservation Agriculture* (CA) research and information gaps. In spite of this difficulty, we have included in **Appendix 11** a series of statements regarding knowledge gaps in CA for the four platforms. The topics considered in the Mediterranean Platform R1.2 report have been used as a reference for this exercise.

The available data do not allow a comprehensive comparison among platforms in terms of knowledge gaps, and only support general statements. Based on the pattern of data submitted, it appears that, in general, data availability in the various platforms varies greatly. Research is asked and needed to provide knowledge to assess the trade-off between beneficial and negative impacts. There is a wealth of knowledge in terms of research and farmer's experiences assured by Latin American Partners in terms of CA (especially no-tillage systems). For the other platforms, though there is a substantial information available, the knowledge gathering and generation process is being more slow and perhaps more fragmented.

The adoption of CA leads to the necessity to revise the whole management process. Yet, it appears that gaps in knowledge in crop and soil management under CA are still permanent in most countries, possibly on a lesser extent in Brazil and Argentina. Most data are gathered from experimental plots and hence extrapolation or out-scaling stay difficult in countries where no-tillage is still at experimental or R&D stage (i.e. Morocco, Bolivia, European countries, India, Vietnam). Asia countries are basing the CA adoption on exploitation of international research and R&D results rather than in-country built-up or capitalisation of research.

For the **European platform** researchers, there is little information available on CA. Data on yield and soil quality (i.e. soil organic matter and carbon cycle) with regards to CA is incomplete. The majority of the results come from French long-term experiments in which crop yield and soil organic matter characteristics and dynamics in no-till systems are studied in comparison with conventional systems. Concerning crop and soil organic matter quality, there is very few data available in Europe. The main results come from French studies and highlight that only cropping systems with a permanent cover differ from conventional systems in the distribution between particulate (> 50 µm) and humified (< 50 µm) organic matter. There are few results on greenhouse gas emissions and, consequently, more studies on this subject matter should be carried out. The results on water erosion and runoff under CA vs conservation agriculture are kept rare and mainly come from French experiments, which are carried out both on-farm and in experimental stations and from German experiments.

While in western countries the fate of pesticides is one major issue in agricultural and environmental research, this subject is of less importance in eastern European countries. This is due to the fact that the input of pesticides in eastern European countries is usually very low because of high market prices. Very little is known on the fate of pesticides under reduced tillage (RT) situations, though it is broadly accepted that RT, and especially no-tillage (NT), may lead to an increased use of herbicides and an increased number of treatments for weed control. When changing the tillage system, it is a challenge to adapt weed control to the new situation. However, no exact results are described on this subject. Furthermore, some studies point at a higher need for fungicide use because of a higher infestation risk under reduced tillage conditions. However, there are also contradictory experiences. Further research is needed in this field through the cooperation of soil tillage experts and those who study the fate of the various pesticides.

There is little research conducted to date solely on sociological and economic factors concerning the evolution and the social impact of CA systems and various authors state the need for more research into the social and economical implications of these ‘new’ agricultural systems. In fact, from existing results, the socio-economic impact of CA may appear to be contradictory. Global environmental impacts of CA have to be considered: climate change, resource management, and fuel consumption.

For the **Latin American platform**, even with the great amount of available information and knowledge on CA in Brazil and Argentina, it is proposed to fill gaps in research on:

- Impacts of the use of pesticides in CA on soil and water quality and on biodiversity
- Definition of soil quality indicators for different agro-ecosystems
- Definition of indicators of farming systems’ sustainability
- Dynamics of soil organic matter in agro-ecosystems
- Dynamics of soil nutrients in agro-ecosystems
- Quantification of the potential of CA for carbon sequestration
- Studies of genesis and mitigation of soil compaction in CA areas
- Technology development for the increase of efficiency of liming and fertilisation
- Development of CA systems less dependant on pesticides
- Development of cover crops more tolerant to abiotic stresses and compatible to different farming systems
- Development of agricultural machinery for mixed cropping in CA
- Comparative economic studies between CA and conventional agriculture
- Technology development for runoff management in CA
- Technology development for precision agriculture

In the **Asian platform**, the few research studies related to mulch based direct sowing technologies concentrated on production parameters alone as in most of the conventional agricultural evaluation studies. They rarely include their impact on natural resources, its quality, processes/relationships that enable the success or failure of the study. It seems that CA is not built on country’s specific research results but development route was conceived from existing off-country experiences. CA research should be carried out on all aspects: agronomy, environment, socio-economy, etc.

Finally, for the **Mediterranean platform**, research and knowledge gaps are important since data are confined to experimental fields in Spain and Morocco. It is important to develop a network of benchmark sites on CA among Mediterranean countries to generate information. The research gaps concerned the following topics:

- More studies on crop production and quality under no-tillage systems
- Combined water and nitrogen use efficiency under CA
- Integrated weed control practices in CA

- Integrated pest and disease management approach and studies
- Nutrient cycling and fertilization under CA
- Genetic interactions under CA
- Irrigation systems vs CA
- Crop diversification in CA
- Intercropping and cover crops performances in CA
- Soil quality indicators under CA
- Soil erosion
- Carbon sequestration
- Contamination and pollution of soil, air and water
- Green house gas emission and global warming
- Soil biodiversity
- Social and economic studies
- CA adoption studies

A synthesis of statements contained in the R1.x platform reports regarding knowledge gaps in *Organic Farming* is presented in **Appendix 12**.

III-2. Refined research topics

The research priorities in ***Conservation Agriculture*** (CA) for the Mediterranean Platform region should be focused to fill the gaps of knowledge in the following general subject matters:

- Site-specific and well-designed long-term experiments research is needed in selected areas of the Mediterranean Region (rainfed and irrigated condition; and research and on farm level).
- Crop and soil response of CA under irrigation conditions (different irrigation methods)
- Integrated studies of crop technologies (plant material, fertilization, crop rotations, ICM, etc..) on CA
- Soil conservation studies under CA
- Water economy, quality and management under CA
- Machinery and equipment adapted to some selected areas (e.g. Southern Mediterranean countries).
- Crop nutrition and fertilisation (research has to be focused on soil test calibration and plant analysis for recommendations under CA and on banding fertilisers and type of fertiliser application in some areas).
- Studies on integrated crop and animal production systems under CA.
- Research is needed on short and long-term dynamics and balance of C and N in soils. Soil organic matter and C sequestration promoted by CA
- Socio-economic impact of CA (studies on farmer perception of CA systems; no-tillage sociology; economic analysis and modelling)

Regarding future research priorities in ***Organic Farming*** (OF) for the Mediterranean Platform, these should take into account the following aspects:

- Development of scientific cooperation among Mediterranean countries and promotion of scientific knowledge on OF adapted to Mediterranean conditions (networking)
- Long term effects on crop yield and quality
- Crop nutrition and fertilisation in OF (soil test calibration and plant analysis for agronomic recommendations)
- Water economy, quality and management under OF
- Development of varieties resistant to pests and diseases under OF (development of biological control practices)
- Quality improvement of certified seeds and plants under different OF systems
- Fate of heavy metals and organic pollutants from organic materials used as fertilisers
- Fate of mobile nutrient elements under different OF systems (N forms)
- Development of weed management practices under OF systems
- Development of machinery and equipment adapted to OF
- Studies on integrated crop and animal production systems under OF
- Comparative studies between OF and conventional farming practices

III-3. Proposals for appropriate local and regional policies

Taking into account that ***Conservation Agriculture*** (CA) contributes to reducing poverty, induces food and environmental security, enhances natural resources conservation, and improves livelihood and development of rural communities in the Mediterranean area, it is recommended that future local and/or regional policies (i.e. forthcoming CAP agri-environmental measures in Northern European Mediterranean countries) should be aimed at:

- Promotion of education, demonstration and dissemination of CA
- Promotion of Extension Services for CA technology transfer
- Involvement of farmers and farmer association in CA development and dissemination
- Support of integrated studies for national, regional or local adoption of CA
- Promotion and support the access of farmers to CA technology
- Support networking on CA for knowledge development and sharing
- Promotion of participatory CA projects involving all the stakeholders

With regard to ***Organic Farming*** (OF) appropriate local and regional policies should consider the following aspects:

- Dissemination of information about the importance of OF products
- Official training on OF systems
- Specialised extension services for continuous education of organic farmers
- Seminars on OF sponsored by the EU

- Identification of potential markets (strategic marketing)
- Suitable distribution network for OF products
- Support of integrated studies for national, regional or local adoption of OF

Appendices

Appendix 1

Synthesis of major driving forces regarding shifting from conventional agriculture to Conservation Agriculture (CA)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Better economy at farm level More flexible technical possibilities (sowing, fertiliser application, weed control, etc.) Greater water economy in dryland areas Soil protection Cropping diversification Yield increase and stability Greater nutrient-use efficiency (less use of fertilisers)	Soil erosion Soil crusting Pebble raising Increase OM necessity Higher trafficability Development of technologies (machinery and herbicides) Improvement of labour organisation Farmer associations promoting CA Costs and labour time reduction Yield increase/stabilisation Political decisions that indirectly favour CA Regulation measures (reduction of environmental impacts) Subsidies	Better economy (savings on machinery, labour and drudgery) Institutional factors (public and private sectors) Technical facilities (machinery, agrochemicals) (Brazil, Argentina) More flexible technical possibilities (e.g. sowing) (Bolivia) Soil erosion (Brazil, Argentina) and fertility and yield (Brazil) Crop x livestock integration (Brazil)	Institutional factors (public and private sectors). Population pressure Better economy (savings on machinery, labour and drudgery) Livelihood improvement (by increasing yields, crop diversification, timely planting for the rice-wheat system) Improvement in environmental quality (land and water resources) Availability of adapted machinery Herbicide resistance in weeds

Appendix 2

Synthesis of major constraints regarding shifting from conventional agriculture to Conservation Agriculture (CA)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Time to adaptation Some soil physical constraints in specific environments Weed control Pests and diseases incidence Crop residue management Lack of information on fertiliser use efficiency Some economical negative reasons related with risk and use of herbicides Access to adapted equipment in less developed countries Lack of information on crop rotations Insufficient technical support	Soil texture and waterlogging Soil humidity and temperature Infestations (weed, slugs, mice) Crop residue management Disease and pest increase Soil structure Novelty of the systems Difficulty to transfer results to other conditions Need to change many practices Psychological changes Marginalization (neighbourhood, development networks) Technical investment and education Expensive equipment Transition period Decrease in yield Straw burning	Technical difficulties (weed control, herbicides management) (Brazil) Pest incidence (higher use of pesticides) (Brazil) Other uses and management than mulch for crop residues (sale, livestock) (Bolivia) Lack of capital (machinery) (Bolivia) Religious beliefs *(menonites)* (Bolivia)	Information on constraints to CA adoption is not clear in the Asian Platform report In Section 9.1, it is stated: Crop residue incorporation is not very much useful. Availability of residues will be a problem in cropping system´s diversification without rice/wheat.

<u>Appendix 3</u>

Synthesis of major <u>driving forces</u> regarding shifting from conventional agriculture to <u>Organic Farming</u> (OF)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Greece has the largest potential for organic agriculture among EU countries due to soil and climate conditions Greek consumers are willing to pay a higher price for a product of better quality Greek consumers seek for safe, natural and free from agrochemical food products Increasing demand for exporting OF products Farmers of northern Mediterranean countries receive subsidies form the EU	Control and certification of seeds promote the development of OF practices Increase in the demand of products of quality and increase in prices Proximity of urban markets Increasing demand for exporting OF products Farmers receive subsidies form the EU		

<u>Appendix 4</u>

Synthesis of major <u>constraints</u> regarding shifting from conventional agriculture to Organic Farming (OF)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Greek consumers do not have the appropriate information background Majority of producers focused on a few perennial crops due to lack of information about OF techniques for other crops There are producers who are unaware of treatments that should be applied during the conversion period Lack of information throughout the production, post-harvest and marketing process Small number of organic producer associations and small size of the majority OF operations adversely affect the marketing of OF products Economic risk during the transition period OF products are influenced by agrochemicals used in conventional agriculture	New rules for certification give problems because there is a lack of organic seed varieties Weed infestation Crop rotation Slug infestation Difficulty for implementing stockless OF in some areas Economic risk during the transition period		

Appendix 5

Synthesis of knowledge about the agronomic impacts of Conservation Agriculture (CA)

Topic	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Crop yield	Crop yield increase of 10 to 15% in CA compared to conventional agriculture Positive under dry conditions Similar under favourable conditions	The impact of soil tillage on crop yield is variable depending on climate, soil conditions and properties of the cropping system Reduced tillage (RT) has no strong effect on yields with respect to conventional tillage. The risks of yield losses are likely to be higher in direct drilling than under reduced tillage Dry conditions generally favours yield, which increases under RT The effects of CA on yields result from modifications of soil physical, chemical and biological properties, climatic conditions and cropping system	Crop yields increase at farm level, but it varies with the year and requires long term results The advantage of no-till system (NT) regarding the final crop yield, is the decrease of variability In years of low rain, the higher productivity is obtained under NT while during years of normal rain distribution the productivity is similar As time passes NT tends to stabilise crop productivity	Improved and stable yields
Emergence and crop establishment	Positive or negative response is site and crop specific. However, in general, this response does not affect final yields			Improvement of crop establishment
Water use efficiency	Positive response under dry conditions; similar in favourable conditions Increase efficient water use, especially in rainfed farming areas		CA systems can reduce runoff and increase water infiltration by 50%. Direct evaporation is reduced Available water during eventual dry spells is higher under CA systems reducing climatic risks	CA improves water use efficiency up to 50% Bed planting + mulching or residue retention has the potential to reduce evaporation losses
Nutrient use efficiency	There are results evidencing the possibility to improve this efficiency		Global N and other nutrients efficiency increases because of the important total biomass produced in CA systems with additional cover crops	CA improves the capacity of soils to retain nutrients
Soil fertility			NT improves total soil fertility compared to conventional tillage. Soil organic matter (SOM), P and K content is higher under NT than in conventional tillage	
Crop residue (amount and management)	It is the basis for CA and it is very positive Better soil protection with crop residue covers Difficulties at sowing and early crop development in high or low production areas	It is the basis for CA The amount of residues can be a problem at sowing the following crop Efficiency of cover crops to decrease the amount of mineral nitrogen remaining in	The presence of crop residues in CA systems can reduce the runoff and increase water infiltration by 50% with respect to conventional systems SOM content and soil water retention and hydraulic	

		the soil and to reduce the risk of leaching	conductivity increase when grasses increase their participation in the crop rotation	
Weed management	Change and inversion of flora with positive or negative impact Weed control should be more precise, with careful use of herbicides	Perennial weed and species with root propagation and rhizomes may cause a problem in reduced tillage The effect of covered cropping systems that suppressed weed population has been shown in many studies Crop rotation has a strong effect on wed infestation in RT systems Living mulches have been shown to have control weed more efficiently compared to dead plant	Some studies have demonstrated the agronomic and economic viability of Integrated Weed Management in NT systems A great advantage of NT was the substitution of incorporated herbicides by post- or pre-emergence products less persistent and used at low doses. In some cases species with more aggressive behaviour and more tolerant to herbicides (like perennial) have been selected in NT	CA plus crop rotation reduces the incidence of weeds Rotation of herbicides and crops has been recommended. Zero-tillage system has led to reduced weed population pressure in the short term.
Pest and diseases management	Some negative incidences of particular pest and diseases in favourable humid areas	Permanent vegetal cover remaining on unploughed soils favours the proliferation of various pest, but also that of their natural enemies Numerous diseases, especially fungal diseases, have been reported to increase under CA Higher quantity of pesticides must be used and soil type appears to play a role The use of disease and pest resistant crop varieties in CA is more important than in conventional systems Problems with different toxin producing fungi on seeds had to be solved	Pests and diseases has a higher incidence in NT Crop rotations and the use of specific cover crops could reduce the incidence of some pests	
Crop rotation	Permits higher crop diversification Positive to weeds, pest and diseases control and crop nutrient management	Strong effect on weed infestation in reduced tillage systems	Improves and stabilises yield more than continuous cropping More lucrative and results in less risk NT plus crop rotation results in better energy conversion and energy balance than conventional tillage and continuous cropping	Demonstrates to be positive to weed, pest and diseases control and crop nutrient management
Fallow management	Increase or similar water storage under CA Crop residue cover and chemical fallow are necessary for optimum performance of fallow in CA			CA reduces rice-fallow acreage
Intercropping and other crop associations	Cropping system diversification Double crop possibilities in some areas		Crop diversification producing different crop residues reduces soil loss, interferes with pathogen cycles and eliminates weeds	Intercropped crop grows very well on the residual fertility of the other crops

Appendix 6

Synthesis of knowledge about the environmental impacts of Conservation Agriculture (CA)

Topic	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Soil physical properties and processes	Pore size distribution under conservation tillage was more homogenous than under traditional tillage. In contrast, more bio pores were observed in conservation tillage Better distribution of pores and higher macro porosity under CA Aggregate size and stability is higher in CA Increase in soil resistance to penetration After several years of CA different results have been found in soil hydraulic conductivity CA improves soil water holding capacity	The effects of tillage practices on soil physical properties highly vary, depending on pedo-climatic conditions For NT, the porosity decreases in the upper layer, but in deeper layers, no differences are found Soil penetration resistance increases Reduced hydraulic conductivity and evaporation is very important in dry areas Soil water content may increase in the upper soil layers in NT	CA has higher macroporosity Improves soil structure. Increases weighted mean aggregates diameter Available soil water is higher under NT than under conventional tillage Increase in soil water retention and infiltration rates	Save irrigation water. Decreased sediments in waterways Improved capacity of soils to retain and regulate water availability and supply
Soil chemical properties	CA increases SOM and nitrogen content in the soil upper part and lower nitrate levels in the whole soil profile Higher soil P stratification, lower soil P content (available P) in deeper horizons and higher soil P content in upper layers Higher soil K stratification, lower K soil content (exchangeable K) in deeper horizons and higher K soil content in upper layer	Accumulation of organic mater and nutrients in top layers, but very few studies are available Minimum tillage reduces losses of phosphorus Decrease of nutrient (N, P, K) losses under reduced tillage intensity, especially leaching of nitrate seems to be reduced	The amount and dynamics of N and other nutrient mineralization depend on the nature and quantity of the residue, and so, on the kind of cover crop Total nitrogen increases. N is the nutrient whose dynamics is most influenced by the adoption of NT Nitrogen released by mineralization is lower in CA In the 5-10 cm layer the P concentration can be seven times greater in NT systems. NT reduces retention or immobilization of inorganic P applied as fertiliser NT increases nutrient availability NT reduces P loss by runoff	CA increase SOM
Soil biological properties	CA improves enzymatic activity Earthworm population increases	Abundance and fresh biomass of earthworms is higher when tillage intensity is reduced Diversity and abundance of biennial and perennial species increased under NT conditions	Under NT the soil microbial community and activity is more concentrated in the first centimetres of the soil profile. Increase in soil microbial biomass at 0 to 10 cm depth A higher enzymatic activity under NT and also a positive relation between SOM content, microbial biomass and the action of soil enzymes (urease and catalase)	Increase biological activity and natural predators and competitors

Herbicide and pesticide losses	Mobility and persistence of herbicides in soils lower under conservation tillage than under conventional tillage.	Few studies There are contradictory experiences Pesticides are generally faster broken down in NT soils due to higher microbial activity Higher sorption rates of heavy metals under NT	Herbicides showed higher transport by runoff water in NT when compared to conventional systems	Reduced pollution of surface and ground water from chemical and pesticides, from improved inputs use efficiency
Greenhouse gases	Increase soil organic carbon (SOC) content at upper layers C stratification ratio increases Lower CO2 fluxes	When giving up ploughing, SOM accumulates in topsoil A decreasing gradient of organic carbon is established from the surface to the deeper layers Organic carbon and nitrogen stocks are higher in NT systems Few data concerning SOM quality Few results on greenhouse gas emissions due to the novelty of that issue and the difficulty to implement methods of measurement in situ	SOC and SOM content higher under NT Carbon accumulation is higher but there are contradictory results related to high clay contents NT might increase C sequestration in subtropical soils (few studies)	Increased carbon sequestration and reduction of CO_2 emissions
Erosion by wind and water	Reduction of water and wind erosion	Erosion is reduced during both cropping period and the intercrop period Time of tillage is important	NT has advantages in soil protection due the surface soil cover crop Positive impact of the NT to control the wind erosion	Reduced soil degradation, erosion and runoff

Appendix 7

Synthesis of knowledge about the socio-economic impacts of Conservation Agriculture (CA)

Topic	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Input costs	Higher or lower depending on situations and cost of herbicides and energy	Economical interest of conservation agriculture comes mainly from cost reduction, variable from case to case There is a great variability of data between counties The new Common Agricultural Policy (CAP) will determine the most important aspects of the impact of CA	Lower operation costs but spending on herbicides is higher	CA reduced use of inputs, fertilizers, pesticides, production cost
Labour	Lower	Labour cost in CA depends on the type of machinery and soil	Lower	Lower
Energy (fuel)	Lower	Lower but depends on the type of machinery and soil	Lower in CA	Reduction of fuels fossil
Total energy		May appear to be contradictory: reduced labour costs but increase in pesticide costs		Lower
Investment	Higher initial investment in machinery	Higher initial investment in machinery	Higher initial investment in machinery	Higher initial investment in machinery
Time in operations	Lower	Lower	Economic studies have reported that CA agriculture promotes an important reduction in the total hours of equipment and machinery (46%)	Lower
Profitability	In most cases is higher or depending on the CA systems and local conditions Producers can achieve a much better economy at a farm level	Difficult to judge, very few data is available for the moment The socio-economic impact of CA may appear to be contradictory	Crop rotation and NT systems contributed to the stability of profits produced Crop rotations such as grasses and legumes, can increase the competitiveness and economy of agricultural production systems Studies on economic evaluation of CA have shown lower operation costs compared with conventional systems. This is explained by reduced use of equipment, machinery, and fuels, lubricants and labour costs Greater profitability and the smaller risk of NT plus rotation	Benefits of CA come about over a period and in some cases might appear less profitable in the initial years CA is beneficial not only to the farm family, but also to other members of the society

Appendix 8

Synthesis of knowledge about the agronomic, environmental and socio-economic impacts of Organic Farming (OF)

Agronomic impacts

TOPIC	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM
Crop yield	Similar or lower than in conventional agriculture	Good crop yields Rotation without a green manure crop produces the greatest total grain yields
Product quality	Clear evidence of better product quality	
Crop residue management	It is the basis for OF and it is very positive	
Weed management	Clear evidence of better control of weeds by mulching and by crop rotations and soil cultivation (tillage)	Crop competition against weeds can be improved by the choice of more competitive crop cultivars Lower weed infestation in cereals without catch crops
Pest and diseases management	Clear evidence of positive benefit from biological control	Clear evidence of positive benefit from biological control, using resistant varieties and using solarization
Crop nutrition and crop fertilization	There are evidences that organic materials (manure, compost…) improve crop response Nutrient status is better than in conventional agriculture When this material is applied in excess, can arise plant toxicity from microelements and salinity	
Adapted genetic resources	Very limited data	Is very important including GMO crops
Crop rotation	Demonstrate to be a basis for OF. Demonstrate to be positive for weed,pest, diseases control and crop nutrient management	
Intercropping and other crop associations	There are evidences of increase total crop production per surface unit	
Cover crops (including sowed crops and weed covers between rows in perennial crops)	The use of cover crops under OF increases or improves the water status Cover crop mobilises the P to upper parts of soil profile Decrease weed population	Beneficial effects on biodiversity

Environmental impacts

TOPIC	PARAMETER	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM
Soil physical properties and processes	Soil porosity	Total porosity is improved Pore-size distribution improves	
	Soil structural stability	Stability of microaggregates	

	Soil aggregation	is increased	
Soil water	Water-holding capacity Water retention	Improves water-holding capacity.	
Soil chemical properties	N cycle	Higher soil nitrogen accumulation	A saturation of crop rotation by faba crops increases the quantity of the accessible forms on nitrogen in soils
	P cycle	P accumulation	
	C cycle (CO2 emissions, CO2 sequestration….)	Increase soil organic carbon (SOC) content at upper layers	
	Pesticides Herbicides		Few studies There are contradictory experiences
	Other pollutants	Some toxicity from accepted fungicides has been reported High levels of Cu in soil have been reported due to Cu fungicides	Few studies and rather less reliable data are available at present
	Salinity/Alcalinity	Increases salinity	
	Leaching of nutrients		The risk of nutrient losses is generally lower
Soil biological properties	Microfauna Microbial activity	Improves enzymatic activity	
	Biodiversity		Increase of flora species after 3-4 years after conversion Beneficial effects of cover/intercrops
Erosion by wind and water	Soil losses	It is reduced due to use of cover crops	

Socio-economic impacts

TOPIC	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM
Input costs	Same or higher	
Labour		Greater
Total energy	Lower	
Profitability	Same or higher	Few studies have assessed the long-term potential for the market premiums obtained for organic products

Appendix 9

Synthetic statements contained in the R1.x platform reports regarding technical changes, innovation processes and policies for Conservation Agriculture (CA)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Technical changes Land management through CA responds to the need for improving sustainability and management of natural resources Suitable indicators for CA monitoring are required. **Innovation processes** The crucial land access problem needs to be solved in the Mediterranean area where farm dimension doesn't really permit a sustainable land management Likewise, aging of rural population is another constraint that has to be solved The discussions had focused on CA practical issues and a lack of relationship between researchers, agricultural extension services and farmers has been detected **Policies** We were aware of the importance and opportunity of involving farmers in the process of developing CA research and policy agendas for the Mediterranean region	**Technical changes** CA adoption leads to the necessity to revise the whole management process Suitable indicators for CA monitoring are required New technology: specific machinery are needed The transfer of knowledge on management process is difficult because the objectives and impacts are different from case to case Training and exchange of experiences **Innovation processes** The pioneer farmers adopting innovative practices have a crucial role Private companies are involved in four processes: technology development, development of suitable indicators and methods of measurement, communication (press, brochures..) and developing the ideas and proposals of research outcomes The role held by extensionists and researches is difficult by the lack of references and the necessity to take into account the whole system from a multidisciplinary point of view Farmers have the impression that researches do not answer their requests It may be difficult to launch into conservation agriculture due to the lack or references and the change of paradigm (psychological and sociologic aspects) **Policies** It is necessary to think about a system of governing in order to precise the role played by each actor in the innovation process Policies seem to play a major role: political decisions, regulation and subsidies The need to harmonize laws on soil protection in Europe References, indicators and decision support tools are needed	**Technical changes** Reduction in the intensity of soil disturbance Maintenance of the crop residues on the soil surface Changes in the seeding and planting processes Changes in the limiting and fertilization processes Adoption of crop rotation systems Changes on cover crops management Integrated insects, diseases and weed management Changes in the spraying technology and types of herbicides Technology development for the increase of efficiency of liming and fertilisation **Innovation processes** Adaptation and development of equipment for planting/seeding and crop residues/cover management Changes in the methodology for soil sampling and interpretation of soil analysis Feasibility of and additional cropping season ('safrinha') Feasibility of integrated crop and pasture systems Incorporation of marginal areas for crop production Suppression of contour planting and terracing Re-design of mechanical measures for erosion control Development of agricultural machinery for mixed cropping Technology development for runoff management in CA **Policies** Technical assistance Research and development Credit Environmental legislation	**Technical changes** Various technologies need to be to advanced to suit specific situation/cropping system, particularly key will be to adapt NT/crop residue management in a cropping system/alternate cropping perspective To promote institutional changes to achieve need based participation and multidisciplinary approaches to solve the problems To promote partnership with private-public organizations will ask for a greater role of social scientists to play to understand and include policy perspectives Mulch based technologies in combination with NT can led to improved capacity of soils to store rainfall, support crop and reduce erosion **Innovation processes** Continue to refine drill prototypes Develop transplanting techniques for unpudled soils or direct seeding Design of spreaders for uniform distribution of residues by combine harvesters **Policies** There is a strong need of suitable policy focused on trading of agricultural commodities under global market Policy support through targeted subsidies and favourable credit packages is likely to remain very important to maintain low food prices and lower producer risks and sustain investment in farm productivity Future focus is needed to address issues of poverty as well as production gains to match population growth. These will have to come from pioneering yield enhancing technology that improves farmer likelihoods, uses natural resources efficiently and minimizes environmental degradation An expanded set of stakeholder working in innovative alliances

			will be needed for extending complex CA technology to this bypassed group of farmers

Appendix 10

Synthetic statements contained in the R1.x platform reports regarding technical changes, innovation processes and policies for Organic Farming (OF)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Technical changes World-wide application of unified and/or harmonised production standards for organically produced foodstuffs is extremely important for a greater development of organically grown land and organic products markets Identifying forms for a sustainable use of land is a primary need in order to reduce the degradation of primary resources, biodiversity and rural environment Land management through OF responds to the need for improving sustainability and management of natural resources The crucial land access problem needs to be solved in the Mediterranean area where farm dimension doesn't really permit a sustainable land management Likewise, aging of rural population is another constraint that has to be solved The discussions have been focused on OF practical issues and a lack of relationship between researchers, agricultural extension services and farmers has been detected. **Policies** Awareness of the importance and opportunity of involving farmers in the process of developing OF research and policy agendas for the Mediterranean region	**Technical changes** Necessity to revise the whole management process Suitable indicators for CA monitoring are required New technology: specific machinery The transfer of knowledge on management process is difficult because the objectives and impacts are different from case to case. Training and exchange of experiences **Innovation processes** The pioneer farmers adopting innovative practices play a crucial role. Private companies are involved in four processes: technology development, development of suitable indicators and methods of measurement, communication (press, brochures) and developing the ideas and proposals of research outcomes. The role held by extensionists and researchers is difficult due to lack of references and the necessity to take into account the whole system from a multidisciplinary point of view Farmers have the impression that researches do not answer their requests. It may be difficult to launch into CA due to the lack or references and the change of paradigm (psychological and sociologic aspects) It is necessary to think about a system of governing in order to precise the role played by each actor in the innovation process		

<u>Appendix 11</u>

Synthesis of statements contained in the <u>R.1.x</u> platform reports regarding <u>knowledge gaps</u> in Conservation Agriculture (CA)

Topic	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Crop yield	More detailed research for some crops (winter cereals, legume crops, summer crops) Lack of information on some crops (tree crops, i.e. almond and vineyards….) Lack of information under irrigation systems Site-specific and well-designed long-term experiments research is needed (i.e. Algeria, Tunisia)	More information is needed	Long-term and comparative well-designed experiments are needed	
Product quality	More information is needed to check the improvement on product quality			
Water use efficiency (WUE) and nutrient use efficiency (NUE)	Substantial information in WUE and NUE is available but knowledge on a combination of both is still needed			
Crop residue management	More long-term information is needed on site-specific cropping systems More information is needed related with livestock husbandry and grain production systems	More information is needed: space scale (from the field scale to the regional scale) and time scale: long-term effects (carbon storage, biodiversity…)		The straw collected from the fields is of great value as livestock, fuel and industrial raw material An alternative method of straw disposal is needed.
Weed management	Research has to be focused on integrated studies on dynamics of weed populations and herbicide environmental impacts An integrated weed control approach is required.	Combination of different techniques is crucial to succeed: soil tillage, suitable herbicide strategy and suitable rotation	Weed resistant, presence of problematic weed species, and high use of herbicides can be avoided or eliminated by adopting Integrated Weed Management strategies	Need for new cultivars. In case of CA either under flat planting or bed planting the weed problem will solved to great extent thereby providing eco friendly cultivation Develop stale-bed technique Develop cultivars competitive to weeds Solarization and biological control measures
Pest and diseases management	Research has to be focused on integrated studies on the dynamics of pests and diseases, control methods and integrated pest management methods with a sound environmental approach	Research is asked and needed to provide knowledge to assess the trade-off between beneficial and negative impacts. To less is known on the fate and environmental behaviour of specific pesticides used in CA	Global environmental impacts have to be considered More research to evaluate the effect of the greater persistence and prevalence of fungi in NT Development of CA systems less dependant on pesticides. Research has to be focused on impacts of the use of pesticides in CA on soil and water quality and on biodiversity	Need of use rotations
Crop nutrition	Research has to be focused on			

and fertilization	soil test calibration and plant analysis for recommendations under CA It is needed to carry out studies on banding fertilisers and type of fertiliser application in some areas.			
Adapted genetic resources	More research is needed	The selection of plat material adapted to CA has not yet begun		
Crop rotations	New crops have to be tested within common crop rotations. Crop rotation under irrigation systems has to be experimented	Adaptation of the entire cropping system		Develop agronomic and crop management /relay cropping practices
Intercropping and other crop associations	Research is needed			
Cover crops (including sowed crops and weed covers between rows in perennial crops)	Research in new species to be used as cover crops		Development of cover crop more tolerant to abiotic stress and compatible to different farming systems	
Soil quality	Take advantage of available knowledge to identify the best criteria or indicators for the assessment of soil quality under CA Integrated studies of soil quality aspects (physical, chemical and biological) Soil suitability studies for CA adoption in Mediterranean conditions More soil erosion studies should be conducted		A new technique called vertical mulching under a NT system reduces water losses by runoff Reduction in soil erosion Definition of soil quality indicators for different agroecosystems Studies of genesis and mitigation of soil compaction in CA areas	
Soil organic matter and C sequestration	Research in needed in short and long-term dynamics and balance of C in soils	More studies are required	More studies are required For any agroclimatic region, conservation management systems as NT seem to be an interesting cropping management option to mitigate global warming Dynamics of soil organic matter in agroecosystems Quantification of the potential of CA for carbon sequestration	
Contamination and pollution of soil and water. Greenhouse effect gases	More information to test the potential contamination of the environment using CA technologies		NT seem to be an interesting cropping management option to mitigate global warming from greenhouse gas effects Reduction of environmental costs	
Soil biodiversity	More research is needed			
Social aspects	Studies on farmer perception of CA systems No-tillage sociology	Education: CA requires personal training New form of farmers networks, which provide new dynamism to rural populations.	Formation of farmers and technicians' groups for the exchange of experiences Formation of research, technical assistance, dissemination and technology transfer, supported by farmers and private sector	To enhance the human resource development which will be "the critical" prerequisite in taking up some of this emerging areas of long term natural resources concern as a way for transition to achieve sustainable agriculture
Economy and profitability (input costs)	Economic analyses and modelling	Economic viability in CA depends on cost reduction Transition period is precarious The possibility to receive subsidies, especially during the transition period is a major factor for economic viability	Increase in the life of agricultural equipment Decrease in power requirements Decrease in the operational costs Increase in the stability of production	

			Economic feasibility of marginal areas for annual crops Comparative economic studies between CA and conventional agriculture Definition of indicators of farming systems' sustainability	

Appendix 12

Synthesis of statements contained in the R1.x platform reports regarding knowledge gaps in Organic Farming (OF)

Topic	MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Crop yield	Little information is available on some crops More information in the performance of yield is needed for most of the crops Site-specific and long-term Research is needed			
Water use efficiency (WUE) and nutrient use efficiency (NUE)	Extensive research is needed in both topics			
Weed management	Research has to be focused on alternative methods (other than mechanical)			
Pest and diseases management	Research has to be concentrate on pest and diseases with difficult control			
Crop nutrition and fertilization	Research has to be focused in soil test calibration and plant analysis for recommendations under OF4 Studies are needed on some types of organic fertilisers			
Adapted genetic resources	More research is needed			
Crop rotations	Long-term experiments are needed for weed, pest and diseases control and for soil nutrient status assessment			
Cover crops (including sowed crops and weed covers between rows in perennial crops)	More research is needed to determine the optimum species in particular agroecosystems			
Soil quality	Take advantage of available knowledge to identify the best criteria or indicators for the assessment of soil quality under OF Integrated studies of soil quality aspects (physical, chemical and biological) Soil suitability studies for OF adoption in Mediterranean conditions			
Contamination and pollution of soil and water. Greenhouse effect	More research on the effects of cultivation practices on organic and inorganic pollutants in soil and water bodies			

gases				
Soil biodiversity	More research is needed			
Social aspects	More information flow between researchers and producers More studies on training are needed at research, extension and farmer levels	Education: OF requires personal training. New form of farmers networks which provide new dynamism to rural populations.		