KEY AREAS OF CONSERVATION AGRICULTURE RESEARCH IN SOUTH AFRICA

Introduction

Before initiating research programs, extensive reading of existing international literature should be undertaken. Care should be taken to keep the unique South African conditions in mind and extrapolate results against that background.

Care will also have to be taken to ensure that research is orientated towards the most pressing problems. This will require extensive and close consultation and co-operation by, and between all stakeholders, especially farmers, and on-farm participatory trials should be an important component. Experience showed that farmers are not aware of the specific research areas, although they want to do experiments to familiarise themselves with the challenges of the CA system.

International technologies that are not certain to be successful should not be recommended. However, it must be emphasised at all levels that no agricultural practice always works 100% all the time. In any given situation, farmers and advisers should discuss and choose an initial 'starter pack' of system components that will **probably** work, but should simultaneously identify one or two alternatives that **might** work. Thereafter individuals will start to 'own' their own systems, and advisers will have to be trained to appreciate that their primary role is that of facilitator, suggesting alternatives and not absolutes, and also to impart knowledge gained by other farmers and/or elsewhere.

Critical steps to CA adoption:

1. Improve knowledge about the CA system, especially for weed control.
2. Analyse your soil (aim at a balanced nutrient status, incorporate lime if necessary).
3. Eliminate soil compaction before going into the CA system and find solutions for re-compacting after every crop.
4. Know your soil type, duplex soils, low or high clay content, fine texture. Find a solution or system for each type.

5. Produce the highest amount possible of mulch cover.
6. Buy a no-till seeding machine (specifically for your soil conditions).
7. Use strip till equipment and adjust conventional planter.
8. Start with a crop that is easy to manage such as soyabeans, increase area and include maize or other crops as you master the system.
9. The suggestion was made that a program of CA should start with growing a successful cover crop and not with the cultivated crop. This may mean sacrificing crop production while the cover crop is growing but should help ensure a successful CA program, better yields and thus more residues for ground cover in future crop cycles.
10. Adapt fertilizer programme and placements and select appropriate nutrition sources (N-Gas).
11. Avoid areas with aggressive and difficult to control weeds or with excessive weed growth (or solve the weed problem first).
12. Be prepared to learn constantly and keep up-to-date with new developments.

Research areas should focus on these issues and find answers to promote the adoption of CA.

SUMMARY OF KEY AREAS FOR CA RESEARCH IN SOUTH AFRICA

1. Investigating effective soil covering for the fallow system.

The success of CA depends mainly on the management of dead or living organic soil surface covering. The principle of organic soil cover is not effective when the coverage is less than 30%. This is a problem with some crops that do not produce enough material, with wide row widths, long fallow periods up to 18 months, livestock grazing and weed control during the fallow period.

A permanent soil cover is important to protect the soil against the effects of exposure to rain and sun; to provide the micro and macro organisms in the soil with a constant supply of "food"; and alter the microclimate in the soil for optimal growth and development of soil organisms, including plant roots.

Although farmers in the areas vulnerable to wind erosion have found effective ways to protect the soil with mulch, much still has to be done to improve the effectiveness.

2. Crop rotation: Efficient profitable crops available in all production areas.

Rotating crops will have to be identified for each homogeneous area and genetic improvement programmes that are implemented.

The rotation of crops is not only necessary to offer a diverse "diet" to the soil micro organisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients. Nutrients that have been leached to deeper layers and that are no longer available for the commercial crop can be "recycled" by crop rotation. In this way the crop rotation function acts as biological pumps. Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients. Crop rotation also has an important phytosanitary function as it prevents the carry-over of crop-specific pests and diseases from one crop to the next via crop residues.

Seed companies should be approached to assist in identifying adapted crops, varieties and the production of seed.

3. Cover Crops

Cover crops are grown during fallow periods, between harvest and planting of commercial crops, utilizing the residual soil moisture. Their growth is interrupted either before the next harvest or after sowing the next crop, but before competition between the two crops start. Cover crops energize crop production, but they also present some challenges.

Surface cover is critical for the success of CA and the South African climate differs from benchmarking countries because our winter is not as cold and is much drier. For this reason recommendations and information cannot merely be applied directly.

One of the important factors relating to CA is the development of sufficient ground cover. In the low rainfall areas, lower crop yields mean less crop residue, but cover crops is another way of producing the biomass needed for ground cover. One key research area will be to evaluate the many different plants that can be used to obtain this vegetative cover in the varying agro-ecological areas of the country.

In general, too little attention is paid to soil cover in the CA system in South Africa. In the western parts of the country, cover crops throughout the year is a major challenge and is in some cases, impossible.

A cover crop guide for South Africa, based on the research carried out in KwaZulu-Natal, could be used as the basis for this guide. In South Brazil a cover crop publication was very important in order to develop a sustainable no-tillage system.

Recommendation:

- Characterise (both from the literature and local experience) the different species and selections.
- Acquire cultivars and selections from especially other African, American and Australasian countries and compare them with one another and South African selections.
- Put together small scale demonstration/research trials (using e.g. the 12m x 2m x 2m plots used in Brazil) to enable interested farmers to select a cover crop for their specific purpose. Each agro-ecological zone should have demonstration plots.
- Compare no-tillage associated to cover crops and crop rotation against ripping tillage and monoculture; “tillage culture” versus “fallow culture” regarding the efficient use of rainfall. What farmers see happening in the field will make them feel more confident to introduce it on their own farms.

4. Herbicide application

Herbicides may be a critical component during the initial stages of CA, although ideally over time, if weeds are not allowed to sprout seed, this problem should be

reduced. For small resource poor farmers it is important to impart training on how to properly apply these chemicals.

The critical area for research is the effect glyphosate will have on microbe populations and activity and the effect of glyphosate during uptake of macro and micro elements.

5. Pest and disease balance

When conservation agriculture is practised correctly, pest and disease incidence will be lower compared to conventional tillage due to crop rotation and the use of cover crops. Consequently, the cost for treatment will also be reduced.

It was observed during the past favourable climatic season that yield losses occurred in maize due to severe lodging and pathogen build-up. The causes of the imbalance in soil microbe compound need to be investigated.

Integrated Pest Management (IPM) should also be added to the CA set of recommendations, since if one of the requirements is to promote soil biological activity, minimal use of toxic pesticides and use of alternative pest and weed control methods that do not affect these critical soil organisms are needed.

Baseline data for the impact of Agricultural Management Practices (AMP) on soil microbial populations is limited for South African soils. This information is essential to ensure that accurate recommendations are provided to farmers on AMP to sustain soil health and quality, in order to maximise profitability. Microbial community biodiversity plays an integral part in soil quality and maintenance of ecosystem functioning. Both the size and activity of microbial communities need to be analysed. This enzyme activity can act as biological indicators for soil degradation.

Soil nematode communities are sensitive to disturbance in food and changes in their environment. There is a positive and negative relationship between non-plant-parasitic nematodes and soil nutrient concentrations. Since soil and plant nematodes are relatively easy to extract and identify, they could be used as

indicators of soil quality and crop health status. This could only be possible when interrelations are studied holistically.

The effect of pest and rodent infestation on CA is not known, although no negative incidents were reported. Rodents are a severe problem in the maize production areas and termites may be a problem in the western areas.

6. Economic aspects of Conservation Agriculture: Adoption of Conservation Agriculture

Providing an economic analysis of advantages in the application of CA for potential adopters. Reduced cost is a very understandable language to farmers.

Unfortunately, short-term solutions and immediate benefits always attract farmers and the full technical and economic advantages of conservation agriculture can be seen only in the medium to long-term, when its principles (no-tillage, permanent cover crop and crop rotation) are well established within the farming system.

CA requires a new way of thinking from all concerned. Along with this "new way of thinking agriculture", there is already enough technical and agronomic evidence that could positively influence farmers contemplating the adoption of CA principles. It is, however, important to demonstrate to farmers that the technical and agronomic aspects are directly related to the management and economic aspects and, therefore, any technical and agronomic improvements obtained by applying CA principles need to be quantified in monetary and economic terms.

The potential conservation agriculture adopter may be confronted with additional capital investments of planter and spraying equipment. He might experience cash flow constraints for production inputs such as herbicides during the fallow period. However, there will be substantial savings over time. A complete cost analysis will be useful for financial planning.

7. Conservation Agriculture in smallholder and development communities

These areas should be identified and a representative demonstration site for each area needs to be started and supported.

The objective should be to achieve a reduction of rural poverty through contributing to more productive, sustainable, competitive, market-oriented farming by smallholders.

Basic research is not a priority; however, the transfer of knowledge and financial and technical support will greatly assist these groups.

In the previous Transkei and Ciskei most households have kitchen gardens. The quality of these gardens varied considerably but would be an obvious target for improvement and promotion of CA principles. Part of the kitchen garden initiative could be training and promotion of village people in raising seedlings of various plants, composting techniques, etc.

8. Animal interaction

The interaction of the animal sector with CA is critical. Uncontrolled animal grazing is probably one of the major reasons for land degradation. Fencing of land to protect crops and cover crops from animal grazing is essential. Use of living fences would be one possible direction to follow since the fencing used today is very expensive.

Increased understanding of management options and trade-offs of crop/livestock CA systems, including the increased productivity of marginal or degraded lands.

9. Implementation of CA on sandy and duplex soils

The unique water table of sandy soils of the Northern West Free State requires special management to implement CA successfully. Annual ripping, herbicide application, crop rotation, row width, wind and water erosion, and effective planting practices need to be addressed.

The issues of compaction and acidity are best resolved before embarking on a CA programme, although they can also be resolved through ripping and liming after initiation of a programme. The issue of compaction needs more research to see if

the problem can be resolved biologically or whether it requires some physical intervention. This will obviously be dependent on soil texture and previous land management. Acidity can be resolved, as demonstrated in Brazil, by applying lime on the surface during cropping or cover cropping. The data shows that the lime is moved to lower strata in the soil by the biological action of roots and micro-organisms.

Research on the application of CA on various soil types, textures and structures is critical to incorporate international and local research results.

The presence of duplex soils and the use of 'dust mulches' as opposed to those from the low biomass crop residues attained under marginal precipitation are sources of contention.

10. Agronomic changes

The following agronomic practices need investigation:

Row width, plant populations, agro type of hybrids and drought tolerance.

Research and development on adaption of hybrids and varieties will mainly be done by seed companies.

ADOPTION OF CA AND INFORMATION

Recommendations:

- Quantify the process changes that demonstrate why CA-based systems are better and more sustainable than conventional agriculture systems, including the generation of more rigorous information on the benefits to farm family livelihoods and the broader society.
- Evaluate capital losses from soil degradation and the economic gains to be derived from CA-linked rehabilitation.
- Develop crop/soil/livestock/economic system models that integrate the effects of CA systems; extrapolate results to other regions and conditions and indicate areas that require further research and understanding.

- Improve CA machinery to move beyond expensive imported equipment and create local manufacturing capacities and markets to meet growing demand (consider the special needs of small farmers with little cash or credit to buy CA equipment).

DIRECT SEEDING TRIALS BY INTA IN SOUTH AFRICA

The Argentinean National Institute of Agricultural Technology (INTA), in co-operation with Argentinean equipment companies (planters, sprayers, headers for harvesters), made expertise available to plant demonstration and observation trials in four regions in South Africa.

The positive results of these trials will encourage farmers to adopt CA.