Conservation Agriculture: The role of Academia in its technology transfer

Today, almost all players in the different agricultural sectors know what Conservation Agriculture is about and the potential benefits CA is able to generate. Whereas in many parts of the world the adoption and regular practice of CA, whether continuous or rotational, has reached considerable levels both in terms of acreage and percentage of arable land (Derpsch and Friedrich, 2009) other regions lag far behind in the uptake of CA. This is certainly the case for Europe and Africa. Despite the scientific and empirical evidences generated in numerous studies and on-farm experiments showing that CA works over many agro-ecologies, it appears that something is missing to have this technology broadly accepted in these two continents. This contribution tries to identify the main reasons for the lack of adoption and to provide possible approaches to overcome the reluctance and even resistance to try or to continue the application of the principles of CA. It further attempts to give suggestions on the potential role of academia in the adoption of CA.

- **Technology transfer: The case of Conservation Agriculture**

In almost all countries there had been and still continue attempts to introduce and/or to spread the practice of CA as a whole, or at least one or the other of its principles. The drivers that made farmers search for more sustainable production systems and motivated the massive uptake of CA are well known and are different from region to region. Whereas in the USA it was mainly the concern of the degradation of the highly erodible soils subject to both wind and water erosion, in Brazil, despite the occurrence of severe soil erosion in many regions, it was mainly the economic aspect that led farmers to initially adopt no-tillage in the early 70s (IAPAR, 1981). It was also the perceived need for cost reduction and the timely crop establishment that boosted the uptake of no-till in UK in the early 80s to almost 300.000 ha. But there, the straw burn ban caused farmers to abandon this technique due to increasing problems of weed control and volunteer cereals (Christian, 1994). Analysing the evolution of CA, there are quite different experiences around the world that after the introduction of CA showed a steady increase or even a boost (South America) of this technology, but also others where CA never received a significant attention by farmers, and still other situations where after an initial notable uptake and even positive results the further adoption was very limited or even declined.

It seems therefore necessary to understand the possible causes for these situations, both success stories and failures, in order to come up with approaches able to counteract these constraints. At several occasions Basch et al. (2008) and Basch (2005a,b,c) referred to the main causes for the very poor adoption of CA in Europe. Those reach from the ‘cultural entrenchment of traditional tillage methods’ over the ‘low economic pressure’ and “too” ‘favourable natural conditions in many regions’, to the ‘lack of problem oriented research’. In Africa, the causes for the limited adoption and sometimes lack of success of CA are certainly quite different and also highly variable from region to region. Some of the most important constraints (natural, individual, socio-economical, institutional, technical, etc.) have been identified at a workshop held in Kenya in 2008 and published by the FAO Subregional Office for Eastern Africa (Thiombiano and Meshack (eds.), 2009). To recall:

- Highly degraded soils,
- Pests and weeds;
- Mindset, lack of awareness and improper knowledge;
- Capital constraints and the need for external drive;
- Insecure land tenure;
- Inadequate cover crop - Livestock factor;
- Insufficient enabling policy environment to boost sustainable land management and scale up success stories of projects and community's efforts;
- Weak capacities at institutional, community and various stakeholders levels;
- Insufficient partnership and investments in CA.

Once identified these critical factors, it is important to take into account the diversity of situations and contexts and to tailor any technology transfer approach according to the specificity of the prevailing conditions. Based on the knowledge that CA has shown to work in many different agro-ecological conditions and that CA is capable to deliver manifold benefits with respect to all aspects of sustainability (environmental (soil, water, air, biodiversity, etc.), economic, social and agronomic), the fundamental questions to be answered are:

1. What is necessary to make CA work under given, often very specific conditions, and,
2. What does it need to have the principles of CA accepted and adopted broadly in a continuous form?

Whereas the first question has to be analysed under the light of the principles underlying the concept of CA and of what is needed to guarantee the minimum physical, chemical and biological conditions to get CA working (technology generation), the answer to the second question seems to be much more complex and requires the inclusion of the cultural, socio-economic, institutional and even political framework (technology utilization).

Most probably, the answers to the first question (technology generation) for a given place and conditions already exist somewhere but are not known to those who look for solutions locally. This means that effective information exchange is one of the most critical factors in technology transfer, even at a very basic level, especially where resources for technology generation are very limited. The establishment of local, regional, national and even international networks for the exchange of relevant information seems a crucial endeavour to guarantee the necessary spread of information in real-time. This exchange has to take place at different levels and seems to be easier between members of the same level as there are different mental perceptions of the same problem by the different players, e.g. empirical (indigenous) knowledge vs. scientific or professional knowledge. However, other approaches of technology transfer, i.e. top-down and bottom-up should coexist as they facilitate the necessary problem-oriented support.

With regard to what is needed to have a technology improvement accepted by farmers, it needs much more than technology generation and communication. The adoption of a new technology is the result of a complex decision making process, which is more difficult when several objectives (e.g. yield, profit, labour savings, etc.) overlap or the priorities are not well defined, as it is occurring more frequently with smallholder and/or subsistence farmers. It also requires the involvement of the different stakeholder groups and their interaction to learn from each other and to overcome potential perception gaps regarding the implementation of the new technology. Table 1 resumes the potential role of the different stakeholders in this process.

Table 1: Potential role of the different stakeholders in reducing the perception gap in the process of technology transfer.

Stakeholder Group	**Role**
Farmers	∗ Collaborate with extension research and agribusiness stakeholders ∗ Practice autonomous decision making and actively participate in setting experimental objectives and defining standards for technology and agricultural management ∗ Communicate knowledge of useful technologies from one farmer to another (farmer dominated study groups, network of reference farmers) ∗ Address experienced problems to the other stakeholder groups
Extension, Research, NGOs (professionals, scientists, etc.)	∗ Create problem awareness and CA message dissemination ∗ Obtain information from farmers' behaviours and redirect decision making to provide farmers with information to enable them to make their own analyses and decisions (set experimental objectives define standards for crop management) ∗ Reevaluate current technologies to incorporate farmers priorities and "practical knowledge" alongside "scientific knowledge" ∗ Scientists learning from, and understanding farmers, their resources, needs and problems to then incorporate

	conservation agriculture technologies (farmer participatory adaptive research) * Farmer training and farmer field schools
Agribusiness	* Develop good relationships to collaborate with extension research and link with farmer groups * Support farmers through technical assistance, training, small grants to invest in infrastructure, and loans to purchase inputs * Provide services such as market information, intelligence and promotion * Partnership with farmers through production contracts and exchanging agricultural inputs and services for assured deliveries of produce
Government (policy, decision-makers)	* Promote the partnership of farmers to work with extension research and agribusiness to encourage sustainable development and progress * Provide improved access to credit and loans * Introduce/promote programs to encourage the adoption of conservation practices, specifically minimum (conservation) tillage * Promote technical capacity at institutional level to mainstream the adoption of CA * State subsidy programs (seeds, inputs, technology)

- **The role of academia**

Besides the provision of advice and expertise to institutional and governmental decision-makers and the privileged access to transnational information and results from research and experimentation (http://www.fao.org/ag/ca/8.html), academia has two important tasks within the process of CA development and adoption. The first and obvious one is the identification of research areas and subjects related to CA and the availability to conduct problem-oriented research and the development of solutions that help to overcome specific constraints for the practice of CA. The research agenda has also to be based on a better understanding of the biophysical and socio-economic environment of farmers, especially smallholders, and focus not only on specific issues but address farming systems as a whole. The establishment of small regional research or experimental stations would help addressing both local specific problems but also the regional farming system perspective.

Key issues of CA research continue to be all aspects related to the introduction of and the respect for the principles of CA, i.e. minimum soil disturbance, permanent soil cover and crop diversity. Therefore, the major research and development demands are:

- adequate equipment for crop establishment, especially for resource-poor smallholdings;
- integrated weed control strategies;
- best residue management practices and crop residue alternatives (alternative mulching materials) to guarantee soil cover;
- crop species/varieties selection for different purposes and applications (mulching, mixed and inter-cropping, nitrogen fixation, weed suppression, etc.);
- crop rotations;
- crop-livestock integration (where applicable)

A second, medium and long-term task is the education of and awareness-raising and change of mindset among students (and sometimes among colleagues) and to imprint the need for sustainable production intensification based on the principles of CA. A search for higher education institutions that offer specific education in the field of CA revealed that topics specifically related to CA are frequently dealt with in modules or classes within curricular units (Duiker 2010, Hobbs 2010, Lal 2010, Lange 2010, Kassam 2010, (personal communications)), but that the dedication of an entire curricular unit or a whole course to the subject of CA and the specific topics related to its concept in the curricula of graduate or post-graduate studies is a rather exceptional situation. According to Prof. João Carlos de Moraes Sá (2010), the first curricular unit on "Direct Drilling into straw (Plantio Direto na palha)" to be created in Brazil was in 1983 and started to be lectured in 1984 at the Federal State University of Ponta Grossa (UEPG) (http://www.tibagi.uepg.br/uepgnoticias/noticia.asp?Page=8714). In 1989, this curricular unit became compulsory. Today, at least another 4 Brazilian universities offer curricular units specifically dedicated to Conservation Agriculture. Apparently, it was only in Brazil where some pioneers early had the perception that the specificity of the concept and the changes introduced by the adoption of Conservation Agriculture were justifying a whole study subject (course unit) dedicated to this "new" approach towards a more sustainable way of agricultural production. In fact, today, Conservation Agriculture must be regarded as a mode of production, which is much more than a new technology applicable to the "traditional" way of farming (i.e. Precision Agriculture). Today, fortunately, other efforts that promote CA at higher education institutions can be found, such as the course on CA at the Punjab Agricultural University (PAU/India). (http://www.krishibhoomi.in/detailnews.aspx?Dept=business&SID=72), or the curricular units offered at the University of Hohenheim (Germany) (https://www.uni-hohenheim.de/modulkatalog.html?&tx_modulkatalog_pi1[mode]=modul&tx_modulkatalog_pi1[sg_id]=28&tx_modulkatalog_pi1[mod_id]=544&cHash=bc16a2df5ff514063ded87d5d76fa278&L=1) and University of Évora (Portugal) (http://www.estudar.uevora.pt/Oferta/mestrados /disciplinas/%28curso%29/448/%28codigo%29/FIT10447).

The lack of education and training around the concept of CA and its exclusion even as a component of traditional agricultural education, courses and qualifications is about to conduct to the establishment of a Virtual Conservation Agriculture Academy (VCAA) with the aim to "address and eliminate the constraining fact that unlike many other subjects, it is almost impossible to find an institution that offers accredited qualifications in CA at almost any level in the education hierarchy from high school to universities" (Putter, 2010, personal communication). The idea behind the VCAA is the open-source development of a) 'plug-in' curriculum components to facilitate slotting CA learning opportunities into existing, formal agriculture courses and training programs; and (b) stand-alone, off-the-shelf curricula that focus on CA as 'major' or 'primary subject'; that is, curricula and learning resources for accredited CA certificates, tertiary CA diplomas and undergraduate university degree courses and qualifications.

- **References:**

Basch, G., Geraghty, J., Streit, B. and Sturny, W.G. (2008): *No-Tillage in Europe – State of the Art: Constraints and Perspectives.* In: Goddard, T., Zoebisch, M., Gan, Y., Ellis, W., Watson, A. & Sombatpanit, S. (Eds). No-Till Farming Systems, Special Publication No. 3, World Association of Soil and Water Conservation, Bangkok.

Basch, G. (2005a): *Conservation Agriculture Experiences in the European Union*. Proceedings of "Congreso Internacional sobre Agricultura de Conservación- El Reto de la Agricultura, el Medio Ambiente, la Energia y la Nueva Politica Agraria Común", Córdoba, November 2005, 235-243.

Basch, G. (2005b): *Socio-economic and political justification for investing in conservation agriculture. Experiences and views of ECAF.* Proceedings of the 3rd World Congress on Conservation Agriculture, Nairobi, October 2006, 26-28.

Basch, G. (2005c): *Europe – The developing continent regarding Conservation Agriculture.* XIII Congreso de la Asociación Argentina de Produtores en Siembra Directa, El Futuro y los Cambios de Paradigmas, Rosario/Argentina, August 8-11, 341-346.

Christian, D. G. (1994): *Experience with direct drilling cereals and reduced cultivation in England.* In: Proceedings of the EC- Workshop- I-, Giessen, 27-28 June, 1994, Experience with the applicability of no- tillage crop production in the West-European countries, Wissenschaftlicher Fachverlag, Giessen, 1994, 25- 31

Derpsch, R. and Friedrich, T. (2009): Development and Current Status of No-till Adoption in the World; Proceedings on CD, 18th Triennial Conference of the International Soil Tillage Research Organization (ISTRO), June 15-19, 2009, Izmir, Turkey.

IAPAR (1981): *Plantio direto no estado do Paraná*. Fundação Instituto Agronómico do Paraná, Brasil, Circular N° 23, 244 pp.

Thiombiano, L. and Meshack, M. (2009): Scaling-up Conservation Agriculture in Africa: Strategy and Approaches. The FAO Subregional Office for Eastern Africa, Addis Ababa.