CLUB OF BOLOGNA

20th MEMBERS' MEETING

Hannover (Germany), November 8th, 2009

on occasion of
67th International Conference Landtechnik AgEng2009 and Agritechnica 2009

CONCLUSIONS

AND

RECOMMENDATIONS

by Luigi Bodria and Marco Fiala

CONCLUSIONS AND RECOMMENDATIONS

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39 experts from **17 Countries and 2 International Organizations** took part at the 20th Meeting of the Club of Bologna, held on 8 November 2009 in Hannover (Germany), on occasion of 67th International Conference Landtechnik AgEng2009, Agritechnica 2009 and with the sponsorship of DLG and UNACOMA.

There were two Topics under discussion.

The first Topic on "**International Research Projects Database – Step One (European Projects)"**, had a preliminary contribution:

- **Research Project Database Agricultural Engineering. A first draft,** by *H. Auernhammer (Germany), L. Bodria and R. Oberti (Italy)*.

The second Topic on "**Innovations for Sustainable Agricultural Mechanisation"** has been presented by 4 Key-Note Reports considering different areas in which sustainability plays an important role for an environment friendly farm mechanisation:

- **Tractor Innovations and Sustainability,** by *K. Renius (Germany)*;
- **The New EU Directive Requirements and the Innovation in Pesticide Application Technique**, by *P. Balsari and P. Marucco (Italy);*
- **Conservation Tillage Technology for Tropical Agriculture**, by *E. Mantovani and J. Denardin (Brazil);*
- **Conservation Agriculture in Developing Countries**, by *T. Friedrich, J. Kienzl and A. Kassam, (FAO).*

Conclusions

Topic 1 - International Research Projects Database – Step One (European Projects)

The topic was previously discussed during the 19th Club of Bologna Meeting held in Bologna in November 2008 recognising that a research projects database may be an important tool to promote communications, exchange of information and transfer of knowledge between research organisations and industry.

In addition UNACOMA expressed a high interest in offering to their members an easy way to explore the knowledge offer from research institutions.

The presentation Keynote Report "**International Research Projects Database – Step One (European Projects)"** was opened by: H. Auernhammer, Institut für Landtechnik Freising-Weihenstephan (*Germany*), who introduced a proposal for a prototype of database following the German experience on a similar project presented in Bologna last year clearing up the basic organisation of the database as well as its main goals.

Successively R. Oberti, University of Milan (*Italy*), showed the alfa-version of the arranged database explaining – with some Italian, German and English research projects used as examples - the DB adopted research criteria and the results obtainable.

The aim is to design a simple basis for the future development of a "World Research Database" on agricultural machinery covering three main areas: ready to transfer results of research, special activities in restricted areas, selected contents of main worldwide AgEng Journals.

The database will be internet-based, so that to allow the access, information input, and administration from anywhere.

As a first step, results from research projects only are considered. Project description will be in native language, but essential data and a comprehensive summary in English will be included to guarantee

worldwide users to access to worldwide information. Additional inputs will include institution and contacts, data publication year and possible attached documents. In order to obtain organised and easily retrievable information, the projects will be classified by means of keywords chosen from a closed list.

By translating the keywords list in different user languages, multi-language querying of the database will be possible also to poorly or non English-speaking users, encouraging the dissemination of transferable research results among small companies and manufacturers.

Possible contribution of valuable inputs should be open or requested from worldwide research institutions and authoritatively reviewed to guarantee excellence. To this end, Club of Bologna could play a primary role.

Topic 2 - Innovations for Sustainable Agricultural Mechanisation

The first Keynote Report "**Tractor Innovations and Sustainability**" presented by K. Renius, University of Munich (*Germany*) deeply analyses the importance of tractor design and tractor-implement operation for the sustainability of agricultural mechanisation.

Sustainability means to save material by intelligent design; to save energy by efficiency-improved tractor components as well as by intelligent external tractor-implement management systems; to develop renewable engine fuels and working fluids; to protect the environment by degradable fuels&working fluids and surrounding people by adequate technical measures regarding health and safety.

Particular problems rise for the lower developed regions by the fact that technical measures for a higher grade of sustainability generate additional first costs. On the other hand, human suffering, personal productivity decline and high long term costs for consequences such as health recreation, assurance expenses, environment recreation, resource shortages and others have to be taken into account. This means that sustainability has a high long term quality of general welfare.

High sophisticated computer design technologies allow accurate stress analysis in order to save material and cost of machinery.

Increasing efficiency of Diesel engine as well as transmission lines is an important engineering challenge to make sustainable the agricultural energy balance. To this aim intelligent communication between the tractor's components as well as between tractor and implements via ISO-BUS system is an important step forward.

Alternative fuels development is rapidly growing and many expectations are related to the development of second generation of Biomass to Liquid (BtL) technologies. Hydrogen fuel cells as well are expected to offer in next future important benefits in term of sustainability.

Alternative fuels together with new engine technologies for reducing engine emissions and fuel consumption will play an important role for environment sustainability of farm mechanization.

Unfortunately many of the measures required are not driven by the market. This is a typical situation in which state-released regulations and international standards should be applied. They create also common conditions for all manufacturers within a certain market. The very interesting experience is that most improvements which have been generated originally by regulations became popular later on; see for example, the quiet tractor cabs which have today even a much lower noise level than originally required.

Based on this analysis, the Club of Bologna recommends to further steps forward in sustainability for tractors worldwide but in the same time to use the experiences and expertise of the higher developed countries for the lower developed areas.

The second Keynote Report "**The New EU Directive Requirements and the Innovation in Pesticide Application Technique**" was presented by P. Balsari, University of Turin (*Italy*). The Author underline how the use of pesticides will remain essential in the future in order to guarantee food quantity, quality and profitability for an estimated world population of 9 billion in 2050.

Only since 1980's the safety aspects related to the operator and to the environment have been taken into account as priority aspects and these latter have addressed the evolution of crop protection equipment in the last twenty years. This line of evolution will be enforced in future especially in Europe due to the issue of the EU Directive on Sustainable Use of Pesticides and to the amendment of the EU Machinery Directive. These Directives are focussed on the implementation of environmental safety requirements regarding plant

protection machinery and address to develop new sprayers and accessories able to improve the users and consumers safety as well as the environmental protection.

The main risks connected to application of Plant Protection Products (PPP) come from unintended losses of PPP to water resources.

The main entry routes into surface water are:

- the "point sources" related to the handling of PPP during transport, storage, filling, cleaning, management of remaining liquids, and te disposal of empty packages;
- the "diffuse sources" related to drift losses during application and run-off and drainage from treated fields.

Regarding the first pollution factor improvements of sprayers filling and cleaning systems are necessary: induction hoppers, programmable flow meters, closed transfer systems providing direct suction from pesticide container to the thank, can considerably reduce the risks of environmental contamination as well as operator exposure.

The reduction of the amount of remaining spray mixture depends on the ability of the operator to precisely know the amount of spray applied per unit area and to prepare the required thank mix accordingly. It can be considerably facilitated by appropriate control devices for filling operations to enable farmers to conclude distribution whit the thank empty.

In order to limit diffuse sources contamination electronic system based on GPS and sensors are able to immediately adapt the spray distribution parameters to the target characteristics, adjusting the volume rate and activating the nozzles only when necessary.

Adoption of air-induction nozzles allows a low working pressure limiting the production of small droplets under 100 μm size.

In developing countries the need to improve the quality of spray application (at present spray losses range between 60% and 70% of the applied volume) and to reduce the environmental risks related to PPP dispersals is particularly high.

Due to the growing attention related to environmental aspects it is expected that spray application techniques will receive important inputs to prevent pollution from pesticides. Regular inspection of sprayers in use will stimulate change the most obsolete machines.

The inspection in Belgium, Italy and Germany showed that a percentage of 5-20% of sprayers components and 1.5% of full machine must be replaced in order to fulfil the requirements of EU Directive.

It is estimated the potential market improvement for sprayers and components due to the entry into force of the new EU Directive that for the next seven years has been calculated in a value of 1,3 billion Euro.

The third Keynote Report "**Conservation Tillage Technology for Tropical Agriculture**" was presented by E. Mantovani, EMBRAPA (*Brazil*).

Conventional farming practices utilized in many parts of the world have had negative consequences in terms of soil and water preservation as well as on the environment conservation. This is due to improper soil use, monoculture and the use of tillage tools that leave the soil bare and pulverize it excessively, leaving it in such a condition that heavy rains can carry it away.

The use of inadequate technologies (not adapted to specific conditions in terms of slope, rainfall intensities) results in run-off and soil erosion. Furthermore, most European and American experiences of soil conservation management put great emphasis in use of soil preparation equipments, paying little attention to the production system.

The unavoidable negative effects of intensive and repeated soil tillage in the tropics and subtropics on organic matter content, soil erosion, soil structure, soil temperature, soil moisture, water infiltration, soil biological processes and loss of nutrients result in chemical, physical and biological soil degradation which causes a decrease in yields.

A new soil conservation tillage systems, the "Tropical Agriculture", is based on the improvement of agricultural equipment, the development of new short-cycle cultivars, pasture grass for winter growing season and crops less sensitive to water stress.

In Brazil, since 1991 a innovative concept of no-tillage system, adapted to the subtropical conditions, gave the possibility to solve the erosion problems in the Southern Region, reducing the amount of soil losses to acceptable levels and giving results (especially in milk production) very impressive.

This no-tillage system positive experience was progressively applied and improved in the Midwest of Brazil, establishing a new conservation system for tropical conditions, called "Cerrados's no-tillage".

This "Tropical-Agriculture System" is based on well-established schedules, crop rotation and succession, improvement of tillage equipments for all production scales and more efficient herbicides at low cost. More in detail, no-tillage cultivation of crops and the successful application in mechanized farming has been closely related to the following factors:

- availability of appropriate knowledge under different agro-ecological and socio-economic conditions;
- practice of adequate crop rotations including green manure cover crops (this has been the basis of successful application, especially in Latin America);
- availability of a variety of efficient low-cost herbicides;
- availability of appropriate machines at adequate prices.

All these factors enabled the exponentially expansion of the no-tillage system on Brazilian production area; as a result of this process, Brazilian agri-business plays an important role in the national economy, accounting for 23% of the Gross Domestic Product.

At the moment, the world-leading countries with crop production area under no-tillage system are Brazil (25,5 milion hectars, 50% of total cultivated area, while in other parts of South America no-tillage accounts for more than 80%) and the USA (25,3 milion hectars, 16% of total).

Considering three parameters (GDP > 400 billion US$; land area > 100 million km^2; population > 100 million), only China, United States, Russia and Brazil fall into this circumstances. Taking into account the world agriculture situation and the future possible future expansion, Brazil - due to the large amount of available land - seems more able to expand its agriculture, to increase some crops productivity and, consequently, to improve much more its agri-business.

The fourth Keynote Report "**Conservation Agriculture in Developing Countries**" was presented by *T. Friedrich, FAO* (Rome).

The new paradigm of "sustainable production intensification" recognizes the need for a productive and remunerative agriculture which at the same time conserves and enhances the natural resource base and environment, and positively contributes to harnessing the environmental services. Sustainable crop production intensification must not only reduce the impact of climate change on crop production but also mitigate the factors that cause climate change by reducing emissions and by contributing to carbon sequestration in soils. Intensification should also enhance biodiversity in crop production systems above and below the ground to improve ecosystem services for better productivity and healthier environment. A set of soil-crop-nutrient-water-landscape system management practices known as "Conservation Agriculture (CA)" delivers on all of these goals.

Consequently, CA represents a practical concept to achieve improved soil health and better soil-crop-nutrient-water management leading to ecologically and economically sustainable agriculture.

The CA concept is universally applicable, but it is not a one-size-fit-all ready-to-use blue print recipe for sustainable farming; the actual soil and crop management practices and cropping systems require site specific adaptations and eventually specially designed mechanical technologies and farm power.

CA in the context of sustainable agricultural mechanization is more than just a mechanical technique, such as no-till and direct seeding. It represents a fundamental change in the soil system management and in the cropping system design and management which in turn lead to consequential changes in the required field operations and the related mechanization solutions. When a tillage-based production system is to be transformed into a CA-based system, it involves a shift in the prevailing on-farm mix of mechanical technologies, some of which will remain but with only marginal use in future, and there will be the development of completely new set of mechanical technologies, changes in farm power requirements, and in land use suitability for sustainable intensification as elaborated in the following sections.

CA is based on enhancing natural biological processes above and below the ground; interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes.

CA is characterized by three sets of linked and mutually reinforcing practices:

- continuous no- or minimal mechanical soil disturbance (the disturbed area must be <15 cm wide or 25% of the cropped area. No periodic tillage that disturbs a greater area than the aforementioned limits);
- permanent organic matter soil cover, especially by crop residues and cover crops (soil cover should ideally be above 100%, measured immediately after the planting operation. Ground cover <30% is not considered as a CA practice);
- diversified crop rotations in the case of annual crops or plant associations in case of perennial crops, including legumes (rotation should involve at least 3 different crops. Monocropping is permissible as long as no other related problems occur).

The most significant change from tillage-based farming to CA is in the land preparation and seeding practices. The use of tillage as a standard periodic operation is completely eliminated in a fully functioning CA system and remains only for very specific tasks, such as creating the conditions for changing over to CA by breaking up compacted soil or levelling the soil surface.

Another area of significant change is the seeding and planting operation. Equipment for seeding and planting must be able to deposit the seed with a similar accuracy of conventional seed drills into an untilled soil which ideally is covered with a heavy mulch of crop residues. For this reason the equipment must have specially designed furrow openers which can penetrate the mulch without collecting it or pushing it into the soil and deliver the seed into the soil at the desired depth.

Equipment for weed management remain partly unchanged under CA system; while cultivators and hoe type equipment loose importance, slashers, cutters or crimper-rollers are used for mechanical surface weed management. Chemical herbicide applicators play a significant role and sprayers remain the main tool for application.

The harvest operation in CA is part of the land preparation for seeding the next crop. The management of crop residues during the harvest has direct influence on ease, problems and quality of the subsequent planting operation.

The integration of crop and livestock production is therefore an important issue. Forage production as part of the crop rotation with forage, cover or relay crops will have to be inserted in the cropping system, and the grazing or withdrawal of residues for forage purposes will have to be controlled to strike a compromise between feeding the soil and feeding the livestock.

Another significant change that is taking place is in the farm power requirements; in mechanized systems the overall power requirement for tractors decreases by about 50% with an additional shift towards lower horsepower by about 40%. Consequently, for a farmer switching completely to CA system, there would be significantly lower amount of capital tied up in farm machinery.

While some common farm equipment looses importance when changing from tillage-based farming to CA system, other new equipment (knife roller, residue spreaders, etc.) are introduced, offering new opportunities for technology development. The consequent application of CA will also lead to modifications in the design of some existing equipment.

Another aspect which will gain increasing importance under permanent no-till CA system is the avoidance of soil compaction, particularly in mechanized farming and in humid climates (low pressure tyres, rubber tracks, tyre pressure adjustment systems, wheel track monitoring, controlled traffic farming).

A new promising complementary technology in this context also could be the “Bio-Agtive Emissions Technology” (currently under development and investigation): the tractor exhaust emissions are directed into the soil, in order to reduce emissions into the atmosphere and bring to the plant heat and elements (N, in particular), rising the use of mineral fertilizers.

Recommendations

Topic 1 - International Research Projects Database – Step One (European Projects)

- **considering** that the proposed database could really enhance the linkage between researches institutions agro-machineries producers and if successful it will be a valuable asset to small and medium manufacturers;

- **underlining** that many research databases already exist on the web in different countries and from different organizations;
- **noticing** that an effective database design and operation will require a substantial commitment of time and effort in order to be successful;

the participants unanimously:

- **encourage** the Club of Bologna to continue the project of International Research Project Database making available the necessary human, technical and financial resources;
- **confirm** the need to consider the existing databases in order to avoid duplication and to select the entries so that a world-wide compendium of results of researches can be offered to manufacturers;
- **acknowledge** that a strict keywords list with defined translations into the used languages must be developed and expanded in a systematic and controlled manner.

Topic 2 – Innovations for Sustainable Agricultural Mechanization

- **considering** the growing importance of sustainable mechanization as a tool for assuring long term protection of environment, satisfying the demand of consumers for safe food end answering for healthy working condition for the operators;
- **recognizing** that sustainability of agricultural mechanization is a complex process for which it is necessary to consider an integrate approach including energy consumptions, emissions and life cycle costs for the entire production system;
- **recalling** the key role of innovation for the development of environment friendly engines, not polluting pesticides distribution technologies and less energy consuming soil tillage methods;
- **recognizing** the importance of specific legislative direction as driving force for more sustainable agricultural procedures as well as of training support, education and technical facilities for machines utilization, inspection and certification in line with sustainability;

the participants unanimously:

- **recommend** a closed collaboration among research institutions and industrial actors in order to define the innovative operating procedures based on appropriate sensors and information technologies for sustainable utilization of machinery;
- **invite** agricultural machinery manufactures to make all possible effort to look beyond simple design process of machines adopting a multidisciplinary approach for the development of a complete systems able to environment friendly operations;
- **urge** the administrations to enact institutional machines monitoring directives and promote educational and training initiatives aimed at farmers to enable them to efficiently implement sustainability.