CLUB OF BOLOGNA

CONCLUSIONS AND RECOMMENDATIONS

68 experts from 35 countries and representatives from FAO, CIGR, AIT and UNIDO took part in the 13th Club of Bologna meeting, subdivided into two separate sessions held respectively on 27 – 28 July 2002 in Chicago, in conjunction with the ASAE Annual International Meeting and the 15th World CIGR Congress, and on 16 – 17 November 2002 in Bologna on the occasion of the 33rd EIMA show.
The general subject – common to both sessions – was: **Mechanisation and traceability of agricultural production: a challenge for the future.** The topics covered during the Chicago session were:

1. *The quality of productions. Market needs. Institutional and regulatory aspects.*
2. *The role of mechatronics in the traceability of crop and livestock productions.*

During the Bologna session, the topics covered were:

3. *Measurement and data collection systems for agricultural equipment.*
4. *System integration and certification: the market demand for clarity and transparency.*
5. *Traceability: the role of mechanisation in monitoring processes and the quality of productions*

1 - ***The quality of production. Market needs. Institutional and regulatory aspects.***
The subject was discussed on the basis of introductory presentations by: ***P. De Castro*** (Italy), ***F. Pierce*** and ***R. Cavalieri*** (USA).

P. De Castro started discussing the changes in the consumer patterns and food markets of the European Union, where demand has now become explicitly tied to the process and production systems, as a result of new requirements arising from consumer purchasing decisions. These changes have also prompted the European Union to amend the CAP, to take into account the fact that over 90% of European citizens have explicitly stated that they expect the CAP to guarantee safe, healthful and compatible with the environment food products. This led to the enactment of the "Food Law" in July 2001, which among other things provides for the establishment of a food safety Authority. This measure was also made necessary by differences between the rules of the various national legislations, which could disrupt the functioning of the internal market. Hence the push toward traceability and the emergence of new roles for agricultural mechanisation. These involve reducing production costs and developing the functional characteristics of the various machines so that they are able to fulfil the requirements of traceability at all times, and hence provide the assurances demanded by consumers. But the most important point of interest for mechanisation is, without question, the problem of independently managing the different machines within complete production chains.
What is more, there is a need to evaluate the "indirect" effects of the anticipated demand for technical solutions equired by the new agricultural and food industry scenarios.

F. Pierce and ***R. Cavalieri*** underlined first of all that the future of agriculture in the U.S. and beyond and the effects of traceability are difficult to assess alone. U.S. agriculture produces the highest quality food at affordable prices. Traceability, whether mandatory or voluntary, appears to be inevitable because consumers demand it and because it is possible to achieve. The appropriate response to these challenges is technological innovation that improves crop quality and reduces the cost of production. To achieve this, machinery of the future must be increasingly automated, capable of detecting crop quality at various points in the production and processing system. Current efforts in agricultural automation - robotics, guidance, and mechanical harvest – are on the right track but are inadequate; they need more investment from government and private industry to make needed advancement. The public agricultural research programs in the U.S., consisting primarily of the USDA and Land-grant universities, no longer have the cadre of scientists and programs it once had working on mechanisation. Crop quality detection will benefit greatly from emerging nanotechnologies and biosensors but efforts to adapt current and future sensors to machines at affordable costs are critical. Equipping machines with tracking capabilities needed for traceability should be technologically feasible but efforts to make tracking systems affordable and interoperable will be the challenge. Smart machines with these capabilities will be increasingly important for U.S. agriculture to compete globally and to meet the needs of consumers for a safe and high quality food supply. However, to reach this goal requires new public and private sector investments in research and development that are not currently available.

2 - ***The role of mechatronics in the traceability of crop and livestock production.***
This important topic was covered in two keynote papers by: ***H. Auernhammer*** **(**Germany) and ***I. De Alencar Nääs*** (Brazil).

H. Auernhammer began by noting that: the new food production models arising from the evolution of the market and growing concerns about the healthfulness of agricultural products require continual monitoring of the productions and full knowledge of their history (traceability) from field to distribution.
To accomplish these objectives it will be necessary to achieve wide adoption of innovative crop production technologies, such as precision agriculture, and the ensuing generalised application of mechatronics and hydraulics to agricultural machinery. Recent applications of mechatronics, in particular, have provided useful solutions to the technical and management problems of individual machines as well as of complete agricultural machinery chains, making it possible to continually monitor performance and optimise utilisation through remote service systems. A fundamental role, in this connection, will be played by field robotics.
The continual evolution of sensor technology and other electronic systems makes it possible to achieve traceability of productions, including the acquisition of crop and environmental data, as well as the integration of different types of information. The same can be said of sensor technology employed in the post-harvest phase for the non-destructive measurement of specific characteristics of the various products before they are placed on the market.
There is therefore a need to: make agricultural machines increasingly intelligent; further develop precision agriculture methods; assure the collection of information at every stage of the production chain up until the point of sale, developing appropriate sensors and automation.
Because the scope of traceability normally goes beyond the capabilities of individual research institutions or industries, it will be necessary to set up integrated projects that can enable to quickly develop applicable technical standards.

I. De Alencar Nääs started by noting that: biosensors in livestock farming, based essentially on the miniaturisation of electromechanical devices, have been employed since the mid 70s in various stages of production, from the monitoring of feeding to the monitoring of animal behaviour. Their application has considerably expanded over the past ten years. These are important and interesting developments with a view to applying the principles of traceability to the processes and events of the protein production chain. The latest generation of these technologies offers a true capability for storing data about the animals and their life, making it possible to authenticate specific protocols. Managing specific events, rather than a general scenario, as is the case of the crop production sector, will enable livestock farmers to evaluate losses and detect incorrect diagnoses, thereby increasing the efficiency and accuracy with which precision methods are deployed. The application of mechatronics to livestock production, through the use of biosensors and the electromechanical devices, makes it possible to improve data collection and hence to take more effective actions accordingly. In this connection, the Author supplies some interesting examples of the use of these technologies in specific sectors of livestock production.

3 - ***Measurement and data collection systems for agricultural equipment.***
This interesting subject has been dealt with in the key note paper by ***J. F. Reid*** (USA).

J. F. Reid starts by underlining that current sensors and data collection systems on agricultural equipment are fundamental elements required for the development of traceability. The current precision agriculture technologies, where adopted by producers, provide basic capabilities in data collection within the limited availability of sensors. However, despite the capabilities provided by these systems, agricultural traceability is clearly in the early phases of development.
Agriculture will not have to independently develop all of the core elements for traceability. For example, data collection needs for traceability can benefit from the technology developments that are contributing to the continued information richness we have in society from advances in computer and electronic systems. Data processing and data mining tools are also becoming available for general use and can be adapted to agricultural needs.
On the other hand, sensors are a limiting factor for traceability. One reason is that many crop and soil characteristics are difficult to measure and sensors that exist suffer from interferences to their response. Additionally, several important sensors for traceability have not been developed. This is especially true for sensors required for the measurement of the characteristics of individual fruit and vegetables. Unfortunately,

during this time of increasing needs for sensors, research supporting the development of suitable sensors in clearly lagging.
In addition: data collection systems will need to expand to match the level of data needed for the traceability systems; automated data transfer between elements of the systems will increase the effectiveness of traceability; permanent storage methods are needed to provide a record of the responses measured by traceability.
Additional sensors will be needed to facilitate the measurement of responses and to provide automated data transfer. Increased funding will be required to lead to the development of these innovative technologies.

4 - ***System integration and certification. The market's needs for clarity and traparency.***
This topic has been considered in the key note reports by ***Y. Zaske*** (Germany) and ***L. Bodria*** (Italy).

Y. Zaske starts by reminding that: all parties involved in the food chain increasingly demand from the preceding supplier the proof of quality and safety of the products. The basis for this is an uninterrupted documentation of the product flow and of all process steps via the entire chain, from primary production, via transport, storage, processing, distribution, up to the consumer.
Accordingly, the product safety has to be monitored by public or private inspections on the basis of national and/or EU regulations.
Because of high risks, due to the complexity of production and large volumes of produce, the food industry was the first to establish comprehensive Quality and Safety (QS) Management Systems including Hazard Analysis and Critical Control Points (HACCP) Systems, generally in accordance with ISO 9000 ff.
Industry and trade not only demand from primary producers that they supply large quantities of safe products of defined and constant quality. Increasingly they force farms or farm groups to prove this, e. g. by having their products certified (QS-seals, Bio-seals etc.), or by establishing their own QS-management systems, usually according to ISO 9000 ff., too.

L. Bodria underlines that: food production chains are becoming increasingly complex so that an appropriate standard for food safety is now of the highest priority for the consumers.
Traceability - that can be defined as: "identification of the organisations and materials flows involved in the formation of a product unit that is individually and physically identifiable" - is an essential tool in order to provide the necessary level of information and to identify responsibilities in case of unsafe food products on the market. A better appeal of traceability is associated to a voluntary application of international standards within a national certification system monitoring the compliance of the required documentation. A voluntary traceability system will be an added value element contributing to enhance the competitiveness of the various products and a guarantee of a free and conscious commitment on the part of the organisation management.
Club of Bologna, concludes the Author, should then stimulate and encourage an appropriate development of automation in mechanisation in order to allow suitable information collection storage, and transfer able to "track" the origin of agricultural products.

5 - ***Traceability: the role of mechanization for the control production: a challenge for the future.***

This last, interesting topic was covered in a joint paper by ***R. Guidotti*** and ***A. Pagani*** (Italy).

R. Guidotti and ***A. Pagani*** began with a historical overview of these past 50 years of development of mechanization. This only in the '90s has had to confront the need for traceability by leveraging the enormous potential of electronics applied to agricultural machinery, as amply discussed in the preceding reports.
This concept has not, however, been seized upon by farms which in most cases continue to operate without an awareness of traceability or an appreciation of its importance in human technical, financial and environmental terms. And this continues to be true despite the many great steps forward which have been taken toward increasing farmer awareness. Nearly all nevertheless require at present some form of support for broad-based training in this respect, so as to be able to meet the demands of consumers. At present and for a few years to come, however – especially in light of the fragmentation of farms – the authors believe that a concrete aid toward traceability might be found in the broad geographical distribution of contracting associations or companies that are particularly sensitive to these new issues and capable of addressing them.

At the end of the various presentations, held both in Chicago and Bologna, the participants engaged in productive and in-depth discussions, after which they agreed upon the following:

Conclusions and Recommendations

- **considering** the growing importance of traceability as a tool for assuring the healthfulness of plant and animal food products by tracking their history, utilisation and sources, for the protection of consumers;
- **recalling** that the widespread adoption of traceability will require the involvement of the various governments and countries, to identify and define specific directives aimed at safeguarding the health of citizens;
- **reasserting** the consequent need to: develop specific informational processes on a large scale to: identify the crucial links within the various agri-food chains; promote drafting of international standards for the various productions, as well as techniques for tracking and recording the material and energy flows which characterise each production and distribution system;
- **reaffirming** the need for traceability to be defined within the wider context of the certification of farms;
- **identifying** in mechanisation the key element for documenting the history of the individual productions that leave the farm, enter the agri-food chain and ultimately reach the consumer's table;

the participants unanimously recommend:

that the Club of Bologna should:

- undertake to further examine, in special working groups, the various procedures for implementing traceability, defining the new technologies–based on appropriate sensors and electronic instruments as well as targeted information programs–necessary for collecting, storing and transferring the information acquired about the different agri-food productions, so as to offer the various countries useful models for drafting the pertinent legislation.
- collaborate closely with the industrial actors to define the necessary technologies, taking into account the specific technical and economic needs of the different countries with a particular eye to the emerging nations in which agriculture is, even today, the principal component of the economy;
- promote wide-ranging educational and training initiatives aimed at farmers, to enable them to comprehensively and efficiently implement traceability;

that agricultural machinery manufacturers should:

- urgently complete lines of commercial machinery equipped with appropriate instruments for tracking and acquiring information during the operations carried out on agricultural and livestock farms;
- act as complete and qualified partners in the negotiations with the other industries involved in the agri-food chain, in order to precisely define the level at which information about traceability is needed;
- ensure that the technology for traceability is appropriate to the needs and working conditions of farms, and does not entail increased workload but, on the contrary, encourages its use;
- guarantee that the cost of the new additional technologies can be borne by farmers and agricultural contractors, particularly with regard to the economic needs of the developing countries;
- complete their knowledge and expertise in the design, production, marketing and maintenance of the sensors, software and hardware necessary for managing the data, the communications, etc.

that the agricultural sector should:

- elevate its level of knowledge in order to be prepared to operate with these technologies, acquiring a good command of their use;

that research institutions should:

- undertake activities aimed at addressing the important and recurring technical challenges entailed by the objectives of traceability, working in close collaboration with the industrial and agricultural sectors.

Club of Bologna. "Conclusions and Recommendations". Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Invited Overview Paper. Vol. IV. December, 2002.