CLUB OF BOLOGNA

PROCEEDINGS OF THE 13th MEMBERS' MEETING

General Conclusions and Recommendations
Conclusioni e Raccomandazioni generali

13th MEMBERS' MEETING (*Part 1*)

Chicago (USA), 27th – 28th July, 2002

13th MEMBERS' MEETING (*Part 2*)

Bologna (Italy), 16th – 17th November, 2002

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GENERAL 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 productions: a challenge for the future.** The topics covered during the Chicago session were:

1.1 The quality of productions. Market needs. Institutional and prescriptive aspects.
1.2 The role of mechatronics in the traceability of crop and livestock productions.

During the Bologna session, the topics covered were:

2.1 Sensors and data collection systems on agricultural equipment.
2.2 System integration and certification: the market demand for clarity and transparency.
2.3 Traceability: the role of mechanisation for the control of processes and the quality of productions.

1.1 The quality of productions. Market needs. Institutional and prescriptive 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 to 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 US and beyond and the effects of traceability are difficult to assess alone. US 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 US, 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 US 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.

1.2 The role of mechatronics in the traceability of crop and livestock productions

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.

2.1 Sensors and data collection systems on 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.

2.2 System integration and certification. The market demand 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.

2.3 Traceability: the role of mechanization for the control of processes and the quality of productions

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;

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.;

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;

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.

CONCLUSIONI E RACCOMANDAZIONI GENERALI

68 esperti provenienti da **35 paesi**, oltre ai rappresentanti di **FAO**, **CIGR**, **AIT**, **UNIDO**, hanno partecipato al XIII meeting del Club of Bologna articolato in due differenti sessioni svoltesi, rispettivamente, il 27-28 luglio 2002 a Chicago in occasione dell'ASAE annual international meeting e del XV Congresso mondiale del CIGR ed il 16-17 novembre 2002 a Bologna in occasione della XXXIII EIMA.

L'argomento generale – comune ad entrambe le sessioni – ha riguardato: **Meccanizzazione e tracciabilità della produzione agricola: una sfida per il futuro.** Nella sessione di Chicago sono stati svolti i temi:

1.1 La qualità delle produzioni. Esigenze del mercato. Aspetti istituzionali e prescrittivi.
1.2 Il ruolo della meccatronica nella tracciabilità delle produzioni vegetali e animali.

Nella sessione di Bologna, invece, sono stati affrontati i seguenti argomenti:

2.1 Sistemi di rilevazione e raccolta di dati sull'equipaggiamento agricolo.
2.2 Integrazione e certificazione del sistema: le richieste del mercato per la chiarezza e la trasparenza.
2.3 Tracciabilità: il ruolo della meccanizzazione per il controllo dei processi e la qualità delle produzioni.

1.1 La qualità delle produzioni. Esigenze del mercato. Aspetti istituzionali e prescrittivi

L'argomento è stato discusso sulla base delle relazioni introduttive presentate da: **P. De Castro** (Italia), **F. Pierce** e **R. Cavalieri** (USA).

P. De Castro ha articolato il proprio rapporto in quattro capitoli principali. Il primo ha riguardato i cambiamenti dei consumatori e del mercato alimentare nell'Unione Europea, ove la domanda legata al processo e al sistema di produzione ha ormai assunto dimensioni esplicite attraverso l'assunzione di nuovi requisiti legati alle scelte d'acquisto. Queste modifiche hanno indotto l'Unione Europea a dover ritoccare anche la PAC in conseguenza del fatto che almeno il 90% dei cittadini europei ha esplicitamente riconosciuto di attendersi, appunto attraverso la PAC, prodotti sicuri e sani e il pieno rispetto dell'ambiente. Ciò ha portato a emanare nel luglio 2001 la cosiddetta "Food Law", prevedente, tra l'altro, la costituzione di un Authority per la sicurezza alimentare. Ciò si è reso necessario anche per il fatto che i provvedimenti nazionali presentano differenze nei metodi e dettagli che possono perturbare il funzionamento del mercato interno. Da qui la spinta verso la tracciabilità e i nuovi ruoli per la meccanizzazione agricola. Questi riguardano il contenimento dei costi di produzione e lo sviluppo delle caratteristiche funzionali delle varie macchine così da poter rispondere in ogni momento agli aspetti propri della tracciabilità e, quindi, alle garanzie richieste dai consumatori. Ma indubbiamente il principale elemento di interesse per la meccanizzazione, si lega al problema della gestione autonoma delle varie macchine nell'ambito di intere filiere di produzione. Si impongono, poi, valutazioni sugli effetti "indiretti" che derivano dalla prospettiva della domanda di mezzi tecnici in relazione ai nuovi scenari agricoli e alimentari.

F. Pierce e **R. Cavalieri** sottolineano, anzitutto, che molti fattori influenzano il futuro dell'agricoltura sì che il problema della tracciabilità come tale è difficile da considerare individualmente. L'agricoltura USA produce alimenti della più alta qualità a prezzi abbordabili. La tracciabilità – sia essa obbligatoria o volontaria – risulta inevitabile in quanto i consumatori lo richiedono sapendo che essa è raggiungibile. Una risposta appropriata a questa sfida è ottenuta dall'innovazione tecnologica mirata a migliorare qualitativamente le colture e a ridurre i costi di produzione. A tal fine le macchine in futuro devono essere sempre più automatizzate, capaci di registrare la qualità delle colture nei vari momenti del loro sviluppo e della loro trasformazione. Gli sforzi correnti nell'automazione robotica avvengono nella giusta direzione, ma richiedono maggiori investimenti governativi e dei gruppi industriali. I programmi pubblici di ricerca agricola in USA vengono svolti principalmente nell'ambiente USDA e delle facoltà agrarie. L'andamento della qualità delle colture beneficerà grandemente dell'introduzione della "nanotecnologia" e dei biosensori. Gli sforzi per adattare i biosensori alle macchine sono critici. Così si dica per quanto attiene tutte le altre tecnologie avvenieristiche che, applicate alle macchine agricole, consentiranno all'agricoltura US di competere globalmente incontrando le esigenze dei consumatori per prodotti alimentari sicuri e di alta qualità.

1.2 Il ruolo della meccatronica nella tracciabilità delle produzioni vegetali e animali

Su questo importante argomento sono state proposte due valide relazioni di base prodotte da: **H. Auernhammer (**Germania) e **I. De Alencar Nääs** (Brasile).

H. Auernhammer ha esordito ricordando che: la modifica dei modelli alimentari dovuta all'evoluzione delle forme di mercato e la sempre più sentita esigenza di salubrità delle varie produzioni agricole richiedono il controllo delle produzioni stesse e la conoscenza della loro storia (tracciabilità) dal campo alla distribuzione. La realizzazione di tali obiettivi comporta, anzitutto, la diffusione di tecniche innovative legate alle produzioni vegetali, com'è per l'agricoltura di precisione e la conseguente generalizzata utilizzazione della meccatronica e dell'idraulica applicate alle macchine agricole. Le recenti applicazioni della meccatronica, in particolare, hanno fornito utili risposte ai problemi tecnici e gestionali delle singole macchine in quanto tali, così come dell'intero parco macchine agricole consentendo il controllo in continuo delle prestazioni, l'ottimizzazione degli impieghi per mezzo di sistemi di servizio gestiti a distanza. Ruolo fondamentale in merito, è poi destinato a giocare la robotica di campo. L'ampia disponibilità attuale e la continua evoluzione della sensoristica e di altri strumenti elettronici consente di realizzare la tracciabilità delle produzioni includendo l'acquisizione dei dati culturali e ambientali, nonché l'integrazione delle varie informazioni. Analogamente può dirsi per la sensoristica da applicare nelle fasi post-raccolta al fine di registrare con tecniche non distruttive le caratteristiche specifiche dei vari prodotti prima della loro offerta sui mercati. L'uso di queste tecnologie e procedure può garantire che la tracciabilità renda sicura l'informazione, evitando manipolazioni improprie e garantendo la qualità dei prodotti. Da qui l'esigenza di: rendere sempre più intelligenti le macchine agricole; sviluppare le tecniche proprie dell'agricoltura di precisione; assicurare la raccolta di informazioni a tutti i livelli della catena produttiva fino alla commercializzazione sviluppando sensori appropriati e l'automazione. Poiché i concetti propri della tracciabilità eccedono normalmente le capacità offerte da singole istituzioni di ricerca così come da singole industrie, si rende necessaria la messa in essere di progetti integrati tali da consentire di raggiungere rapidamente standards tecnici applicabili.

I. De Alencar Nääs ha esordito ricordando che: l'applicazione di biosensori alla produzione animale, essenzialmente basati sulla miniaturizzazione di dispositivi elettromeccanici, è in uso dalla metà degli anni '70 nei vari stadi della produzione, dal controllo dell'alimentazione a quello del comportamento degli animali in allevamento. Tale applicazione, in questi ultimi dieci anni, si è notevolmente ampliata. Si tratta di passaggi interessanti e importanti al fine dell'applicazione dei principi di tracciabilità relativamente a eventi e processi che avvengono all'interno della catena della produzione proteica. L'ultima generazione di queste tecnologie comprende la reale possibilità di immagazzinare dati sugli animali e la loro vita, pervenendo all'autenticazione di protocolli specifici. La gestione di un dato evento, anziché di un quadro generale, così come avviene nel comparto delle produzioni vegetali, porta la precisione della produzione animale a valutare perdite ed a individuare errate diagnosi incrementando l'efficienza e l'accuratezza dell'uso delle tecniche di precisione. L'applicazione della meccatronica nella produzione animale è possibile tramite l'uso di biosensori e degli accennati dispositivi elettromeccanici, consente di migliorare la raccolta dei dati e, conseguentemente, di ottenere più precise azioni al riguardo. Vengono, in merito, riportati alcuni esempi sull'uso di queste tecnologie in particolari comparti della produzione animale.

2.1 Sistemi di rilevazione e raccolta di dati sull'equipaggiamento agricolo

Questo interessante argomento è stato trattato nella relazione di **J. F. Reid** (USA).

J. F. Reid inizia rimarcando che i sensori attuali e i sistemi di raccolta di dati nell'equipaggiamento agricolo sono elementi fondamentali richiesti per lo sviluppo della tracciabilità. Le attuali tecnologie dell'agricoltura di precisione, adottate dai produttori forniscono caratteristiche basilari nella raccolta dei dati nella disponibilità limitata dei sensori. Comunque, a dispetto delle caratteristiche fornite da questi sistemi, la tracciabilità agricola è chiaramente nelle prime fasi di sviluppo. L'agricoltura non dovrà sviluppare indipendentemente tutti gli elementi centrali per la tracciabilità. Per esempio, la necessità di raccolta di dati per la tracciabilità può beneficiare degli sviluppi tecnologici che contribuiscono alla continua abbondanza d'informazione nella nostra società grazie al progresso informatico e di sistemi elettronici. Gli strumenti per processare ed estrarre dati sono in procinto di essere disponibili per usi generici e possono essere adattati alle esigenze dell'agricoltura. D'altra parte i sensori sono un fattore limitante per la tracciabilità. Un motivo è che molte delle caratteristiche riguardanti il raccolto e il suolo sono di difficile misurazione e i sensori esistenti patiscono delle interferenze nelle loro risposte. In aggiunta non sono ancora stati sviluppati importanti sensori per la tracciabilità. Ciò è sicuramente vero per quanto riguarda i sensori atti a misurare le caratteristiche proprie di frutta e verdura. Sfortunatamente, in concomitanza all'aumento di richieste di sensori, la ricerca supporta lo sviluppo di sensori adatti in chiaro ritardo. In aggiunta i sistemi di raccolta di dati necessiteranno di espandersi per eguagliare il livello dei dati richiesti per la tracciabilità. Il trasferimento automatico dei dati tra elementi del sistema intensificherà l'efficacia della tracciabilità; sono richiesti metodi di stoccaggio permanente per provvedere alla registrazione di risposte misurate dalla tracciabilità. Sensori addizionali serviranno a facilitare la misura delle risposte ed a fornire il trasferimento automatico dei dati. Un grande investimento sarà richiesto per sviluppare queste tecnologie innovative.

2.2 Integrazione e certificazione del sistema: le richieste del mercato per la chiarezza e la trasparenza

Di questo argomento trattano le relazioni di **J. Zaske** (Germania) and **L. Bodria** (Italia).

J. Zaske esordisce ricordando che: tutte le parti coinvolte nella catena alimentare esigono sempre di più dal fornitore precedente la prova di qualità e sicurezza dei prodotti. Il fondamento di ciò è una ininterrotta documentazione del flusso del prodotto e di tutti i passi del processo attraverso l'intera catena, dalla produzione primaria attraverso il trasporto, l'immagazzinamento, l'elaborazione, la distribuzione, fino al consumatore. Lungo questa strada, la sicurezza del prodotto deve essere monitorata da ispezioni pubbliche o private sulla base delle regolamentazioni nazionali e/o della UE. A causa degli alti rischi, dovuti alla complessità della produzione e al suo largo volume, l'industria alimentare è stata la prima a stabilire Sistemi Amministrativi di Qualità e Sicurezza (QS) che includono l'Analisi del Rischio e Sistemi di Punti di Controllo Critico (HACCP), che si accordano in generale con la ISO 9000 ff. Industria e commercio non richiedono solo ai produtori primari di fornire grosse quantità di prodotti sicuri di qualità definita e costante. Sempre di più obbligano le aziende o gruppi agricoli a provvedere a ciò, per esempio con la certificazione dei loro prodotti (marchi QS, marchi Bio etc.), o stabilendo propri sistemi di QS-management, sempre in accordo con l'ISO 9000 ff.

L. Bodria sottolinea che: le catene di produzione alimentare stanno incessantemente diventando complesse cosicché un appropriato standard per la sicurezza alimentare è in questo momento di alta priorità per i consumatori. La tracciabilità – che può essere definita come "identificazione delle organizzazioni e flussi dei materiali coinvolti nella formazione di un'unità di prodotto identificabile individualmente e fisicamente" – è uno strumento essenziale atto a fornire il necessario livello d'informazione e ad identificare le responsabilità nel caso di prodotti alimentari non sicuri sul mercato. Un interesse più profondo della tracciabilità è associato all'applicazione volontaria di standards internazionali all'interno di un sistema di certificazione nazionale che controlli l'adesione alla documentazione richiesta. Un sistema di tracciabilità volontario sarà un elemento di valore aggiunto che contribuisce ad aumentare la competitività dei vari prodotti e una garanzia di un impegno libero e consapevole da parte dell'amministrazione dell'organizzazione. Il Club of Bologna, conclude l'autore, deve inoltre stimolare ed incoraggiare uno sviluppo appropriato dell'automazione nella meccanizzazione per fornire immagazzinamento della raccolta di adeguate informazioni e trasferimento capace di "tracciare" l'origine dei prodotti agricoli.

Tracciabilità: il ruolo della meccanizzazione per il controllo dei processi e la qualità delle produzioni

Quest'ultimo, interessante argomento è trattato congiuntamente da un rapporto preparato da **R. Guidotti** e **A. Pagani** (Italia).

R. Guidotti e **A. Pagani** esordiscono richiamando, pur per sommi capi, la storia di questi ultimi 50 anni di sviluppo della meccanizzazione. Solo negli anni '90 essa si è trovata a dover affrontare il concetto della tracciabilità con tutto l'enorme potenziale di elettronica applicata, appunto, alle macchine agricole e ampiamente ricordato dalle precedenti relazioni. Questo concetto travalica il ruolo delle aziende agricole che, in molti casi continuano ad operare senza essersi rese conto di esso e della sua importanza in termini umani, tecnici, economici ed ambientali. Ciò anche se, pure da questo punto di vista, molti passi avanti sono stati compiuti nel progressivo acculturamento degli agricoltori. Questi, tuttavia, richiedono ora tutti una forma di assistenza per un ampia formazione al riguardo, sì da poter rispondere alle richieste dei consumatori. Al momento e per alcuni anni, tuttavia, gli autori ritiengono che – specie a causa della frammentazione aziendale – un contributo materiale per la tracciabilità possa essere fornito dalla diffusa distribuzione territoriale di contracting associations or companies particolarmente sensibili a questi nuovi problemi e in grado di farvi fronte.

Al termine delle varie relazioni, si è aperta, sia a Chicago, sia a Bologna, un'intensa ed utile discussione alla fine della quale i partecipanti hanno concordato sulle seguenti

Conclusioni e raccomandazioni

- ***considerata*** l'importanza crescente della tracciabilità come strumento atto a garantire la salubrità delle produzioni alimentari di origine vegetale e animale ripercorrendone la storia, l'utilizzazione e la localizzazione e, quindi, proteggendo i consumatori;
- ***ricordata*** l'esigenza che un'adozione generalizzata di questo strumento deve impegnare gli stati e i governi dei diversi paesi nell'individuare e definire precise direttive atte a contribuire alla salvaguardia della salute dei cittadini;
- ***richiamata*** la conseguente esigenza di: sviluppare specifici processi informativi su grande scala per: identificare i punti cruciali propri delle varie catene alimentari; promuovere la definizione di standards internazionali delle diverse produzioni nonché dei segnali per la registrazione e il controllo dei materiali e dei flussi energetici propri di ciascun sistema di produzione e distribuzione;
- ***riaffermata*** l'esigenza che la tracciabilità venga definita all'interno del più ampio contesto della certificazione delle aziende agricole;
- ***individuata*** nella meccanizzazione la chiave per la definizione della storia delle singole produzioni che dall'azienda entrano nella catena alimentare per giungere sino alla mensa;

i partecipanti, unanimi, raccomandano:
al Club of Bologna di:

- assumersi il compito di approfondire, tramite specifici gruppi di lavoro le varie procedure necessarie a detta tracciabilità, definendo le nuove tecnologie necessarie - basate su appropriati sensori e strumenti elettronici oltre che su programmi informativi adatti - a raccogliere, immagazzinare, controllare e trasferire le informazioni acquisite sulle diverse produzioni alimentari, sì da offrire ai vari paesi gli strumenti utili a legiferare in merito;

- collaborare strettamente con i gruppi industriali per la definizione delle tecnologie necessarie, considerando le specifiche esigenze tecniche ed economiche proprie dei vari paesi con particolare riguardo a quelli emergenti nei quali l'agricoltura resta tuttora la componente principale delle loro economie;
- promuovere un'ampia azione educativa e di training tecnico per gli agricoltori, sì da consentire loro una completa ed efficiente gestione della tracciabilità;

all'industria costruttrice di macchine agricole di:

- completare con urgenza le linee delle macchine commerciali con appropriati strumenti atti a tracciare ed acquisire informazioni durante lo svolgersi delle operazioni proprie delle aziende agricole e zootecniche;
- porsi come completo e valido partner nei necessari negoziati con le altre industrie della catena alimentare al fine di definire con precisione a quale livello le informazioni sulla tracciabilità siano necessarie;
- assicurarsi che la tecnologia propria della tracciabilità sia adatta alle esigenze delle condizioni di lavoro proprie delle aziende agricole senza apportare ulteriori aggravi di lavoro ma anzi promuovendone l'uso;
- garantire che il costo delle nuove tecnologie aggiuntive sia affrontabile da parte degli agricoltori e delle imprese di meccanizzazione, con speciale riferimento alle esigenze economiche dei paesi in via di sviluppo;
- completare le proprie esperienze e conoscenze nel progetto, nella produzione, nella vendita e nella manutenzione dei sensori adatti, del software, dell'hardware per la gestione dei dati, la comunicazione ecc;

al comparto agricolo di:

- migliorare il proprio livello di conoscenza per essere pronto ad operare con queste tecnologie appropriandosi del loro uso;

alle istituzioni di ricerca di:

- svolgere attività utili a far fronte alle importanti ricorrenti sfide tecniche per soddisfare gli obiettivi della tracciabilità, operando in stretta collaborazione col comparto industriale ed agricolo.

13th MEMBERS' MEETING (*Part 1*)

Chicago (USA), 27th – 28th July, 2002

In the occasion of:
the ASAE Annual International Meeting and the XV World CIGR Congress

Opening Session

Session 1

Mechanisation and traceability of agricultural production: a challenge for the future

1.1 The quality of productions. Market needs. Institutional and prescriptive aspects

1.2 The role of mechatronics in the traceability of crop and livestock productions

Leading person: ***Richard O. Hegg, USA***

List of participants

OPENING SESSION
Leading person: Giuseppe Pellizzi, Italy

Prof. Giuseppe PELLIZZI
President of the Club of Bologna – Italy

I am especially pleased to be opening this working session of our Club of Bologna which – as already happened in 2000 in Tsukuba (Japan) – is being held here in Chicago in conjunction with the Annual International Meeting of the ASAE and the XV CIGR World Congress. All this confirms the importance of the Club's activities, which are carried on with the backing of UNACOMA (Italian Association of Agricultural Machinery Manufacturers) and under the aegis of CIGR itself. The subject we are about to discuss—the issue of traceability—and which will later be completed in the forthcoming meeting to be held, as usual, in Bologna on 16th and 17th November of this year, is of particular importance both to help combat hunger in the world, as well as to answer the growing demand for safe and healthful foodstuffs. In fact traceability is, very simply put, the history of each food product beginning with the preparation of the land in which it will be grown, to the harvest operations, its subsequent partial or total processing, and ending with its placement on the market. This is a topic that has been discussed and worked on for some years throughout the world, and the first concrete decisions – such as the European Union regulation passed on 18 January 2002 – defining methods for monitoring the entire supply chain, have already been adopted by the main countries. But – as unfortunately still happens all too frequently – the prevalently biological character of these issues means that lawmakers completely forget the role of mechanisation and equipment in the supply chain, thereby neglecting the associated problems and needs. However both machinery and equipment play an indispensable role in every stage of the supply chain, and it is therefore necessary to be able to evaluate them, understanding their performance, identifying the needs for innovation and fulfilment of specific requirements for assuring the quality and safety of products. Consider, by way of example, the important effects which machines for spreading fertilizers and pesticides can have in this connection, and the ensuing need for adjusting the operation of such machines. This is why we consider it important to begin discussing these complex problems as of now. And we will be doing this with two sets of papers, the first of a general character and the second with a more technical and scientific slant, precisely in order to underline the role that mechanisation must play, also as a tool for tracking the production process and safeguarding the consumers. These papers will deal with the following topics: the first two papers will discuss the meaning of traceability, the quality of productions and the needs of the markets; the second two papers will address the role of mechatronics in the traceability of plant and animal productions. The speakers will be: Prof. Paolo De Castro (Italy) and Prof. Francis Pierce (USA), followed by Prof. Hermann Auernhammer (Germany) and Prof. Irenilza De Alencar Nääs (Brazil). I extend our warmest thanks to all of them and wish them all the best with their presentations, which I hope will be followed by a serious and constructive debate that will enable us to draw useful Conclusions and Recommendations.

Before closing and handing over the presidency to full member Prof. Richard Hegg (USA), who has kindly accepted to serve as chairman of this session, I would like to extend a warm and friendly greeting to the official representative of UNACOMA who is here with us – Mr. Tugnoli – as well as to CIGR President Bartali, and to ASAE President Skaggs. I have had the pleasure of spending some interesting discussion days with both of them in April in Morocco. And finally, a special thank you goes to ASAE for the support which they have once again given us, to New Holland America and in particular to Dr. Allen Rider for his customary helpfulness in organising yesterday's excellent technical tour.

Please allow me now to add a few remarks on:

- *what has been done for the propagation of the Code of Ethics which was discussed extensively at our last meeting;*
- *what steps have been taken for the proposals put forward by K. Renius for setting up a permanent structure for the transfer of technology to African countries.*

Well, for what concerns the Code of Ethics, we have distributed it to all 12 European associa-

tions of agricultural manufacturers adhering to CEMA and to EMI in the United States; for what concerns Japan, I have asked Mr. Kishida to directly forward the Code to the Japanese association of agricultural machinery manufacturers. All these recipients have been asked to examine the document and get back to us with their comments and opinions. So far, I have only received responses from a few associations, but I am confident that more will be forthcoming. For what concerns Prof. Renius' proposal, we have contacted various Italian and international organisations to illustrate what is needed, requesting an initial financial contribution able to permit to about ten experts from different developed countries to attend an initial meeting that will be held in Morocco, hopefully, I hope within the end of the year. At the same time, we are establishing contacts with organisations in Asia and South America for the same purpose. The activities are therefore growing ever more intense and, I hope, productive.
I now give the floor to Valerio Tugnoli, followed by Bartali and Skaggs.

Prof. Wayne SKAGGS
President of ASAE – USA
Thank you Prof. Pellizzi. It is a pleasure for me on behalf of ASAE to welcome you to the USA and to Chicago. We are glad to have you with us as we hold our 2002 Annual International ASAE meeting jointly with the 15th CIGR World Congress. Many of you are members of ASAE and many of you do not get the chance to be with us often, and we are particularly glad that you are here. ASAE is this year 95 years old. In former years, just a few years back, we held two meetings per year and almost every year one of those meetings was held here in Chicago. Conditions are a little bit different now than they were at those meetings, which were held in December in the rain and the snow and sleet, usually or often. Nevertheless, we are glad to be back here in Chicago again and I hope you will be enjoying your stay here as the meetings go forward. You were housed yesterday by two former ASAE presidents, Al Rider and Gail Holloway of CNH. I understand your field trip went well, and that the weather cooperated, with the sun coming out in the afternoon, just as we promised that it would. You have an outstanding programme planned for today, and I am sure you will have productive sessions. I hope all of you are planning to attend the CIGR-ASAE meetings starting today through Wednesday, There will be over 900 technical papers presented at the meetings which will be organised in technical sessions to accommodate both CIGR and ASAE technical presentations. The meetings will include presentations by many of the world's experts. You are some of those experts and you will be making some of those presentations. Those papers will be on topics that span the breadth of our profession. I am going to particularly call your attention to the session 75; there are many other interesting sessions, but session 75 is on agricultural engineering and international development in the third millennium; it will be held on Tuesday starting at 9 a.m., in rooms K and L. I think that this will be a session of particular interest to many of you.
Of course, our meetings also include normal receptions, discuss events, tours. I think it is shaping up a bit to be an outstanding meeting and we appreciate you participation in it with us. If you have not registered yet and you wish to do so, there is still time. The registration desk will be open today just outside this room, just down the hall. Again thank you for your attendance, your presence here adds to the prestige of the ASAE-CIGR meetings and helps us to make this cooperative effort truly a world-class event. Thank you for being here.

Mr. Valerio TUGNOLI
Representative of UNACOMA – Italy
At this session of the Club of Bologna, I have the honour of representing UNACOMA's President, Aproniano Tassinari, and its Director General, Carlo Ambrogi, who are unable to attend, as they would like to do, this meeting, which coincides with the International Conference of the American Society of Agricultural Engineers (ASAE) and with the 15th World Congress of the International Commission of Agricultural Engineering (CIGR). Besides greeting all the participants on behalf of UNACOMA, I would like to express the organisa-

tion's warm appreciation to Prof. Giuseppe Pellizzi, the Club's President, for all he has done, and I would also like to give a special thanks to Prof. Paolo De Castro, President of Nomisma, an important Italian Institute, who will be reading a directory report. The leitmotiv of this session is "Mechanisation and Product Traceability: a Challenge for the Future". It will be followed up when the Club will meet in Bologna in November. The title expresses one conspicuously important aspect: where should agriculture be heading for; hence, the increasingly decisive role falling to mechanisation in ensuring higher product quality together with compatibility with the environment. This explains why there is such interest in the role that can be played by mechatronics in product traceability. I certainly don't plan to get into the substance of the debate here. But I think this is a good chance, on behalf and in the name of the Italian Agricultural Machinery Industry Association, to confirm UNACOMA's full willingness to continue its support for the Club, both in its home turf in Bologna, at EIMA, but also at other events such as here in Chicago that attracts the attention and interest of international experts, who thus ensure a debate with highly qualified participants and contributions. We are convinced that technical and technological issues of which mechanisation is surely emblematic cannot be considered independently of what we might describe as a cultural pre-condition. This is why the knowledge in question should be propagated to all the geographical areas where agriculture is practiced, as a function - in different social and economic realities - of the value of the tools that mechanisation makes available: tools that can be modulated according to the needs emerging in each area as a result of history, traditions and lifestyles, in brief, the differing life-stories of the each people and civilisation. This is why the birth of the Club of Bologna and its evolution over the years represent something going well beyond the affirmation of an association of agricultural mechanisation experts at the highest level. It also provides a stimulus to initiate a debate and an improvement, identifying solutions that will work in countries with an advanced agriculture, but also in the developing countries to which increasing attention must be directed. Above all, the Club's role must be to create a climate of cooperation in which it is possible to transfer the knowledge acquired to the vast range of people involved, as well as to public opinion. Once again, I thank you for your participation on behalf of UNACOMA and wish you a good debate.

Prof. El Houssine BARTALI
President of CIGR – Morocco

Thank you very much, Prof. Pellizzi. I am pleased, also on behalf of CIGR to say that we are very proud and happy to see the Club of Bologna meeting take place on the occasion of this joint 15th World Congress organised by the CIGR in conjunction with the annual ASAE meeting. While we were touring yesterday I counted 17 countries represented in this Club of Bologna meeting, which I add, as Prof. Skaggs said, give prestige to this event. The subjects that are debated are of the utmost importance for the CIGR global network and we are happy that we can benefit from the discussions and put this in our e-journal newsletter in order to communicate them to the rest of the world.

Let me say that Prof. Pellizzi, who is behind this initiative, and UNACOMA are eager to contribute to CIGR feasibility. In Marrakech last April, Prof. Pellizzi attended a special meeting of CIGR, there were also Prof. Skaggs and the meeting was to prepare this big event of Chicago. I am also happy to mention that from what I heard, Prof. Pellizzi was also behind UNACOMA to prepare a meeting in Morocco that is to take place towards the beginning of next year and which will be joined to a field day where Italian agricultural machinery will be on exposition and introduced to Moroccan agriculture. But at the same time, about 20 African participants will be sponsored to come and see what can be adapted to their context. This in fact, as you know, is the best way to support and develop technology transfer and we are grateful to support the unity that UNACOMA and Prof. Pellizzi of the Club of Bologna offers us.

I wish your meeting every success and thank you again for your participation.

Giuseppe PELLIZZI

Thank you very much El Houssine for your speech. With this, we have finished the opening session. Let me remind you, before we start with the work, that, in your bag, you have a yellow sheet with the address of each of you. Please check it. There are some modifications. If something is modified, in the e-mail, or in the fax or in the address, please inform the secretary.

I am pleased to give now the floor to our session chairman, Prof. Richard Hegg.

SESSION 1

Mechanisation and traceability of agricultural production: a challenge for the future

1.1 The quality of productions. Market needs. Institutional and prescriptive aspects

1.2 The role of mechatronics in the traceability of crop and livestock productions

Leading person: Richard O. Hegg, USA

Prof. Richard O. HEGG
USA

I am very pleased to serve as moderator today and I think it is a very interesting and fascinating topic to address, because it ties in the future of our agricultural-food system, it ties sort of in the engineering aspects, and what kind of roles we and our countries can play. Certainly there could be some tremendous challenges out there in the future and this ties in so I think it is an excellent topic for our session today. And I might make some comments from my personal perspective of looking at these issues we're seeing the issues of traceability as we will find out in the plant systems and certainly also in the animal systems in this food production. In some cases it could be for environmental purposes. We might look at the water, soil and air; what is happening, what is affecting them and why do we need to trace what we are doing in agriculture. Another aspect would be in the food safety area, for example. Many concerns for what has been added in food, what has been modified and to be able to trace that back to the source; once again, another huge challenge for us. Another one that I can think of is workers' safety. This relates back to the machinery and the machinery system, where there are weaknesses and problems that might affect workers' safety. So, those are sort of three examples. Another one that we have probably to keep in perspective here, is looking at what is appropriate for developed countries and what is appropriate for developing countries. A different kind of technology, a different situation and different problems that we and this group would have to address and look at those types of things.

Two other different ways to look at it I think of traceability's legal requirements. What regulations will you have in your country that will require you to trace? For example, we could probably project in the years ahead and in some cases right now where you are using insecticides and pesticides and herbicides. Where are they being used. Tracking, tracing monitoring, record keeping of all that. If you do not have that, it is probably going to be coming. So that is for the legal requirements. Another traceability that we have seen evolved in many countries over the last two years is the marketing of products and I think of the example and even the gentleman of the farm we visited yesterday, if you picked up a little bit of his conversation you will have heard him talking about some of the beef animals that he produces and he uses the Aberdeen Angus and in this case he gets an additional price supplement for that – he can market it as Aberdeen Angus. So they have to be able to track and trace that there is Aberdeen Angus type of beef. So it is for marketing and we think of the organic food areas. Being able to track and trace that something is certified as organic. Again, a lot of traceability is going to be required, and from an engineering aspect we will have to play a major role in that.

Before I turn it over to our first speaker, I wish to remind you that in your packet you also have a couple of sheets that I described before, that you can write down key sentences that you might want to, not present but turn in at the end of our sessions. So you have got a couple of pages there and my suggestion is that, as the discussions and presentations go on, you make some notes yourself and at the end of the day you write down some of those key sentences and you can turn them in to the secretary or to Prof. Pellizzi or myself, so we can gather those and use as part of our Conclusions and Recommendations. I guess that I am going to keep track and when we get to the discussion part and we can try and keep on target and not diverge too far away from the topics we are trying to address today so in some cases I might ask you either to reduce your comments or to focus in; so I apologise for maybe having to do that but we want to address the issues of the day.

So the overall purpose of this and I think we will do well to set it off as recommendations. We have some tremendous experience and brain power in this room from a variety of countries and if we can bring something together, some key recommendations that we can then support, and promote, and push for-

ward to the potential industry or policy makers. This type of thing is what we want to be able to do. So what would be the end goal of today is to have some good recommendations that we feel for that can be supported in the future. That will conclude my comment and the first speaker I would like to introduce is Prof. Paolo De Castro professor of Farm Economics in the University of Bologna. He will be making our first presentation. Then we can continue with the second presentation by Francis Pierce and Ralph Cavalieri.

Topic 1.1 a - The quality of productions. Market needs. Institutional and prescriptive aspects in EU

*by **Prof. P. De Castro** (Italy)*

1. The consumer and food market changes in the European Union

The recent years have seen a substantial and sudden change in the behaviour and in the relations between consumers and the agri-food chain. These changes, though characterised by distinct dynamics, have a common root in the relation with quality.

If, on one hand, the relationship between consumers and food produce has experienced, in functional terms, a growing demand of product built-in services – such as single dose packs, fast food, whether frozen, fresh in modified atmosphere or vacuum-wrapped – on the other, the demand related to the process and the production system has taken a great visibility. The consequence has been that consumers in purchase choices are considering new issues: “how is it obtained?”, “where is it produced?”, and “what are the impacts of the production methods on the environment and on land?”. Considering the market and non-market problems occurred over the last ten years, these questions seem particularly topical and urgent in the field of animal husbandry, while still involving, at least for the future, the whole agri-food sector.

The data of a recent survey on Italian consumers provide quite clear indications on the ranking of food products perceived as being of higher quality (**Table 1**). In other words, the table illustrates the “premium” consumers are willing to spend to ensure quality produce.

As clearly indicated over 90% of interviewed are willing to pay a premium. In particular, one third of the sample is willing to pay between 6 and 10% more than the conventional produce. There are, however, substantial shares of consumers who are willing to recognise largely higher price differences.

A recent survey of Eurobarometro on the EU consumers does confirm these values.
Shortly, it may be stated that, from the perspective of the EU production firms and chains, quality is a choice that may find a direct return in the consumer even in economic terms. Obviously, for these indications to translate into effective economic results, it is necessary to achieve and communicate a quality that is perceived and could be recognised by the consumer.

Next to these “traditional” definitions of quality, a new issue has been recently emphasised, that is food safety. Focus on this has been induced and stimulated by particularly attracting issues for the public opinion and the media, such as the “mad cow”, the debate on biotechnologies and on genetically modified organisms (GMOs) in the food sector, and even some scandals such as the Belgian dioxin-chickens.

Moreover, looking closely at the Italian reality we discover further paradoxes that deserve some reflections. This is the case of the BSE in which Italy has seen, on one hand, the highest drop of domestic consumption of beef in Europe, and, on the other, one of the lowest numbers of affected animals in Europe. Actually, in 2001 the Italian beef sector has experienced a 28% fall in consumption, with -30% for veal and a less, although evident, marked reduction for beef (-25%). This trend is countered by the increase in pork (+18%), poultry (14%) and rabbit meats (4%).

Such severe effects did not occur in other European countries, where the epidemic showed stronger effects: from 1987 to 2001, indeed, over 18,000 cases of infected animals were observed in Great Britain, 277 in France, 246 in Ireland and 125 in Germany, against 50 cases only recorded over the same period in Italy.

In the same way, other affairs that have concerned the European poultry sector have not spread in our country thanks to the high health-sanitary standards adopted. Nevertheless, despite these objective data, the consumption on the domestic market has, however, decreased as a result of information campaigns and of the attention devoted by media to food scoops.

2. The changes and the new orientations of the EU agricultural policy

Besides the direct impacts on the market and on demand behaviour, these events have had a further effect that has no precedents in the past; they have indeed modified the attitude and the citizen-consumer relation as well as the whole chain related to foodstuffs. This has also influenced the Common Agricultural Policy (CAP), that is the system of rules, tools and economic resources aimed in the past to ensure the food requirements of the European Union but also the economic conditions and farmers' income. For some years the CAP has been put under "observation" by the public opinion because, on one hand, it absorbs a considerable share of the Community budget, nearly 50% with an expenditure of over 40 billion euro, but, on the other, it has not been able to prevent "shocks" such as the BSE and swine fever, and to ensure the consumers' and citizens' safety, in general.

This has pointed out explicitly the issue of the quality of rules and of the agricultural policy, but also the problem of their acceptance by the public opinion. On this basis it is interesting to look at the data of the last Eurobarometro survey of 2001, which has indicated the objectives the European citizens would like to have as basis of the CAP (**Table 2**).

The table shows the theme of the new objectives as compared to the past; the priorities are the "safety and healthiness of products" (90%) and the "environmental sustainability" of productions. Vice versa the economic and productive objectives that have supported the historical functions of the CAP are not considered today as being priorities.

If we consider the recent evolution of Community policies we find that some major moves have been made in the direction indicated and expected from citizens.

First of all the White Paper on food safety and the so-called "Food Law" of July 2001. In compliance with the prescriptions, in few months the Authority for food safety will be established. Next to these horizontal "pillars", which are essential to build a relation of confidence with the consumers, the other great effort should concern the CAP. The CAP is making, during these weeks, the first moves towards the mid-term review of the agreement on Agenda 2000, signed in 1999. This will give the opportunity both to check and improve the relationship of agriculture with the markets and to revise the relevant tools and objectives. The CAP will increasingly become a tool able to orient the farms' and the system operators' behaviour towards quality and consumers' expectations.

The European agri-food chain is facing the new cause and effect relationship that relates the CAP, its cost and the objectives it is intended for. If the definition of the objectives, based on the review of the CAP scheduled for 2003, is respondent to the "new" citizens' requirements it will be maybe possible to undertake an action of sustainable development of the agri-food chain and of its enterprises over time. In this action, more than in other options, quality products could find the appropriate space.

Nevertheless, these new bases do not only concern the European Union but also involve directly the countries and international production systems. This is due, on one hand, to the constant increase of the international trade of agri-food products with the subsequent enlargement of the scope of the rules and requisites of products and of their production systems. On the other hand, there are an increasing number of countries in which the public opinion and the politicians address explicitly new requirements to the agricultural and agri-food sectors.

3. The EU approach to quality and food safety

Without going deeply into the specific policies, these scenarios find a common denominator in the new needs of "assurance" on food safety, in general and on the transparent certification of production processes and of the single products being used and obtained.

Adequate tools should support this assurance, and it is within this context that the European Union is strengthening the need to introduce systems of product traceability. This is a choice that opens up new prospects, such as the handling of information, the labelling and segregation of sectors (the so-called identity preservation).

The development of the European food legislation has been influenced, over the last forty years, by scientific, social, political and economic forces. Within this period, the food legislation has pursued different strategic objectives, such as harmonising the national measures and supplying a basis for the domestic market, or adopting common measures within the common agricultural policy (CAP). Although not always explicit, these objectives have been indissolubly related to the creation and keeping of a high level of human health protection, consumers' safety and safeguard. The multiple objectives have entailed some differences in the approach to food legislation as well as inconsistencies or even gaps.

On this basis, the White Paper on food safety of the European Union has defined the strategic objectives, the priorities and the work programme relative to food legislation, in general, and food safety, in particular. Actually, the White Paper has confirmed and defined the commitment of the Commission to devise an overall integrated approach to regulate the entire food chain. In particular, the White Paper has launched the proposal to establish a European Food Authority and has provided a complete range of definitions, principles and measures to ensure a high level of protection and an effective operation of the domestic market in the food sector.

The White Paper has identified the need to face the issue of consumers' and commercial partners' confidence in the European food sector. Consumers and commercial partners have actually lost confidence in the public bodies' capacity to regulate and control the safety of food supplies, in the system of elaboration of the European food legislation and in the European institutions themselves. This has necessitated a substantial revision of the Community organisational system.

The need to have promptly a sound and reliable scientific consultancy in a sector that is getting more and more innovative and technological, is heavily weighing on the European system of the scientific committees in charge of devising specific views. The Community legislation makes use more and more of scientific evaluations designed to protect the European population. In the food sector such a task is charged to the scientific committees established by Commission decision No 97/579/CEE2, that sets up the scientific committees in the field of consumers' health and food safety, and decision No 97/404/CEE3 that establishes a steering scientific committee. This growing need has inevitably enlarged the system, both in terms of the committees' ability to assess the safety of scientific papers and for the evaluation of more general issues relating public health.

This proposal reviews the organisational changes required to ensure the working out of scientific views and to encourage co-operation with the member States so as to ensure the best use of the available skills.

The regulations of the European Parliament and Council (COM2000/716), commonly known as "Food Law", have actually materialised these objectives, establishing the principles and general requisites of food legislation, and fixing some procedures for food safety, including an early warning system for food and feedingstuffs. Moreover, it has established the European Food Authority, defining its scope, tasks and responsibilities.

Contrary to the relatively recent development that food legislation has experienced at the Community level, the national laws in the food sector are much older. Therefore, the definitions of food and the general principles and requisites of food legislation are deeprooted in the legal history of some member States.

While having similar notions and principles, national provisions show some differences in terms of methods and details, which can disrupt the domestic market operation.

In other words, they refer to some basic principles, definitions and guidelines (also in terms of obligations and responsibilities for enterprises) that could be useful for the future review of the measures in force or for working out proposals in new sectors. One of the strengths of "food law" is that it has fixed some common definitions, including the definition of "food", and has established the guidelines and general legitimate objectives of food legislation, so as to ensure a high level of health protection and an effective operation of the domestic market.

In conclusion, focussing on the legal issues related to the origin, the recent food scandals (BSE and dioxin) have shown that the possibility to identify the origin of feedingstuffs and foods, including the ingredients and food sources, plays a major role for consumers' protection. In particular, the traceability facilitates the possible withdrawal of foods at risk, and allows consumers to have ad-hoc and accurate information on the products concerned. The recent proposals of the Commission that are directed to re-formulating legislation in the field of food hygiene indicate the general requisites applicable in this field and enable, however, derogating the need of traceability in the sectors where it is not feasible while establishing, where necessary, more specific requisites.

In particular, there is already an existing trend for all feedstuff and food producing companies to establish systems enabling them to identify their own suppliers of food, feedstuffs and animals intended for human consumption, as well as those who, in turn, supply their own products.

This is to be made available, upon request, to the relevant authorities. This provision also concerns importers, as they should be able to identify those who have exported a given product from a third country. This measure is intended to ensure that enterprises are at least able to identify the previous and subsequent rings of the food chain, unless specific provisions require a greater traceability.

4. Enterprises and chains towards traceability: new roles for mechanisation

Without going deeply into the regulatory and legal aspects, it is now possible to address the key issue of my presentation, that is the implications and effects of new quality tools, in particular traceability, on the agricultural sector.

First of all, it is important to underline that the past experience points out that the single components of the sector cannot, per se, satisfy the conditions required to ensure the consumer effectively: it is therefore essential to ensure an integrated sector-based approach, which has long been accepted at the European level, and emphasised in the White Paper on food safety.

This means that each operator of the food chain, ranging from agriculture to distribution, should be responsible for his/her competence, developing "sector protocols" that include also the points of change and transition from a phase to the next.

If considering the quantitative aspects, the experience of countries that are currently involved in the production of GMO agricultural products– such as the USA – provides important indications showing that there are – above all – direct effects on production costs.

From a recent study of the EU Commission referred to the segregated management of maize and soy-bean in the USA, it results that farms have experienced an increase in production costs between +6/7% and +16/17%. The cost items with the highest impact are those referred to the management of contamination and to the transportation and storage phases.

But the effects of this situation affect the whole sector, including the first buyers such as the milling and feedingstuff industries. The purchase price of "ogm-free segregated" maize and soybean in the USA experience exceeds the conventional price by about 13 US$/ton for maize (about 10% of the price) and 40-45 US$ for soybean (about 15% of the price).

Nevertheless, we should frame these brief indications in a larger context. Above all these significant impacts on costs could change significantly as related to the scale economies resulting from a large spreading of these methods. On the other hand, the recent experience does confirm that the adoption of these methods can support policies of supply differentiation and commercial upgrading, thus shifting actually on final buyers all or part of the actual increase in cost.

Lastly, we cannot ignore that in some cases, these new production orientations are not an option but a forced choice to aim at the long-term sustainability of agricultural activities and of the agricultural policy as well.

In the light of these indications, we can draw some conclusions on the effects of these scenarios on the future prospects of agricultural mechanisation. These prospects could be analysed at two levels:
• directly
• indirectly.

The first level is the one that derives directly from the application in food sectors of traceability systems, and hence their extension to all production phases, including those related to the field.

Within this prospect the major relevant item for agricultural mechanisation is related to the issue of segregation, that is the autonomous or fully separated management of entire production chains. At present, the needs of traceability associated to segregation are strong for "ogm-free" and organic sectors. Nevertheless, these needs are likely to extend in the forthcoming years to other certified productions that shall be segregated.

These methods of chain management necessitate and will increasingly necessitate a special focus on the possible sources of crossed contamination. Within this frame the demand for specific mechanical tools and means related to the needs of segregated management will grow and will demand both technical solutions able to respond effectively to crossed contamination problems (attention is to be paid to the cleaning of means and mechanical parts) and mechanical means, more flexible in use and likely to be efficient even at different scales from the present ones.

On the other hand, it is necessary to assess the "indirect" effects resulting from the prospect of technical means demand in relation to the new agricultural and food scenarios. These scenarios could lead to:

- re-define the geographical distribution of productions in different world areas, within single macro-areas or within the European Union;
- reduce the subsidies (despite the recent change in trend in the USA), notably those oriented to direct objectives of increase in production and productivity, with possible negative impacts on the capacity to invest in technical means;
- further trade liberalisation, with the major effects of China accession to the WTO and the future accession of Russia;
- and lastly new demands even for technical means will emerge; in this sense the most relevant case is that of Eastern Europe countries that will join the European Union starting from 2004, thus causing an enlargement of the European agriculture by over 60 million hectares.

Next to these dynamics there are other major variables that are still very uncertain; they range from the signing of agreements on international trade (especially for the contents related to the Trips and the international protection of designations), to the mid-term review of the European Union agricultural policy (Agenda 2000).

Table 1 - How much one is willing to pay as an extra for a quality produce [Source: Swg 2001 Investigation “The challenge of quality”].

EXTRA-PAYMENT	SHARE (%)
Nothing	5
Till 5%	20
Between 6 and 10%	33
Between 11 and 15%	16
Between 16 and 20%	11
Between 21 and 30%	6
Over 30%	5
I don’t know	4

Table 2 - What do the European citizens expect from the Common Agricultural Policy [Source: 2001 Eurobarometer Survey].

OBJECTIVE	SHARE FIRST OPTION
Safe and healthy products	90%
Respect of the environment	89%
Protect small enterprises	82%
Adapt agriculture to consumers’ needs	81%
Improve the living conditions in the rural world	80%
Increase the competitiveness of the EU agriculture	78%

Topic 1.1 b - The quality of productions. Market needs. Institutional and prescriptive aspects in US

*by **Prof. F. J. Pierce** and **Prof. R. Cavalieri** (USA)*

1. Introduction

The topic evolved from the belief that the new trend on traceability of products is related also to an appropriate mechanization and that each machine has to answer to the quality requirements of food needed by the market (Prof. Giuseppe Pellizzi, personal communication, 2002). In this paper, we address the topic of traceability in agriculture and what traceability means to the future of agricultural mechanization with particular reference to the state of agriculture in the US Prof. Paolo De Castro addresses this topic with reference European conditions.

We approach this assignment with the following perspective. Our context will be production agriculture in the US, with special reference to irrigated agriculture of high value crops. We will briefly address the "state of agriculture" in the United States because there are many issues beyond traceability that are shaping the future of agriculture in the 21st century and that create new demands for technology and mechanization beyond that needed for traceability. It is our premise that US agriculture in general must reduce the cost of production of the highest quality crop and food products if it is to be competitive in a global market with both global and localized demands on what is produced and how. We then discuss traceability and what that means to US agriculture. Regardless of whether traceability is mandatory or voluntary, it appears that the US must be able to deal with it because consumers will continue to demand it and because it is achievable with current if not emerging technology. We discuss three areas where mechanization can contribute to crop quality and traceability: Automation, quality detection, and tracking. We conclude with a belief that while technological advances to improve quality and traceability of crops and food products are feasible, the degree to which the US can produce the needed advancements in these areas depends on the strength of its research programs in agricultural mechanization and technology development. At this point, the public capacity in the traditional agriculture research institutions in the US is not adequate for the challenge due to lack of funding and national priorities in this area over the last few decades. Gearing up the research capacity for this effort should be a priority for the US.

One caveat before we proceed. Nowak (personal communication, 2002) suggests that there are two agricultural systems emerging in the US: the large, commercial, highly mechanized producer and the small, niche market, green label producer often found in the urban fringe. Nowak suggests that the latter group will not need traceability since the market they serve does not demand it and accepts the food they sell because they are "local" or their market pitch sells "trust". Therefore, while our discussion may not pertain well to this agricultural system, it will have relevance if these producers engage in the broader marketplace, particularly the world export market.

2. The State of Agriculture in the United States

Any discussion about mechanization and traceability must begin with an appreciation of the economic environment in which US agriculture must operate. Eastern Washington agriculture experienced a rash of difficulties during 2001 that exemplify the general state of agriculture in the United States. In January, 2001, potatoes were selling for US$ 0.022 per kg, well below the cost of production, largely due to a glut of potatoes on the market. In February, the anticipated drought from lack of snow pack in the mountain ranges of the Pacific Northwest and Southwest Canada caused water districts in Eastern Washington to reduce irrigation supplies to junior water right districts to about one-third of their normal allocation. In some areas of the Pacific Northwest, specifically Kalamath Falls, Oregon, water was completely shut off to hundreds of thousands of acres of irrigated land. Low water levels increased the competition for water resources due to priority water rights for fish in Eastern Washington rivers. The Western United States' electrical energy crisis hit, further reducing water availability and taking hundreds of thousands of acres out of production when the water rights for those lands were purchased by power companies like Bonneville Power Administration. In April and May 2001, the Bush Administration proposed extending and broadening of the Andean Trade Preferences Act (ATPA), which expired at the end of that year and gives duty free or reduced-rate treatment to the products of Bolivia, Peru, Ecuador and Colombia. Agricultural products arriving from countries covered under earlier version of this Act, such as asparagus, reduced the market price to levels unsustainable to these US industries. The year 2001 was the last year for farmers in select counties in Washington State to meeting strict water quality standards for irrigation in which water leaving a farm field has to be as clean or cleaner than irrigation water entering that field. The US Environmental Protection Agency (EPA) continued their process of removing targeted groups of pesticides from the market, many of which have been essential to pest management in irrigated crops of Eastern Washington. These changes are part of a general move to what are referred to as "soft" crop protection chemicals that are much more selective and allow for the management of beneficial organisms. Finally, apple growers lost money for the third straight year in 2001, resulting in the consolidation of both growers and processors in the tree fruit industry. The year 2002 has the same problems perhaps with a different set of players. This year, drought plagues other regions of the US, such as Colorado, which is experiencing the drought of a century and widespread fires.

The long-term outlook for farmers and agribusiness has not been bright for these and many other reasons. Globalization, national policy, environmental accountability, competing uses for water and farmland, frequency and intensity of drought and floods, energy shortages, and overproduction all make farming tenuous. Add to that concerns over food quality and safety, and most recently, homeland security, and it becomes increasingly difficult to select the business model needed for sustainable food and fiber production. The relevant point is that any discussion about the effects of traceability on mechanization cannot ignore the other factors shaping agriculture in the United States.

Solutions proposed to reverse the downward trends in farm profitability in the US take three general tracks: legislative, including farm subsidies and trade protection; increased marketing; and improved competitiveness. The recently passed Farm Bill is record setting in the dollars allocated to farm subsidies in the US; thus, the legislative track is increasing in intensity, although arguably, there are winners and losers here. Increasing markets for farm and food products is generally the favorite of farmers because it fulfills the notion that anything they can produce can be sold. Many would like a return to the scenario that occurred in the early 1970's when grain prices quadrupled and farmers were encouraged to farm "fence row to fence row" [1]. Improving competitiveness involves a preference for our products over others. While very desirable, this is the most difficult track for agriculture largely because it involves improving quality while at the same time reducing the cost of production and requires strict attention to consumer preference, which is often illusive and constantly changing. Traceability is important here because product differentiation and branding foster competitiveness and require traceability and/or identity preservation. However, there is more to competitiveness than traceability.

Consider the apple industry in the United States, which has declined, in recent years due to issues discussed previously. Until the last two years, apple growers were not receiving direct payments from the Federal government that several commodities enjoy. While accepted by growers as short term aid, for the most part, apple growers do not want to take this track in the long-term. Marketing has been and will continue to be an integral part of the apple industry and is well supported by industry dollars. However, after three years of losing money, this industry has realized that marketing alone cannot sustain profitability. The fact is that globalization has made it possible for others in the world to produce apples at lower prices and levels of quality that are adequate to compete with US apples. The US apple industry now realizes that it must increase it's competitiveness in global and domestic markets by offering the highest quality apple at an affordable price. While simple in concept, this is difficult to achieve for two reasons. The cost of apple production has and continues to increase while retail price and total consumption remain flat; and, secondly, consumer preferences have changed more rapidly than the industry's products have changed.

To this the tree fruit industry in Washington has responded by developing a "Technology Roadmap for Tree Fruit Production" (www.treefruitresearch.com) which outlines the research and development program needed to attain their stated vision: "For the tree fruit industry in the Pacific Northwest to be globally competitive, it must reduce the cost of production of the highest quality fruit by 30% by 2010". The underlying notion here is that Washington apples can compete in the global market if they are of high quality and are affordable even if retail costs for their applies exceed the competition. This belief is held because, when done well, the unique growing conditions of apple growing areas produce fruit of exceptional quality found in few other places in the world. The details of the roadmap can be found in the documents available on the web site. What's important to this discussion is that the key to achieving the roadmap's vision is technological innovations that lead to automation in orchard and packing operations, highly efficient and effective orchard management systems, intensive and site-specific information systems from field to market (including identity preservation for market differentiation), and value-added throughout the production and packing operations. A major target here is worker productivity and safety, both large costs in apple production and packing. Of significant importance is optimizing orchard management since various management practices have direct impacts on product quality.

Certainly, there are many new opportunities available now and forthcoming in niche and differentiated crops in the US. In some cases, there exist significant infrastructure limitations to what farmers can actually achieve. One such case is the opportunity for marketing wheat based on quality (e.g., protein content). Basically, certain markets, for example, Japan, are seeking wheat with specific protein ranges and will pay a premium for wheat with guaranteed quality. The problem for wheat growers is twofold: wheat proteins varies within fields and from year to year and there are constraints within the harvest operation to separate and segregate wheat in the combine and in segregation in grain storage and transport, at least at the local level. With current technologies, wheat farmers suggests that while the premium is desirable, they are unable to extract that premium given current equipment and infrastructure.

It appears that the forces acting on agriculture discussed above – globalization of markets, national trade policies, environmental quality concerns, climate change, and consumer preference (including traceability) – will continue to shape US agriculture. Efforts to counterbalance these forces and fortify US agriculture – farm subsidies, country of origin labeling, trade protection – will also continue. Some predict that this situation will inevitably lead to an even more dramatic decline in agricultural production in the US, with food production relegated to other nations that can produce food more cheaply than us. Blank [2], in his book entitled "The end of agriculture in the American portfolio", argues that technological innovations have made it possible for other less developed nations to compete globally. This new competition has reduced prices and created relatively low and static returns on investments in US agriculture over the last quarter-century. Blank [3] states that the average real net return to assets in US agriculture has been negative every year since 1994, was -3.8 percent in 1999 and that "farmers could do better just depositing their money in the bank". In reality, over the last 25 years, the retail cost index has remained relatively flat while the farm value index has fallen remarkably, leading Duffy [1] to conclude that it does not appear that in the United States the primary beneficiary of future technological change would quite likely be agribusiness firms. In Blank's [3] view, the fact is that prices are falling faster than are costs per unit of production and unless future technologies can reverse this trend, American producers will continue being forced to make the investment decision to leave commodity markets and, ultimately, the industry.

While Blank [3] portrays the end of agriculture in the American portfolio, he does leave open the possibility that future technologies might reverse this trend. Others take the view that technological innovation is in fact the way the US can compete globally. While Friedman [4] agrees that technology created globalization, he believes that it is technology that will allow the US to compete in a global market place. He postulates that there is no other country better poised to compete with technology than the US. In traceability issues, like non-GMO foods, rather than view this as another lost market, Friedman would view this as another opportunity for technological innovation and suggest that no one is better positioned than the US. While the situation for a given farmer or sector of US agriculture may be closer to that postulated by Blank, we subscribe to the Friedman view that technological innovation provides the US with what it needs to be globally competitive. We also subscribe to the general vision of the technology roadmap that to be globally competitive, US agriculture must produce high quality food at an affordable price, recognizing that consumer preference, including the demand for traceability, largely defines food quality.

The general challenge for mechanization is to assist agriculture to manage and/or overcome constraints so that US farmers and food processors are positioned and equipped to effectively compete in global markets. President Bush, in a speech delivered on November 28, 2001 to the national Farm Journal forum, called on Senate leaders to abandon efforts to resurrect old-fashioned crop subsidy programs and urged them to embrace the future by passing farm bill legislation that meets his goal of improving the ability of farmers to compete in a global marketplace. Bush suggested increased spending on agricultural research and extension programs to provide American farmers with the highest quality crops and most technologically advanced farm equipment and practices in the world [5]. The 2002 Farm Bill creates record subsidies but also proposes large increases in research and extension.

We draw from this discussion that the best response of US agriculture to the issues facing it is to embrace technology and develop whatever is needed to be globally competitive. Such an effort is non-trivial and it suggests a significant role for mechanization. We next explore the issue of traceability to explore ways in which mechanization can contribute to a world of "traceability" in agriculture.

3. Traceability

Traceability is "the ability to track the history, deployment or location of an entity (for example a plant, animal or food-stuff) by means of recorded identifiers" [6]. Essentially, traceability systems are systematic record keeping systems and are used primarily to keep foods with different attributes separate from one another either by physical segregation or by identity preservation (IP) [7]. Thus, IP is a system of production and delivery in which the grain is segregated based on intrinsic characteristics (such as variety or production process) during all stages of production, storage and transportation [8]. Traceability is closely linked to product identity but IP can also relate to the origin of materials and parts, product processing history, and the distribution and location of the product after delivery [9]. The recordkeeping, segregation, and "all stages of production, storage, and transportation" dimensions of IP systems immediately suggest an important role of mechanization in traceability since they all involve mechanization to some extent.

Golan et al. [7] suggest that the purpose of IP is to guarantee that certain traits or qualities (the source and nature of the crop or food stuff) are maintained throughout the food supply chain for purposes of: (1) product differentiation and marketing of foods with undetectable or subtle quality attributes, (2) to ensure food safety and quality, and (3) to improve supply side management, for example, to improve management of production flows and tracking retail activities. The upside of traceability is the opportunity it presents for increased value at various places along the food chain - from genetics to crop production to food processing to marketing and to retail. For example, Tastemark™ is a unique marketing program designed to provide the consumer with the same recognizable taste guaranteed across all fruit and produce types (www.tastemark.com). The program is based on a technology developed by Taste Technologies Ltd in New Zealand that provides for high speed, non-invasive, online Brix (soluble solids) sorting system using near infrared spectroscopy. The guarantee is sweet fruit and the key is providing consumer value through the guarantee and the brand. The system has been in use for at least two years in a few fruit packing operations in the US This trademark system, under the Tastemark™ brand, guarantees one aspect of fruit quality to the consumer for a premium price, adding value to both the packer and the grower. Labeling is increasingly used to meet consumer demand and is exemplified by the organic food industry in the US

The downside of traceability is its use as a requirement to compete in the marketplace. The most notable example is the mandatory tracking of genetically engineered crops and food proposed by the European Union (EU) to distinguish them from conventional foods. There is considerable resistance in the US regarding the mandatory tracking of genetically engineered crops and food, with Golan et al. [7] arguing that it "is not among the practical or efficient uses of traceability", proposing performance standards as a better solution. The United States government believes product tracing should be required, if at all, for food safety purposes only [9]. Regardless of whether traceability is mandatory or not, the demand for non-GMO product markets has grown at rapid rates such that certain markets, like Europe, require them. Thus, the willingness to provide non-GMO products has grown and adjustments are being made to meet traceability requirements. Take for example the efforts at identity preservation in soybean production and processing as reported by Wijeratne's [10] who writes:

"The need and opportunity for identity preservation in oilseed processing" derives from the fact that "the conventional technology for vegetable oil production evolved on the basis that refined vegetable oils from different sources become similar in appearance, smell and taste. The advantage is that they can be blended at will to derive desired functional characteristics in food applications. The disadvantage is that oils lose their identity upon refining and blending. The structure of the traditional oil extraction and refining industry does not lend itself to identity preservation in processing. The Industry has responded to the economic opportunity of identity preservation during oilseed processing by developing a non-solvent system for oil extraction" that "can be decentralized and operated on a relatively small scale" and is "complimented by small scale oil refineries that match the extraction rates of the small non-solvent systems. This concept has provided a total value adding opportunity to soybean with a relatively simple technology that can be practiced at the rural level."

This new method of extraction (called the ExPress® System) had been established in 60 installations in the Mid Western United States at the time of Wijeratne's [10] assessment.

The previous example demonstrates that innovation can be key to implementing traceability. There are, however, more subtle issues associated with traceability. In reality, what may have emerged as a product differentiation opportunity producing added value to farmers, processors, and wholesalers, can evolve over time into an industry standard, and as such, become a requirement rather than a premium as originally envision. The expectation is that the Tastemark™ system may change the market permanently and no fruit will sell without it or some equivalent consumer guarantee. Those who innovate can pay for the conversion costs with the premiums received early in the adoption of the new technology; those who delay until the technology is required must absorb those costs as part of their capital budget outlay. This evolution is to be expected and clearly illustrates the dynamic nature of traceability issues.

One additional aspect of traceability that further complicates its implementation is that often the quality attributes of importance to the consumer are qualitative in that attribute testing is not possible. Golan et al. [7] refer to these attributes as credence attributes and offer some insights into their properties and how they affect traceability as follows. When quality attributes are easily detected, like specific colors and shapes, traceability is not required to evaluate food quality. However, quality differences that involve credence attributes, ones that are difficult to discern even after consumption of the product, generally require IP and traceability systems to establish market credibility. Credence attributes involve either a change in the content of the product which is difficult for the consumer to discern (e.g., a change in nutrient content) or involve a characteristic of the production process which cannot be discerned by the consumer or by specialized testing equipment (e.g., organically grown). With credence attributes, product differentiation must be achieved by segregation of production lines, by intensive tracking and/or through the services of third party entities (ISO, ANSI, government agencies) that provide such things as standards, testing, quality assurance, certification and inspection. Products with credence attributes as their source of differentiation must establish market credibility either by making it or buying it from third parties.

Whether traceability is economical depends on many factors but is certain to involve consumer preference and their willingness to pay for value added beyond conventional foods. Traceability and IP may be necessary to create new market opportunities or to even sell in markets where traceability is mandated as is proposed by the European Union. A traceability system will likely add to the costs of food products and must produce benefits that justify them if they are to be of value to agricultural producers and affordable to the consumer. For farmers and food processors, the value in traceability is found in areas where consumers are willing to pay, particularly differentiated products and improved food quality and safety, and where traceability improves supply side management, the three motives for traceability suggested by Golan et al. [7]. Of great importance is the issue of how the desired quality attributes for traceability are created, acquired, recorded, and, perhaps most importantly, assured. Furthermore, it is critical to the economics of traceability to find ways to minimize traceability costs while maximizing the benefits of achieving it. The situation gets even better if traceability offers collateral benefits to other aspects of food production.

Given the nature of traceability systems and the fact that segregation and identity preservation involve "all stages of production, storage and transportation" the role of mechanization in traceability seems intuitive. We believe that mechanization is critical to the success of traceability and is essential to the future of agricultural production relative to the issues facing US agriculture outlined above.

4. Food Quality, Traceability and Mechanization

We envision three major areas where mechanization can contribute to quality and traceability in crop production, handling, and processing: Automation, quality detection, and tracking. We will couch this discussion in terms of tree fruit production and packing but the general principles discussed here apply broadly to production and processing of crops and food products.

4.1. Automation

Labor alone will not be able to achieve crop quality and traceability standards needed for US agriculture to be globally competitive. Many

US industries have turned to automation as a means to achieve global competitiveness. The automobile and steel industries are good examples of US business sectors that needed to improve product quality and achieve it at an affordable price in order to compete globally. These industries turned to automation because it offered a means to control the manufacturing process to ensure product quality while at the same time reduce labor costs that were higher than their competitors and continually increasing. The situation is much the same for agriculture today but the major issues – labor (shortage of willing and qualified workers, worker productivity, and worker health and safety) and product quality and safety, including traceability – may be more intense for agriculture than it was for other industries who dealt with these issues decades ago. Of significance here is the US domestic policy in place since 1979 that excluded federal funding of any research that reduced the labor force in agriculture. The result of that policy was the demise of public research and development in mechanization particularly in such areas as mechanical harvesting. While that national policy was recently (February 2001) reversed, it will take a considerable effort to gear up government sponsored research in mechanization to return to the needed level of effort.

What's needed are machines that (1) reduce labor costs by either replacing labor or by increasing the productivity of the workforce by assisting workers to improve their efficiency, remove workers from harmful or repetitive tasks, and reduce worker exposure to undesirable materials; and (2) are capable of doing things to enhance crop quality that were not previously possible. Labor is the orchardist's greatest cost and improving labor productivity, health, and safety represents a major opportunity for reducing fruit production and processing costs. Furthermore, quality improvement in fruit production will require a better trained workforce that may not be available to meet the labor needs in the orchard. Envisioned here are robotic tractors for mowing, spraying, thinning, pruning, etc., all tasks that now require extensive labor, machines capable of assessing crop and soil conditions and adding inputs accordingly, and machines that can harvest and process fruit based on quality attributes desired by consumers.

Considerable progress has been made recently on robotic and auto-guidance/control tractors. John Deere publicly presented its driverless orchard tractor in 2001 that can safely apply chemicals without operator assistance but it is not clear when these will be available for commercial use. Auto-guidance systems are available from Bee Line of Australia and Trimble of the US that provide very precise positioning and tractor guidance and research continues [11]. An operator is still required with these guidance systems but applications are being developed that allow a single operator to utilize more than one vehicle simultaneously using automatic following vehicle systems [12]. Reid and Niebuhr [13] report that automated vehicle navigation may be the next revolution in agricultural production; however, machine safety and machine function sensing (e.g., edge detection, locating and dealing with obstacles) continue to pose barriers for implementing autonomous technologies and therefore remains a research priority.

Even without automated vehicles, there are many opportunities for automation of production and processing practices, including tree specific fertility and pesticide applications based on real-time sensing of tree condition [14]. An important area of mechanization for tree fruit is mechanical harvesting, although the needs are different for fruit grown for processing than that grown for fresh market. Tree fruit is still picked primarily by hand and, with labor shortages and increasing wages, at increasingly greater cost. Mechanical harvesting is generally available only for tree fruit harvested for processing (e.g., citrus grown for juice) and generally consists of shake and catch systems which are limited in use for fresh fruit because of excessive damage to the fruit [15]. Fruit picked for fresh market can be harvested using a shake and catch system, but systems such as the new cherry harvester developed by Peterson and Wolford

[16] requires new approaches to marketing. The cherry harvester requires the use of an abscission-promoting chemical to reduce the fruit retention force of mature cherries to enable removal without stems and damage. However, a market for stemless cherries did not exist until efforts focused on making stemless cherries acceptable to consumers. Robotics makes pick and place harvest systems possible and while progress is being made [17], no economical systems are available commercially.

While mechanical harvesting is desired because of reduced labor costs, harvest automation is also desirable because it offers the opportunity to value add during the harvest operation. One opportunity is the exclusion of cull fruit from harvest bins sent to the packing house. The industry average for percent culls (fruit that does not meet fresh market quality standards) is approximately 25% (David Allen, personal communication, 2001). Cull fruit is removed from packing and processed mostly for juice. The bottom line is that the cost of cull fruit in the packing house exceeds its market value and that cost is charged to the grower creating a negative to cash flow to them. The point is that anything done in the field to assure that only quality fruit is placed into bins that are sent to the packing house (the notion of selective harvest) increases the profitability of the grower and the packer. Machinery that automate tasks in the orchard can, along with detection, separation, and tracking functions discussed below, improve fruit quality, assure it, and reduce costs, thereby achieving the goal to be globally competitive. Thus, the smart mechanization of selective harvesting will lead to improved quality. Compare this with the mechanized harvesting of tomatoes which required the development of a uniformly ripening tomato that could stand up to the rigors of mechanized harvesting. The mechanical and electronic systems of those days were not capable of making the selection necessary to take advantage of multiple pass harvesting – of course, for salsa and other processed tomato products, there probably isn't the price premium for doing other than they are currently doing.

4.2. Quality Detection

The appeal of quality detection as part of mechanization is that a machine has access to the crop or food product at a time when a management decision can be made that either affects quality or leads to the segregation of the crop or food product in a timely and efficient manner. In a cereal grain crop, for example, knowing early in its life cycle that the crop is short of nitrogen creates the opportunity to add fertilizer to optimize grain protein. Knowing at harvest that the grain passing through the combine varies in quality, such as the presence of a toxin, protein content, or test weight, makes it possible to separate the grain according to grain quality and is desirable if doing so increases its value. Fruit is often thinned to ensure a given size or quality. If quality attributes of immature fruit could be detected, then automated thinning machines could remove the fruit with the poorest potential thereby optimizing fruit quality. At harvest, the ability to detect soluble solid content (Brix), skin defects, or internal disorders, would allow growers to separate cull fruit and send only quality fruit to the packing house. Quality detection and sorting is performed in the packing house but is not currently done in the orchard.

Quality detection remains an important issue in post harvest research and these techniques offer potential applications in quality detection associated with agricultural machinery. In the future, crop quality tests will deal with physical quality attributes (color, texture, shape), internal (chemical) quality parameters (soluble solids, flavor components) and perhaps, nutritional parameters (nutraceutical content, vitamin contents). Testing may even get to the point where the DNA content is analyzed to verify such things as variety or GMO status. Incorporation of quality detection as part of an automated harvest system would be desirable if it could be done economically. The notion here is that whenever quality detection occurs in the field or as early as possible, the more likely quality can be assured and costs reduced.

Emerging technologies, like biosensors and nanotechnologies, offer new possibilities for quality detection. New biosensors are being developed that in principle consist of small computer chips designed to change properties when exposed to specific chemicals which can be detected remotely. For example, scientists at Sandia National Laboratories, Albuquerque, NM are developing a real-time sensor based on a chemiresistor [18]. The principles of this technology were reported as follows:

"a chemiresistor is an array of miniature, polymer-based sensors, each of which responds to a particular VOC (volatile organic compound). The sensors are made by mixing a commercial polymer, dissolved in a solvent, with conductive carbon particles. The fluid is deposited and dried on wire-like electrodes on a specially designed microfabricated circuit. In the presence of VOCs, the polymers absorb the chemicals and swell up. This swelling changes the electrical resistance in proportion to the chemical vapor concentration, which can thus be measured and recorded. When the chemical is removed, the polymers shrink and their resistance returns to its original state. The array can be used to identify different VOCs by comparing the resulting chemical signatures with those of known samples." [18].

The appeal of biosensors in agriculture would be that they can be mass produced at sufficiently low cost that they can be spread throughout a crop. The function of machines may be to place, measure, and/or retrieve biosensors as part of their normal field operations.

Quality detection at specific points in the production and processing of crops will be critical to assuring quality and is a prerequisite to quality separation and tracking. Many quality sensors are available during post harvest but will need to be redesigned if they are to be economical for use in the field. Nanotechnologies and biosensors may be important if they can be produced at low costs. The access of machinery to the crop during production and post harvest makes it critical that machinery detection systems be incorporated into their design.

4.3. Tracking

Traceability involves physical segregation or the preservation of identity (IP) and requires intensive record keeping. Since machinery is involved in many phases of food production and processing, intelligent machines that can acquire, process, store and transmit data on operations will be required. The technologies and principles of precision agriculture are well suited to meet the needs of tracking for traceability [19;20]. However, agricultural technologies can be inadequate because they often are too expensive, unavailable in rural areas, too application specific, and/or difficult to implement. Therefore, affordability and interoperability are important considerations in any tracking system. Computer speed, storage capacity, and miniaturization are more than adequate for this task and continue to improve. Emerging technologies include high speed wireless internet, radio telemetry, and radio frequency tags (RFID) will make data acquisition and data management effortless. Wireless technologies are also advancing automation [21] and quality detection as discussed earlier. Read/write RFID technologies are capable of making supply chain and asset management seamless from field to the table. There appear to be few technological limitations for tracking crop and food quality. Costs and lack of standards for interoperability may limit progress unless these are considered in the design of tracking systems.

5. Summary and Conclusions

Many factors are shaping the future of agriculture in the US and beyond and the effects of a single factor, like traceability, are difficult to assess alone. Given the state of agriculture, to be globally competitive, US agriculture must produce the highest quality food at affordable prices, a task other business sectors have faced decades ago. Traceability, whether mandatory or voluntary, appears to be inevitable because consumers demand it and because it is possible to achieve. We believe that 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, and fully equipped for tracking information about the crop from field to the table. 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 advancements. The public agricultural research programs in the US, consisting primarily of the USDA and Land-grant universities, no longer have the cadre of scientists and programs it once had working on mechanization. Either these public sector research programs have to be strengthened or the private sector has to fill in the gap if agriculture is to embrace technology as a primary means of attaining global competitiveness. 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 US agriculture to compete globally and to meet the needs of consumers for a safe and high quality food supply. However, to get there will require significant public and private sector investment in research and development that is not currently available.

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DISCUSSION

Richard O. HEGG

I wish to remind you again that there are sheets in your folders that you received about conclusions or recommendations and key sentences. Keep that in mind as we conclude our discussion and that you will be able to prepare something to turn in. Now I also have a list here of people who want to participate in the discussion by raising your hand so that I can identify you and so we can have some sort of order of this and then when you speak give your name and country and then direct your comments whether they are comments or questions or whether you want to direct questions to one of the speakers.

Dr. Yoav SARIG
Israel

I have some comments for Dr. Pierce. I had a lot of discussions with Steve Blanks while I was at Davis (College, UC), and while I contest his final conclusions he is not easily brushed off, though his statement is very valid, very strong, and would be very hard to contest because the fact is that less people are involved in agriculture in the US. And if people think that traceability would save agriculture in the US, I do not think that Ralph Cavalieri and Prof. Pierce are that naïve. I think that unfortunately the former Secretary for Agriculture of the US caused a lot of damage to agriculture in the US. There is no question about it. But I am afraid that what is being done today might be too little and too late. I would have asked Dr. Pierce of all the things he posted on his presentation how much research money does he get now, to cap up all his projects. I know what the situation is in California. With thirty thousand dollars of research projects you cannot go too far and I am afraid the US in many respects is getting itself to be behind the UK and the European Community. And with countries like China, which already over passed the US in agriculture in apple production, putting the US as number two. And many other countries similarly; it would be very hard to compete with these countries because these countries will eventually also adopt quality assurance and quality evaluation techniques that we enjoy now today and they still enjoy cheap labour. Ironically, as their standard of living goes up and more mechanisation is being introduced into their country, their cost of production is also going to be high. So then it might be easier to compete with them. So I am not trying to undermine the importance of traceability. It is very important, but it is only one aspect of the general picture. Like I said before I fully agree with you, Dr. Pierce, with your general conclusion: technology – that is the only salvation for US agriculture. The question is, how fast policy makers in the US will move to implement that.

Richard O. HEGG

That is an excellent question and one we struggled with right now. The reason for the technology road map is to do two things, one is start outline what we need to do and the other one is to serve as a vehicle to raise the resources to get it done. Actually the value of the road map in its current condition is more for the latter. It has been well received by the agricultural community, by the tree food industry and by the politicians. But the funding to support that does not exist and it is going to take a new initiative out of the Federal Government to support research in this area. We are not the only ones pursuing that, the citrus fruit industry is also very interested in that and I know you know about the tree fruit folks of our state because they know you very well. We are going to need the expertise of folks like yourself and the Club of Bologna to help us because we do not have it. The resources to get this done are going to have to come, largely from the Federal Government. The United States are all broke right now from the economy. We are in deep trouble right now, in the state budgets. The Federal Government has to take this as a priority and the have to realise that the farm bill should include capability to make us grow competitive, not just subsidies, and that is going to take a long time to change. But we are *hoping to do this in a very short time because we used the year 2010 and everyone laughs at us like "2010, that's eight years. You can't do anything in eight years" And the answer is: "We do not have more than eight years!" to get some of this, I think you agree on that. So, we are in a desperate situation to get this started. I think we got the scientific community in groups like this, to do the work. I think we got to resource setting. We are going to need the federal dollars. I guess what I would ask for this group is to take out our proposal and that technology road map and say "The mechanisation industry and the scientific community supports that approach, and that would be helpful to us, I know". Does that answer your question?*

Prof. Egil BERGE
Norway
There are a number of very important issues mentioned in this piece given by Prof. Pierce, and I would like to add to that: I think that it will also have an effect here because when we speak of economy and competitivity, we must remember that the price that they can get in the market depends a lot, not only on the cost of production, but also on the market balance. When there is no volume control and how much is put on the market you never know where the price ends. And the price might vary far below the cost of production and that is where automation comes in, as far as I can see. The other unbalance is international trade. A situation where low cost countries try to compete with high cost country farmers and in the developing countries are compelled to work for almost nothing and they will do it. They will be more competitive than the farm in the high cost country. So the price is very much influenced by the current currency exchange rates and some of those poor countries have so high currency exchange rates that you can beat it no way. The idea is not even to compete in any situation. I think that the task we have is to supply food at a reasonable safety and quality for the whole world and that has many, many sides, of course competitivity is important but it can never be the only solution.

Prof. Josse DE BAERDEMAEKER
Belgium
I have a few questions for Prof. De Castro and for Prof. Pierce. We see from your statement that consumers are willing to pay more. However we find that in the discussions with supermarkets in setting standards for performance they say that they will not use those standards and that they will not pay more for it. So maybe the supermarkets are getting the profit out of these standards of performance. That is one of the issues. The second one is those standards of performance should be global. Because yesterday at the farm we saw that the man did not have traceability all the way back to the origin of his calves, although in Europe this is mandatory and we see that there could probably again be a beef war between Europe and the US now, not for the whole month but for the traceability that is not on there, that is, that cannot be performed. So we have to have something that has to be global. And it means that when those things are global we will probably find that the competitor will have an advantage that we could have and will disappear. So if we force everybody in every country to continuously adapt to this changed technology to take a step forward together, we will have some more advantages again.

Prof. Karl Th. RENIUS
Germany
I would like to make a comment on Prof. Pierce's presentation. He addressed the technology road map points you see which should help us find solutions for the problems. I think that one general aspect in this discussion is to replace open loop control by a closed loop control. In my opinion this is very important. If you see the production in this way you can find that output targets compare with status by actual standards, so we need the standards and then make input corrections in order to hit the target if necessary. By this principle, which we discussed several times in Germany in recent years, there is an important principle: precision farming, of course. Everything can be made better: yields can improve, quality can improve, costs can be reduced, loads on environment can

be reduced and from the data you need to run this process you can document your traceability. So this is a headline among these technology road maps.

Eng. Aad JONGEBREUER
The Netherlands
I have a comment on the lecture of Prof. De Castro, especially about the consumers' willingness to pay. I think we have to underline that there is a difference between what consumers' opinion is and what consumers really do, and that is a problem: why the supermarkets are not willing to pay more for special type products.

Prof. Abdel GHALY
Canada
I think that the agricultural production has to be considered as a whole system in which the quality and the cost of production are not the only criteria used in evaluating the system. During the production when you are starting the process from A to Z there are a number of waste streams that one has to look at. Value Added Products are technologies that can use waste material and covert it into a valuable product or kind of production. But the health aspect and the environment have to be considered as negative costs in order to improve the whole equation. If you go back into the short history when DDT was invented, the person who invented DDT Paul Moller, was actually given the Nobel Prize for Public Health. And it was only fifteen-twenty years later that we stopped using DDT because it was unhealthy. So I think that these issues of environment and health have to be considered in the whole equation not only mine at the farm gate.

Prof. Axel MUNACK
Germany
I would like to comment in more detail a problem that has already been addressed by someone else. Prof. Pierce pointed out that there is a lack of standards and I think that it is a very important thing to mention because in the product flows we would like to have that kind of tracking and traceability. These product flows must be accompanied by an information flow and usually product flows are trans-border flows today. So, the product is often shifted across different borders between and in states so you need a certain kind of standardisation for these trans-border flows and these information flows. I think that we do not have the time to let such a standard evolve within the next ten-fifteen years; it should be pointed out that there is initiative needed for standardisation and that someone should jump into the ring and take on this task.

Yoav SARIG
I fully agree with Prof. De Castro's assessment that the consumer is ready to pay more for higher quality. I know this is controversial and I would like to propose an explanation for this discrepancy between what some people consider not to be true. I think his statement is correct, but only for a segment of the population, not everybody is ready to pay more. However there is an increasing number of people who are ready to pay more for specialty products. For example, in California you find more and more people, but not all the population is ready to pay for organic products. A better example is from the Chinese market. China is still a poor country but some people again, not the whole population but a segment of it, is ready to pay more for good quality. Twenty years ago they bought anything that was offered to them on the market; they were ready to pay for whatever they got. And the quality was at its lowest possible. Now they have the option of buying high quality products at a higher cost and you have more and more people ready to pay for that. So I think this is still true, however. As Dr. Jongebreur said "Some people say they would like but they do not actually do that simply because they do not have that kind of money".

Dr. Antonio PAGANI
Italy
Mine is a general observation on both presentations, which I found excellent. Just to say I got a bit confused on the use of concepts and terminology, because concepts such as quality and food safety are being treated at the same level and then we talk about traceability and we deal

with it as if it were the final objective we are conceiving. But at the same time in Mr. Pierce's presentation we talk about lower production cost as one of our objectives. So I feel like suggesting that we streamline our concepts a bit. In trying to define what quality is at least among ourselves because we cannot treat food safety in the same way as we treat food quality. Food safety is a prerequisite, it is a must. If a food is not safe it is poison, its name changes entirely. So what is quality? I believe if each one of us had a piece of paper to note down what quality is, we would have 46-47 different definitions. So we can choose any one of the thousands and thousands of definitions and choose only one, that of Phil Crosby which says that "quality is matching standards". So we have to find standards and if the standards are matched then the product has quality. If not, it is not quality. It is not higher, or lower or medium quality. So there is a need, in my opinion to put things in order. Say quality is perhaps the objective. Traceability is a means to achieve this objective is a different thing again. So lower cost production is a different thing in my opinion. I get a bit confused on that.

Paolo DE CASTRO

I will first respond to Prof. Sarig. Of course not all consumers are able to pay for the high quality products they want and you have to make a kind of degree depending on how rich the country is. It is the same problem the European community is facing now and they are trying to put one policy for the fifteen members today and the new ten members from the Eastern countries that will join the European Community into 2004, because the needs and feelings of their consumers are completely different, when we talk about animal welfare. For example, how can we explain animal welfare when we talk about it in Poland, or Hungary, where there are completely different situations? So of course, when I listen to the brilliant presentation of my friend Pierce, I say:" It will be hard for a country like Italy if we have to compete in the world market and we only have the possibility to reduce the production costs. How can we compete with the US for example? With the cost of production if the average size of an Italian farm is about 7 or 8 hectares, at any rate less than ten, whereas in the US we have something like 150 hectares. So of course it depends on the market we are pushing to. We need to compete in quality in the sense that we have to link the product with the territory, the tradition, the country, or the area, where this product is produced, so this is the reason why we are so tough on trips question in the WTO, where the trip question means: How can we protect the geographical denomination, even outside of the European Union - because it now only works with the Fifteen? Therefore, the approach is different and the marketing system that the farm will use will also be different, depending on the market we are thinking about. In addition, talking with my friends from Belgium on the consumer problem; they introduced the big distribution system. One of the main problems, especially in Europe, is we do not have the giants like Marks and Spencer's or other big distribution systems typical of the United States. If you take a look at the budget of these very big firms, World Mart, is the biggest, it is so big that if they decide to buy all the Italian distribution systems, they can decide at a very low level, they do not have to go to the chief executive's office. The problem will be how to link, how to manage, the relationship between such different dimensions like the distribution and the producer. The problem also is how can the producers make the characteristics of the product they produce well known to the consumer. We send an apple – just to stay in the Pierce's example - from a specific area in Italy, like Trentino or different area and we can get a better price, because of marketing expenses, because of a Regional Program to promote the knowledge about the history of the apples produced in the area of Trentino. Therefore, the producer must concentrate on the market in the sense of how we can get the consumer to pay more. Because if it is only the cost of production, of course in the globalisation system we cannot have a chance to compete. At the same time, I would like to ask my friend Prof. Pierce another question, because I heard about what Dr. Sarig said how the Federal Programme support the products that or are lower or are get-

ting some problems for income etc. I remember, but I am not sure that it is true. The farm bill approved in May introduces some specific programmes for apples and this is the first time, if I remember well, that these were introduced, because these were usually involved in the soybeans, cereals or arable crops. This is the first time that specific help was introduced for the apple producer, which is very different if I compare it with the discussion going on in Brussels this week, where we are talking about how to reduce and we had on the table the Fischer proposal to cut 20% of the direct tax from one end, and introduced the cutting system that could be absolutely the first step of the facing out of the common agricultural policies. So, this is the reason why all the farmers in Europe are very, very worried and pushing the commission not to go in this direction otherwise we have no chance to compete in the world.

Francis PIERCE

About the supermarkets willing to pay more. The reason for external cherries was that the supermarket was willing to take it and market it to the public. So, you are right that the price tends to stay flat and that is a problem. They are in fact looking for new products and new ways of doing it so it is not a total divorce there. Also, traceability should be global. So long as there are no external issues, I think the problem is that traceability is going to have some extra baggage along with it from each country and you are going to have to get rid of it so that traceability can cross boundaries like that. The question about quality. Our folks get into this discussion all time and apples and tree fruit and grapes and the problem is the consumers definition of quality. So, we can sit round and define quality, and the consumer is going to change as soon as we get it out. So, we have to think of how to get that thing moving in view of the consumer. The cost of production. Really, quality is number one. But it cannot be at any cost, you have to get quality at an affordable price. So, quality is number one but it must have a price associated with it, which is the reason the price of production language is in what we are doing. The question about the apple producers getting help. Our farmers say: "we want a hand up not a hand out". The policy in the US has been "the hand out" and they do not have policies of the "hand up". We need people that say: "Invest in the future to make you globally competitive". I quoted a president of the US in my paper, and he actually did support the idea for putting dollars in the research. The problem is that the legislature did not support that. So there are people that like the idea of supporting research to develop new globalisation competitiveness, but it is not the general feeling of our Congress. The issue of privacy. I had not put it in my paper and I realise now that I should have. We have people who say that you can measure anything you want but you cannot talk about it with anybody. We will have to deal with the privacy issue. If I do anything we have talked about at this meeting, we will have to know everything about what everybody does. We will have to put a privacy statement in whatever we do because our growers will tell us that you are not going to touch me in some places. So, if we are going to deal with traceability and maintain privacy, we probably will not be so successful.

Prof. Richard J. GODWIN
UK

I would like to ask Prof. Pierce his opinion with respect to traceability on bulk produce: wheat, corn, soybeans, because it is very easy at the moment I think to see apples, strawberries maybe in small packages, and other things that can be easily identified and moved around within those packages. Unfortunately we are in Europe; when GM soybeans came from the American market told us it was impossible to separate GM and other soybean products coming into Europe and that therefore it would be totally impossible to have any traceability in any product differentiation. How do we see that happening? Because that has a big impact in many of the items that we eat, and the animals that we eat as well, and have in the food chain, how can we handle 60% or 70% of the traceability in agricultural products.

Francis PIERCE

I will be glad to answer that, I want to give you *an analogy. I was in Michigan State in 1984 at the time the car industry was in trouble. The Federal Government said you will raise the fuel mileage standards. Industry said it is impossible, we cannot do it. They were thinking of the paradigm of the current carburettor system and how they built engines. When they went to fuel injection they found out and changed some things that they could not effect to achieve very high levels on fuel efficiency, if they changed their paradigm. I spoke with Pioneer representative before I came here last week and here is an example of what they said they were willing to do. They had thought of an RFI detect, that would be in the machine and that would, you know, fractions of a percentage. They would drop that into the grain flow every 100 bushels. And then the collection device on the other end, if that grain was flowing would look to see if it was flowing within RFI detects, if the spacing as not within tolerance then somebody got in there and started mixing the grain. So, what I am trying to say is that they are thinking of ways to doing that but it is not going to be the same paradigm in which they think we are going to come up with all new ways. I think this chip-check analogy and laying things in place and using the machine to change things and move is probably going to be interesting but we do not think that way. I enjoyed the visit to see CNH yesterday but I did not see any of those in improvement and into the machines yesterday. We saw the traditional way to make tractors and I loved them and I would like to have every one of them that I saw yesterday. But they were not thinking how that tractor was going to be smarter and help us in the cereal, I mean we need them to do that and I mean some of those folks from those companies are here and I would like to hear what they have to say about their making machines smarter.*

Prof. Makoto HOKI
Japan

I would like to back, as many others did, to One short comment on quality. I think that food safety is not part of the project. It is a must. I think, when we say quality the taste and texture must be considered, as well as colour and shape, or damage or storability. There should also be factors deciding the quality of the food.

Ralph CAVALIERI

Back to the question of bulk products and traceability. We have just released a new variety of white wheat in the State of Washington and it was determined that to develop a market they needed to be able to trace from seed to market of this wheat. It has really unique properties. It turned out that for 20 cents a bushel to the farmer, they are put enough money in the system to ensure identity preservation and they would achieve it using containers rather than bulk shipments in a ship. So, if the price is there it can be achieved in smaller segments. I agree there are serious challenges when we are talking about shipload volumes of material. On the issue of quality. We have an experience in the State of Washington, where we have uniform federal standards for various commodities, fancy and extra fancy, and all of that, in apples. But is we, as a world community set up some standards of quality, there will always be those individuals who will want to set higher standards. So, for example for the State of Washington they created standards that exceeded federal standards and imposed those on the industries from Washington. So, if you see a box of apples, they will often say "Washington extra fancy" and that is a greater, higher standard of quality than the federal one. So I think there are some difficulties in setting some minimum standards in thinking that the automation industry will be able to just use that as their target because there will always be people pushing for the ability to sense additional quality parameters to elevate the standard for a perceived market opportunity.

Karl Th. RENIUS

Since many have mentioned quality and quality standards, I would like to mention the quality standard ISO 9001. It embraces mainly technical systems but it may be interesting to mention the main content, which is very easy. "Satisfy the customer regarding any aspect which can be taken into account". That is the main content of ISO 9001 and it makes sense to develop another main standard similar to ISO 9001 for agriculture products. My question is one, I am not so fa-

miliar with this area of product quality; is there any work in ISO to express such a product?

Giuseppe PELLIZZI
I am not an expert in this field, but I have the impression that we are insisting too much on quality and that is very different from traceability. Traceability is another thing because we can have traceability of each product with different qualities. So, it needs a different organisation.

Yoav SARIG
I fully agree with Prof. Pellizzi. Traceability is not synonymous with quality and I agree with dr. Pagani. It is one aspect, it is one means of obtaining good quality. It is not the main topic. I think Prof. Renius has mixed standards with quality. There is a clear definition, there are many books, but finally people have come to realise (Prof. Pierce is right) the consumer decides what quality is. we cannot tell the consumer what quality is. What we are doing is to satisfy his requirements for what he perceives as quality. So all that we develop is for the industry to be uniform in what they produce to satisfy the consumer As a last remark I would like to suggest to the people of the Club of Bologna . I would like to add a third book to the two books that Prof. Pierce has quoted. It pours some cold water on some of our ideas on mechanisation. It is called "Fatal Harvest ". It preaches against agro-business, and down scaling, and against biotechnology. Everything we preach for they preach against. It makes good reading, good material, and gives you food for thought.

Abdel GHALY
I just want to make a quick comment. The question was about ISO 9000, if any work was being done on this or not. The ASAE standard council at the present time the standards council has considered looking into this in the food processing area

Prof. Pierre ABEELS
Belgium
So far we have discussed quality and traceability. First point: quality characteristics definitions are part of family and social behaviour; Second: quality of products and productions are part of social ethics; Third: safety in food industry and commercialisation are part of ethics and – should I say - stock exchange. So I believe, one thing for the Club of Bologna to do is to emphasise special communication and education beside our mechanisation objectives.

Josse DE BAERDEMAEKER
I just want to add a little bit about this quality thing (Prof. Pellizzi does not like it I know). I must just say that quality changes throughout the chain so, tracing the quality change throughout the quality chain is also the objective that we should keep in mind because they are very appreciable products in many cases we work with.

Dr. Suraweth KRISHNARENI
Thailand
I have to say something about quality. The market would like to have good quality. I think we need quality. If the people improve the quality of the product the price should increase. So what is the standard for quality. Because you know, we need quality some time, we improve the quality. The price is low, especially in the Asian countries. We try to develop the standard of fruit, but the price of fruit is very low. In my opinion if the quality is improved the price should correspond to the quality. That is my suggestion. How can we meet these standards?

Dr. Yoshisuke KISHIDA
Japan
A comment on traceability. Recently in Japan the consumer likes to buy some agricultural products directly from the producer, because the consumer can find who makes these products, how they make these products. There is also a movement called the "straw food concept". Traceability is a problem of the technical system and at the same time this is ready to the system of the production and the consumer. This means that we engineers have to prepare the engineering system to ensure the traceability of the food and at the same time we have to consider the total system of the production and consuming of the agricultural products.

Prof. Abdel KAMARUDDIN
Indonesia
I would like to underline something said by Prof. Pierce about Green Power, or knowledge about agriculture in order to solve all those problems. Particularly in our case in Indonesia the education of the farmer in order to reach a certain level, like in the example of yesterday the farmer can manage all his inputs in order to make the farm a good and sound basis. So that is the kind of recommendation I would like to put forth. Train the farmer to a certain level that he can manage his farm and make use of all his inputs, and respond to all regulations like traceability that we have discussed here and so reach that level.

Dr. Claude LAGUE
Canada
I really appreciated the presentations by both Professors De Castro and Pierce especially regarding the needs for mechanisation in the future. They talked about issues such as automation, quality, detection, tracking, segregation, and reduce cost contamination. All are likely to result in highly sophisticated equipment with probably a fairly hefty price tag attached to it. At the same time, we have also talked about the need to implement standards of production that may be related to environment and traceability and I just have a question. Is it possible to make those systems affordable to small family farms? I was looking at the paper and I think there is a great need to support family farms. Maybe in a survey in Canada or the US, you would pretty much get the same result. So I think we have a fairly big challenge ahead of us. And as to how we can implement all those things that would be affordable to a small family farm who own and operate their farms and not creating an environment that will result in further consolidation if that is important to the public feels a strong need that agriculture should be in the hands of small producers to a large extent, so I think we have a big challenge ahead of us.

Prof. Malcolm MACKAY
Australia
I would like to follow up the comment made about privacy and take one step further. As traceability data is collected and aggregated we will have marketing intelligence value and from Prof. De Castro and Prof. Pierce's point of view how is this aggregated data and marketing intelligence going to be used in the market place.

Francis PIERCE
Let us go five years down the road here. The storage capacity in the electronic age is going to go up by about one hundred. A hundred times more storage. Five years I am going to have today. So we are going to collect a massive amount of data is what you going to. There is a benefit to be able to manage that information and in your kind of information, who is going to get this, who is going to extract the value from that data stream. That is a tough one. Agriculture has been fighting that at John Deere, for example, all the other companies have tried to get into that business and it did not work for them. So, it is not so easy as one might think. Because we are going to spend a fair amount of effort and we are not capable. Think about the way the professor from Minnesota spoke last week: Most of the data will never be seen by him. Which means that we are going to have intelligent systems that are going to bring that data down to something a lot simpler for the human being to use. And this is going to be my comment to the question: the price is too high; what about the smaller farmer. It is going to be part and parcel of the machines. If we are going to build machinery for traceability, we will have to look at what it is going to look like in five years. The fact of the matter is that you are not going to handing data to anybody. It is going to be automatically recorded and returned in a format that is usable for the decision-making. If we do not do that we are not going to have anybody who is extracted anyway we are going to have to build it right in the first place. So I dodging the question a little bit, but frankly, we had better be producing data products and not just data or we are not going to make some advances whatsoever.

Paolo DE CASTRO
I would like to make some comments, regarding

what the professor Lague said. Yes, if we make the same survey in the US and Canada probably we would have the same answer: of course there is some inattention of the consumer of the items of quality, traceability. The problem is not giving the minimum standard, but it will of course, be needed of all products. There should be at least a food standard quality. The problem is how is the producer able to convince the consumer that the products that they have is something different. The key word is "diversification". How can we get such a market, such a premium consumer who is able to pay ? But we have to be able to make it clear to the consumer that my products have something different I am not talking about the scandal which will be at least all the products will add a scandal. I am talking about that quality is something more than what we will be able to communicate to let the consumer understand that this product has a specific quality taste. If you talk about wine, for example, it would be easy to understand what I am saying, or olive oil, or some cheese or some fruit or vegetables. We have a very specific organoleptic tasting or history of the product and of how they make it. This will depend on the ability of the producer to transfer some concepts to a consumer, so the consumer will pay. You can see the example of Parmesan cheese. The price of Parmesan cheese is 25% higher than other kinds of firm cheeses, which are similar, like Grana Padano, another Italian cheese, but at a lower price. Why does the consumer pay 25% more for Parmesan? It is difficult to understand the difference between the cheeses. But the history of the product, the area where the product is produced, and the protocol that all the producers must follow to obtain the Parmesan Cheese label. They have to follow specific rules. So all these things will push the consumer and the producer will say: "consumer, my product is different". And then we can try to get this premium. Otherwise, it is not only a question of traceability, it is an instrument, it is a question of having to make it, at least reach the standard. Then it is a question of rules to make the standard up to WTO level and at not only a European or American level. We have to follow the main standard otherwise there will be distortion of competition. But the problem of quality and the consumer paying is how the producers are able to make it clear to the consumer that the product is different. That will be the challenge. Of course, it is for the rich people, I mean we are not talking about the poor countries. There, it is a kind of commodity at the lowest price. But in the richer countries, there are consumers who are able to pay, but we should be able to make it clear to the consumer, otherwise they do not pay this premium, of course.

Francis PIERCE

I think the concept of a road map is a good one and we have used it in the tree food industry to help them organise how they want to approach there problems and fundamentally it is: where do you want to be and what is it going to take you to get there? And, I do not think there is a better group in the world to do that in the relationship between traceability and mechanisation than this group. I would recommend that this group take this on as a task and to do that by the next meeting and have that presented and approved by your group in their November meeting in Italy, and that gives you six months and that is a long time. For all the brainpower that is in here you should get this done in six weeks but I give you six months.

Yoav SARIG

I would like to make some practical recommendations addressing the issue of traceability. I think we talked a lot about traceability, combined this with quality and consumer preferences. I think what we need to do and I would like to recommend to Prof. Pellizzi to delegate this mission to somebody or some group, for the next meeting, to list all the existing technologies that address the issue of traceability today broken up into different commodities like field crops and fresh commodities, including grains and fruit and vegetables and then list the technological gaps that still need to be addressed. This will give us some practical targets for people around this table and top address other research people to come up with their practical solutions, how to do that, we talked a lot about *what it is, we did not talk enough about how to do that.*

Dr. Lawrence J. CLARKE
FAO

I have been trying to sort out a lot of these comments that have come up, in particular this relationship between the producer, the consumer, the talk about quality, and then talk about traceability and it would seem to me that the question of quality is an issue between the producer and the consumer. The producer does his utmost to produce something that the consumer perceives to be of high quality and he is prepared to pay for it. Consequently traceability is a tool by which the industry is regulated. Then we come to the public sector. The public sector sets down the standards by which the producer has to comply with for the safety of the consumer. Ttraceability is a tool that enables the public sector to determine, to control, to look after, the interests of the consumer. One example of this: recently in Germany there has been a scandal about organic farming and one of the main problems of that has been to trace the origin of the contaminating product into the organic food chain. Now in my opinion the organic farming movement will not develop much further, because at the moment and up to now, it has been a self-regulated movement. It has been made up of people, producers, who are committed to organic farming. It is one of their principles to produce food. When we start getting into the area of producing organic foods for profit then of course, motives will come in to introduce, where possible, non-organic products and it is therefore going to be important that there are standards that apply to organic products. But we also have the traceability to be able to identify when non-organic product s enter into the chain and where they are originally from.

Prof. John K. SCHUELLER
USA

Since the Club of Bologna is dedicated to worldwide, we have currently been hearing so much talking of North America and about Europe. I think that one thing I would recommend that the Club and its Members support is while traceability may give the capability to develop the economies to advance market crops but that the traceability technology strictly should not be used as artificial trade barriers. In other words, that the technologies and the techniques should be available to the developing and other countries. My second statement is that it seems to me a big advancement in something that would be supported outside of the electronic area this would be in the machinery transportation would be to support and encourage the development of portable simple systems to avoid cross contaminations. There is a lot of potential for cross contamination for GMO-free and organic as was just mentioned could cause problems. But simple systems could advance this technology. My third comment is the country's need to work together to develop traceability standards and techniques. Prof. Auernhammer and Prof. Stone and others worked on the electronics, took a pro-act of approach in this, suffered a lot in doing so by thinking advanced act technology. We should similarly work on the traceability techniques and standards. Another thing to be concerned about, fourth thing, is: verification and auditing techniques. In the county we are in, Cook County, Illinois, there is a huge lawsuit, multimillion dollars that McDonald's is having to pay, because their potatoes - their French fries - were assumed and told to consumers to be potatoes. But there was a small amount of beef fat essence used in the French fry and this has created a tremendous problem. When we start doing traceability and we start doing it on a international scale, we need to have some verification system. The ISO 9000 system has attempted to do that in the manufacturing industry although there are many of us who feel that maybe the cost might be more than it was worth but that we should consider the opportunity of developing something similar in the agricultural industry.

Dr. Philippe MARCHAL
France

I have two comments, one about the food market chain and one about the safety. On the food *market chain, we have noted in France that the part of the family budget decrease from 23% to 12%, in forty years, for food. And it is clear that the customer is not ready to pay more. He spends less and less money for food today in Europe. I am not sure that he is ready to accept traceability, ready to pay traceability. The second comment concerns food safety. It is very important to know that the level of safety is very high today in Europe if you take into consideration the number of humans dying due to infection, and it is clear, that when you discuss about dioxin or BSE is ok, but not that the level of safety increased more and more each year. The main problem of the Club of Bologna is which technology we have to develop to prevent contamination and to detect contamination, that is some all. For me it is more than ever important to develop technology to prevent the contamination of water, of food, that is what will be important.*

Prof. Hugo CETRANGOLO
Argentina
I think that quality depends on each consumer. The concept of quality is different for each consumer. For some consumers organic products are a synonym of quality, for another non-transgenic, for another again a nice product. The food industry must satisfy all of them because the differentiation of the product and the sensation of the food are very important to attend to the demand of each consumer or each group of consumers.

Richard O. HEGG
I think we are concluding this session at this point. I will refer you back to the sheet I referred before, about some key recommendations and some key sentences. But may be appropriated if you haven't already to put something down, this is the prime time that your mind in here absorbed, or you have responded, or feel strongly about a particular topic that has been discussed. So this would be the appropriate time, we will take just a few minutes for you to put something down on your sheet.
The next two presentations were prepared: the first, by Prof. Hermann Auernhammer from Germany and the second, by Prof. Irenilza De Alencar Nääs from Brazil but it will be read by Dr. Aad Jongebreur from The Netherlands.

Topic 1.2 a - The role of mechatronics in product traceability

*by **Prof. H. Auernhammer** (Germany)*

1. Introduction

Feeding the world's growing population will Today crop production worldwide has to be realised on continuously decreasing agricultural used areas combined with an increasing world population. Starvation on one hand and affluence on the other hand are dominating our daily life. Engineering is delivering higher and higher performances and new technologies are changing traditional production processes. The community often meets this development with scepticism, because agricultural production became a strange unknown thing to the people:

- milk comes from the super market, if milk has a connection to the cow it is because of TV advertising for chocolate with the colourful (violet) cow;
- the well protected environment is required by all people, agriculture is the primary enemy of the environment;
- crises like BSE and Foot and Mouth Disease support the consumer in his distrust against agriculture – agriculture means environmental pollution and profit;
- the work in the garden, with flowers and pets, loved by almost all people, leads to a self-overestimation – everyone becomes a specialist in agriculture.

Against this background the community has given agriculture the role of the "bad boy" – agriculture has become a looser. Agriculture itself has to remember its results and advances in production, in the protection of animals and in environmental protection. In many cases agriculture is very sceptic against technical developments and progress and is therefore missing new chances.

2. Overview on precision crop farming

2.1. Intelligent technologies

New intelligent technologies in agriculture are leaded by the utilisation of information technologies. "Mechatronics", the combination of mechanics and electronics together with hydraulics makes intelligent components available which can be connected using electronic communication. This connection can be limited to the internal communication of a machine or an implement where it increases the performance of the machine significantly and/or where it makes the control much more easier. But the electronic communication can also connect tractors with implements or implements with other implements if standardised communication system like LBS / ISOBUS (**Fig. 1**) are used.

If positioning services like GPS NAVSTAR, GLONASS or Europe's future "Galileo" will be integrated, than the way for automated information acquisition and information use by location and time can start.

2.2. Precision Farming

Intelligent technology in combination with "position and time" is much more than dividing fields into management zones. Precision farming is positioned within the structure of precision agriculture (**Fig. 2**).

Within this structure also precision forestry, precision horticulture and precise landscape management are located.

Within precision agriculture precision (crop) farming and precision livestock farming are well known. Both are completed by precision pasture or grassland management.

Precision (crop) farming also can be differentiated. It starts with information acquisition, continues with site specific farming and ends with machinery management and organisation and the field robots (**Fig. 3**).

3. Applications of mechatronics

Key examples should illustrate the new possibilities and show their realisation.

3.1. Automated data acquisition

By the use of sensors intelligent technology is able to collect information autonomously. In combination with position and time electronic data acquisition makes the documentation of production processes possible. If all machines and implements involved in the production process can be electronically identified the automation of the data acquisition can be realised. Agricultural production traceability is on the way (**Fig. 4**).

3.2. Site specific crop management

Site specific farming needs fields which can be divided into zones and is therefore limited to farming structures with large fields. In this regions precision farming has started and has already become an established farming system in many areas of Europe and the US.

3.2.1 Site specific farming

In areas with large fields (large scale farming) site specific plant production takes the heterogeneities within a field into account following three different strategies (**Fig. 5**).

- Following the **mapping approach** the level of the basic fertilization (not nitrogen), seeding and planting densities are deduced from multiple local yield data and/or systematic (geo-referenced) soil sampling.
- Sensor systems (**real-time approach**) register the actual situation of the plant development (biomass) in the field or the growth of the weeds. Based on defined algorithms of the target yield (biomass) the amount of nitrogen fertilizer is calculated and on-line directly distributed.
- Finally both systems can be combined (**real-time approach with map-overlay**). With this combined strategy the application of too much nitrogen can be prevented, especially if caused by unusual plant development nitrogen fertilizer amounts are calculated from the sensor signals which do not compare to the long-term yield structure.

All this strategies require larger fields with the possibility of a virtual separation of management zones with similar yield potentials, similar soil types, similar weed population or similar irrigation requirements.

3.2.2 Transborder farming

Farms with small fields (small-scale farming systems) can only participate to this technology if there is a very strong heterogeneity within their fields and if they have special precision farming technology available for small fields which is - compared to enterprises with larger fields – much more expensive. But with existing site specific farming technology the system can also turned around – the existing small fields are used and treated as the management zones of a larger virtual unit. Creating larger units (transborder farming) will introduce a "virtual land consolidation". On these fields site specific farming can be realised following different aims and strategies (**Fig. 6**).

3.3. Fleet management

Together with position and time the machine internal information can be used not only for economic decisions, but also for the central management of the machine organisation and utilisation. For that purpose the information transfer from the mobile equipment to a central coordination headquarter and/or vice versa is needed. For use in the headquarter the locations of the machine action with all fields has to be made available in geographic data. Machinery co-operatives (e.g. sugar beet harvesting co-operatives like shown in **Fig. 7**), machinery rings and contractors would be able to calculate and plan the machinery demand to:

- make the needed machines available at the right place just in time;
- control the performance continuously;
- react on upcoming or possible capacity shortage;
- optimise the machinery adjustment using telemetric-service;
- initiate necessary service or repair measures from the headquarter;

by using fleet management systems.

At least the intensive internal machine information together with position and time and a geographic planning of the sequence of events makes the automated guidance of vehicles without any human driver possible (**Fig. 8**).

Developed step by step starting with:

- automated machine or implement guidance with human control on board;
- combinations of manned guidance vehicles and unmanned following vehicles (master slave principle);
- unmanned autonomous guided self propelled machines based on existing concepts / constructions can be realised. But at the end there has to be developed a new type of specialised unmanned autonomous guided vehicle for multi purpose field works. With such a new conception the trend towards bigger and larger and heavier machines in agriculture might be stopped and with a "herd of robots" it could become possible:
  - on one hand to preserve and to farm small scale agriculture like in Japan and
  - on the other hand to minimise the huge demand for seasonal workforce in large and highly specialised farms like in parts of the USA, GB and Eastern Germany (vegetable production).

Therefore there is a real need for an active and efficient research and development in the area of field robotics with a lot of possibilities and requirements not yet mentioned.

4. Traceability

With the availability of machine internal sensors, actuators, positioning and timing with GPS and the use of electronic communication all technical parameters and activities in processes of the field processes can be automatically collected, stored and processed. In combination with manually collected information a new type of information pool will be available. It spreads across the agricultural production processes on the fields, the farm management, further processing and storage units up to the distribution and the retailer systems.

Information in this context means traceability **(Fig. 9**) with interfaces in the production chain from one process to the following one and with interfaces to the:

- administration → taxes, control and subsidies;
- society → confidence (transparent production).

Though the real information requirements within the product chain have not been defined until now. The information demand is varying very wide. Regarding the three main steps in **Figure 9** the following information groups with sub-information seem to be important:

Farm level (Farmer)

- Field location, field size, crop, treatment, yield expectation, yield, ingredients.
- Nutrition application, nutrition balance.

Commerce/Trade (Succeeding processes)

- Mass/volume, origin, route of transport, time of transport, occurrence during transport.
- Processes, ingredients, classification.

Consumer

- Farming type, farmstead, region, time of production, field operations.
- Applications, fuel consumption, working conditions, soil stress/working distance/ha.
- Ingredients, water content, quality rate/class.

The farmer will be able to deliver different information parts to the consumer depending on his participation in the production and to take over the necessary responsibility in parts or in total (**Fig. 10**).

Starting with the total responsibility of the farmer it decreases with increasing transfer of the processing and treating more and more. At the same time the influence of the farmer on the product is reduced:

Farmer-only (direct marketing) chain:

- Customized products are the demands of the consumers.
- Responsibility only by the farmer.

Farmer-commerce chain:

- No influence on the end product by the farmer.
- Main responsibility by the farmer.

Farmer-contractor-commerce chain:
- No influence on the end product by the farmer.
- Contractual influence to the contractor.
- Main responsibility by the farmer.

Contractor-commerce chain:
- No influence on the end product by the farmer.
- Contractual influence to the contractor.
- Main responsibility by the contractor.

Also the shown information chain includes additional information of supplementary products (**Fig. 11**).

Regarding this products the farmer respectively the processing chain play the role of the consumer. This shows the complexity of a continuous and complete documentation because also the means of production have their own "side information". Therefore for the farmer clear and comprehensible (realisable) interfaces have to be created. They must be applied to his production and to his farm management.

From the situation of a farmer traceability includes (**Fig. 12**):

- signalling from crop, soil, environment;
- information gathering;
- information processing;
- information integration into the farm management;
- information supply to/from the trade (hand over and take over).

The role of mechatronics therefore means all activities in this processes and steps of farm work. Mechatronics on the farm level should:

- be prepared to sense signals;
- use sensors for crop and field processes;
- use controllers and actuators;
- establish a through-going information flow and information management;
- guarantee the information flow and information quality.

4.1 Efficient sensors

Traceability includes the complete documentation of:

- the process with its typical figures;
- the product;
- the unequivocal temporal and local assignment of the collected data and the changes within the process.

In a modern technology many sensors are available today. Problems occur with the unequivocal mass and weight detection (harvesting and application).

At a very early stage of development are the possibilities of the detection of quality and ingredients under "real-time / on-line" conditions in the field (**Table 1**).

Here a new wide field for future developments is opened which is expecting and requiring to much of single institutions or manufacturers. Therefore integrated projects should be established to investigate and examine the different possibilities and solutions. In connection to this "standardised calibration routines" have to be defined and their improvement and modification have to be tested with newest information technologies. Indispensable are "sample extraction units / sampling automation units" with the possibility to store samples for a longer time for the documentation of the actual status.

In addition such systems need also additional information from the point of the consumers. These are objective possibilities to detect:

- form, shape, size;
- colour;
- consistency;
- and others.

4.2 Distributed controllers

The usually used sensors are components within a control unit together with actuators, integrated control strategies and an interface to other controllers (nodes). The sensor information therefore normally is only one sub information of the controller and must be processed in combination with other information to the target information. Already today dedicated controllers are able to detect with its sensors a wide variety of information and create and document well known as well as new process parameters in the assignment to position and time (**Fig. 13**).

More sophisticated networks of controllers need in both, the mobile as well as in the stationary technology additional and new functions e. g.:

Extended Task Controller: Besides the organisation and the control of tasks provided by the farm management (normally by application cards and so on) this controller should be able to collect and create required field parameters for traceability depending on the specific needs of the farmer under his specific conditions. Starting from a basic-data-set of total working time, total amount of used/harvested material and total consumption of diesel more and more detailed information should be provided.

Field-tracing controller: Detailed field data have to include the position and the time information from GPS/Galileo. The provided records may again include a basic-data-set and/or a more extended one for geografic data processing. Its resolution in recording may be defined by different criteria like:

- time stamp based (e.g. once per second);
- occasion based (e.g. by changing on parameter in the whole process like application rate, working depth and so on);
- distance based (e.g. every 10 m).

In-field controller: As more and more information during field processes may be obtained on-the-go, a specific in-field-controller may integrate this information into task order data from the management. Its function and organisation may be explained by the following example.

Today the needed nitrogen in top dressing is calculated from a given yield target and the real-time sensor signals showing the actual growth stage. Oversupply on spots with historical low yields and/or low fertiliser uptake depending on available soil water create avoidable pollutions of ground water and inefficient use of nitrogen. In this case a more sophisticated controller with an included knowledge base could optimise both and only such a controller would be able to generate a traceable in-field information.

4.3 Standardised communication

Today these requirements could be fulfilled if the worldwide acting agricultural equipment manufacturers would be willing to take over the standardised electronic communication by ISO 11783 (ISOBUS) as an international realisation of the German standard LBS by DIN 9684. To realise this:

- all interfaces have only to follow this standard;
- controllers for all technologies have to be available;
- test installations for the standards have to be available.

Because of the high number of manufacturers and because of the company specific interests this ideals seems not to be able to reach. A reason for this is also that every standard as smallest common denominator includes not all needed contents and beside this some contents are still not clearly defined. In this realisation into the code of silicon this leads to unavoidable incompatibilities with:

- very long development cycles;
- extensive and continuing tests on conformity;
- frustrated users because of remaining incompatibilities with not detectable reasons in a complex system.

Because of this only the use of a standard code like it is realised in a “open source project” (**Fig. 14**) is able to deliver the needed acceleration in the development with fast error detection and solving. If not incompatible “open systems” or more or less “closed systems of the global player” will dominate the market of tomorrow.

4.4 Integrated security/safety

Traceability needs an overall information security. To reach this aim much more efforts are needed as mentioned and planned until today (mind crises like BSE, FMD, Nitrofen). Manual possibilities to manipulate the system are the week points. Therefore more and more automation has to be used (**Fig. 15**).

Only by using these procedures it can be guarantied that traceability:

- makes a general information security possible;

- manual manipulation can be avoided;
- on farm security is possible;
- pass the control of the administration;
- earns and stabilise the confidence of the community.

5. Conclusions

From these selected criteria of mechatronics and traceability the following conclusions may be drawn:

- Agricultural machinery is becoming more and more intelligent. Position detection with GPS (or Europe's Galileo after 2008) will become a basic component as well as a standardised electronic communication based on LBS / ISOBUS and a high number of different sensors on tractors, implements and self propelled machines.

- Precision Farming seems to be the farming strategy and practise of the future. Within Precision farming applications automated data acquisition will have the highest priority. It will be followed by site specific crop production and fleet management. As a final development autonomously guided vehicles will be introduced into agriculture.

- Product traceability needs information gathering, processing, integration in the farm management and information supply to/from the trade/commerce and documentation.

- Within mobile agricultural equipment GPS and the standardised communication by ISO 11783 opens the best possibilities for traceability.

- Sensors available today are able to detect a wide variety of process parameters. There is a big demand to detect the product quality, the ingredients and parameters defined by the consumers.

- Traceability exceeds all existing security concepts. Manual inputs make manipulation possible. Automation may be the adequate answer.

- Comprehensive traceability concepts are possible in crop production. But they exceed the capabilities and possibilities of many institutions and agricultural equipment manufacturers. Only in multidisciplinary integrated projects a minimum standard can be reached fast and certainly which can be further developed in many directions.

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Figure 1 - Structure of LBS / ISOBUS

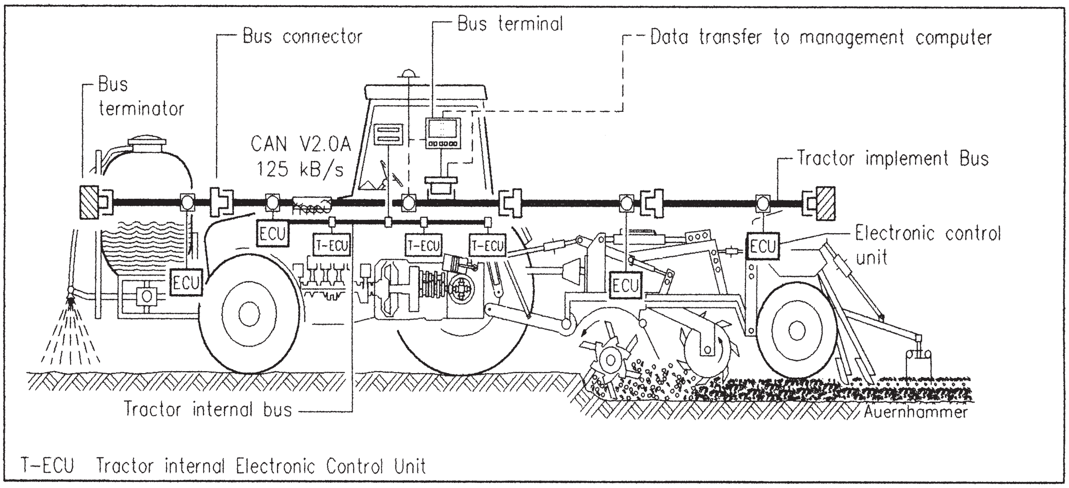


Figure 2 - Precision agriculture

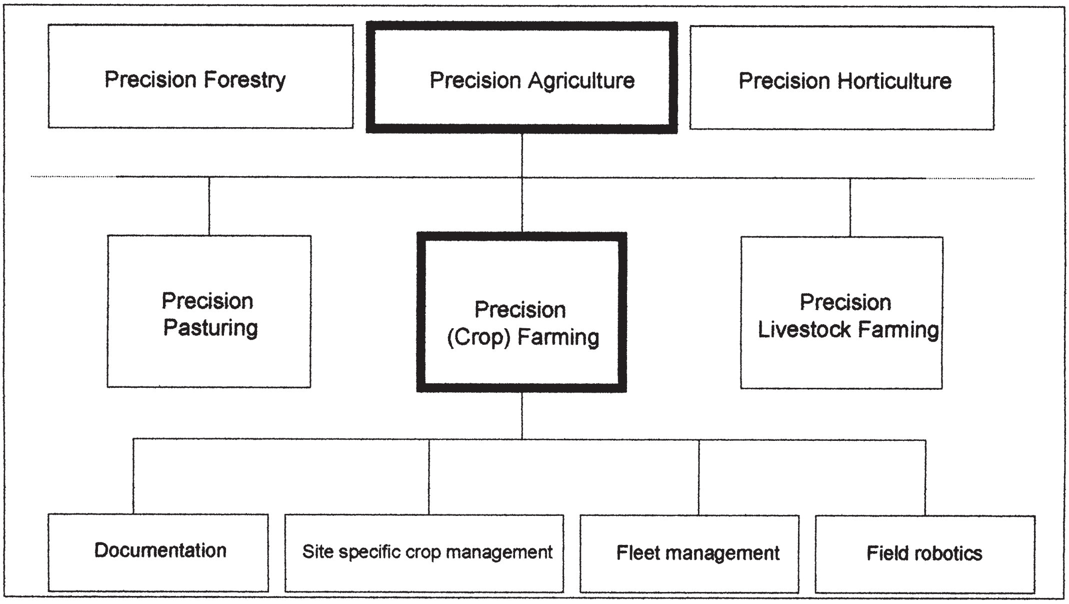


Figure 3 - Applications of Precision Farming

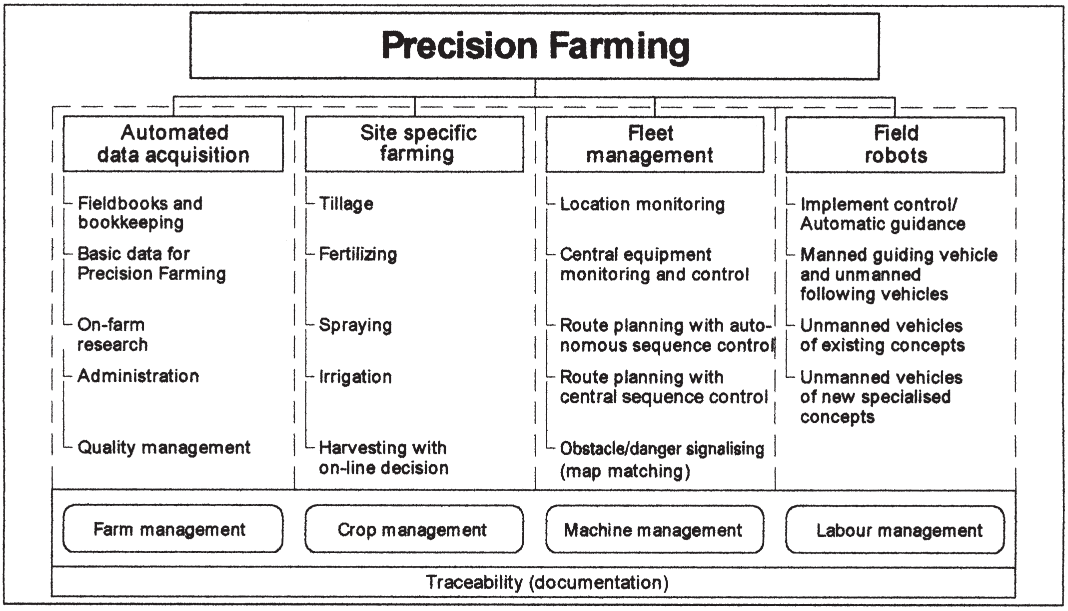


Figure 4 - Automated process data acquisition with LBS, GPS and the implement indicator IMI

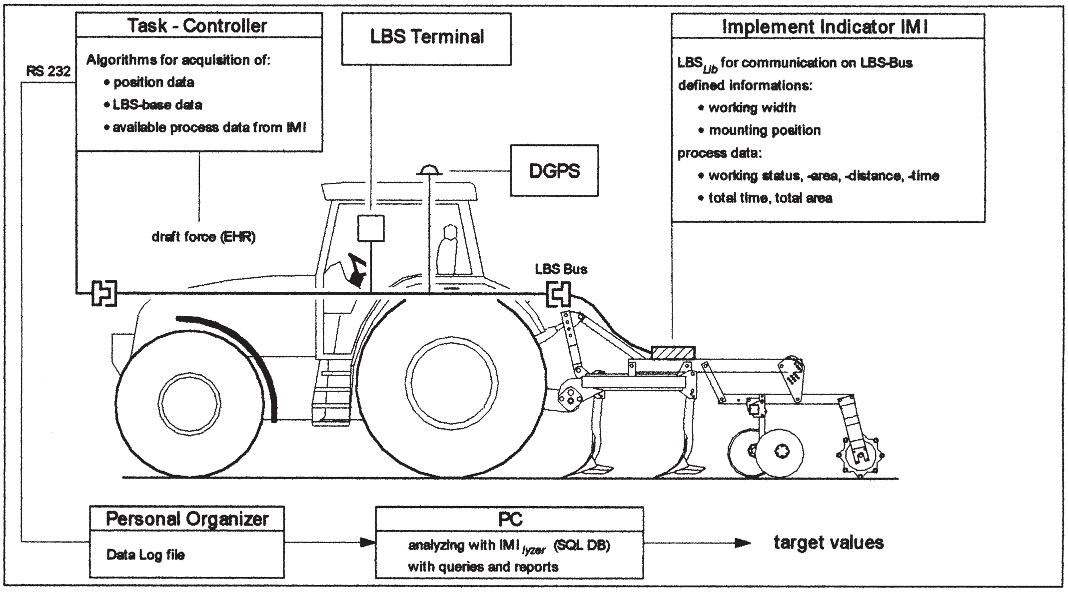


Figure 5 - Strategies of site specific plant production

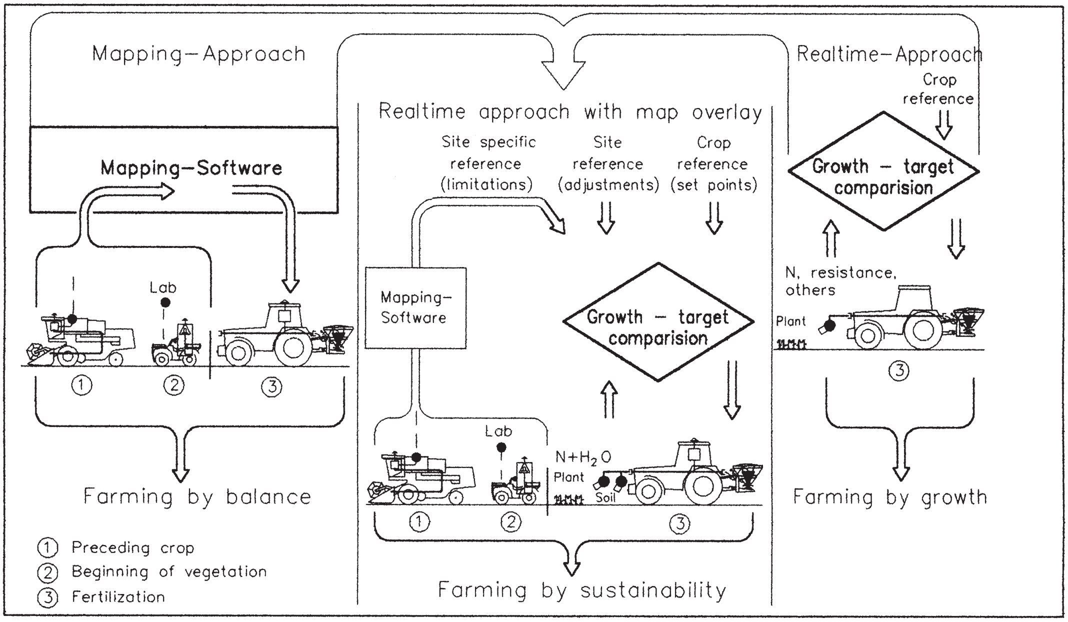
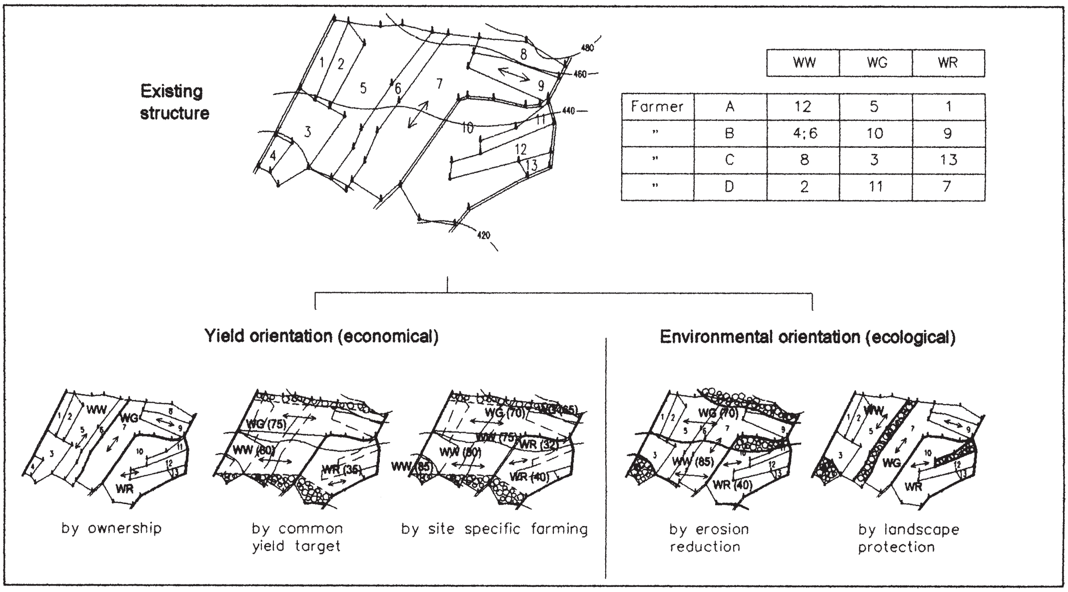


Figure 6 - Transborder farming in a “virtual land consolidation”



		WW	WG	WR
Farmer	A	12	5	1
"	B	4;6	10	9
"	C	8	3	13
"	D	2	11	7

Figure 7 - Fleet management system for sugar beet harvesting and transport by machinery co-operative

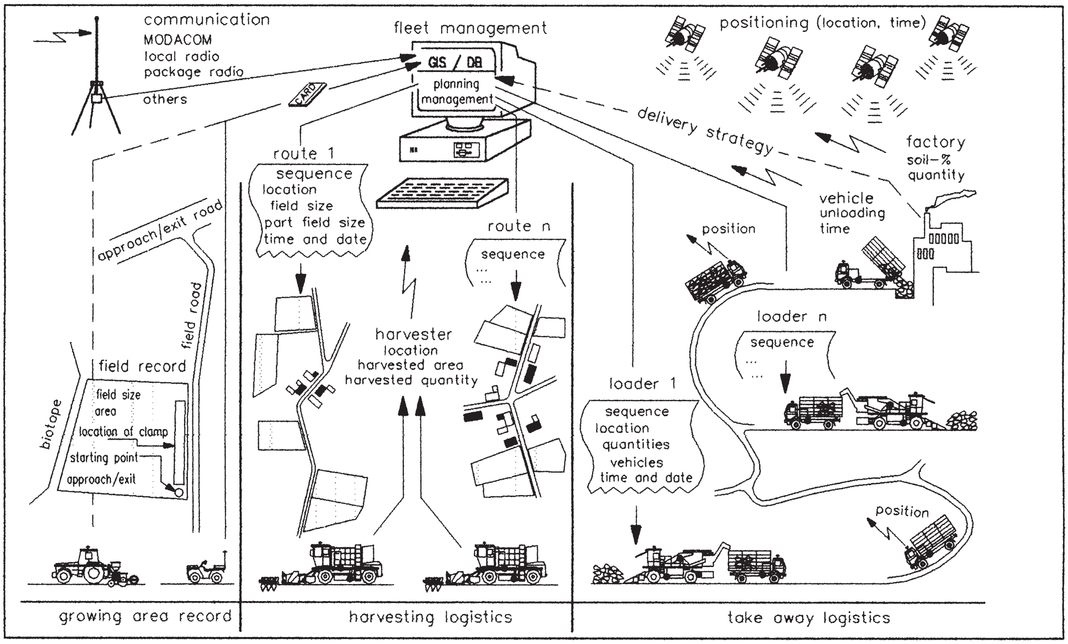


Figure 8 - Autonomous vehicle guidance in a master slave system

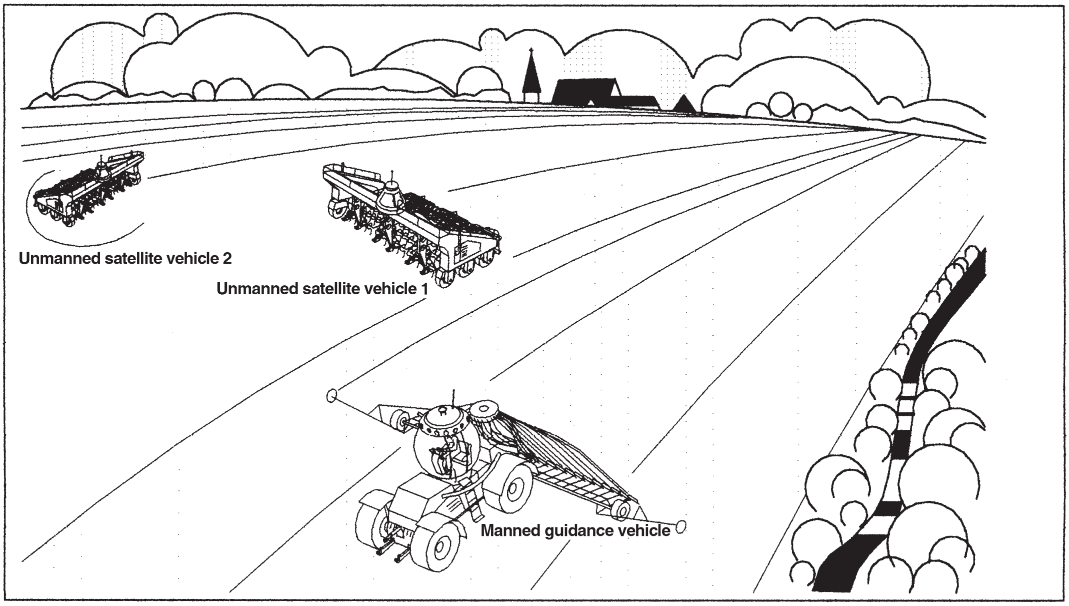


Figure 9 - Traceability in the production chain

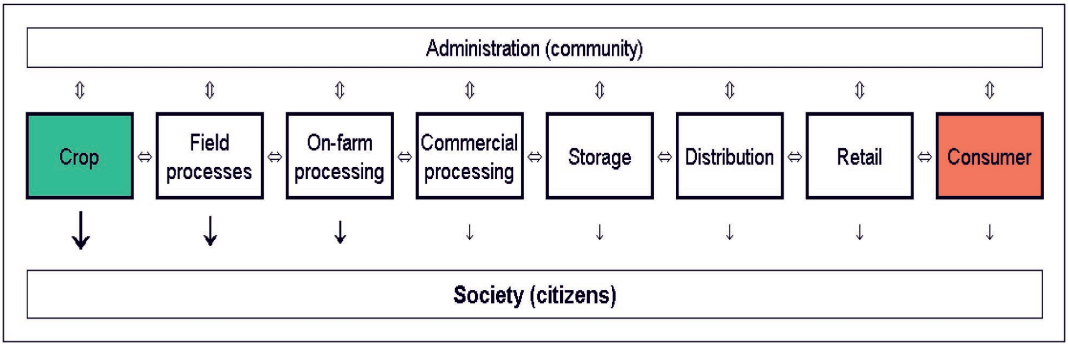


Figure 10 - Information responsibility in the crop product chain

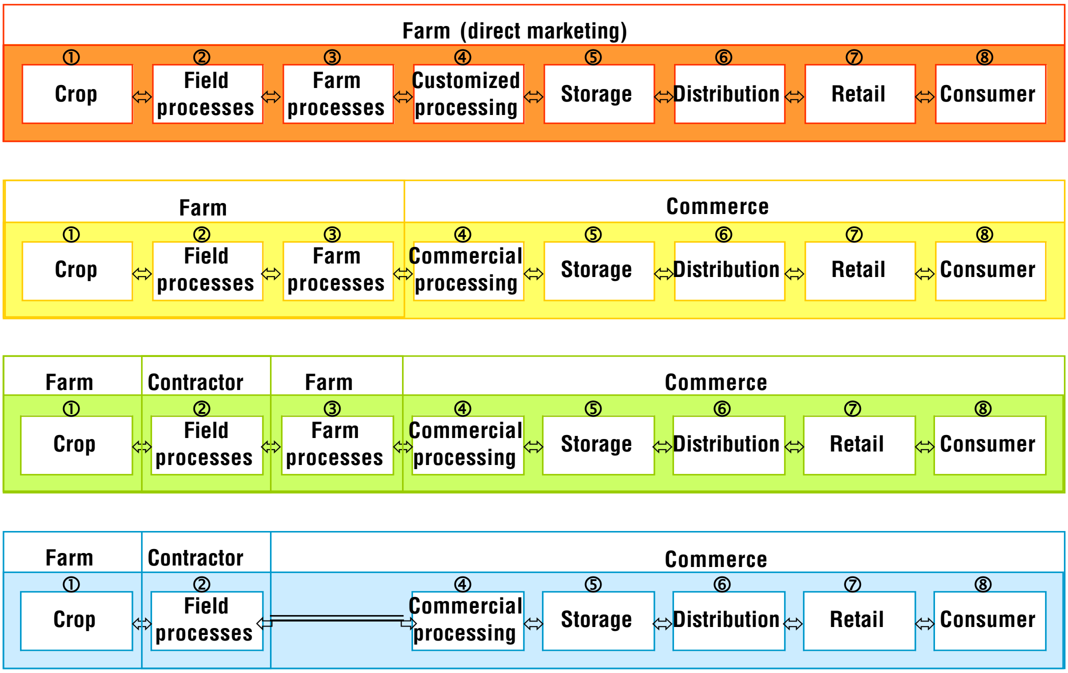


Figure 11 - Product chain with supplementary products in the food production

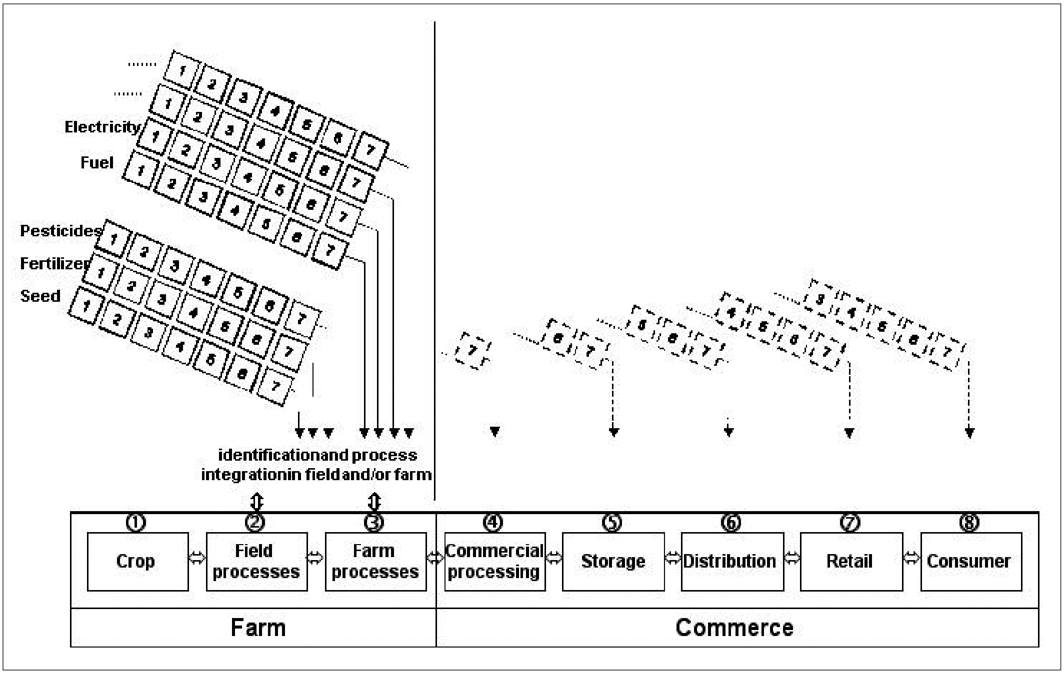


Figure 12 - Information flow on the farm level

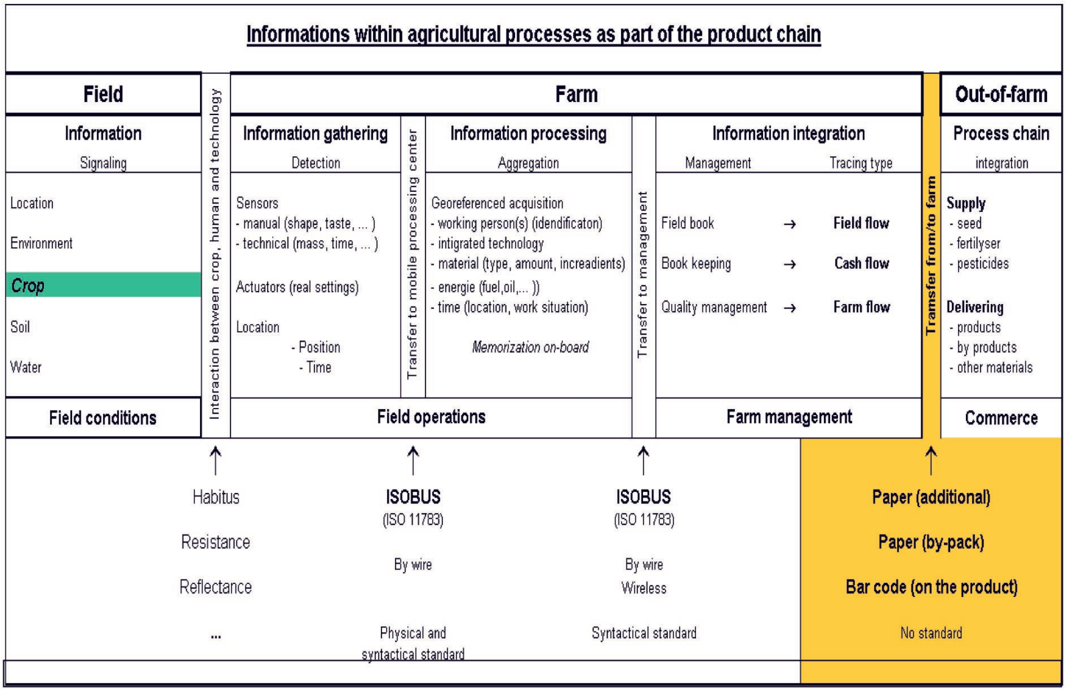


Figure 13 - Parameters from automatic data acquisition in field work

date	start time	end time	field	tractor	implement	procedure
2001.04.30	19:45 pm	20:30 pm	TH01	MB-trac	spreader	fertilising

used time in field				
total	*working*	*turning*	*standing*	*time / field*
0.59 h	61 %	23 %	16 %	0.10 h/ha

driven distance in field			
total	*working*	*turning*	*distance / field*
4.11 km	81 %	19 %	0.71 km/ha

working speed		**PTO speed at work**	
mean	*stddev.*	*mean*	*stddev.*
9.26 km/h	2.27 km/h	450 RPM	61 RPM

cultivated area	**applicated volume / weight**		
sum	*sum*	*mean*	*stddev*
4.75 ha	915.6 kg	203.4 kg/ha	34.9 kg/ha

Figure 14 - Open source model LBSlib

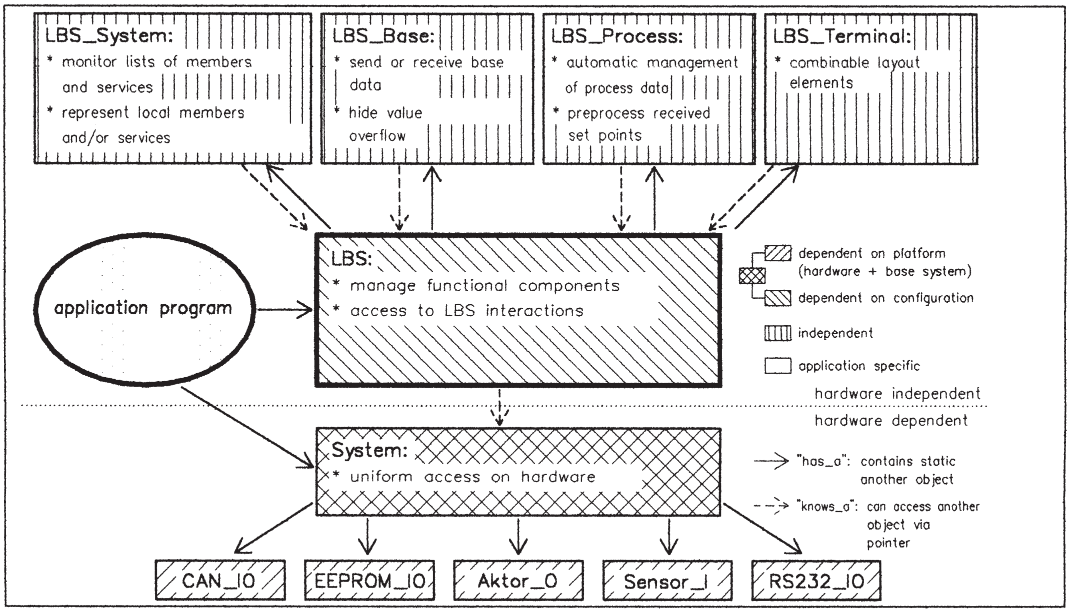


Figure 15 - Safety concepts for the automated process data acquisition

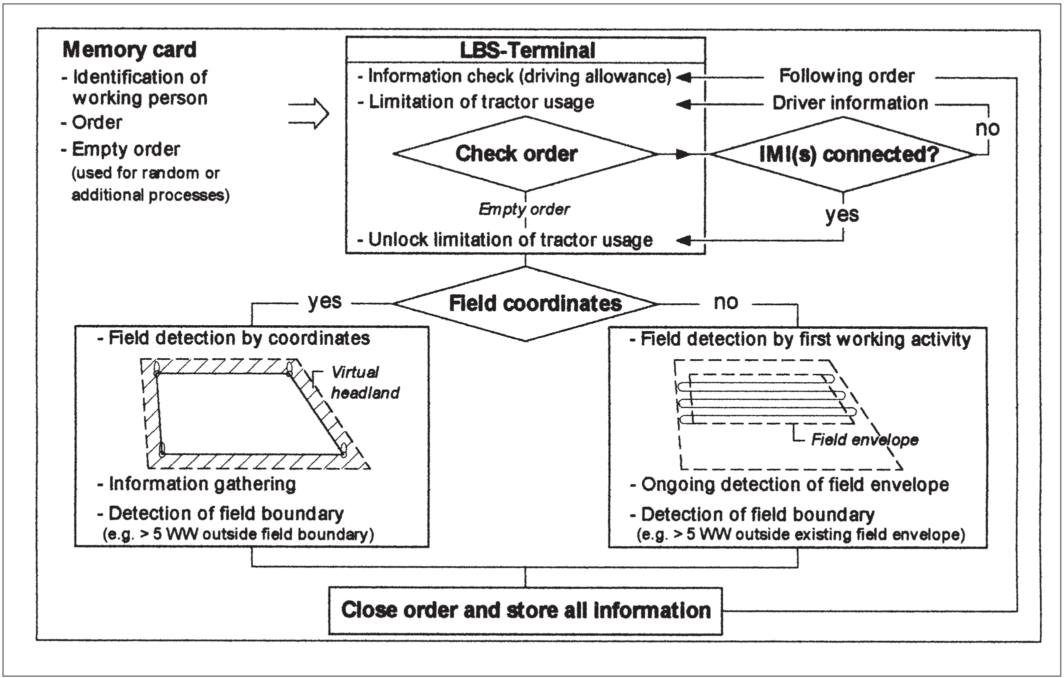


Table 1 - NIR-real-time sensing for quality detection

PARAMETER	SPAN [%]	R_	SECV [%]	FACTORS
Water	57,4 – 68,6	0,774	1,39	13
Amylomaize	28,0 – 41,2	0,608	1,62	13
Elos	63,8 – 75,9	0,449	1,69	16
Crude fibre	12,4 – 21,4	0,423	1,39	13
Crude protein	6,5 – 8,9	0,706	0,28	12
Slag	3,5 – 4,8	0,303	0,25	11
ME [MJ/kg]	10,0 – 11,5	0,348	0,23	9
NEL [MJ/kg]	5,9 – 7,0	0,360	0,17	9

Topic 1.2 b - The role of mechatronics in animal productions

by ***Prof. I. De Alencar Nääs*** *(Brazil) (*)*

Abstract

The concept of biosensors technology applied to animal production, mainly based on the miniaturized electronic mechanics (MEM) has being used since the mid 70s into several stages of production, such as feeding, detection of metabolic testing in animal husbandry, as well as to individual identification and monitoring, which is an important step towards tracking of actions and application of traceability of events and processes in the animal protein production chain. Last generation of such devices includes the real possibility of storing animal data as well as providing authentication protocols. The concept of specific management of a certain event rather then treating the herd/flock as a whole, likewise the precision farming, leads the precision animal production to re-evaluate losses and misdiagnosis by increasing the efficiency and accuracy and the use of precision techniques. The application of mechatronics in animal production is found through the use of biosensors and MEMs, improving data collection and allowing more precise decision making actions. This paper presents some examples of the use of this technology in specific areas related to animal production.

1. Introduction

The overall performance of animal production depends on the herd or flock management as well as the nutrition, sanity control and lodging facilities. The concept of this kind of production is directly related to the reduction of selected losses and process control. Each production segment is controlled for reaching optimization in the whole production system. The concepts of precision animal production may apply at farm level for the animal management, housing environmental control, disease and nutrition control, information and identification, and ultimately, the overall treaceability. In the last decade new technical tools have been introduced in animal production units/farms as support to decision making, especially for management, feeding strategies, animal health and fertility. Along with that, specific computerized systems were developed in order to elaborate the related variables and to provide the manager/farmer with opportune and appropriate tools and alert signals.

Average based models were the basis for the standard method in commercial animal production farms for monitoring most operation, and the forecasted values were compared to measured ones as well as to the next forecasted value, generating a predict average estimated value and, generally introducing an error, so called deviation. This has been applied for feeding system, reproduction practices as well as for predicting behavioral patterns.

With the advancement in microelectronics the possibilities of its use in animal production became feasible mainly for providing reduction of losses by better supporting decision making processes. Biosensor technology has great potential for improving animal welfare, health and production efficiency. The recent increasing incidence of diseases, such as bovine spongiform encephalopathy (BSE), tuberculosis, brucellosis, mastitis, and foot and mouth, has raised concern in the livestock industry and in society. Infectious diseases of livestock have major implications not only in animal welfare and production efficiency but also in human health, and food safety and quality.

According to [1], the future of animal protein commerce depends mainly on an industry reacting towards the following concepts: honesty, openness, detailed information available, traceability, assurance of quality, and flexibility for changes. For the retailer or fast food buyer, it is only possible to build up a business when quality is always renewed, when final

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design is correct, and it is always available in the right place at the right time.

This paper reviews the state of art as well as the prospective possibilities of the use of mechatronics in animal protein production systems.

2. Overall view on the possibilities of precision animal production

Currently, diseases are controlled mainly with vaccines and drugs but the emergence of antibiotic-and drug-resistant pathogens means that diseases will continue to be a problem. Moreover, the use of antibiotics will become even more severely restricted in the future. Biosensor approaches are a promising tool to diagnose, and thereby aid in controlling animal disease in a more individual basis. These systems are inexpensive and reliable diagnostic tools that can be used by non-specialists. In addition, the test could be done at the animal's side providing immediate information about the status of a disease.

The widespread use of antibiotics and chemotherapeutics in animal husbandry (to control diseases and improve animal performance) has led to the occurrence of veterinary drug residues in foods of animal origin. Many countries have been introducing more restrictive food control measures but traditional microbial methods are not sensitive enough to meet new regulations and classical analytical techniques are often precluded owing to the level of experience, skills and cost required. Biosensor technology offers an alternative drug-screening method that is highly sensitive, does not require sample preparation, and can be rapidly carried out on-line at a low cost. Biosensors could also be used in the detection of metabolic levels in veterinary testing and animal husbandry, for example estrus detection by monitoring progesterone levels in milk.

By the mid-1970s experiments had been carried out with electronic transponders for individual feeding of cows and automatic data recording [2, 3]. The electronic "black boxes" (first generation) were attached to collars used around the neck. Later on, further miniaturization of electronics allowed the development of tiny electronic transponders, which could be injected under the skin (second generation). Also the price declined dramatically. Because of the many logistical and tactical benefits of electronic animal identification, a worldwide market could arise for this application, primarily for agricultural animals, but also for companion and zoo animals. This needed the standardization of codes and interrogation techniques. For this purpose, IOS came up in 1996 with two standards: ISO 11874 for the 64-bit code structure and ISO/11785 for the combined FDX/HDX interrogation protocol, working at 134.2 kHz [4, 5 and 6]. The third generation, currently under development, includes also read/write possibilities for storage of the (medical/gentics) history of the animal and sensor technologies for automatic monitoring of animal health and performance. Moreover, advanced third generation transponders can also be provided with authentication protocols to prevent fraudulent copying of transponder codes. IOS is also developing a standard for this new generation, which will be compatible with the existing standards.

It is understood as precision farming the use of special techniques and tools that permits specific management for a certain specific site and/or specific situation on field occurrence. The use of such techniques and/or tools is supposed to lead management to a certain specific decision, and more precise action, rather than the use of average based values decision. Likewise in animal production large herds or flocks incorporate losses due to management decision based on average values. As an example, literature states that the upper critical housing temperature (UCT) for raising poultry breeders is around 28°C, however when studying individual animals it is found that UCT can vary from 27 to 32°C in the same genetics, and in some individuals the fluctuation within this range can cause losses up to 4% in the final result of fertile eggs. Apparently geneticists could detect through molecular genetics and genome tracing, a genetic marker responsible for this fluctuation in environmental response, leading the genetic development of breeders in a direction of a specific selection of thermal resistant animals and consequently, making the flocks more homogeneous, reducing losses related to heat stress exposure.

The use of electronic olfactometry is another example. Electronic olfactometry mimics the human smelling system by using an array of gas sensors and a simulated “brain”, transforming the organic compounds contained in the headspace of the sample into an electrical signal in the form of curves via chemical sensors (metal oxides). Currently, the combined use of an array of gas sensors and neural networks approach provides a rapid method for measuring smells and a complement to the human nose in smelling analysis. In this sense, quality control in the food industry is one application that has seen the strongest development in recent years. The differentiation of products derived from Iberian breed of swine by the use of olfactometry for classifying products on the basis of the diet they have received using adipose tissue as samples was studied [7]. The occurrence of fraudulent practices, consisting of the use of greased feed in an attempt to imitate the characteristics of range-diet animals, means that new methods are required to characterize these animals on the basis of their diet. Characterization of the aroma of Iberian breed products has mainly focused on cured products, using extraction with solvents, static or dynamic headspace, on solid adsorbents by gas chromatography coupled to “sniffing”, or extraction with supercritical fluids. In this sense, relationships have been reported between the diet, genetics and sensory characteristics. The authors developed an algorithm that uses the electronic nose for identifying and classifying the specific meat product with precision. Olfactometry can be used as well to identify hazardous gases inside animal housing.

3. Applications

3.1. Biosensors

Most biosensor developments have been in the biomedical field, where many in vivo applications demand small sizes. The on-line nature of a milk progesterone sensor did not require that the sensor be miniaturized to the point of utilizing microfabrication technology [8]. Their primary considerations were the physical sensor design, fluid transport, optical sensor configuration, fluid mixing, sampling of the raw milk, and automation. The ideal biosensor would be a probe, similar to that found in a pH meter. Since the standard enzyme immunoassay identification of progesterone (EIA) is currently performed and standardized using microtitre plates, they used this technique as a starting point. The biosensor was then developed using EIA for molecular recognition and consequence identification of estrus in milking cows.

Radio frequency identification (RFID) plays a key role in electronic monitoring systems, which are inherently related to sensing systems. This combination makes it easier to switch from intensive to semi extensive animal husbandry systems (e.g. group housing of sows) as cited in [9]. Different systems are used as RFID as shown in **Table 1**. Integration of on-animal sensing devices opens possibilities for the automation of sophisticated tasks such as health monitoring and reproduction status (estrus, pregnancy) (Hurst et al, 1983 cited by [8]). Some examples are transponders equipped with a temperature sensor, as presented by [10], or in combination with activity tracking [11]. The accuracy of these implanted temperature sensors is about 0.2°C. As in most cases not the absolute values, but just the relative changes contain the significant information, the resolution must also be specified, and because of the digital representation of the temperature measurement, it is necessary to provide the result with at least one decimal place.

Sensor-based transducers also have been developed for monitoring the body temperature, the electrical cardiogram (ECG) signal and the pH value [12]. These sensors have been used to monitor stress on piglets during transportation. The sensors are both the strength and the weakness of the monitoring concept. Typical performance aspects are the selectivity, the accuracy/resolution and long-term stability. In particular sensors with selective bio-interfaces can cause stability problems. An example of this class of biosensors is the interface with the enzyme glucose oxidase (GOD) for glucose detection. Improvements have been achieved with immobilizing techniques (Puers, 1993 cited by [6]). Because the sensor circuitry of these advanced devices requires a more or less continuous energy supply, small (mostly Lithium based) batteries have to be integrated in the transponder. Despite the application of very low power electronics, the lifetime of such devices is limited. One improvement to extend this lifetime is dual powering by using an internal battery for measurement and storage of data together with external an external radiating power source for transmission of data to the reader. Another alternative is the use of an external radiating powering source for both the interrogation and the semi-permanent activation of the sensor circuitry, thus enabling unlimited use of the sensor/transponder [6].

3.2 Accurate behavioral data for supporting optimal housing design

The optimal design of animal housing requires meeting a large array of variables, especially when the welfare standards are faced. For instance ideal dry bulb temperature, which associated to relative humidity and black globe temperatures away from the thermoneutral zone may lead to undesirable environment and consequent losses in production.

The thermoneutral dry bulb temperature for breeders during the production stage lies between 22°C and 28°C. When the upper critical temperature (UCT) is reached, the latent heat lost by evaporation is highly affected by environmental relative humidity level.

The bird's UCT is influenced by the ventilation rate, the presence of cooling devices, and the temperature of drinking water. The bird's thermal regulation process in response to heat stressing conditions uses extra energy, leading to loss in productivity. Broilers in the first three weeks are more sensible to sudden weather changes requiring a more isolated building. Optimum poultry production requires a housing environment that can offer well-distributed ventilation within especially for the last week bird's requirements.

The seasons characterization is related to solar declination, and the solar orientation of a building is then affected by the solar radiation flux intensity that reach all the housing sides throughout the day. During the Winter at latitude of 40°S, for instance the North side of a building receives in average three times more solar radiation than the East and West sides. While during Summer the North and South receive together only half of the solar radiation that reaches the Eastern and Western sides. In lower latitudes, as the case of São Paulo State, by the Tropic of Capricorn those differences are more enhanced and, during some clear sky Winters the Northern side is highly affected in term of incident solar radiation.

The location of a poultry housing regarding solar orientation is then of importance. Depending on the time of the year some side of the building will have more incident direct solar radiation as well as the diffuse radiation according to the sun movement. This will influence directly the total heat load inside the building.

Using RFID [13] recorded poultry breeder's behavior and related their behavior to the environment characteristics using telemetry in small-scale model housing in two different solar orientations. Six female breeders were used in the models and they all had a transponder implanted. Four readers were used to record their movement within the small-scale housing placed on: nest, drinker, feeder and wall. The environmental parameters measured were: dry, wet bulb and black globe temperatures. Data were compared and the breeder's behavioral pattern according to environmental characteristics was determined as seen in **Figure 1**.

Knowing in a more accurate way the behavior of animals by using RFID, it will be possible to design better housing for intensive animal production.

3.3 Use of transponders for ID in animal production and the use of treaceability processes

Nevertheless consumers are quite aware of the health problems the ingestion of unsafe food may bring to them and their families and associate this item to the animals housing and management, ingestion of drugs and ultimately the process and conservation of the product throughout the market chain. Safety is one of the most demanded qualities in food products nowadays, and it interacts mainly for assuring quality. It is important to meet the consumer's requirements for food safety through the use of treaceability of the animal welfare and health control as well as the labor welfare and health, reducing also the risk of contamination from all sources in the process of production.

Devices for electronic animal identification, becoming available in the mid-1970s, facilitated the implementation of sophisticated livestock management schemes. The standardization by IOS of the next generation of injectable electronic transponders opened a worldwide market for all species of animals. The third generation, currently under development, includes also read/write possibilities and sensor technologies for automatic monitoring of animal health and performance. The addition of these sensors facilitates the automation of sophisticated tasks such as health and reproduction status monitoring.

The discussion about the best place for implanting transponders in some species of animals is still being updated. A solution for transponders applied in new born piglets inside the ear's base, for use in posterior traceability inside the whole swine production system was presented [14]. The use of transponders for complete electronic traceability in swine production remains a challenge. The use of electronic ear tags is still the most common way of tracking swine within the production sites.

Electronic identification of cattle usually referred to as RFID has many advantages for farm management. First, it can be regarded as a considerable improvement in relation to visual identification of numbers. The main advantages are the elimination of labor costs and the decrease of incorrect readings from 6% to 0.1% [11]. RFID also facilitates the use of automated housing systems and combines the advantages of the conventional loose housing systems (relative freedom for the animals, attending some animal welfare demands) with the advantages of the stanchion barns (control of single animals). Allowing the automation of, for example, feed monitoring and rationing, weighing and drafting can implement sophisticated livestock management schemes.

Using RFID cattle management can be carried out on basis of the individual animal performance recording (as suggested in **Fig. 2**), dispensing of feed, geographic routing dependent on the animal status. Examples are robot milking and the implementation of geographic information systems to assess the potential transmission of infectious diseases between herds [9]. Also from the point of view of return on investment, RFID systems seem to be a good solution. Other important applications enabled by injected electronic transponders are improvement of disease control and eradication as well as fraud control. The latter application is very important within the European Union (EU), where premiums are being paid to stimulate extensive sheep and beef production. Also within the EU, it is not longer allowed to eradicate some contagious diseases by means of vaccination. In case of an outbreak, it is very important to trace back the origin, movements and contacts between animals to be able to stop the further dissemination of contagious diseases.

In practice, RFID implementations can give rise to several problems. Reading speed and distance must be optimized for specific applications. The International Committee for Animal Recording (ICAR) developed in 1995 a set of requirements regarding (among others) the reading distance and reading speed. Other issues include biocompatibility of encapsulation, as well as the injection site in connection with migration problem, recovery in slaughterhouses, and the open trade that needs standardization, and proper effective management of issued unique life-numbers.

Due to the consumers demand on requiring certain characteristics of the product including those related to sanity control up to ecological features, identifying the final product is one of the objectives on the treaceability process. The treaceability in this case is to assure the consumer herd or flock welfare and health, good nutrition, non use of certain drugs and that there is adopted in the farm environmentally safe waste management.

3.4 Detection of estrus in dairy cows

In many countries breeding results are declining as can be illustrated by a decrease in conception rates after artificial insemination and by an increase in calving intervals. Part of these problems seems to be related to the failure to detect estrus or to the misdiagnosis. It is generally accepted that heat detection efficiency is lower than 50% in most dairy herds (and, considering progesterone concentration in milk or plasma on the day of service, from 5 to 30% of the cows were not in or near estrus when inseminated [1, 10, 15, 16 and 17].

Continuous or almost continuous observations studies have shown that displays of estrous behavior occur unevenly throughout each 24 h period and many of them are of short duration (Esslemont et al, 1980). These findings were recently confirmed on large number of animals using electronic devices that allow continuous monitoring of behavioral activity. Therefore regular periods of observation of estrus are required which is less and less possible within the constraints of actual management practice, particularly because individual dairy herds increasing in size, the manpower input per cow will decrease. **Figure 3** shows the percentage of accuracy in the estrus detection rate of milking cows, using two systems of observations.

Tested by [18], the DEC® system (IMV Technologies, France) is an electronic device designed to detect estrus in the bovine species. Its principle is based on the electronic detection of standing mounts accepted by cows in estrus. The criteria (number of, length and interval between mounts) are analyzed by a microprocessor associated with the sensor and give a definition of the onset of estrus. During the course of this experiment, the efficiency of estrus detection by visual observation (69.8%) was higher than the efficiency usually reported in the literature (38 to 56%); however these values are averages and efficiencies over 60% have been already observed in individual herds. The continuous (24 h a day) surveillance of the cows represents one of the main advantages of electronic devices when detecting estrus. Therefore it looks surprising that the efficiency of the DEC® system was approximately only 50% of the efficiency provided by visual observation. Their data were not in agreement with this statement as the false positives represented 12.8% of the estrus detected by the DEC® system versus only 7% of those detected by visual observation. In comparison with the accuracy reported for HeatWatch®, another electronic pressure-sensing system, the accuracy for the DEC® system (84.6%) seems to be lower than the value of 100% reported by [19] but similar to the 85% observed by [20].

Another way of detecting estrus in milking cows is the use of on-line system to automatically monitor luteal function by assay of each cow's milk for progesterone every time the milking machine was attached. A sensor technology to implement the rapid assay and create an automated sensing system for operation in the dairy parlor during milking, and to evaluate the sensor performance and reusability for multiple test cycles was presented [8]. For an automated on-line sensing system, sampling of the raw milk stream was necessary. Although various sampling devices are commercially available to remove small volumes from a flow stream, a device was specifically designed for this biosensor. Since this mechanism is in contact with the milk being shipped commercially, cleanliness is of considerable importance. By using pinch valves, the milk never wetted the valves, and sample flushing by the next cow's milk was relatively quick and simple. Since flow through this valve was always inward, milk contamination was not a problem. The accumulated blocking effect of the milk proteins limited conjugate absorption to the fluidics components. The sensor was successfully developed to work on-line in a dairy parlor using a control computer for sequencing its operation.

3.5 Reduction of losses in animal production by the use of mechanized and electronic processes

Individual electronic feeding has been used in dairy cows and grouped gestating sows breeders for nearly ten years. A transponder is placed in a necklace that opens automatically the gate and feeds individually each animal according to its milk production and need. The use of this technology has been developed mainly for large mammals (beef cattle, dairy cows and swine breeders) and is yet in development for broilers, specially breeders.

Processes such as milking of cows in the milking parlor are dependent on the control of the pressure in the pump, and the individual monitoring is important for identifying variables that may affect production.

In [21] is presented a system that uses a radio transmitter and a flux register inside an on-line milk production, pressure data can be measured and controlled, reducing the incidence of mastitis (due to pressure fluctuation) in the herd. **Figure 4 a** and **b** show the way the sensor measures and corrects the pressure in real time during milking. Several methods of cleaning dairy cows prior to milking and found that the best way for this process was the mechanized use of water spraying with an electronic device that controls the amount of water sprayed as well as pulsing timing have been studied [22].

4. Conclusions

Biosensors show great potential for applications in the livestock industry, particularly where rapid, low cost, high sensitivity and specificity measurement in field situations is required, but the technology must overcome several obstacles before becoming a commercial success. The barriers for the slow transfer of technology from the lab to the field are mainly technical, particularly in the production methods to fabricate reliable and inexpensive sensors, in the stabilization and storage of biosensors and above all in the total integration of biosensor systems. The application of biosensors requires a specification that should include a sampling system, a biosensor, a calibration system and a model of how the information is to be used to control the process of interest.

More than 100 million dairy cattle, as well as sows, in the developed world are managed using artificial insemination and thus the potential for the progesterone biosensor system is tremendous even if only a small proportion of farmers take up this technology. The biosensor system will also be capable of being extended to disease monitoring, analyzing routinely for markers of mastitis infections or antigens of disease.
With the use of miniaturized electronic mechanism (MEM) will be possible to record and control, each time in a more accurate way, events or diseases in order to respond for the optimization of animal protein production.

The use of automation/mechatronic in animal production will help farmers decrease losses during the animal production cycle, by the use of precision principles and more accuracy, improving animal management.

The role of traceability in the animal protein production process remains a challenge for facing the consumer's demand, while practical solutions in the complete food chain are still missing. There is a large room for transfer of technology as well the development of new devices and applications of new techniques and systems.

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DISCUSSION

Richard O. HEGG
Now we may start with the discussion.

Prof. Jaime ORTIZ-CAÑAVATE
Spain
A question to Auernhammer. What do you mean by landscape protection?

Hermann AUERNHAMMER
It is just an idea. Maybe we have to have the targets set in an existing structure should survive in the next 10 or 20 years So we have to look for what or which technology can do on this small scale farm. Landscape Protection looks like what I called transborder farming, a "virtual land consolidation" managed as a large unit. Since it is just an idea, we should think on it, we have no solutions at that time.

Francis PIERCE
Prof. Auernhammer is it possible that there is such a thing as a certified traceability machine? If you buy that at a shop can you get it to give you people traceability requirements?

Hermann AUERNHAMMER
Not at the moment. It takes a long time. There are various problems at the moment.

Egil BERGE
I just want to add to what was presented that there are different problems when we speak about big and small animals because it is economical to put one automatic identification tag on these big animals, while if you have a lot of small fish or chicken the cost is more then the profit. So you need some kind of badge identification to follow the products from the farm. The next problem is to carry the traceability on to the consumer.

Prof. Luigi BODRIA
Italy
I should like to underline that traceability is a need of the market and you have to pay for the system that can be generally applied on agricultural production. Traceability is a need of the market. So in this presentation, mechatronics offers very many possibilities for setting the parameters of production. So this excellent presentation offers us many points for our discussion, and underlines, as has been done several times today I think, that one of the main goals of our discussion in this session is to define the really necessary parameters that can be in the traceability process to avoid so many numbers and figures that makes systems very complex and costly and difficult to apply system. We must define traceability, what does it mean. It starts from the farmer and arrives at the consumer. In the long run we need a very simple practical way to utilise information that will be our duty to find by the end of our work.

Richard O. HEGG
Prof. Auernhammer, you offered many different parameters in your presentation. Is there any classification that they can be put in? Are there any critical ones? Since you have a very large number and I though they were listed.

Hermann AUERNHAMMER
It was my intention to find out what they might be and how much they may be and whatever may be implied. I still have no list of priorities it could be this road map to ask for specific products. I believe that every product has some specific priorities, the location of the production maybe one; another one may be the ingredients and so on. Within such a road map the main examples should be looked for to get a list of priorities and then the remainder is parameters and they will increase as we use more electronics, more sensors and the list of parameters increases.

Francis PIERCE
I have found when Prof. Auernhammer was speaking on Figure 9 that there was a chart showing traceability in production chain and another one that showed up a whole lot of possibilities and I could not help to think of genomas where there are thousands and thousands of combinations and the question would be:

Could this group do what? Could we lay out one figure nine for one cropping system for the production of corn for animal feed and how are we going to do it? You get one done, because there are – what are the possible combinations – it must be an absolute phenomenon – so it's the same problem as the genoma. Let us take rabbits arches and figure the simplest one out first and say "no we did one", so that my recommendation would be to do one. And figure out how to lay one out. I do not care how you are going to do it. Whether you are in Germany or anywhere else. Take a crop or something that is simple and lay it completely in a figure nine and everybody said "you know what? You got it" and that is it. And you got one done. Then you have a model and you do not take the most complex. Take something that is doable and force it all the way out. And I think his framework here is fairly good. But to have it done and have this group to agree you know. But you did one, so now let us go to the second, and the third one and one day there will be thousands of combinations.

Richard J. GODWIN
I would like to support those last statements. The other thing that occurred to a number of us just before lunch was: where did their lunch come from? What was the traceability of everything that we ate, and where do we stop? I mean we heard all the arguments about traceability. I am not quite sure where they are coming from but I think they will happen. The question will be: how far do they go? Because if we are looking forward to see a chip alongside the dinner that we eat, then we are looking for many, many multiples of chips, bringing that dinner to our plate. One plate of chips. But where does it stop? I think that of we take it through to the consumer, to the ultimate end, what we collect in the field or in the farmyard or in the animal housing will be a very easy part of our I. T. information gathering session. What happens in the bounces of the higher regency when one produces meals for us it will be a completely different thing. Therefore, I think that common sense will have to come into this at some point in time. But I do not know what drive for it all is, and I would like to hear something about this from people who have more knowledge on it than I have. To amplify a little bit what you said. I mean we heard the story many times. I mean of the most hazardous place for food safety is in your home kitchen.

Aad JONGEBREUR
In order to come to priorities, I think we first have to look at what the market is demanding and then have to go at the production process and I think that, in animal production, the market is requiring it be free of antibiotics and drugs and it must be free of special microbes that can cause damage to animal or human health. I think then we have to put priority on crop production. I should say that you must also underline the questions connected to the application of chemical products. The identification of these issues and the prevention of these issues are also important points over there.

Josse DE BAERDEMAEKER
I think we have heard excellent presentations on collecting all the data and registration. This is basically I think an upstream activity. In the trade there is a big concern about downstream traceability which means that if I have my doubts today that something went wrong today in my production processes of products I shipped last week I should be able to find where they are. I think that probably this is better for the consumer, acceptability, rather than shipping all the data all the way through. We just know that if something went wrong we can find where the products are, and if we got something, what is wrong.

Richard O. HEGG
Can be interesting any comments regarding this aspect to the traceability and on the proper animal products related to developed and developing countries. What are the implications?

Antonio PAGANI
I was just wondering if we leave to the market to decide which are standards, which are the features of any product in order to provide what the market asks for. Do we not risk being biased

and selective, in as much the market in the developing countries might require very little or almost nothing and that the last countries market may require far more. So, I do not know where we will end up with traceability. Are we producing different types of products, some with a given traceability that lead to certain quality standards and others that do not because the market does not require anything specific in Italy? Somebody mentioned this morning that the Club of Bologna should take care of marketing in general not only in the industrialized countries' markets. Also, is there a point, I ask myself and to you, in defining more precisely to which traceability should apply to, in order not to risk to leave some countries behind?

Lawrence J. CLARKE
I would just like to add my concern. In the FAO we were working with clients who came from developed and developing countries, most of the work of course is in the developing countries. What I have been hearing this morning and this afternoon has been going through my mind and is leading to an increasing polarisation of the market between the developed country market and the developing country market and whether this will lead to increase barriers to trade, to refund developing countries into developed country markets, because when I think at the level of technologies of many countries, particularly in Africa I think that many of the technologies and the concepts that we are talking about are out of reach., with even the EU regulations, for example, on pesticides residues and things like that. Many products from developing countries even though they may comply, they will not be able to prove they comply and they will therefore be turned away at the border.

Hugo CETRANGOLO
Traceability could be the cheapest way to give the consumer specific knowledge about specific products. Traceability will be different for different market requirements. In the specific case of the developing countries I think the developed countries that are producing for export must decide on the traceability system that the customer requires. In our experience, for example, World Mart, Carrefour and the other royal accord have the similar requirement in the domestic market that they want in the international market. The other way of distribution with a traditional food be small shops, they are not in requirement of traceability.

Giuseppe PELLIZZI
I have the impression that we are having a general discussion on a question that needs to be considered into more deeply. So I suggest that we define a small work group that could provide some more detailed information on this problem. Taking into consideration that the Club of Bologna was founded by UNACOMA, that is the association of manufacturers, we need to give some technical suggestions to the manufacturers in order to provide or produce machines able to respond to the different problems. I do not know if you agree to this.

Richard O. HEGG
Yes I think it is an appropriate comment. we can wait till after the conclusion to appoint the working group.

Giuseppe PELLIZZI
This group can meet one time during this year and then produce a document that can be studied later in more detail, so that it do not seems that we are continuing to discuss without reaching any conclusion.

Jaime ORTIZ-CAÑAVATE
I think that from this discussion we are having a bad impression. At least for the European Community, we have more safety in our food than ever and we eat better than ever before. There are very few cases of poisonous or some deaths produced by the mad cow disease. People are aware that they are dangerous, but I think it is also because this information in the newspapers produces a large impact. In any case, as Richard Godwin said: What are we eating in our lunch? I think that the manufacturer or the producer of milk or other products has the responsibility to give the right product and also to give the expiry date when the food will no longer be fit for human consumption. So, to

conclude, we engineers meet to provide better sensors to establish quality and health aspects of the food, for the consumer. We have to be aware that we are making progress and normally and we must realise that we have good food for consumption.

Yoav SARIG
Although that it is obvious that we have a responsibility towards UNACOMA who sponsors the activity of this Club. But I think that UNACOMA and definitely the Club of Bologna has greater responsibility, and I fully agree with Lawrence Clarke, and it seems that there already are major rifts between the developed world and the undeveloped or developing countries. What we have discussed today applies primarily to the developed world – Europe, the US, Canada etc. – and these are issues that are very important, and we should continue to admit this, but at the same time we should try to develop – I do not have a magic solution – the mechanism with which we could possibly educate or deliver the message and look for what technologies are applicable for the less developed countries we/you will be dependent also on some food from these countries and we want all the restrictions we apply upon ourselves to be applicable to them. So as I said before, I do not have any magic solution to do that, but it is certainly a problem. We should be aware of that.

Prof. Gajendra SINGH
Thailand
I agree with the earlier speaker, we have to think of the whole world, not only of the developed world. You have seen the examples of the food produced in the developing countries (is expected to be cheaper and with globalisation there is likely to be an excess for the market. I think the problem explained about apples from Washington is related to that. I think that apples in China, apples in India are much, much cheaper, for the years to come than the apples produced in Washington State. It is very little support to them in terms of quality maintenance and traceability. I think they are not able to enter these markets, otherwise there will be the fear of creating this rift. It is already there, the haves and have-nots. So, they will benefit from your technology, from the developed countries' technology and this is an excellent need for farmers that the business houses can set up this mechanism there of quality control and bringing in lower cost products for the developed markets which is already happening that the number of developing countries have contract farming systems where a big international food distribution firm sets up an industry and contract the farmers to furnish a certain product with all the food supply and quality monitored and then they supply the finished product to the developed market countries. So I think that it is a mechanism already started, you cannot stop it, but I think this is where a Club like this and other organisations can help to ensure that this process is a benefit to all sides.

Prof. Daan GOENSE
The Netherlands
I think traceability also gives developing countries a number of excellent opportunities. They grow a number of expensive crops like special coffees, special teas. When they can prove the original place of origin with a specific taste of that origin they can reach premium prices on the international markets. So, I do not think that traceability is only a threat to them; it's also a challenge. The point of departure must still be the need for cheap identification and education and traceability technology to make it affordable for them.

Richard O. HEGG
Let us go back to the comment that Prof. Pellizzi made earlier regarding the possible formation of a working group. I recall from the presentations of the afternoon a framework, or roadmap. I saw that for both the crop and the animal productions from the product to the consumer and you can start that out with the framework and then fitting in all the possible technologies that exist or the lack of technologies, what is appropriate, what is a priority listing. All those types of things would be potentially a task for a working group to complete. That is my problem.

Josse DE BAERDEMAEKER
I think that is an interesting idea. If we go back to the farmer of yesterday and think of how much time he spends in his office, probably entering data just manually. We could do as well automatically with the machines, then the question is: what is the price of doing that? How much is it worth for a farmer to have his registrations done automatically? And then we come back to the question that Prof. Pellizzi asked, can we do something like that, with guidelines for our machine manufacturers?

Richard O. HEGG
Then the comment that Prof. Pierce made too, saying: Well let us just take, if we have a framework out there, one and put a complete system in, as maybe another task that the working group could do, that type of things and I think that would be a very serviceable document to have.

Karl Th. RENIUS
I have a proposal regarding this working group. I think the subject we are discussing is a political subject also, does everybody agree? So, what about a small working group, which builds up a contact with the Ministry in Italy responsible for this area, which looks for the problem. Our group is a neutral group, a delegation from the Club of Bologna, so we can have any meaning; we are in a neutral position without any political aspects. So to make the first step of this small group, those people will contact the Ministry, seeing it is also a technical problem and then at the next meeting report what the outcome was. Could that be a solution?

Giuseppe PELLIZZI
I doubt if there is somebody in the Ministry in Italy who could understand what traceability is and the difference between it and quality itself. So maybe this could be the interest of the European Union. In any case one of our speakers, Paolo De Castro, was the former Italian minister of agriculture and he could help us.

Lawrence J. CLARKE
We started by talking about traceability, the engineering aspects of traceability. The discussion matter is fully known, as has been said, into the whole area of food safety. I know that in FAO we have a huge group working on international food safety standards. I have not brought any information with me on that but I could discuss with them the possibility of them cooperating with this working group, to bring into the discussion the actual current status of international standards of food safety and how they are working towards that.

Francis PIERCE
I was going to make a comment earlier and I think it still holds. When I was given my assignment it was the machine had to be in the picture because this is a huge topic and I think it would be a disservice for this group to stray all the way across the whole board here and not focus on how the machine is going to help or how it is going to make this happen or not happen. So I would like to see it tied to the mechanisation as you, because that is the strength of the Club of Bologna, and let some other organisations chase after some of the bigger issues that are far beyond anything this group can do, because I would like to see it make a contribution on the machinery side. I think that if you focus on it, every time you get into a discussion you have a machine on the table, whether it is a developing country or the most developed farmer on the planet, there is still a machine there. What is the machine going to do? And I would encourage you not to lose sight of that because this is what this group is best at.

Lawrence J. CLARKE
I would just like to respond to that and I tend to agree. However, when we talk about the development of engineering technologies to develop traceability, we also have to be aware of what we are developing it for, and that is set by standards, by legal requirement, by what producers are obliged to produce because only if we know that, do we know what tool we actually have to produce.

Josse DE BAERDEMAEKER
I think that you are right, but at the same time there are already a number of private initiatives

from supermarkets, from consumer organisations that specify what you have to register, what information they want to have. So, these are things that we could use, and say: can we deliver that automatically using the machine, as Prof. Pierce says.

Francis PIERCE
I just want to talk on one comment. It was mentioned that you are going to take 15 years for that one single standard for one single thing machinery. I am just a little concerned, you just drift off and twenty years from now we all are just sitting here and saying: yes that was a nice idea where are we? I want to hold to my comment about focusing, because we do have machines everywhere in the world and I do not care how sophisticated they are, if you keep to that focus maybe you can get more done and maybe you will not be here fifteen years from now say we never made it.

Richard O. HEGG
I think I am about ready to conclude the discussions this afternoon. Thank you very much for your participation and the good ideas that were shared. I guess I am going to make a suggestion that is a little bit on setting up a working group and maybe turn that over to our President to do that. And one of the thoughts would be that some of the people that were involved in the preparation of these presentations that we heard today could be obvious players in that working group as possibilities. I have written down some ideas here that I shall share with you about some of the things we discussed. At this point then, before you can leave the room, you have the sheet in front of you where you are going to write down your key comments or sentences. Prof. Pellizzi is going to be at the door collecting them before you leave. I thank you again for your participation. I think it has been a very good session.

Giuseppe PELLIZZI
Before closing this meeting, I want to express my deep thanks to Richard Hegg and to all of you for your cooperation. I found this meeting very, very interesting. I have taken note of your proposals on the working group composition and I will try to organize it following your suggestions. Thank you very much. The best to all of you, looking to meet you in Bologna in November.

LIST OF PARTICIPANTS

Giuseppe Pellizzi	ITALY	*President*
Valerio Tugnoli	ITALY (UNACOMA)	*MC (replacing C. Ambrogi)*
Malcom McKay	AUSTRALIA	*MC Member*
Lawrence J. Clarke	FAO	*MC Member*
Philippe Marchal	FRANCE	*MC Member*
Karl Th. Renius	GERMANY	*MC Member*
Pietro Piccarolo	ITALY	*MC Member*
Osamu Kitani	JAPAN	*MC Member*
Oleg Marchenko	RUSSIA	*MC Member*
Gajendra Singh	THAILAND	*MC Member*
Richard O. Hegg	USA	*MC Member*
Bill A. Stout	USA	*MC Member*
Hugo Alfredo Cetrangolo	ARGENTINA	*FM*
Pierre F.J. Abeels	BELGIUM	*FM*
Josse De Baerdemaeker	BELGIUM	*FM*
Abdel Ghaly	CANADA	*FM*
Claude Lague	CANADA	*FM*
Arne Møller	DENMARK	*FM*
Hermann Auernhammer	GERMANY	*FM + KNS*
Axel Munack	GERMANY	*FM*
Peter Schulze Lammers	GERMANY (CIGR)	*FM*
Abdullah Kamaruddin	INDONESIA	*FM*
Yoav Sarig	ISRAEL	*FM*
Paolo Balsari	ITALY	*FM*
Luigi Bodria	ITALY	*FM*
Antonio Pagani	ITALY	*FM*
Makoto Hoki	JAPAN	*FM*
Yoshisuke Kishida	JAPAN	*FM*
Hidetoshi Ura	JAPAN	*FM (replacing N. Kobayashi)*
Won Kyu Park	KOREA	*FM*
Yeodoo Yun	KOREA	*FM*
Manuel Cabrera Sixto	MEXICO	*FM*
El Houssine Bartali	MOROCCO (CIGR)	*FM*
Hassan Bourarachi	MOROCCO	*FM*
Aad Jongebreur	NETHERLAND	*FM+KNS (replacing I. Nääs)*
Evert Niemeijer	NETHERLAND	*New Full Member*
Egil Berge	NORWAY	*FM*
Shujun Li	P.R. CHINA	*FM*
Maohua Wang	P.R. CHINA	*FM*
Leonid Kormanovsky	RUSSIA	*FM*
Jaime Ortiz-Cañavate	SPAIN	*FM*
Suraweth Krishansreni	THAILAND	*FM*
Richard J. Godwin	UK	*FM*
Allen Rider	USA	*FM*
John Schueller	USA	*FM*

Daan Goense	NETHERLAND	*Invited*
Paolo De Castro	ITALY	*KNS*
Ralph Cavalieri	USA	*KNS*
Francis Pierce	USA	*KNS*
Wayne Skaggs	USA (ASAE)	*Invited*
John F. Reid	USA	*Invited*
Valeria Vicinanza	ITALY	*Technical Secretary*
Roberto Oberti	ITALY	*Technical Secretary*
Frauke Beeken	GERMANY (CIGR)	*Technical Secretary*

13th MEMBERS' MEETING (*Part 2*)

Bologna (Italy), 16th – 17th November, 2002

In the occasion of:
the XXXIII EIMA show

Opening Session

Session 2

Mechanisation and traceability of agricultural production: a challenge for the future

2.1 Sensors and data collection systems on agricultural equipment
2.2 System integration and certification: the market demand for clarity and transparency
2.3 Traceability: the role of mechanisation for the control of processes and the quality of productions

Leading persons: ***Bassam Snobar, Jordan – Philippe Marchal, France***

List of participants

OPENING SESSION
Leading person: Giuseppe Pellizzi, Italy

Mr. Aproniano TASSINARI
President of UNACOMA – Italy

The Club of Bologna's annual appointment at EIMA can by now be seen, not so much as a tradition, as an institution. It started out as a hope expressed in far off 1987, during an international symposium on agricultural mechanisation, research and its propagation with a view to innovation in the agro-industrial system in the years to come. The idea stemmed from the need for constant study and debate on development strategies for agricultural mechanisation, north and south, east and west.

We owe the growth in the Club's authoritativeness to its president, Prof. Giuseppe Pellizzi, and the Management Committee, thanks to professional and scientific rigour they gave instilled in the debate and the globa1 scope of the conclusions and recommendations that are the result, which would certainly merit greater attention from the institutions responsible for planning agricultural policies.

It is quite clear that modernising and rationalising agriculture, the indispensable premiss if it is to be competitive and profitable, is conditioned to an important extent by the use of machines appropriate to the different crops or animals raised and the differing geographical, soil and climate conditions in which they have to work.

Here, I won't recall the intense development of attitudes and culture that the club has passed through in the last few years, with reference to the themes it has discussed, and which have undoubtedly offered food for deeper thought from alI those involved with these issues, from academics to manufacturers.

But I would like to say something about a question I find particularly important, and part of the discussion during the meeting in Tsukuba in 2000 and resumed last year in the second session of debate at EIMA. I am referring to the ethical aspects of agricultural machine which have now been formulated in terms of an "Ethical Code" drawn up by Y. Sarig (Israel), with L. Clarke (FAO), I. De Alancar Nääs (Brazil), R. O. Hegg (USA). A. Munack (Germany) and G. Singh (Thailand). The code covers not only how agricultural machines are designed and made, but also how manufacturers shou1d behave towards their employees, customers, suppliers, shareholders and competitors.

The assumption lying behind the code is that agricultural machine makers work in a field vital for mankind, guaranteeing food as part of an environmentally compatible process, whence follows an especia1ly demanding range of responsibilities and a mora1 obligation to maintain standards of professional behaviour in line with the most stringent conditions of ethical conduct.

In an era of "globalisation", there sometimes seems to be the risk that competing successfully is placed at al1 costs before raising process and product quality, so I think a strong cal1 for the application of principles of social ethics as wel1 as professional principles is more opportune than ever. On behalf of UNACOMA, I voice deep thanks to the club for making such a valuable tool available to anyone who wants to understand its importance.

That said, I would like to stress the importance of the club's f1irstst session of the year , in Chicago in July, on the occasion of the ASAE Intemationa1 Conference held jointly with the CIGR's 15th World Congress, on problems of product traceability in agricu1ture and agricultural mechanisation.

The introductory reports by P. De Castro, F. Pierce and R. Cavalieri and the technical contribution from H. Auemhammer and I. De Alencar Nääs certainly represented a valuable contribution and a basis for fruitful discussion with a view to giving manufacturers reliable indications of how machines and plant can best respond to the specific needs of product traceability. Continuing the debate during the session here in Bologna, focussing especially on mechanisation in product and quality control will make a further contribution of interest to the sector .

On this occasion, I am also happy to highlight the fruitful cooperation begun between the club and the CIGR and ASAE and to express a big thank you to their two presidents, Prof. El Houssine Bartali and Prof. Wayne Skaggs. This cooperation is opening up prospects for joint initiatives for objectives of general interest for the

development of agricultural mechanisation.
I would also like to offer my special thanks to Dr. A. Rider, the vice president of CNH America (and past president of the ASAE) for offering the participants in the club's session in Chicago a technical study day with a visit to the CNH Product Engineering Center at Burr Ridge and a farm devoted primarily to cereals.
I thank all of you for attending this session during EIMA 2002 and wish you the best for a fruitful debate and a happy stay in Bologna.

Prof. Giuseppe PELLIZZI
President of the Club of Bologna – Italy
Dear Colleagues and Friends,
Let me add only few words to the welcome addresses by the President of UNACOMA. I would thank, first of all, Mr Tassinari and all UNACOMA staff for their support and to give to you some information on what happened in these 3.5 months after the Chicago meeting, as far as the general subject "Traceability and Mechanisation" is concerned. We will have today and tomorrow to discuss the three last topics on the subject as a continuation of what we have discussed in Chicago on the basis of the excellent key note reports by De Castro (Italy), Pierce and Cavalieri (USA), Auernhammer (Germany) and De Alencar Nääs (Brazil). During this period I have provided to nominate a working group on the subject composed by Auernhammer, Bodria, Cetrangolo, De Baerdemaeker, Marchall, Nääs, Piccarolo and Sarig. This group met for the first time yesterday afternoon. Today it will present a first draft of guidelines with which we have tried – as decided in Chicago – to define what Traceability means and which new problems for mechanisation we have to solve. This proposal, of course, will be discussed during the meeting and I hope that you will improve the text giving also specific tasks to the working group in order to arrive within our next meeting in Bologna (2003) to have a complete frame of the problem as well as precise technical indications to be distributed abroad. A second important aspect is concerning the "Code of Ethics". Most of the agricultural machinery associations belonging to the main European countries have accepted the Code proposed by the Club declaring their adhesion to it and their availability to distribute it within their associates.
I apologize to inform you that also this year, after the death of prof. Laszlo Lehoczky in 2001, at the beginning of last September our colleague and good friend Derek Sutton (UK) passed away due to a hearth attack. I have a very good souvenir of him, of his kindness, of his clearness and capability as well as of his humanity. It is a big lost for the Club.
A more enjoyable information concerns the fact that we have 5 new members of the Club: prof. Luis Santos Pereira (Portugal) incoming President of CIGR; Mr Galen K. Brown (USA) from Florida Department of Citrus; prof. Theofanis A. Gemtos (Greece) and eng. A. Ronzoni (Italy) consultant expert in agricultural machinery. He probably will be nominated general manager of the Regional network on agricultural machinery of Asia and the far East. To all of them our deep welcome, sure that they will actively contribute to the work of the Club.
Now we start and I am pleased to give the floor to B. Snobar (Jordan) to whom I have asked to serve as session chairman for today, while tomorrow our chairman will be Philippe Marchal (France). To both of them my deep thanks for their availability. Please, Bassam.

Prof. Bassam SNOBAR
Jordan
Good morning everybody. I bring you greetings from our country Jordan, and my colleagues at the University of Science and Technology of Jordan. I am very happy to be here even though we are in Ramadan, once supposed to be fasting and enjoying a religious holiday. Nevertheless we will start with the topic 2.1 "Sensors and data Collection Systems on Agricultural Equipment" presented by Dr. John Reid from USA.

SESSION 2

Leading persons:
Bassam Snobar, Jordan – Philippe Marchal, France

Topic 2.1 – Sensors and data collection systems on agricultural equipment

by ***Dr. J. F. Reid*** *(USA)*

1. Introduction

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.

The relevant commercially available and research sensing and data collection technologies will be discussed in more detail.

2. Data Collection System

The current data collection systems used on agricultural equipment result from the products used for tracking product characteristics in precision agriculture. These are typically of limited computational capabilities build up around special processors under the control of the various manufacturers. These systems can be adapted to traceability within the limited scope of their capabilities. These systems serve the basic record keeping needs for crop planting, chemical applications, and yield. Although successful in the storage of the basic information, these technologies lack the capabilities for seamlessly documentation of crop information and require a substantial effort on the part of the producer to enter data.

2.1. Data Storage and Retrieval

The most common methods for storage and retrieval of data on field equipment are PCMCIA storage cards. These devices are typically, taken to a desktop platform for integration with company specific GIS software for analyzing the data.

Data archiving is dependent on the level of management of the producers with computer technology. The potential for errors is often high from year-to-year. And the resources for permanent documentation are subject to change based on advances in computer and storage technology. There would be value for systems that can permanently house information for producers. However, such systems would have to provide guarantees of data security and may have difficulty becoming adopted by producers.

The trends in the industry are for data entry to become more reliable with automated data acquisition methodologies to remove the need for operator data entry. RFID tags and bar code scanning methods are methods that can potentially ease the data transfer process. It is also possible that some of the materials used in production can be sensed automatically. One example would be modular seed and fertilizer containers that link directly to planter bins with RFID detection of seed information for entry into the seed monitor database for a specific row unit.

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2.2. Data Visualization and Operator Interfaces

Data are visualized through displays of numerical and graphical data. Typically, operators pass through a number of screens related in the operation of display device. Current systems support the display of a limited amount of information. Comparisons between various manufacturers products reveal significant that there are significant variation in display size, resolution and format.

In addition to displays, there are a number of additional modes used to interact with the operator, primarily as output devices. Lightbars are one common mode of communication to the operator. Some manufacturers use audible indicators.

Operator inputs to the data collection systems are typically through pushbuttons and hard and softkeys on the interface devices. Micro switches that interface with data collection system activate some machine functions to document the operator's use-mode of the machine.
As equipment becomes more automated, there are several challenges related to the operator interfaces and the operator's visualization of machine functions. At a basic level, there is a need for interfaces that can ease the entry of data. Human factors studies can be used to identify new methods for data entry that ease the burden on the operator. More advance technologies, like speech recognition, can further support interaction with the operator. Operator dependency issues and the effect of machinery noise need to be minimized. The general increase in machine intelligence can foster cooperative interactions between the operator and machine. A second challenge of the increase in information is that operators are subject to information overload. Increased data richness are going to require tools to isolate relevant information for the operator to control and provide automated methods to respond to non-critical information.

3. Sensors on Agricultural Equipment

Modern agricultural systems are becoming more integrated with electronics and sensors technology. The sensors measurements are combined with localization to identify where measurements are being made. Sensors for perception of plant and soil environment will be reviewed as potential systems for use in traceability.

3.1. Localization of Measurements

Localization in agriculture is primarily achieved using GPS technology. Differential GPS (DGPS) is the basic level required for most agricultural applications. DGPS combines the GPS solution with a correction signal from a local reference station to improve the quality of localization. Differential GPS correction signal come in the form of signals broadcast over ground or satellite sources. Some of these corrections are free, including WAAS and the AM corrections broadcast from Coast Guard beacons, while others are subscription services received from service providers (i.e. Omnistar and Starfire SF2 corrections).

There is a need for measures of performance of GPS receivers. The stationary performance of GPS receivers is a commonly used measure of performance. Performance is characterized by positioning accuracy and precision of the receiver. The accuracy is calculated from the measurement errors compared to the absolute true location, whereas the precision is determined from the measurement errors compared to the estimated true location, which is the average of the measurements. The accuracy and precision of several competitive systems (**Table 1**) reveals that a accuracy can be greater than 0.80 to 2.0 m for several competitive systems tested over a 24 hour period. The precision can be 0.4 to 2.0 m over the same time period. The better quality corrections come from subscriptions that are purchased for a fee and they indicate accuracies of 0.8 1.0 m with a precision of 0.4 to 0.6 m.

Dynamic performance can provide additional insight into the performance of DGPS systems that relates to their use in the field. In fact, some systems perform better under static conditions due to Kalman Filtering algorithms that do not perform as well under dynamic conditions. Some experimental evaluations of dynamic performance have been attempted. One such measure has measured the performance of DGPS systems used in parallel tracking operations of straight-line passes. In this case, the performance of the GPS systems can be documented in terms a receiver bias and cross-track error (**Fig. 1**). Performance of DGPS systems is much better in dynamic performance due to the short time frame between passes, which is typically less than 20 minutes for many applications. Pass to pass errors can often be less than a few cm (**Table 2**).

GPS for localization needs to consider the receiver performance and match that with the requirements of the specific application. The commercially available systems are adequate for mapping the characteristics of large planter, sprayers and harvesters. But as the need for precision information increases, these systems may be inadequate. RTK-GPS provides for high accuracy that can offer repeatable positioning on a day-to-day basis. However, these systems are expensive and are not widely deployed. GPS measurements are adequate for agricultural on fields with low slope. However, many agricultural lands have significant slopes and GPS needs to be supplement with sensors to correct for the slope of the terrain.

Additional localization methods will be required that can augment GPS to provide more detailed information on specific product traceability. These will require relative on-machine locations of sensors that can be determined from implement configurations in some applications. Addition sensors on the vehicle that provide a perception of the environment will require calibration of perspective relative to the vehicle GPS positioning systems.

3.2. Crop Quality

Current sensors for measuring crop properties those available for measuring harvest characteristics of crops in precision agriculture. In most cases, moisture content and mass flow rate are measured. Typical systems measure grain flow and moisture content independently. One method of measuring grain flow rate is based on force transducers on an impact plate placed in the gain flow path in the clean grain elevator. Grain moisture content is measured using the well-known capacitance methods by sampling the flow from the grain flow in the clean grain elevator. The sensing elements are near the exit to the grain tank and thus suffer a time delay from the actual time that the crop is harvested.

Cotton production systems also have sensors available for yield monitoring. One commercially available cotton yield sensor consists of pairs of emitter/detector units mounted on the row units of the picker chutes. The emitter unit provided multiple beams of infrared light to the detector unit mounted on the opposite side of a picker chute. Cotton being conveyed to the basket interrupts the beams and this information is used to compute seed cotton weight. Other methods have been explored for cotton yield measurement including the cumulative weight of the basket. This challenge in some of these measurements has been the removal of measurement biases or the effects of machine operation on the sensor response.

Other crop quality sensors based on bulk weight measurement are in early stages of commercialization for cotton, beets, tomatoes, carrots and other crops. These systems are primarily based on measurement on the accumulated load.

New sensors for crop quality are emerging for corn and cereal grains based on NIR, NIT and other RF technologies. If successful, these will lead to detection of crop moisture, oil and protein level that can be used to further characterize crop quality. Another advantage of these systems is multiple measurements of the crop characteristics at a reduced number of sampling points.

Sensor calibration is a critical factor for most crop quality sensors. Grain moisture sensing based on capacitive plate measurement of the material flow is the most mature of the technologies and has good performance based on identification of the specific cereal grains, beans or corn crops. The performance of other sensors based on RF and optical technologies are limited by calibration curves that are often specific to crop, season, and variety.

The fouling of sensors during tough crop harvest conditions can also be a significant obstacle for sensor performance. Interferences result from dust, surface moisture, and other residues that can bias the sensor output.

3.3. Soil Properties

Soil sensors have been a popular research topic over the last 20 years. The primary sensors for soil properties have been related to the detection of soil nutrients, moisture content and pH. Some activity has focused on the detection of soil physical properties, primarily related to the identification of compaction.

3.3.1 Soil Nutrient Sensing

Sensors for the automation of soil properties measurement have been an active research area over the past 20 years. The current most-adopted practice is manual sample collection at widely spaced grid points with remote laboratory analysis of samples. Increased grid resolution has been considered to provide more information on the process. Trucks, tractors, and ATV's and information collection systems have been deployed in assisting scouts in data collection. The automation has come in the form of systems to assist in the identification of discrete sampling points at GPS-controlled sampling locations. A strong research topic has been the development of on-the-go sensing systems to increase the data density and reduce the time for the availability of information. If perfected, these systems could also provide a direct link to control operations for field operations. Research is exploring on-board sample collection with on-board analysis.

On-the-go direct sensing of soil nutrient concentrations is still an immature concept. The primary problems relate to sample acquisition, sample preparation, and sensors for the nutrient response. Sample acquisition is a simple as exposing the sensor to direct "contact" with the soil, as in an optical measurement, to sampling and preparing the soil for a measurement of a solution extract from the soil sample (i.e, ion-selective field-effect transistors). Other methods such as electrical conductivity provide more indirect measures of soil properties.

The difficulty in all soil analysis is that the sensors have to deal with interferences from the multitude of soil properties to the specific response that is desired.

3.3.2 Soil Physical Properties

The primary sensors for soil physical properties include soil surface residue and detection of soil hardpan layers. Surface detection methods have been primarily based on machine vision sensing. Hardpan detection methods are typically based on load cells in the drawbar or on instrumented shanks to relate the forces to a specific depth of operation. These sensors are in the research phase and will require some advancement to be made useful for production agriculture.

4. Conclusions

A review of the sensors and data collection systems use in production agriculture leads to the following conclusions with respect to the development of traceability:

- The sensors and data collection systems that are available today provide a low-level foundation for the development of traceability systems.
- 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.

Figure 1 - Definitions of the measurement error (Ei), cross-track-error (XTEi), track-error (TEi), and bias error (Bi).

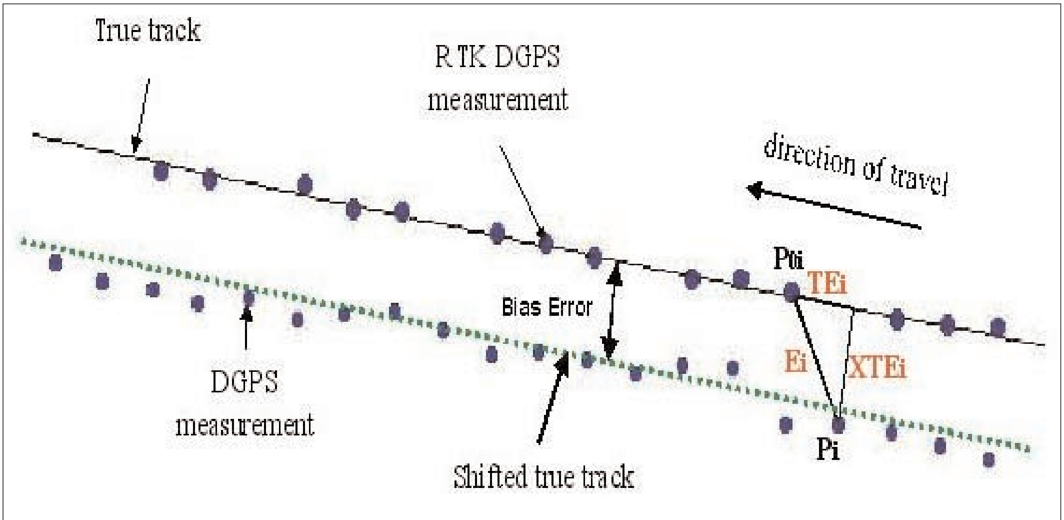


Table 1 - Static positioning accuracy and precision of GPS receivers from all the stationary test tests data using a Trimble RTK-GPS as a reference

GPS RECEIVER	ACCURACY (ONE-SIGMA) (m)	PRECISION (ONE-SIGMA) (m)
StarFire/SF2	0.88	0.45
StarFire/SF1	1.92	1.10
StarFire/WAAS	1.34	1.17
AgGPS132/OmniStar	1.10	0.58
AgGPS132/Beacon	0.81	0.56
AgGPS132/WAAS	0.85	0.57
Outback/WAAS	1.01	0.61
GarminGPS17N/WAAS	2.30	1.94

Table 2 - Dynamic positioning accuracy of GPS receivers from tests conducted on a north-south-run field using a Trimble MS-750 RTK-GPS as the reference system for DGPS measurements.

GPS RECEIVER	PASS ERROR (BIAS) (cm)	PASS ERROR (SD) (cm)	PASS-TO-PASS ERROR (AVERAGE) (cm)	PASS-TO-PASS ERROR (RMS) (cm)
StarFire/SF2				
4.8 kph (15 tests)	8.2	0.9	0.6	1.2
8.0 kph (15 tests)	8.1	0.9	0.3	0.9
12.8 kph (15 tests)	9.3	1.1	0.3	1.1
19.2 kph (16 tests)	8.9	1.6	0.3	1.6
all speed (61 tests)	8.6	1.1	0.4	1.2
StarFire/SF1				
4.8 kph (15 tests)	12.1	0.6	1.4	1.6
8.0 kph (15 tests)	11.6	0.5	1.0	1.2
12.8 kph (15 tests)	11.1	0.6	1.0	1.2
19.2 kph (16 tests)	11.3	0.8	0.8	1.2
all speed (61 tests)	11.5	0.6	1.1	1.3
StarFire/WAAS				
4.8 kph (2 tests)	5.3	2.3	2.2	3.4
8.0 kph (1 tests)	9.8	2.3	1.7	3.1
12.8 kph (2 tests)	9.4	2.0	0.9	2.3
19.2 kph (2 tests)	9.8	2.0	1.1	2.3
all speed (7 tests)	8.4	2.2	1.5	2.8
AgGPS132/OmniStar				
4.8 kph (15 tests)	5.2	2.2	1.9	3.1
8.0 kph (15 tests)	4.7	1.8	1.3	2.3
12.8 kph (14 tests)	5.7	1.8	1.6	2.6
19.2 kph (16 tests)	7.0	1.5	1.5	2.1
all speed (60 tests)	5.7	1.8	1.5	2.5
AgGPS132/Beacon				
4.8 kph (11 tests)	13.8	2.5	3.8	4.7
8.0 kph (11 tests)	11.3	2.5	2.4	3.9
12.8 kph (11 tests)	9.6	2.1	2.0	3.1
19.2 kph (10 tests)	9.6	1.9	2.1	3.0
all speed (43 tests)	11.1	2.2	2.6	3.7
AgGPS132/WAAS				
4.8 kph (13 tests)	10.0	2.5	1.8	3.3
8.0 kph (15 tests)	10.8	2.2	1.8	3.0
12.8 kph (15 tests)	10.7	2.4	1.2	2.8
19.2 kph (16 tests)	10.3	2.5	1.4	3.0
all speed (59 tests)	10.5	2.4	1.5	3.0
Outback/WAAS				
4.8 kph (15 tests)	9.5	1.0	2.0	2.4
8.0 kph (14 tests)	10.3	0.8	1.0	1.4
12.8 kph (14 tests)	10.3	0.8	0.9	1.3
19.2 kph (14 tests)	10.7	1.1	0.7	1.3
all speed (57 tests)	10.2	0.9	1.2	1.6
GarminGPS17N/WAAS				
4.8 kph (15 tests)	18.7	3.9	9.2	10.5
8.0 kph (14 tests)	16.5	2.6	5.9	6.7
12.8 kph (14 tests)	15.4	2.3	5.0	5.7
19.2 kph (16 tests)	17.4	1.8	4.3	4.9
all speed (59 tests)	17.0	2.6	6.1	6.9

DISCUSSION

Prof. Bill A. STOUT
USA
I wanted to invite John Reid and all the speakers that are meeting today and tomorrow to submit their papers to me for incorporation for publishing in the CIGR e-journal website and also I was impressed by your Power Point slides and if you would be so kind to give me a CD of that, I would like to put that on the website as well. Let me to remember you to transform all the files in pdf form. While we are talking about that all the papers that were presented at the Club of Bologna meeting in Chicago are already on the CIGR website and they are very interesting, and those of you who were not there will find them very interesting, so have a look. I have sheet that has the website address so if you ask me I shall give you the website address if you wish to have a look at these papers.
Concerning the presentation, my question is this: you mentioned that soybeans are disappearing. Let's broaden that comment just a little bit. Agricultural engineering education programmes as we had know them in the past, are also disappearing and there are many, many examples are of that. Where are the young engineers going to come from to carry on work, such as you described, in the future?

John F. REID
This is a very easy question to answer because I'm very passionate about the subject and the answer is: I don't know. I am very concerned about this and at the same time I left Academia a couple of years ago, to go into this industry job and I see it, I even feel worse about it now that I'm in industry and I see how bad it is and it's going to be a big challenge in the future and I often find myself asking questions about the information that we're going to forget and use in the wake of the information that we're gaining.

Prof. Daniel BERCKMANS
Belgium
My question is for J. Reid: you have given a very interesting overview of existing sensors systems under development. However, many times and in the conclusion you said that they are dead and needed for traceability systems, as the final goal. My question is: should this be technology driven? Because that is what we see now, we measure what we can measure, and we are limited by the systems. Another way would be: it is research driven. We define from the product what the data are that we need from traceability. Is that already clear? With a different type of researchers. In addition, we develop the sensor from scratch for doing that. Should it be technology-driven or research-driven? Because this is the best strategy.

John F. REID
Now, I also showed some information systems that are already going in place and it's based on information putting information in chain for traceability and even without sensors the data collection aspect of this is going to evolve much faster. For example, these companies that are giving around the concept of making money off of having the food chain connection is going to take place irrespective of our advances in sensor development. The sensor challenges are that, as these systems evolved and become more capable, they are limited by whatever sensor exists, so I really believe the research approach is better we shouldn't be doing things only because technology, and I say that as a machine vision specialist you are always looking for another machine vision problem and even in my career I have done a few things that I try to apply my skill rather than address the needs of a particular problem. We have to differentiate this but usually the market place will do that for us and will not accept something just for the technology.

Daniel BERCKMANS
I am wondering then whether the variables that have to be measured throughout the production chain are already defined. Let me just give one example, for instance poultry, because I'm more familiar with animals. We know that in the incubation period, and in the

growing period, temperature is crucial. Afterwards when we go to the slaughterhouse, for hygienic reasons, temperature is crucial. In storage and transport, temperature is crucial, when the retailer offers the product, temperature is crucial. Therefore, if we can have a sensor on each egg and that goes with the egg throughout the chain until you have the piece of meat, that is traceability, and how will we find this temperature. My question is: Does this already exist, in the type of products we are thinking about?

John F. REID
I think the concept is very good, and actually, we should be very good at measuring temperature, should we not? It doesn't always require a complicated solution for these problems, and so, maybe you don't even need a sensor, but you need something that responds to temperature to indicate that something bad has happened along the way. The difference is, do you need to know when that bad thing happened and record that and having humans in the loop to observe these types of indicators, and then it is still possible to implement a very effective system. It only amazes me, I have seen examples in countries that are the last developed that are further along in traceability than the high technology methodologies that exist in other countries that try to throw technology at it. It is not just something that is necessarily driven by technology; it's driven by the information and how you attach it to the product.

Richard J. GODWIN
There are a couple of competing questions almost, when we look at the traceability issue versus other applications of the technology in precision farming. Precision farming has almost come and gone in less than a decade, because nobody sees any value in it. There has been a lot of hype, a lot of technology thrown at it, and no great worth perceived by the farmer. If that from a production point of view is not being seen as way to go forward who is going to pay for traceability. Will the farmer pay for traceability or will the consumer pay for traceability?

John F. REID
I think it's not going to be paid for by the farmer, we can't be keep throwing technology at the farmer and have it make him money necessarily. It is making money in a very few cases. The graph, I showed, where the arrow is going in the other direction, from the end user towards the producer. Where the information is valuable in different parts of that chain is where it has to exist. I did not show this in my presentation, because it wasn't a business presentation on traceability, but there is some evidence that the people along that chain can have a reduced cost, become more efficient, by having this information exchanged through the food chain and still allow the producer to be profitable.

Richard J. GODWIN
I do not believe because the people along the middle do not allow the producer to be profitable and what is going to happen is that they are going to put all of those costs onto the producer, what we've got to do is to help the producer to get some added value from this in order that there is a way forward so that he/she are sustainable in business at the end of the day.

John F. REID
I see your point and I agree with you. Actually you're segmenting producers by the ones that need those expectations and the ones that do not. It still doesn't make the producer successful universally which has to still happen in our view; it starts segmenting them into those who can and those who cannot.

Jaime ORTIZ-CAÑAVATE
You, John, mentioned about the localisation in orchards; the information in orchards is more expensive and you have also talked about AGRIS, a system for traceability used mainly in California. Could you please tell us more about this subject?

John F. REID
I can talk a little bit more about orchards, as far as the AGRIS, I am not extremely familiar with the product exact that it uses. I know one

use of it. I talked about tracking tomatoes through the various way, from production into the way stations and caching information through that. Actually there is a website that you can look at. I suppose if you just looked up eTomato you would find that and it gives some examples of the input screens where data is logged, and it's probably more explanatory than I would be on this subject. As far as a localisation in orchards, my experience in that area comes from the friend Pierce who was at the Chicago meeting and he and I have connected as a result of that meeting. I went to his new-style orchards in the US where they are trying to reduce the labour costs and along the way the producers think about being able to identify the characteristics of each individual fruit; and just that concept in itself - of being able to have a machine that can go through and identify each fruit specifically - they changed the tree structure, so that they are more planar. It's easier to say that the fruit is growing almost in a plane as you are travelling down to the orchard. But even though that simplification has occurred the logging of this information - you have a mobile vehicle where you have individual fruit and even clusters of fruit where they have to make some decisions about removing some of the fruits and leaving the others that will eventually be in the crop and having that information go through this chain. It is extremely complicated although to the producer seems that if you have these machine vision centres it must be easy and possible to do. But it is still very far from being in the producer's hands and I see there is a big challenge to that. Furthermore it is made more difficult because GPS technologies are affected by the trees themselves, different architectures, different orchard configurations, different hillsides and block satellite views. There is a lack of an absolute reference in some of these cases, too. These producers will have to drive down through the orchards during the season and decide where they would place boxes for the harvesting, even manual harvesting based on the number of fruit they have detected in the trees. I think that is achievable but is not an easy thing to do.

El Houssine BARTALI

This is a general comment. First of all, I would like, on behalf of CIGR, to thank and congratulate Prof. Pellizzi for this excellent meeting and congratulate the speakers for their valuable speeches. CIGR is a global network and the Club of Bologna is one its important sub-networks. For a better idea of what the Club of Bologna is doing I think I would like to suggest that the participants keep more in touch with CIGR secretariat, because I don't see this important activity shown on our website. Since this is for researcher teams should be set up and many things should be looked for: what types of projects are being funded, where to get funds and what type of topics are covered. All this information is useful and should be updated. Maybe the Club of Bologna should nominate eminent coordinators for the CIGR secretariat website.

Prof. Fanis GEMTOS
Greece

I would like to continue the question of Bill Stout. Who's going to apply all the technology? At least in my country, I know that in the last 20 years a lot of privileged people have left agriculture and now we're willing to ask them to adopt the new technology which is quite difficult to understand, even for an agronomist and I don't know all the situations. A lot of people are ready to apply Precision Farming, so I suppose - if I'm going to do the same in Greece - a lot of people are going to ask "What is all that?" So my question is: How are you preparing this technology to make it familiar to the farmers and easier for them to apply?

John F. REID

I think now, most companies have a service aspect that tries to make these technologies useful to the producers but, frankly speaking, these are not a large moneymaking aspect of the companies in a product like autotrack and parallel tracking in yield mapping; they don't make the most of these companies in terms of the products and the offer. I see some progress but, to your point of connection between people, if you are inventing a technology and you apply it in *crop production we tend to associate with the engineering aspects of that. Let us say that I make a technology that can do crop pulse sensing; for me to sell that to a farmer I have first to convince the agronomist that this is a useful tool. So, along the way, working with these technologies, even if I have scientific evidence that this is good technology to use and we should use it, I have to objectively show this to some very sceptical people and convince them that it makes a difference. These groups sometimes use technology roles, because they become accustomed to the methodologies that work in their local areas. In the US we even have controversies between one State and the next; about nitrogen management, for example, there are completely different philosophies and so it is very difficult for a sensing technology to move through all of that to become something that is actually applied by the farmer. It requires demonstration and production of technologies and proving them to collect evidence that it works. You almost have to have faith that this is something that is going to work and eventually if you provide the technical evidence that it does. At the same time you have to have economic justification for these technologies. In my experience in vision sensors I have found that vision sensors may not be photodiodes. A better way than having this technology, put one in each row rather than having visions sensors - that see many rows - or remote sensing - that can see a bigger area - and you have to keep all of these moving.*

Dr. Theodore FRIEDERICH
FAO

I feel a bit uncomfortable with the discussion on traceability and the way this topic is handled. I feel that we might get carried away with the enthusiasm of solving technical problems so that at the end we might trace back the origin and the history of a specific piece of agricultural produce. Why do I feel uncomfortable? The topic of traceability came up in an environment of globalisation; an environment where it became impossible for the consumer to see where the food was coming from and in an environment where the food was losing in value. Now, if we solve this problem only from the technical point of view, I think we might hand up in a conflict, especially looking back at the ethics discussion, which we had previously. Should we give the technical tools to a system, which is my question (talking about questions of globalisation) or should we not try to define where is it suitable, where should we find technical solutions and where should we say clearly we don't want to solve it technically because we want solve it in a different way.

John F. REID

Of course, my topic was on sensors and data collection and I agree with you. In fact we will see traceability take place without technical advances. It is the flow of information that shows the connectivity trough the system, that is the most fundamental element; sensors make things easier if it's realistic to use them; it may be that the adoption of sensors are not required even no profitable processes. I think sensors will be useful though to track field characteristics that have been measured and perhaps to provide a benefit, but they have to be used if it is an important part of the system.

Axel MUNACK

I would also go in the same direction as Friederich and Berckmans said. I would like to put the question - as a task for the existing sensors - with respect to the application traceability being appropriately defined and have some tasks for new sensors in order to fill the requirements in defining what traceability is and I think it is not the case. So concerning the example of John Reid, with respect to airborne flights and satellites and resolution problems, do you know what resolution you finally need in order to apply these techniques to traceability? At the moment, I think, satellite images have been used mainly for administrative purposes and also airborne images are mostly used in the EU to get some support for olive tree manufacturers and farmers. So, it is more administrative work with those images and not so very much, as what technicians think, such as input control and supervision of material flows. Also for direct fieldwork, when you go into nutrients and *soil moisture, I think you have problems concerning the resolution level: the soil, of course, has a big variance and the usual methods which we apply are point-wise measurements. Therefore, the problem is: how many measurements you need to get average answers? So, I think that there are a lot of problems, at least with respect to the new problem of traceability that is a new application to be redefined and thought as new aim.*

John F. REID
I do not know if I need respond to that, but I agree. I suppose that resolution goes, if you try to look for original problems, widespread stresses that you can detect with a remote sensing, but you would not want to be counting the number of olive trees in the mapping

Irenilza DE ALENCAR NÄÄS
I would like to come back to the point that Bill Stout raised. Actually we need to discuss three major points in my view. One is that traceability can be done manually or electronically. What John Reid presented is still the electronic way of doing that. We already know that if we obtain the files of information manually, we introduce an error and more errors you introduce in the process less value it gets. If you see traceability as the final product it has an added value. So I agree that we have to develop new sensors or use sensors available and address our research towards that, in order to make it profitable in a long run. We could use those sensors to have the value of the product and actually make the food safer; so it starts food safety at the far end of profit. Concerning the research problem it is found - most people mentioned it - that we are not prepared, because most of the research groups are very narrow-minded, if I may say so. Going into the subject, I find necessary to have a multi-disciplinary group working together: people from Information Technology need to be with us, people from physics, from mathematics. New logic, new mathematical logic has been developed to be used in this subject. So in Brazil we use not only multi-disciplinary but even trans-disciplinary; we go into other disciplines in order to understand most of those problems to apply it in a better way, in an optimal way. So, I think we need to train better our students, our people and maybe - if we address the question in a broader view - it would be much easier for us to understand, not only what is going on but also to apply the technology in a right way.

Francis SEVILA
Among the various problems, I would like to point out one: the ability of the farm machine industry to cope with the various challenges relating to sensor and data collection development. I am not talking about the technical challenge, industrial and commercialisation challenge. John Reid, you have quite broad views from your career; you have been in various areas. My question is: do you think that industry - and you are a member of a major company - is technically ready, or business ready, or minded to invest in all the necessary expertise, not only to design, but to produce, to maintain and to bring almost to the consumer and to the commercialisation network all these new technologies? Farm machinery industry is - with certain scope of electronics, physics, data management software etc. - a kind of technology which is not quite so at ease in the old network: to maintain, to sell, to have the growers with them. So what is your opinion on that?

John F. REID
These are subjects that industries are very actively looking at. But I should say that they are not prepared and because they look at it in a very small way. To the mechanical industries, the machine is everything and technology is the small cost you are going to add to it. Even things like autonomous vehicles, it could be that the machine is the small part and the technology you add to it is the big element of this. That viewpoint is definitely not in the industries. That is part of the challenge. We might move into these areas through partnering with other groups. We do not find things in these industries. These are slight to be challenged; there is the increase in efficiency that will be created. It is not just possible that we just make the machine and not worry about the other aspects of

this that the producer has to deal with. It does not mean that industries can make the shift into these areas and go at them I can see there is a big challenge with it.

Pierre F. J. ABEELS
The main and fundamental question about developing sensors and using them is to go back to fundamentals: what are we measuring and for what are we measuring the various parameters? In biology, temperature is the most common parameter to follow during the process. But in agriculture: what is soil compaction? What is soil humidity? What is wind effect on the soil surface? What is growing rate? What is the fertiliser capability for one plant and for another plant; for corn or for soy? You do not have the possibility to manage, to monitor the growth; it is still a variable process in biology. So we need more information from biology, it is necessary to engineer that science. I already started in the 60's to develop some sensors, even to automate them, and we had a lot of parameters to be measured. So we must stop once, just to have a fundamental reflection on what is compatible, what is comparable and how to give the instructions. We are very far in engineering, in high engineering for all machinery, we are not so far in bio-engineering. We just try to manage it, but we do not have information from botanists about the meaning of some substances, of some ions in the plant or in the animal life. So I would like to have support from the industry to organise a kind of meeting of those scientific forces coming from research and teaching and practice, just to validate the sensors.

John F. REID
I support that statement, it is very important. I do not know how we are meeting a challenge by the common mode integrated. But even if you develop a specific sensor, this specific production system you apply has to be considered in this way and made indeed in the different places in the world where you have planned have to be considered those factors, to make that sensor useful. So very complicated in industrial skimmed may be the usual problems and solve them having to address these more difficult issues

Philippe MARCHAL
The title of your presentation, Mr. Reid, is "Sensors and Data Collection". I focus my question on this second point. What is your opinion about the importance of data transmission and data storage technology for traceability? Do you believe that the use of standardized and cheap technologies are the key point for the development of traceability?

John F. REID
The technologies that are used for transmission and data collection are fields of the primitive level. For traceability really is important in some instances that traceability is structured for information from machine to machine and has to follow through the process; we do not have this eased. RFID tags technology exists and could be used. But it is at all another expense of space. So that's right now to have traceability is a more primitive level: the data transfer and storage is manual, sometimes it is carried on a card, on Internet and all these things are error sources that can exist. It is important to completely automate those data transmissions; we do not know the answer yet, but it seems a very big task. Your second question was on standardisation from data storage and data transmission. If you think about all the things a farmer has to do for traceability, it is very important to have a management tool helping him in keeping track the variables. You know some farmers are pretty good at keeping the records in a more business mode than they had. They probably have these historical records but there is an increase in volume of data. I see this thing be an element of a larger development still needed.

Yoav SARIG
I can understand why some of the participants feel uncomfortable, because I have the same feeling. I feel it because of the title. I do not blame John Reid for that because he was delegated for the subject but because of the subject. In many ways he got carried away with technologies. In many respects we put the cart before the horse, we forgot that the theme of this meeting is traceability and not automation, it is not sensor technologies and every-

body is already talking about fancy technologies and transmissibility and recordability and we forget about traceability. I think that traceability, even though it is not spelled out clearly, is a consumer requirement. The producer makes a statement: I have a safe product, I have a fresh product or I have a contamination-free product or some other statement. The consumer wants to verify these statements and they want to make sure that what the producer claims is true. The few examples from the past are meat that met cow disease, the salmonella contamination of eggs and chickens and so on. They make all these products. The treatment of the less developed countries as a separate issue, but it is dangerous, because one gathers that your words imply that it is "ok" for less developed countries to consume products with a higher threshold of residues; they will eventually come to the same status as us, but the consumer will be ready to pay for the added safety of food. The statement I made that food is organic, the consumer who would like to consume organic food will want to make sure that it is organic. So all the things that we have talked about afterwards come afterwards, after the statement of traceability. So in my opinion first we have to define what is important, what are the parameters needed to ensure and identify that the statement is correct, and they will be different for each product. After that we have to decide what technologies are available today: some are new sensors, panel sensors of the product is using ones own sensor devices. Why else should we go to fancy English processing systems that one uses today. Let us focus our attention on what the subject is: to define the parameters, to decide what are the technologies only available and the main task for the Club of Bologna is to give the message to researchers worldwide, what is still needed to be done. That is our task and that is the goal of the Club of Bologna.

Daniel BERCKMANS

I would like to make two comments. I think many comments stay in the same direction: it is not a technical problem. First we have to handle what we have to measure. I think the added value of traceability is not only safety; that is not enough. A product is safe and then only can it be put on the production chain. It cannot be a little bit safe, either it is safe or not. That is one thing. Another thing is input limits; in trying to define these fundamental problems we do not only have to look at an angle concerning environmental impact of fruit products, energy input, without interdiction for the news, that is what people are interested in, what people pay for, until that is not something like they consume. There are many kinds of consumers, for instance, like some people that buy a very cheap car and they do not know it is a cheap car, on the other hand some people buy a very expensive car, because maybe they have good comfort or more safety, they have more information about this product than we have about food product done. I find that the key issue is education. How do I install the interface with the consumer? How is he "educated"? Because if the consumer wants to pay for traceability, the retailer will ask for it and that retailer will act as the production chain will make.

Richard J. GODWIN

Mr. Reid, a question relating to almost three different types of product. We have livestock and with livestock the thing is driven into the yard, it is identified and then chopped up and so it is very easy to take from the thing as a whole and subdivide the beef cattle into steaks and sausages. You have a crop, a series of products, such as apples or oranges or grapefruit that are discrete and are usually marketed in trays; and then you have maize or barley or wheat. In fact, maize wheat and barley go into the livestock. We may be able to do many things, effectively to act as a tachograph to confirm that all of the maize has been cultivated up to standard. But how do we know that it is not contaminated? What happens when you mix farmer A with farmer B with farmer C? And some of each, of their wheat goes into a loaf of bread. I have great difficulty in how we understand and control that. I wonder if you give any thought to that in term of traceability.

John F. REID

I think that today this is impossible. I think the thing we can do easily is farmer crops, in terms of small grain products being able to attach this information as we talked, what is happened in the well known systems. You know what the farmer said happened in a field and maybe you are documented on this event, but in the field next to it there could be a GMO crop that may have some influence on it. So if you don't have your information, it might be true for the crop allocation, but there could be boundary effects that create differences there and you do not have the ability to say that those things on a credible basis. I don't think it's going to be economical to do that either. Although if you look at the key problems, that can happen - you know, parts per billion is a very dangerous amount to have - and so we need that if we consent that level, we are unable to detect these things when it is in a bigger level. A better challenge and better results in some of these research areas are to found variables that are related to that problem and document those, because it is anything we can measure effectively. So this kind of different situation trough the slow food chain on information we don't correct and now can be used some of it can be sensored. It is a prosperous career for someone to work on. It's what we can try to define.

Richard J. GODWIN

The reason I asked the latter question was maybe a few years ago when GM maize was coming in to Europe from the Midwest, it was impossible for the Midwest farmer to differentiate between GM and non-GM products, but it just shows how done difficult is the sharpen in unit control things.

John F. REID

In one part of the world organic and non-organic apples grow in the same land area, and so its practices are organic to meet its prospectuses of the standards is mapped all over the world, so it was discussing last night in different part of world prospectuses of the organic be quite different. So your definitions might not be do allow that happen.

Bill A. STOUT

I wanted to come to the comment that you made and remind the group that this meeting is the step two in the discussion of traceability. Step one we did in Chicago and in the whole meeting in Chicago, which some of you attended and some did not, there was for reasons for traceability the implications to food quality, the consumer driving forces, etc. And now we ask John Reid and other speakers to come here and focus on sensors and other elements of this so big subject and so let us not blame John Reid for doing what we asked him to do. Please go back and read what was presented in Chicago, there were excellent papers, on reasons why we are here today.

John F. REID

To respond to the original question: I could not have agreed more with your comments because when I talk about the issues of traceability it is really a matter of looking at what we have and what we are working on, in terms of sensors and data collection. But it may not be the most important part of this whole process.

Prof. Jürgen ZASKE
Germany

I think we are discussing the topics of the afternoon. What we have learned or what we know is that industry has a lot of solutions for precision agriculture, we know this. Prof. Godwin has mentioned that there is no economic effect so far; this is not true on big farms. I could comment on that. We have learnt in this presentation that there are many technical solutions to trace the production and this is the task of the paper and no more. What we will present this afternoon are the other question, traceability is agriculture policy driven, it is market driven, it has to establish confidence. There are a lot of psychological human aspects in it, what I feel, what is likely is that there is not enough communication between the agriculture engineering industry or the machines manufacturers and the food industry. I think this is the problem. Or the food supply chains which really could say what is required in traceability and what they would like to have: the machinery manufacturers develop-

ing or the researchers developing. This dialogue with the certifying institutions, I feel which gives them the quality seal or the seal of organic production. So on one hand it is a management problem and on the other hand it is a technical problem, but it is market driven, and we should have to consider this. So I think you should have put technical questions to Mr. Reid instead of holding up all with what you are going to discuss this afternoon.

Antonio PAGANI

I have been trying to follow the discussion to see if there was a statement with which I could not agree, but I could not find anything. I agree with everything. But we have been touching several subjects not strictly related to each other, so I would invite my friends and colleagues to comply a bit more with the principle that some of us are very familiar with the logical framework whereby in a discussion you set some objectives to be achieved, some results to be produced, some activities to be implemented to produce the results to achieve the objectives, and some inputs required to implement activities. In this case we were talking, and the presentation was extremely good, even if I am not a specialised engineer in this, I understood something, which is already a result for me, it was sensors and data collection systems in the agricultural equipment, something related to technology. So that is the point of discussion. So the scope of the discussion is what could be the use of the sensors in the data collection in order to apply traceability in view of possibly meeting the requirements what do they want, the customer, the client, the end client market and something else. So why do we not go step-by-step, and this was the point, a terminological issue.

Karl Th. RENIUS

Many intelligent comments have already been made, so my speech will be very short. We have already done two steps in this direction and my proposal is to go two further steps to better understand the problems, coming back to what Sarig said, to identify the needs for the next steps, and my proposal for the Management Committee of the Club is to consider the subject on case studies of traceability for the next meeting. What types of food chains do we have: not only for plant production but also for animal production, and to look for some interesting cases and to identify the problems better. We now have a certain basis and we can learn the problems better if we do that.

Francis SEVILA

I'd like to make a comment composed of two statements. The first statement: when we speak of traceability we are not speaking of goals, we are speaking of four main partners: the retailer, the food distribution company, the food processing company and the grower company. The second is: each of these partners on the chain has different potential for investment in technology; so the cost of the technology that they can afford is different. If we take the retailer the Information Technology that usually he can afford is around a thousand Euro. If we take the food distribution company, the major ones, you realise that the cost of Information Technology that they are obliged to buy, is around one million Euro. In the food processing company, the average cost of their computer system is around 50-55 thousand Euro. And now to the grower, we are speaking of technologies that the grower has to buy. Probably he cannot afford more than 10 thousand Euro. I just mentioned at this point to show that when imagining what kind of technology you have to provide to the growers, we have to take in account this problem of ability to deal with investment and probably the technology that will have to be developed for growers will have to be shared between growers, because it has been mentioned that traceability is a difficult performance and in the food chain the farmer partners have not the same financial ability to cope with this problem.

Bassam SNOBAR

Now, we have to invite Yoav Sarig to give the presentation of the Working Group formed in Chicago "Guidelines on Traceability". Then we have the presentations of Prof. Zaske and Prof. Bodria: "System integration and certification. The market demand for clarity and transparency".

Yoav SARIG

Bill Stout reminded you that this meeting is the follow up of what started at Club of Bologna meeting in conjunction with CIGR-ASAE manifestation that held in Chicago last Summer. So this is the second step and it was decided in that time that a Working Group from the Club of Bologna would meet and prepare a draft recommendation for consideration by the Club members'. The Working Group consist of prof. Pellizzi, prof. Auernhammer, prof. De Alencar Nääs, prof. Bodria, prof. De Beardemaeker, prof. Piccarolo, prof. Marchal and myself. The draft of the paper is as follows:

Draft Guidelines on the Traceability

1. **Traceability:** methodology on tools allowing to know in detail the record of any vegetable or animal product put on the market. Such knowledge allows a correct evaluation of each product in terms of **health safety** proper to each food or feed product.
   Food and feed products safety is mainly related to its natural and genetic contents and to the fact that they are free from chemical and/or toxic residues.
   Food and feed safety depends mainly on components that can be evaluated and quantified.

2. Growing environmental pollution as well as organic production, on one side, and G.M.O. production, on the other, urge actions on food safety, taking into account that the objective of the food system is to produce healthy people, not just food. It is therefore essential to know: for each crop, the environmental conditions, the method of growing as well as the technologies used pre and post-harvest; as for animals, how they were reared and the technology involved.
   - At the **growing stage** it is therefore important to know for each crop:
   - the genetic origin of the crop;
   - the orographic and pedologic characteristics as well as the agronomic and environmental conditions;
   - the know-how and technologies used for preparing the soil, for sowing and maintenance operations;
   - the know-how and technologies used to distribute organic and mineral fertilizers, as well as chemicals;
   - the methods and technologies of harvesting.

   At the **post-harvest stage** it is vital to acquire, in relation to the final destination of products, the information on the various post-harvest and storage technologies and methods.
   As for products or components to be **processed** is crucial to know: the method of preservation, the use of chemicals, a full knowledge of the processing methods and technologies used.
   Products intended for **direct consumers' market** should be tested to detect residues and other undesirable properties.
   Finally, crops for **animal feeds** should be checked to make suitable for each animal species and verified if proper for processing.
   Once the origin of feed is controlled, **animal husbandry** has to be defined as follows:
   - type of breeding;
   - welfare conditions;
   - feeding methods and technologies;
   - methods and technologies for the best achievement of final products (milk, eggs, meat).

3. **Mechanisation** is a key point for improving traceability and each machine has, consequently, to be equipped with appropriate sensors and instruments able to acquire the data mentioned above, within the all food and feed chains.
   To this end there is the need to develop sensors and I. technologies able to measure and record the history of each product with the general goal to associate the information to the product.

4. At the same time it is necessary to acquire **standards** based on each country's or region's legislation.
5. The **main goals** of the workgroup, to be reached before the end of November 2003, consequently are:
   - identification and collection of existing standards;
   - identification of the architecture of different food and feed chains to design a traceability system appropriate to each of them;
   - identification of the architecture of the machinery systems and then of the sensors and electronic requirements as well as of information systems to be applied to the various machines and plants.

Topic 2.2 a – System integration and certification: the market demand for clarity and transparency

*by **Prof. J. Zaske** (Germany)*

1. The food market as seen by the consumers

- **Consumer expectations**

Depending on their social status and educational background, consumers expect:
- safe products
- high product quality
- low or reasonable prices
- consideration of sustainability and animal welfare criteria during the production process

with differing priority.

- **Transparency for the consumer**

In **producer-close distribution** such as:
- Direct distribution by the producer/farmer, ranging from on-farm sales to the farm's own chain of shops (e.g. milk and meat products),
- Sale via regional distribution chains on the basis of producer associations, e. g. "Franconia Farms", (both may include organically and conventionally produced products),
- Distribution directly via the local food craft trades (bakers or butchers).

the personal confidence of the customers in the producer or craft trade is the basis for purchases.

In **producer-distant distribution**, e.g.:
- Distribution via the retail trade; branded products create the basis of trust and confidence.

The packagings secures the product identity and contains essential informations, in particular

· Origin/manufacturer
· Ingredients/conservation agents
· Nutrition facts
· Production and use-by date.
· Batch/Lot
· Storage instructions etc.

Producer-distant distribution increasingly is:
- Distribution via retail trade chains (e.g. REWE; objective: optimising business management and lower prices): The sell branded products too, and to a growing extent house brands (e.g. "Ja!"), which contain the same data on the packagings, but instead of the manufacturer's name state "produced for REWE". Here the origin is frequently no longer traceable (**Fig. 1**).
- Distribution via discount chains (e.g. Aldi; objective: further price reduction with low service input): Products are generally less well-known brands or "pseudo-brands", which almost plagiarise the brand layout. Both are labelled like branded products.

In particular producer-distant distribution needs labelling in order to inspire confidence among buyers. This is also required by law. For logistic reasons labelling is generally supplemented by bar codes.

- **Changes in consumer behaviour**
  - Decline of the market share of the retail trade
  - Market share of retail chains and especially of discount chains is increasing (shopping at discounters is no longer considered to be discrediting)
  - It is generally expected that all products are labelled as described above
  - Food safety is presumed à priori
  - Differentiation on the basis of "quality"("visible" quality, image of the brand, attractiveness of the packaging)
  - Increase in the share of organically produced products due to
    · expected higher nutritional value
    · expected lower contamination
    · supposedly better taste (with possible poorer appearance being tolerated)
    · for reasons of organic conviction.

Organic products can be purchased both directly from organic farmers or in organic food shops. However, shopping in the food trade or at discounters, who are also offering organic products to a growing extent, requires consistent labelling of the foods as organic products.

2. The food market as seen by suppliers

The shift of distribution to large trading chains makes it necessary to offer large quantities of products, processed or unprocessed, with defined and constant quality. The trade and the food industry therefore prefer to buy from large-scale farms, or they force smaller farms to form associations. Parallel with procurement on the home market, the wholesale trade and food industry are increasingly obtaining supplies from international markets, partly at much lower prices. Market liberalisation caters to this trend.

In this way, however, the origin of the primary product becomes increasingly less visible.
This means that the trade (especially in the case of unprocessed products) and the food industry have to guarantee the quality and safety. They have to win consumer confidence by credible labelling (**Fig. 2**).

3. Aspects of food safety and product quality

- **Food safety**

Safety has long since played a role in the sensitive areas of food and nutrition. In this connection there are extensive legal regulations at national and to a growing extent at EU level, especially in the hygiene sector, e.g. covering

- meat and meat products
- milk and dairy products
- bread cereals, flour, bakery products,
- fruit and vegetables.

The product safety is monitored by:

- state inspections (e.g. regarding pesticide residues) or
- self-organised inspections by enterprises or by associations of enterprises (e.g. for milk).

In particular the ingredients and any contamination require very extensive and discriminating laboratory capacities.
It is in the vital interest of both primary producers and processors not to be expelled abruptly from the market due to safety shortfalls. The possible damage in the case of large product quantities is higher and the probability of faults with complex production methods using a variety of material flows and process stages is greater. For this reason the food industry developed new instruments for in-house monitoring to avoid risk at a very early stage.
According to U. Nöhle, Messrs. Nestlé, customer requirements for fault-free products led to exceptional efforts by manufacturers to optimise their information management and their process sequences. "The establishment of HACCP Systems (Hazard Analysis and Critical Control Points), hygiene plans, batch tracing possibilities, recall systems and the operation of laboratories in accordance with EN 45001/GLP, embedded in an overall QM system in accordance with ISO 9000 ff., including traceable documentation and archiving, have distinctly increased safety in food production."
However, the industry is interested in more than secure product safety in its own production process. It wants divided responsibility "upstream" and "downstream":

a) "Upstream" it wants to obligate suppliers of (pre-)products to ensure that their products comply with the safety requirements (in accordance with national and EU regulations); in other words the (pre-) products must be free of:
   - physical contamination (glas, dust etc.);
   - chemical contamination (pesticide residues, nitrate, toxins, other chemicals, that enter the products e.g. via the use of sewage sludge or precipitation);
   - other specific biological disease pathogens (salmonella, bacteria, prions etc.).
b) "Downstream" it wants to be able to remove products from the market selectively if contamination or spoilage has occurred despite all care, e.g. due to negligence or sabotage, in order to hold in check the damage sustained (loss of product, costs of disposal, loss of image), as well as to be able to claim recoveries if appropriate.

The health authorities are interested in this too.

They are also interested, within the context of risk management, in:

- removing products from the market;
- finding the party causing the damage;
- if appropriate, initiating criminal proceedings;
- eliminating causes.

This requires traceability from primary production till the “consumer’s refrigerator”.
The most important instruments here are exact and uninterrupted documentation (declarations, freight documents, laboratory results etc.), which is provided to a growing extent with computer support, and clear labelling of the product.

“Uninterrupted” means documentation via the entire chain:
Primary producer → transport→ storage → processing → distributor → counter display.

- **Product quality**

“Quality” means “the sum of similar or same perceptions of a group of persons (consumers/observers) regarding a specific product or service”.
Quality is an essential factor in determining the price obtainable, and food quality and food safety are closely connected.
While faults discovered in food safety and visible spoiling lead to immediate loss of the market, quality defects impair marketing successively.

Quality in fruit and vegetables
is usually perceived by our senses, e.g. in the case of fresh vegetables or fruit via:

- size, form, colour;
- consistence, “freshness”;
- odour;
- taste.

Corresponding quality criteria are agreed between the producer and the customer (trade or processor) and should be based as far as possible on objective (measurable) assessment criteria. The ingredients (acids, sugar, esters etc.) determining taste and odour and the dietetic ingredients (vitamins etc.) must be determined by laboratory examinations.
In addition, a separate examination for food safety is conducted.
There are very specific national and EU regulations regarding fresh products, too, e.g. concerning:

- trade categories;
- data on varieties and origin;
- cleanliness.

These dates must be given on the corresponding labelling on the packaging or in the display (**Fig. 3**). Transport packaging, e.g. fruit cases or cartons, serve here not only to protect the products, but also to secure their identity. They are marked with the appropriate labelling.

Quality in potatoes
Another example is presented by potatoes, that are usually packed in nets on the basis of variety, size, colour, and cooking behaviour. Here the labelling is provided on tags. Since these data partly concern “internal quality features”, both storage warehouses and packing units require exact information from the producer.

This means that for both potatoes and fruit and vegetables, there is a growing demand for traceability right back to the individual field or plantation.

Quality of bulk products
A third example is formed by bulk products, especially cereals. Here, large bulk quantities have to be “labelled”.

The intended use is of major importance, e.g. as bread cereal or brewer’s grain. The examination criteria are then the baking quality or the brewing quality. This depends not only on the variety, but also on the composition of the ingredients, especially of proteins, and this in turn is determined e.g. by the nitrogen fertilising. This means that the buyers or processors (mills) also require comprehensive documentation from the primary producer/farmer.

Under certain circumstances processors even provide the primary producers with concrete advice regarding production measures, within the framework of cropping contracts.

Additionally safety examinations are directed especially at pesticide residues, toxins, mould infestation or ergot.

4. Quality and Safety Management and Certification

- **Quality and Safety Management**

Since quality and safety are influenced by the way of primary production, grain mills, breweries and feed concentrate mills require comprehensive documentation from the primary producer (farmer), too.

Furthermore, they have detailed requirements for each link of the production chain:

(Farm production) → drying/cleaning → transport → storage → transport → processing/packing → transport → trade or processor

The overall aim is to ensure that the final product satisfies the necessary criteria regarding

Quality and Safety

There is a tendency of moving away from stand-alone solutions in quality and safety management for each link of the chain towards integrated quality and safety (QS) management systems.

This obligates the individual partners to create respective structures, to harmonise these, and to implement measures that serve the common goal "QS".

The foundation of this is agreed documentation, which is based on documents, process data and - if required - samples to verify the different steps of the whole process.

- **Certification**

Subsequently the quality and safety of the products must be certified and labelled in order to achieve marketing advantages! (**Fig. 4**).
The certifying institution can be:

- the bulk buyer (e.g. the grain mill, the food industry or the feed plant), The branded product is here the guarantee for the customer/consumer (flour, bread);
- a number of farms or enterprises in form of a quality producer community (quality eggs production);
- an institution especially created for this purpose, e.g. an executing organisation of a "quality seal" (**Fig. 5**).

5. Integration of the quality of the production process into quality assurance systems

- **Interest of the buyers**

As already mentioned at various points, product safety and product quality depend directly on the nature of primary production (residues, ingredients, suitability for processing etc.).

In this respect, buyers increasingly demand from producers evidence concerning the quality of production (seed used, fertilising programme, consideration of waiting periods after pesticide treatment etc.), in addition to measurable data concerning the product (e.g. moisture, protein content, residues).

This is intended on the one hand to rule out certain undesirable substance in or on the products, and on the other hand to guaantee quality-determining ingredients.

- **Interest of the public**

However, documentation of the production process has further objectives:

a) to provide to a critical public evidence of sustainable, environmentally sound management including the consideration of animal welfare aspects;
b) to provide data for applications for subsidies or to avoid sanctions, especially in connection with national or EU legislation.

Within the framework of this paper we shall only look at point a):

The minimum that the public expects of agriculture is that it observes the "rules of good management practice" and uses the "best available technology".

Since these factors are generally not visible on the product itself, they must be declared credibly by the producer by means of a description of the production process. This then enters the quality guarantee via the brand or a quality seal. A group of the population that is particularly critical as regards organic aspects makes additional demands on top of this:

- specific maintenance of soil fertility (e.g. minimum or conservation tillage);
- matter or nutrient cycles on the farm (including avoidance of mineral fertilisers);
- avoidance of chemical pesticides (substituted by biological or mechanical plant protection measures and special crop rotation etc.);
- animal welfare oriented management (no cages, more space for each individual animal etc.);
- no use of genetically modified organisms (plants and animals);
- reduction of energy consumption etc.

Farmers who want to produce and sell products in accordance with these criteria have to keep strictly to the rules of corresponding institutions. These are organic farming associations that certify the farms after inspection and a transition phase (generally 2 years). Both the farm and the products are labelled accordingly (e.g. by "Bioland" or "Demeter" - seals); or the new EU Ecological Regulation is used as a basis for certification; labelling is then carried out with the new "EU Bio-seal" (**Fig. 6**).

6. Conclusions

Management

- Since consumers increasingly demand food safety and high product quality and environmentally sound production in line with animal welfare, integrated management systems for quality and safety (QS) are indispensable.
- These comprise complete documentation of all substance flows through all process stages including transport and storage, and the performance of checks on food safety and on quality factors at all critical points of the entire process, right through to the display in the retail trade.
- These measures end with labelling of the product and a guarantee of quality and safety via the brand, via QS symbols of various kinds, or via the retail trade chain.
- The more complex the final product, e.g. deep-frozen dishes, the higher the demands reated to the QS management.
- This results in a trend to obligate the suppliers more strongly. Evidence is increasingly demanded that suppliers have their own effective quality and safety management systems. In the case of large product flows and hence high risks, it is therefore required that suppliers be certified in accordance with DIN, EN, ISO 9000 ff.
- Suppliers who cannot produce evidence of this are ousted from large markets in the medium term.

Technical aspects

- In addition to management aspects there are also technical aspects concerning quality assurance and food safety:

  a) suitable software and hardware for the necessary management systems including documentation (IT);
  b) fast, precise and low-cost testing techniques (laboratory technology);
  c) new sensors and process computers for on-line process control regarding quality and safety and for data capture:
     - for stationary plants, e.g. in the post-harvest sector and in the food industry;
     - for tracking products from the producer to the point of sale;
     - for process.

Requirements of agricultural machinery

- For geo-referenced data acquisition during primary production on the farm DGPS is already common practice. The data processing is carried out in a first stage via GIS. These elements form the technical basis for "precision farming (crop) " (**Fig. 7**).
- Equivalent technologies are being developed for the livestock production sector, including an appropriate BUS. The preconditions for "precision livestock farming" have been created with the electronic animal

identification system - at least for "large" productive livestock like cattle.

- What is lacking is a comprehensive interlinking of IT-supported plant production and livestock production in a farm management system that includes the documentation of <u>all</u> data, which are determining food safety and quality.
- Second, new sensors or sensor/process computer combinations have to be developed that, as far as possible, allow the recording of additional safety and quality-relevant factors <u>on-line</u>, e.g. on-line moisture content measurement, protein determination, toxin surveying etc.
- The same applies by analogy for livestock production, where new sensor techniques are in demand for animal-physiological parameters and for questions of behaviour, as well as for quality parameters of the products (milk). There are already several promising approaches.
- Dynamic development can be observed in the field of tracking products from producer to buyer, for example: "active labelling" via sensor/data logger combinations or radio transmission of data for transport surveillance (temperature recording), or the application of new sensors, e.g. the "artificial nose" for early recognition of spoiling, also with radio-remote transmission etc.
- One essential aspect of all above mentioned potential agricultural engineering solutions is the standardization of signals and signal transmission. This has to be solved as soon as possible.

Figure 1 - Branded products and equivalent house brands

Figure 2 - Labelling in the case of convenience products

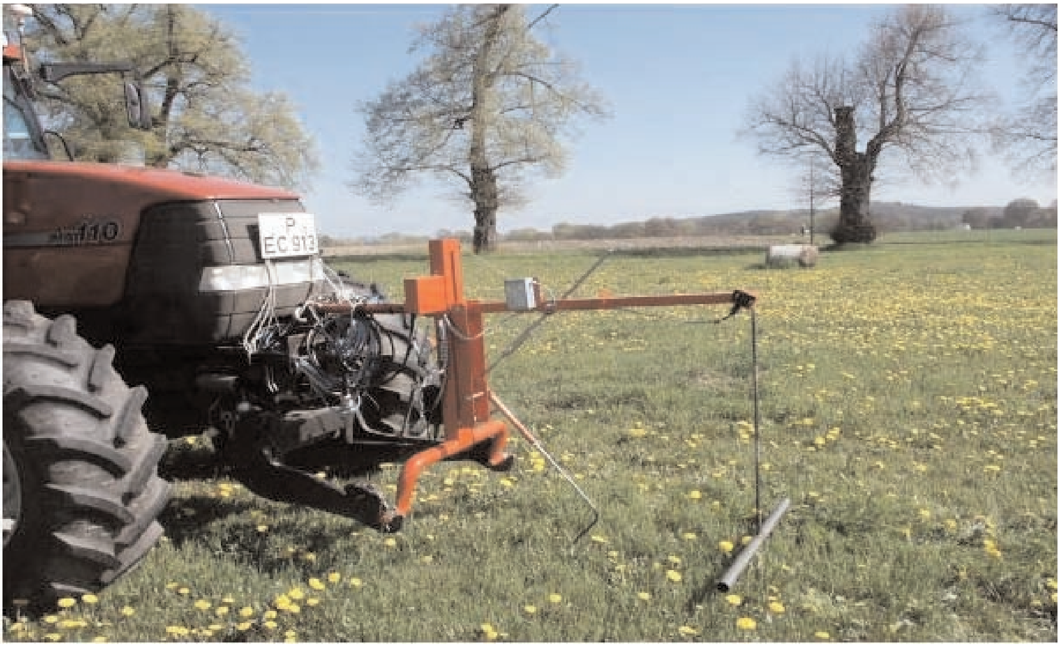
Figure 3 - Labelling in the case of fruit

Figure 4 - Sales promotion on the basis a of quality and safety (QS) management system and certification

Figure 5 - Quality seals of a regional certifying institution, “Quality Product – Pro Agro Inspected”

Figure 6 – “EU Bio-seal” for organic production/products

Figure 7 (A,B) – “Pendulum-meter” for assessing the crop density in front of the tractor/ spreader for real-time precision fertilization; geo-referenced documentation via DGPS



A

B

Topic 2.2 b – System integration and certification: the market demand for clarity and transparency

by ***Prof*****.** ***L. Bodria*** *(Italy)*

1. Introduction

The concept of traceability takes on a completely different significance when it is extended beyond the farm to embrace the agroindustrial sector as a whole.

In this case, traceability means the ability to retrace all the stages of the production and distribution system, and must therefore be viewed as traceability over the entire agri-food chain, from farm field to the consumer's table.

It follows that agri-food chain traceability will be relatively simple when all the processing is handled by a single organisation (**Fig. 1**), but becomes extremely complex for multiple-ingredient products which call upon a number of different systems for raw material production, processing and marketing (**Fig. 2**).

It is necessary, in this case, to identify and characterise all the material flows (raw materials, additives, semi-finished products, packaging materials etc.) that converge into a given product, as well as all the organisations involved at each stage, in order to ensure that the product's history can effectively be retraced to ascertain the causes and responsibilities for any problems or defects.

Agri-food chain traceability is therefore a concept which can be defined as:
"the identification of the organisations and material flows involved in the formation of a product unit that is individually and physically identifiable".

From this definition, it follows that traceability is based on two fundamental elements. Firstly, the fact that traceability is in effect an allocation of responsibility, making it substantially different from other product and process assurance systems such as ISO 9000 for quality and HACCP for safety, which are both designed to control technical aspects.

All the actors involved in the preparation of the product must assume responsibility for the materials used, and for the procedures and operating conditions within their competence, so that in case of harmful or defective products the causes can be identified and the appropriate corrective and control actions implemented.

The second fundamental element of traceability is the lot, that is to say the unit of product that can be physically and individually identified, and which provides the true basis of an effective system for managing emergencies and attributing responsibilities. In fact, the lot makes it possible to identify all the units which have undergone a given production process, so that they can be isolated in the event of quality or food safety problems.

2. Definition of a traceability system

The complex composition of the agri-food chain makes it very difficult to define a single traceability system that can be applied to the broad diversity of food products.

It is therefore necessary – as has already been done for quality certifications with ISO 9000 - to define general standards, which provide guidelines for the implementation, management and surveillance of agroindustrial traceability.

Such standards should aim to assure the traceability of each specific product and the individual actions taken to produce it, as opposed to generic supply chain traceability, as well as to identify the organisations involved in its formation.

A framework of this type requires that some designated "leader" handle the coordination the supply chain, a role that could presumably - though not necessarily - be filled by the organisation which markets the finished product. The leader organisation would be responsible for tracing the agri-food chain leading to the formation of the product, and for defining operational procedures to assure that the causes and responsibilities of any food safety hazards can be identified.

A traceability standard could be developed along the following lines:

- *identification* and *designation*, as the agents responsible for traceability, of the organisations which handle the processing operations and transfers of primary raw materials or other components significant for the purposes of traceability, and of those which supply secondary materials (process agents, additives, packaging, etc.);
- *designation* of a coordinator responsible for defining the operating methods and traceability procedures, and for collecting the relevant documentation and ascertaining compliance;
- *documentation* of the material flows within the agri-food chain, recording each passage in qualitative and quantitative terms;
- *management* of lots through every stage of the process, ensuring that they are identifiable and that their traceability is documented at all times;
- a *code of agri-food chain* on each of the documents which accompany the loose or packaged materials entering the production process;
- the *marking* of every package that reaches the end consumer with a logo identifying the agri-food chain, and with a lot code;
- the *possibility of traversing* the supply chain in both directions: in order to both "trace" (i.e. work back from the finished product to its origins) the nature and history of all the components, as well as "track" (i.e. reconstruct its forward progress) an unsafe raw material in order to identify the finished product lots which may have been contaminated by it.

3. Compulsory or voluntary traceability?

Placing the procedures for agri-food chain traceability within an appropriate regulatory framework is a question of primary importance. Some organisations—most notably the European Union—appear to favour a statutory imposition of traceability. In fact, in its White Paper on Food Safety, the EU in states that "... the competent authorities monitor and enforce this responsibility through the operation of national surveillance and control systems…." [5].

An alternative route, however, would be to leave agri-food chain traceability to the initiative of individual organisations who voluntarily undertake to comply with the rules and procedures set out in the standard.

In the compulsory case, traceability is treated as essential for the assurance of product safety, and hence encoded in a legally binding framework of rules, in much the same way as HACCP hygiene monitoring.

This solution has the advantage of a generalised application of traceability, but also presents a number of shortcomings.

The HACCP experience has highlighted the difficulty of achieving simultaneous compliance by such a large number of production systems and firms, as well as of intervening in business management decisions – by definition tied to the discretion of the entrepreneur – with unified systems for hygiene surveillance.

What's more, there is the risk that a compulsory system will, on the one hand, prove cumbersome and difficult to manage for certain types of organisations, and on the other hand will suffer from the absence of an appropriate and efficient public enforcement system.

Therefore, compulsory traceability could potentially prove difficult to implement, giving rise to an inefficient system of surveillance, thereby opening the way to purely formal applications and false documentation [4].

In contrast, a voluntary system – based on a univocal definition of traceability set out in an international standard – implies a free and conscious commitment on the part of the organisation's management, and therefore leaves less scope for dodges or accusations of excess complexity.

In addition, this type of approach would make traceability a selling point to the consumer, making it an element of added value on the marketplace, thereby enhancing the competitiveness of the product.

Voluntary traceability would therefore have the practical effect of making its fair application advantageous to the producers themselves, as well as to the surveillance bodies.

4. Certification of traceability

It is clear that agri-food chain traceability must be subjected to surveillance and certifications, performed by independent bodies that are credible and representative. In fact, a false declaration of traceability does not just constitute a deception vis a vis the consumer, but is also an act of unfair competition between firms.

In the case of voluntary adoption of agri-food chain traceability, the certification could consist of:

- an *international standard* which sets out general implementation guidelines;
- a number of *certification bodies* accredited by the national standards authorities;
- a system for *documenting material flows* that is appropriate for the different product supply chains.

The final watchdog role, however, would have to be played by the competent public authority, presumably the Ministry of Agriculture or the equivalent regional bodies, which would handle the general supervision, taking part in the accreditation of the certification and control agencies, as is already done in Italy for DOC (controlled origin) marks and organic farming products.

5. Conclusions

Traceability is a tool of fundamental importance for answering the market's growing demand for food products whose safety is assured by a transparent system that is able to attribute responsibilities to farmers and producers.

The best solution for ensuring correct application would be to define a food traceability standard, which can be voluntarily adopted by organisations, enforced and supervised through a synergetic collaboration between private organisations and public product certification bodies. Agricultural mechanisation (or, better, the whole agricultural engineering sector) plays a key role in building a traceability system being appointed to monitor the first steep of the food chain from the field to the process phase.

As it has been underlined by preceding speakers (namely Auernhammer [1], Nääs [2] and Reid [3]) recent development in electronics and sensors technology made now available data collection systems that can provide the basis for the development of agricultural traceability. Current localization systems based on differential GPS can offer accuracy in the order of 1-2 m, while "variable rate" distribution systems and "yield monitoring" systems can easily record what and how much we distribute and we harvest.

So the main steep for the development of a reliable traceability in field cultivation and animal breeding is to enforce and expand data collection systems in order to create a data archiving system able to permanently house and flow information following the different food components along its routing from field to table. At the same the importance of appropriate certification bodies has to be underlined.

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[3] **Reid J. F.**, 2002. *Sensors and data collection systems on agricultural equipment.* Club of Bologna, 13th Members Meeting (Part 1), Bologna.

[4] **Peri C.**, 2000. *Tracciabilità di filiera. Tra obbligo di legge ed opportunità competitiva per le produzioni agroalimentari.* Atti della Accademia dei Georgofili, XLVII.

[5] 2001. *White Paper on Food Safety*. Commission of the European Communities, Brussels.

Figure 1 - Traceability chain is simple in the case of a single product.

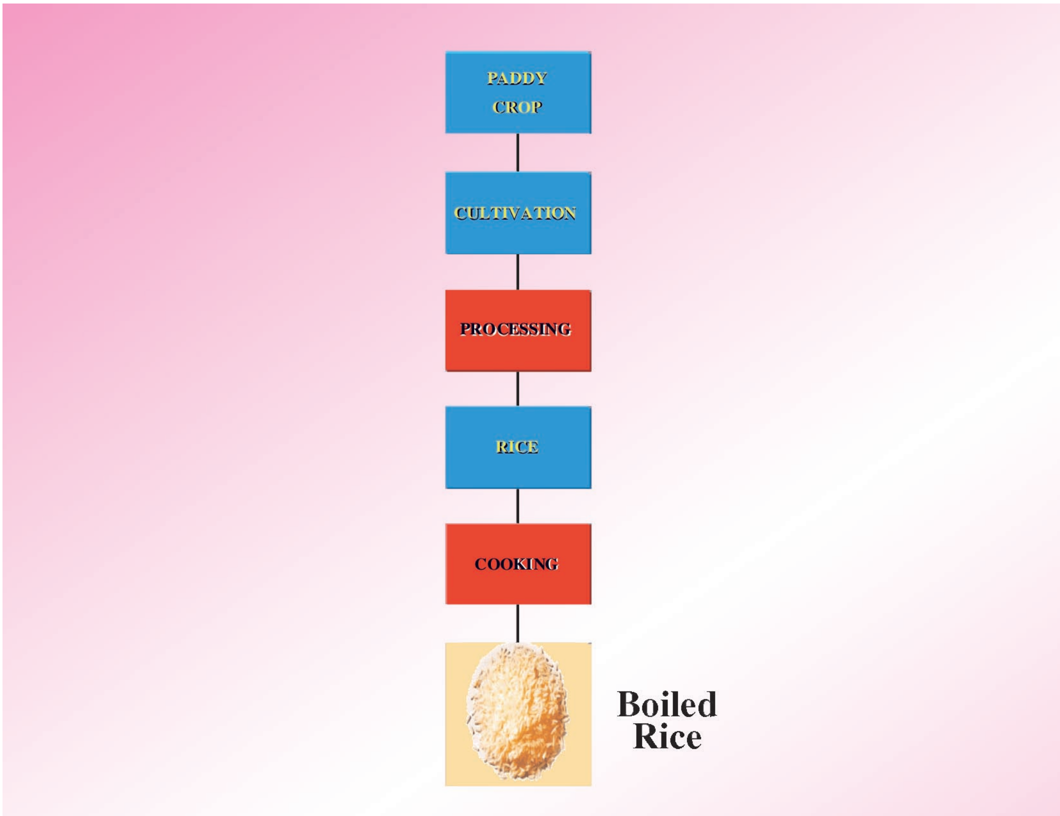
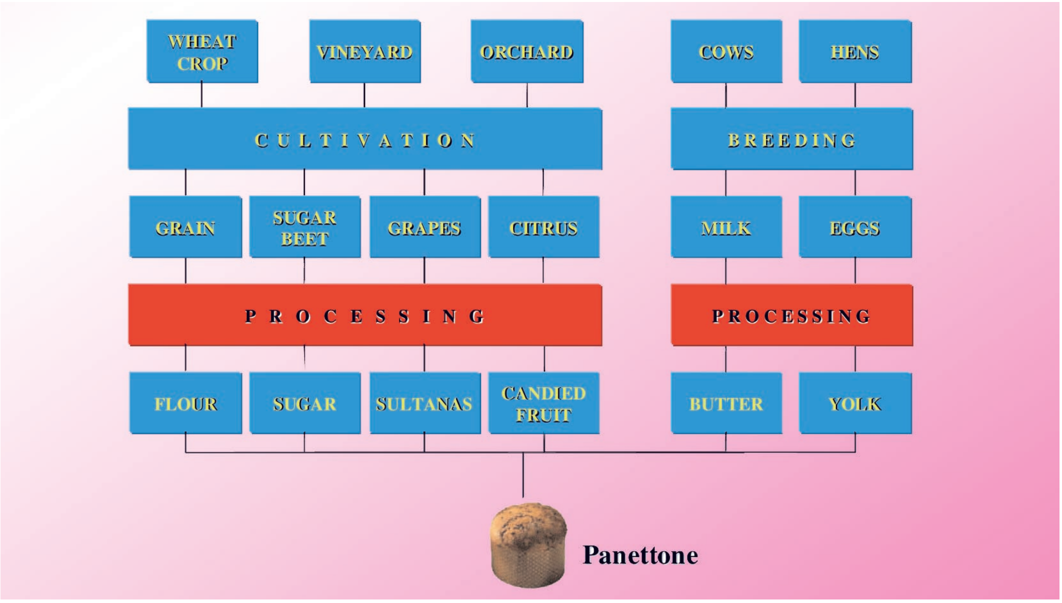


Figure 2 - Traceability is very complex in the case of a product with multiple-ingredients.



DISCUSSION

Bassam SNOBAR
We express our deep thanks to Y. Zaske and L. Bodria for these interest reports and now we can open once more the discussion.

Prof. Ladislav NOZDROVICKY
Slovak Republic
I think that the Working Group work is appropriate and should bring vivid discussion in our group and, as usual, we have to take care to connect this initiative with the existing groups, which are working on it, evidently Information Technology and Traceability up-to-date matters, and various groups are involved. So my suggestion is to check with this group to make sure that everything is connected to work and produce with this group. Concerning the presentation, my question is this: you mentioned that soybeans are disappearing. Agricultural engineering education programmes as we had know them in the past, are also disappearing and there are many, many examples of that. Where are the young engineers going to come from, to carry on work, such as you described, in the future?

Theodore FRIEDRICH
Mine is more a statement than a question. After these two presentations, I am not so sure any more if traceability is really an issue of interest for the final consumer. Does the final consumer really want to know from which farm the grain for his bread comes from? I think it is really more an issue for several steps in the chain and for legal tracing of liabilities and it can lead, as prof. Bodria said, the EU to the idea to introduce a system of punishment and I think that is very dangerous step and I very much like the proposal you brought of the voluntary system, because I think you can sell traceability as a positive instrument not as a an instrument of punishment for the farmer who wants to improve the quality of his product and who wants the people to appreciate and see a better quality product. Because that farmer, in the existing system, has no incentive to do so, because his product will disappear in the bulk of anonymous produce. And so I think that that is the approach I would really prefer to sell traceability really as an incentive for the farmer and not as a control mechanism for the consumer.

Prof. ZOLTAN LANG
Hungary
In Hungary we are learning new technologies to raise quality control. In my opinion, traceability is close to production technologies, so there are different production technologies defined like the normal technologies and the bio-technologies. The buyer is not interested in all the elements of production, like how the soil was ploughed or the sowing or harvesting was carried. But there are critical elements like the use of chemicals and so on. So the buyer is interested in if the production technology was correctly carried out and there are institutions which are be able to verify this, by tracing the spraying during production, or during the processing using chemicals. So not the whole technology should be traced because it would be very, very expensive. Nobody would pay for each of these steps, but only the critical ones. The buyer should only know that the technology was correctly kept or not correctly, even about those elements like grain. If it is not correctly dried then it will not be a good bread, it will not be bread at all, it will be a cereal and the buyer is not interested in this, the consumer he is interested in the final product that it is correctly produced and the plant correctly grown, and that the process was fulfilled correctly. Maybe new technologies should also be introduced, besides the normal technology and the biotechnology, maybe improved level technologies, and marked on the product. But that is all that the buyer is interested in.

Luigi BODRIA
I want to make some comments on the consumer demand. Following the enquiry after mouth cow disease and the recent worldwide food crisis, it seems that the market is very worried about the health safety of what they are eating. The global market, that makes the origin of food so con-

fused worldwide, has caused worries in the consumer, so I am quite sure that people are very interested in having, not to know, but to have the possibility just in case, to verify how the food is produced. So traceability must not be a certification system, that is the conclusion, it makes traceability too complex, it is too costly. It is just information flow, just in case, for all that food that is produced there must be the availability to check the possibility of where your food comes from, how it is being produced, in which area, on which farm and so on. So if that should be on a voluntary basis and that may add value to your market and this cost may be shared by the final consumer and also by the producer, of course, who may have a commercial benefit from a traced product that may be more attractive on the market and produce more interesting commerce.

Jürgen ZASKE

I think that the buyer is not interested in the detailed traceability. For him it is important to be guaranteed that the product was correctly produced and the oldest and best guarantee is the brand. If they make mistakes the brand will disappear from the market immediately, especially if they have short-fallings in safety. Quality can be compensated and tolerated, but if safety is wrong then the product is finished. Secondly, they want information about correct production and here it is in the interests of the manufacturer, of the large bakeries and so on. In Germany you can find, on the bread you buy in the supermarket or in the retail trade, "produced from grain from integrated production". That means correct production with the correct amount of chemicals and correct treatment etc.. So the buyer is only interested in signals. The buyer seal and so on, but the producer, or rather the food industry, is interested in traceability to prevent big problems if by chance, due to negligence, or even due to sabotage, a product was infested or poisoned or whatever. Therefore, they really want to get the product from the market to know where it has gone and take it off the shelf. This is not only in the interest of the food industry it is also in the interests of the Government, so they need this traceability downstream and the Government wants the traceability upstream - who has caused the problem and charge him? I have not mentioned the nitrogene scandal in Germany. They found a plant protection agent in baby food. That is normally the worst case. So they traced, it was the meat. Where did the meat come from? Where did the feed come? This was from a neighbouring country. But they bought the grain in the East Germany. They found the feed mill and they bought from a farm and the problem was the storage between the farm and the mill. It was one of those big hangars you have in East Germany where they stored chemicals during the old regime, before reunification. The hangar was only swept clean and in the corners there were big piles of chemicals, and you can imagine what happens if you store tons and tons of chemicals (hundreds or thousands of tons) and the chemicals went in contact with the grain.

Axel MUNACK

I would also address you on the question of traceability on a voluntary or compulsory basis and I think the meaning of traceability is the ability to trace back and not the usual providing the trace back in any case. So in my opinion also, the consumer is not interested in having a big printout on everything he buys, where it comes from, where it was stored, who did the processing and so on. I think a certain label is enough. For most people, also the discrimination of eggs - we actually have the labelling system: 0, 2, 3, etc. in order to define the eggs from ecological eggs and others - together with the date is enough. Those people who want more information are not going to buy at the big chains; they are going to direct marketing persons and maybe they will pay extra money. They are not 90% of the consumers but only about 5%. Then we come to the decision of whether traceability should be on a voluntary basis or on a compulsory basis. My opinion is a little different from Zaske's who mentioned the big nitrophene scandal in Germany; I think the authorities should be interested in separating the black sheep from white sheep, in some sense. What is in the public interest? The interest of the consumer, as a whole, is to prevent the black *sheep marketing from coming up with what some of the traders and other people are doing. Here you will need compulsory traceability because otherwise you could not make clear to the other people that all the steps they are doing could be - in some sense and if there is any problem with the food they provide - traced back and then they could have a problem. So if you make it voluntary, then you will always have people who would like to make big money in a short time and making something which is not professional and in this way traceability would be measured on the value it adds to the food and, in most cases, it should prevent - not 100% which is never possible - those bad practices and give the consumer some certainty of a good quality product.*

Yoav SARIG
I would endorse what Munack has just said. Why is it true that the consumer is not interested? It would be impossible for him to digest all the information. He is still the moving force behind the issue of traceability. Given the option the producers would not do this voluntarily. Why should they? It would impose more expenses on them. But it is different when dealing with food safety, it is a different issue when we deal with food quality or food safety. With food quality, I am 100% in favour it should be voluntary and let the market play its role. Whoever gains by his superior quality will remain on the market, the others will be left out, but we cannot leave the issue of food safety to the whims of the producers, this is the responsibility of the Government and there are many cases in history of a few poisonous cases, because let us face it, sometimes the producers could not care less, they care more about making money. There are many companies that went bankrupt because of lawsuits, so we should point out that it is to their benefit to actually be behind traceability to make sure that they can stand any loss. So this is the whole case of what we are talking about. That is why we put the major emphasis on food safety rather than on food quality.

Jürgen ZASKE
There are other instruments. First you have to consider that the food industry and the wholesale trade have ethics of the own. Then ask the suppliers of the products from the farming if they have certified their farms and/or if the transport enterprise has certified their enterprise via ISO 9000. If an enterprise is really interested in being correct, then it is self-organising. The organisation within the enterprise, if you have these applets, for primary production, via transport, via drying and so on, each of the enterprises being certified a code into ISO 9000, then you have an instrument that is voluntary. And if you, for instance, as a food producer like Nestlé, asks your supplier: we will take products from you only if you are licensed and you follow the ideas of ISO 9000, then we have a very good instrument and I feel that this is the future. It should not all be arranged by the Government. If there is criminal power behind selling things, getting it from the world market, like the nitrophene grain, it will only get on the market by chance. Generally, if you ask your suppliers to follow general ethics, I think that is the best way and that means arranging the things voluntarily.

Hugo CETRANGOLO
I agree with Prof. Bodria in the necessity of separating the traceability process from the food quality condition or standard. In my opinion, traceability is the methodology and the tools that allow to have all together the information from primary production, the industrial process and the storage, the transportation, the distribution, concerning each single product on the market and their ingredients. Each group of consumers, or each company or Government with different information on each product and a correct traceability system must provide that information. Because of that we think that traceability is a tailor-made system for each product, for each company and for each market.

Luigi BODRIA
I wish to add something more to my colleague Sarig, who has a pessimistic opinion about food producers. When I say that traceability should be voluntary, I don't mean that food production should be completely free, I mean the rules; the

conditions for safe food production are compulsory and fixed by law. Traceability is only a document that trace what process has been used and where production has been done. So traceability must not be confused with process certification. Traceability is only the recording of what happens. The law sets out what must be done. In the case of the recent mad cow scandal, the producer was not within the law. Traceability is the way of finding out who was out of law, but the law must work, of course.

Jaime ORTIZ-CAÑAVATE
I refer to the certifying institution mentioned in the paper of Prof. Zaske. The first thing is to have confidence in the manufacturer or producer. It is a standard machinery in the European Union that all the safety is assumed by the manufacturer. But anyhow afterwards they are testing institutions that they go normally, voluntarily to see if the level of the machinery are ok, like in energy or in playing or in testing machinery. So I feel that these certifying institutions can be very similar to these machinery institutions. They will work to have these standards of qualities and also traceability and later this will encourage these institutions, if they work properly, they will encourage in developing sensors to establish this quality. This was a question to Prof. Zaske. He also mentioned very briefly that there is no use of the Genetically Modified Products, I feel that is a very difficult discussion but just to say no use of that is very strict, too radical.

Jürgen ZASKE
Agricultural machinery has certain rules for being tested, concerning safety, usability and things like that. And exactly the signs or the seals you get on organic production, and so on, is following in the same, you have an accreditation process, first of all, you have a long list of what you have to do and what you do not have to do. That is number one. Then you have a lot of discussions with the organisation which is assessing your farm then and it also includes training, of course, and there is a transit phase of two years, before you can start to produce biologically or organically. There is also a final meeting, where an independent group is looking if you are really ready to produce according to the regulations and then the farm is certified and the products are certified. In any case when you follow the EU laws or the other organisations, which are certifying the things, it is a very strict and very correct way of getting the certification. Then, you are checked regularly again, so surprisingly, some people are coming and checking what you are doing in the right job and if you are using concentrated feed which is not from organic production, if you are raising chickens for instance. So this is, coming to the eggs, a very strict and a very rigid way of getting the seal and maintaining the seal. Very comparable to the testing of agricultural machinery.

Giuseppe PELLIZZI
I have the impression that we have forgotten in our discussion the problem of the developing countries for which there is a must to assure a good, complete safety of the food. This is an activity that has to be performed by the Governments. It cannot be left independent, on a voluntarily basis. So I think that we must consider all these things, we have to consider this problem that is very important. As second point, on what Zaske has just talked about the scandal in Germany. I want to remind my colleague Bodria, that in Milan, a few days ago, 50 restaurants were closed, because the food did not answer to the safety systems.

Luigi BODRIA
This is supporting my idea that compulsory rules are not effective. Because there are compulsory rules for restaurants in Milan; if the cleaning restaurants are cleaned, if hygienic restaurants should be voluntary, so all the restaurants might be clean, but a lot of them are not and this is the problem.

Karl Th. RENIUS
This is, of course, always a typical aspect of discussion when these types of problems are discussed: what should be voluntary and what should be regulated. I think we should look for good balance. If you see machinery (Ortiz-

Canavate mentioned that in the EU we have regulations for machinery safety), we have to focus some safety regulations. But there is a large band still for voluntary activities. For instance, in the machines building industry is defining every part, which has built in a machine, which is relevant for safety, they prepare a special documentation. In case of an accident they can say that it has been done everything and these are the documents. Now we do not feel responsible for the accident. This is a close loop process which is better than a regulation. So, in my opinion we should look for a good balance between regulations and freedom and responsibilities, as Zaske mentioned.

Irenilza DE ALENCAR NÄÄS
I was very surprised of the presentation. As you well know, Brazil is a large grain producer as well as a meat exporter. We have really been discussing traceability since BSE out breaking in England, because we would like to continue exporting meat so we have been discussing traceability distressfully and it is very clear for us that we have three steps in traceability, especially to have the food safety reliable, the first is identification, the second one is certification and the third one is inspection and auditing. It is obvious and clear that auditing and inspection have to be done by the Government, because it is a matter of public health, first of all. Second, it is also an export business, and we have to be very careful. As Prof. Zaske mentioned, he gave an example, I was surprised by that, because some producers got it and for instance they provided a certification for eggs production. For us it was very clear that: identification, certification, inspection and auditing have to be three very separate and distinct sectors of the traceability chain and in the food chain process. It is to be sure that fraud is avoided in the whole process. We also found that standards are needed, because we had a little scandal with Canada, that said that our meat, our beef cattle probably could have BSE. We had an inspection and it ended up that there was something else behind the curtains and our beef cattle were in pasture. This was very good for us; we really thanked the Canadians for doing that without that time because they have got us stronger and we really got the certification and the auditing and we are identifying our beef cattle and we are going towards the getting back the credibility we had in the market. So, this was in a first step very inconvenient for the country. The Ministry of Agriculture imposed on all exporters to get certification and identification for their beef cattle and the slaughterhouses are paying more for that, so they are paying more than the producer to have the animal identifying for beef to slaughter. So standards are needed. There are three steps identification, certification and auditing; in addition training in education is vital in the whole process.

Giuseppe PELLIZZI
We can start now with a new session to finish our discussion. I'm pleased to introduce Phillippe Marchal who kindly accepted to serve as chairman for this half a day. Please Philippe.

Philippe MARCHAL
I thank prof. Pellizzi. Now we have some time for your questions on the Topic 2.1. If you have really very important and crucial questions do not hesitate to ask.

Hermann AUERNHAMMER
I think Yürgen Zaske brought up some more items for discussion when he mentioned the different seals responsible for quality management on the one side or what in Brussels is now called Farm Audit, what we discuss with the BioSeal or what we call Eco Audit. So traceability will give us a lot of information and to some extent the different seals will need the same information or additional information. So when we talk on traceability and also acquiring details from the farm, they should be taken only once and be available in different modules, for example temperature. So it depends on quality management, and it should be available for the farm audit, and should be available as audits too. It means we have to have a kind of modernisation of data management, or whatever it is.

Daniel BERCKMANS
Two small questions. The first is: all of us believe that safety is the main issue, but I am afraid it is the consumer's perception, the consumer that is informed by the press. My question is: do we have enough scientific data to support this perception? I am wondering that safety is the main issue. The second question is: if we look at scientific data we know that a lot of people die from heart disease, could traceability help us to set up long term research to look for the link between what we eat and health impact?

Jürgen ZASKE
I think that safety is expected by the public "a priori". They expect it and it is our job and that of the manufacturers to make sure that the products are safe and the public is not interested in how this is done and traceability is only one instrument. The second question: there should be better cooperation between agriculture engineering and agriculture and the discipline of the health sciences, concerning the dietetic aspects mainly. In Potsdam we have a very big Institute of nutritional research but we have no cooperation and that is typical. I would turn the question to the other colleagues: do they already have cooperation with nutrition research institutes for human beings, not animals or plants?

Giuseppe PELLIZZI
I have a question for all the colleagues. I would ask all of you if you agree with our final recommendations, and confirm that the first obligation is for the States and the Governments and that they have to decide to protect the safety and the health of the people. Do you agree or not? I do not think that it is only a question of consumer needs, it is the need for each Government.

Josse DE BAERDEMAEKER
Mr. President you are right on this. It also happens in the federal agency for food security in Belgium, there are several agencies in other countries and there is the European Food Safety Agency, that are setting out some guidelines for production and registration of production and in that sense, I agree with what colleague Hermann Auernhammer says, as an engineering community, we will have to provides to make easier for farmers to register and that can satisfy the different systems that exist.

Irenilza DE ALENCAR NÄÄS
Yesterday I pointed out that in a "certification chain" we have three major points: identification, certification, inspection and auditing. I agree with Prof. Giuseppe Pellizzi that for inspection and auditing the Government must be part of it, because when we play the role of food safety we are talking somehow on public health problems so we actually need a policy on that and the Government should be part of the auditing and inspection at least.

Jürgen ZASKE
Mrs Nääs, you are absolutely right but the time was too short to explain the chin of auditing and inspection and so on, but the final link or element of it must be the Government. But what I wanted to mention is we have a green-red party in Germany and the Minister of Agriculture is linked to the green party and they have even changed the name from Agriculture to Consumers' Protection and agriculture comes on number 3. So you can see how the hierarchy is in Germany. I think that this is a general tendency and of course they are establishing a food safety agency in Germany closely linked to the European Union. I think that is a political trend, which we can only support, but we must support that they do not forget agricultural engineering.

Giuseppe PELLIZZI
Do you agree that in the Conclusions and Recommendations we underline that the problem of safety and traceability is very important for the developing countries or not?

Jaime ORTIZ-CAÑAVATE
I completely agree, but we first have to provide food and then safe food, it is more important.

Prof. Luis SANTOS PEREIRA
Portugal
I wish to call your attention to the last sentence,

the importance of the said word is particularly related to water when we see that the horticulture near the towns is mainly done with untreated waste water and this part of the problem is absolutely enormous. I suppose that Jaime's sentence was probably not the best, because the health problem that is associated with the food in urban and peri-urban agriculture in some of the world countries is extremely large and I suppose that we cannot forget it.

Yoav SARIG

In the past two days we have talked a lot about traceability and I think it was very educational and very lovely, but I think what was missing is before we leave we need some complete recommendations. What are we going to do next? We talked about voluntary traceability systems, compulsory systems and so on. But we are going to direct for the next meeting some actions delegated from the Club and I'd like to hear from the members some recommendations about what should we do next.

Jürgen ZASKE

I recommend that we go home and try to convince our own Governments. It is very difficult, I think to go to the EU as a group of agricultural engineers like now, maybe Josse De Baerdemaeker can do that, some others of us, but I think that we should convince our national ministries first.

Irenilza DE ALENCAR NÄÄS

We agreed yesterday that mechanisation is a key point for improving traceability, and Sarig you pointed out it quite clearly. What I would like to leave here is the message that we agree that we need to have safe food, I'm sorry Jaime, but we need to produce, it is a matter of "let the people get these by hunger or by eating bad food", it is better that we provide food and safe food for the undeveloped world and why not? If the mechanisation is the key-point. So the message that the Club should really think about this is: how can we do that using mechanisation and that is the key-point: how we can use mechanisation to help the undeveloped world to produce food and safe food.

Philippe MARCHAL

Now it's time to close the discussion about the topic 2.1. The next topic is " Traceability: the role of mechanisation for the control of processes and the quality of production"; we have two co-authors, only one paper that will be presented by both Dr. Antonio Pagani and Dr. Roberto Guidotti.

Topic 2.3 – Traceability: the role of mechanisation for the control of processes and the quality of productions

*by **R.Guidotti** and **A. Pagani** (Italy)*

1. The interlinkages between mechanisation and the 'historical course' of any agricultural produce have never been so strong as from the intensive application of the electronics to the engineering of farm machinery.

Though the 'mechanical' nature of farm-power, which developed after the forties, greatly contributed to alleviating human fatigue and reducing the time of cultivation practices, it was in the sixties and seventies that the advent and utilisation of hydraulics curbed human labour while boosting work precision and timeliness. When in the eighties, the electronics was first applied to farm machinery, it was generally acknowledged that the primary scope was not so much that of improving their performance or reducing production nor utilisation costs, but rather that of attracting the interest of a specific market braket, i.e. the younger part of the potential customers.

It has been only in the late nineties that, with the emerging of the concept of traceability, an entirely new horizon was somehow discovered on the enormous potential of applying electronics to agricultural machinery, as clearly pointed out by the previous speakers.

2. It is likely that the concept of traceability grew out of the need, on the part of processors, to document the history of individual raw material lots in order to comply with the quality standards of their industry—standards which are indirectly determined by the market and hence by the demands of end consumers.

For many agricultural productions, in many countries, this trail of accountability currently ends at the storehouse: in fact, the majority of agricultural goods, with the exception of some high-end productions, consists of undifferentiated products whose origins, cultivar and other quality characteristics are unknown, with the exception of a few parameters geared toward providing the industry with a homogeneous product supply, obtained through the statistical mixture of dissimilar lots.

As we know, the products which the industry considers raw materials are in reality finished goods for the upstream segment (the agriculture) of the supply chain: however farmers take little note of this, other than for those few parameters which can influence the price commanded by their product lots.

3. Nowadays, confronted with the market's demand for an accurately documented history of any product lot, farms are paying the price of poor competitiveness, especially if they are fragmented or of insufficient size.

Very few farms implement a systematic fertilisation plan, fewer still routinely perform soil analysis, and only a tiny number deploy tools for monitoring the response of crops to factors of production, according to the methods of precision farming. This backwardness is attributable both to the small size of farms existing in various coutries, which limits the funds available – in absolute terms – for investments in technology, and to a generalised lack of confidence due to the negative agricultural market trends.

When we speak of adapting an economic system to new conditions, we often forget that such a transition is also accomplished through the withdrawal of those ill-equipped to deal with the change, and that only a few farmers are willing to accept economic sacrifices in order secure future survival in the market.

Many farms - perhaps the majority in many countries - are currently subsisting from day to day, without realising that they have already overstepped the mark and lost all prospects for future development.

4. Mechanisation is an essential ingredient of productivity, both for maintaining the profitability of workers and for assuring sufficient com-

petitiveness to farms, which have long been trapped in a differential between earnings and costs where the former element is dictated by the processing industry and hence, ultimately, by the market.

The impacts of traceability for farm field operations on the edible portions of crops have by now been internalised, inasmuch as they affect manipulations of the (existing or future) product which take place prior to industrial conversion and which can influence how the product is processed. For example, it is just as important to know the quality and quantity of plant protection products applied on a cereal during its vegetative cycle (agronomic aspect) as it is to know the method of distribution (mechanical aspect), as well as the subsequent history of the product during the harvest, transport, drying and storage phases.

5. Much less obvious, however, are the correlations with other mechanical operations, for which we need to consider the global quality of the agricultural system as a whole—a concept that is becoming increasingly important in the minds of consumers.

Setting aside, for the time being, the controversial question of organic agriculture, which looks set to remain a niche sector and will never be able to feed a population, like that of Mediterranean Europe, long accustomed to spending less and less on food, and let us instead attempt to understand the direction that consumers expectations might take.

Clearly, we need to develop a model of sustainable agriculture (where the adjective signifies mutual compatibility of the various objectives pursued) that is able to reconcile the production of good, inexpensive and healthful foodstuffs, with the observance of ethical standards that have become indispensable for public opinion, such as worker health, animal well-being, respect for the environment in general and the safeguard of the rural landscape.

Within this framework, the traceability of the complete production process becomes the only basis for ascertaining whether a given agricultural production complies with the precepts of global quality.

And hence the theoretical cycle that we sketched out becomes aligned with the crop production cycle as a whole, in terms of space and time: it may be important to know not just when the main farm field operations were carried out and by whom, but also the mechanisation chain that was used, for example to make an *a posteriori* assessment of safeguard of the soil.

Another example that can help to illustrate the complex interactions between different crop production options is the choice between direct seeding and traditional methods: in the first case, there are certain problems associated with protecting the crop (total weeding during pre-seeding, greater care during the vegetative development due to the persistence of parasites hibernating on the topsoil), while in the second case there is a cleansing effect on the soil and a reduction in the amounts of plant protection products that are used.

It is clear that the ability to reconstruct the history of the crop that has formed a product lot makes it easy to guarantee its quality characteristics to end consumers, without forcing the industry or distributors to assume responsibility blindly, i.e. without definitive proofs.

From these examples we can conclude that agri-food chain traceability needs to include each of the individual agents that take part the production process – from farm field to the consumer's table – creating an information gathering system that is as simple and intuitive as possible. In fact, although production methods in industry are highly standardised and therefore definable once and for all, the primary agriculture sector often has to alter its plans and agronomic decisions in response to climate events. This makes it necessary to track the crop (and hence the product lot that will ensue...) by recording all the criteria, choices and time periods in a "field log".

It is currently believed that, for instance in Italy, only a few farms are able at present to document the manner in which a crop has been produced, especially for herbaceous and industrial crops which are not grown under contract or bound by specific production standards.

6. The problem of the fragmentation of production units that go into product lots could conceivably be overcome by using – as centres of aggregation – the organisations which handle the collection of the product (commercial firms, cooperatives and consortiums) or a considerable portion of the mechanical operations (contractors).

Contractors, in fact, often play an important role in determining the choice of cultivar, fertilisation and pest control plan, as well as advising on the most suitable operations for a given circumstance, on the strength of their physical presence on the territory and resultant expert knowledge of the soils and their respective aptitudes.

Consequently, contractors could justifiably act as the collectors of information that can help farmers break out of the vicious circle of undifferentiated productions, adding value to their products and confronting markets proactively rather than passively, through deployment of the appropriate mechanical, electronic and information technologies. These must therefore be urgently defined with a view to their dissemination.

7. As far as the consumers are concerned, we have already mentioned how, by representing the market demand, they greatly contribute to the definition of products international standards. However, it should not be ignored the fact that the demand is often driven by well articulated and conceived marketing campaigns that, to a large extent, literally create new needs and forge specific preferences. Needs and preferences that too often coincide with the interest of the intermediaries and the distributors more than with those of the end utilisers.

Within this perspective, the role of the contractors becomes even more important, as they could be the guarantors of cultivation patterns and practices primarily aimed at turning out safe and genuine products, hence protecting the health and eventually the real interests of the end consumers.

DISCUSSION

Josse DE BAERDEMAEKER

I think that in some of the things you said there is a contradiction between production methods that we have and food safety that really exists. For example, there are also indications that in some of the biological or ecological productions which is demanded by a number of consumers and pressure groups that may led to more unsafe products and traceability does not really guarantee the safety of the product, because you could have registration, you could have auditing, but in the end the product may be unsafe. For instance the micro-toxins in grains have been on increase in the last twenty years. Yet we do more controls, we have more registrations and so on, but we use less pesticide. This is one of the problems so if your requirements are to have a label of biological production, you may undoubtedly have a product that is free from pesticides, but has other dangers and so there is a difficulty and there is a contradiction there.

Axel MUNACK

I have some different findings with respect to some of the things presented. I think we have to divide into quality and product properties and traceability, because traceability is one means to find out how the product was treated, but whether the product finally contains the limit or not I think is not a problem of traceability. It is a problem of what product properties we want. So traceability could be a means of testing or making sure that special product properties have finally appeared in the product, but we should separate traceability from distinct product properties, because traceability is a means and not the final property. Another case was: it was cited that there are some product parts, some processing parts that are easy to trace and others that are not so easy. I have my doubts whether we could divide them into easy and not so easy things; if you think about the BSE scandal and the nitrophene scandal; in both cases it was end-processing, end processing of animal feed stuff. And so it is processing and storage of end product is part, which is easily traced, so I have my doubts that you could from the beginning divide into parts that are easily traced and some others.

Antonio PAGANI

I do not think there is anything easy, by definition. As far as the quality and traceability, no doubt: traceability is a instrument, a system, a means to make sure that in the end you have something you have been asked for. So once more, the keyword "quality" comes up again. Even in Chicago there were several references to quality and I also expressed the view that I am not satisfied with the use that is made of this word "quality" among us without quality being defined, it was also said that "quality" is what the consumer wants, and what the consumer wants is not exactly what he has in mind, but is something that has been put in his mind. In my view "quality", and this is Phil Crosby's definition, is the compliance with some standards. Some standards are set and the product that complies with those standards is a quality product, if it does not comply with those standards it is not a quality product, it is something better than average but not a quality product, it is simply not in that line. Here we have a very weak point, because in many cases, especially for food, standards are not very well defined, so we tend to rely on the taste and the intelligence of the consumer, who is very often manipulated by the market. So traceability is a means, a tool, used to achieve the quality standards that should be set. But they should be set and in my opinion they are not yet, in many cases it is left to people's feelings, to "this is better, that is not"..., or they follow the indications of the advertising or of the marketing companies.

Josse DE BAERDEMAEKER

I have one comment on your last statement. I think traceability and other things is not to make sure to have a product that you asked for. I think it is just to make sure that the product was produced with a number of steps that you asked for and it may not be the product that you really want but at least it has passed through *that number of steps that you have been able to register. It does not guarantee anything about the quality of the product.*

Antonio PAGANI
Traceability is a means of reaching a certain point and obtain what you want and in order to obtain that particular product with those particular characteristics you have to follow a certain pattern. I do not have a very clear answer to this question, but I do not see a situation where you follow a pattern that was established and eventually you have a product that is different from what you expected. Unless your expectations are based, as I have already said several times, not on precise reasoning, but just on the outcome of an impression, of a feeling, of a something that has been induced. But if you have a clear definition of what the final product should be and a clear definition of the process that leads you to that result, traceability is just an instrument where you check whether it passes or not.

Luigi BODRIA
I have some comments because I am one of the supporters of the voluntary application of traceability. I agree that the real basic force driving producers to improve their production to apply traceability will be an economic benefit. The point is: will traceability be an economic benefit? Well, the answer is yes, if we think that traceability comes from the market requirements. So, if the market requires traceability that means that traceability is economically available, and we have several examples: with the ISO 9000 the quality certification is voluntary, not compulsory. But there is a rush to have ISO 9000 certification for quality, because all the big companies require it for certification and even with traceability we now have the first attempt for traceability like Auchan, the big distribution chain is tracing vegetable products; the "Latte Milano", for instance, is making a traceability system and that's why? Because there is the very specifically system to point out that there is a thing but they think that is profitable for market reasons, so they do it. The advantage of voluntary traceability is that it will not be applied generally, but will only be applied by people who decide to do it. And if you want to do it, most probably you will not do it so badly. On the contrary we talk about safety; food safety is imposed by law. So that is a necessity, that every countries, as it is has been pointed out by several speakers, have, more or less, aegis for food safety and food control. Yet despite this, we still have so many scandals, because the regulations imposed by law are not respected. So traceability must not be a rule, it must just be a way to control that safety rules stated before must be respected or, as Josse De Baedemaeker said before, how the product is made, so you can choose and decide if the safety rules are respected or not.

Prof. Arturo LARA LOPEZ
Mexico
One is comment and the second one is a question. The comment is that in most developing countries we have an exporting sector in agriculture. These countries have the technical capacity and the understanding and also the economic possibility to gradually introduce the traceability idea. But I must say that, at least as far as my country is concerned, that that will be a small percentage of farms capable of doing that. I also support the idea of not enforcing it but rather go on a voluntary basis, but also, listening to what some speakers and of course Antonio Pagani have said today, it seems to me that it would be good for us to have some relation between this concept and the ISO standards, like ISO 9000, that are already there, do you think that something like that could be related?

Antonio PAGANI
Well I will take a more general level. What I see as a need, is an effort and here I refer to Governments and to the education of the end consumer. So ISO should not be only a topic for specialists, it should become something more for the end consumer. So to educate the end consumer, to express its views on the ground of some real information and data not only on impressions, and feelings and so on. So, that is one of the recommendations I will do, if the Club of Bologna can express a view on that, to encour-

age Governments to start something - and I do not know what - in order to educate the consumer to express or formulate their requests better. Because, coming back to what also Luigi Bodria said, I mean that the open question is whether the end consumer should ask for safe food, healthy food or traceability, he does not know, he asks for something good for himself. He asks for traceability in order to be sure that the things have been done in a certain way, in order to have something that is not defined very well. So that is the feeling, so he is asking for something scientifically, shown and demonstrated, something that is like a map, you know? You have a map of your streets to reach a certain place that is vague, which is represented by healthy food. Does he know what healthy food is? Look how many times in the last thirty years have we been pointing to some food, to some elements and saying "Oh that is ideal for your health", or the contrary "that is really bad". I remember when I was a kid chocolate was bad, it was forbidden. The same applied to many other things.

Yoav SARIG

In my opinion there is still some things that are not clear and some misconceptions, and I would hate to leave without doing my best to clarify. I think that now you will probably begin to understand why we try to separate the issue of quality from food safety. I completely disagree with Dr. Pagani. I think there are standards, but standards are not a substitute for what the consumer wants. You will be surprised but the consumer knows exactly what he wants. Standards are imposed to make sure that we get a uniform quality. But whether there is a standard for firmness the last word is for the consumer to say: "This is not a firm food I am not going to buy it ". In addition, there has been much evidence that the standards have been changed based on the feeling of the consumer. But quality is something the consumer knows. However, with food safety the consumers knows that he want a safe food, he does not know what safe food entails: it is not in his capacity to know and to ask for. But he relies on regulations, regulated systems to ensure that he gets a safe system. Now regulation by itself (that is what Prof. Bodria said) again are not a substitute for traceability. Let us say you have a regulation for safe food and something happens, so what is next? The consumer says: "sues the company", the company says: "we did everything ok, we are going to prove that. The only mechanism to do that is traceability. I fully agree with Prof. Axel Munack: that traceability is a vehicle, a mechanism of information, the trace back all the operations that were done on that certain product, on some major products, to ensure that at the end you can go back and say: ok, here we can see what went wrong. Eventually this would becomes profitable for the producer because this would eliminate the reason to sue him. So in the first place the producer will say: "I fully agree" and in that respect I agree with Dr. Pagani, the producer says: "I could not care less. I sell it, I get money for it, I am happy". He is going be sued for it, unless there is mechanism to ensure, like with the car companies, that if you sue the company and the company shows that they went through all the procedures to ensure all the safe records, they come out clean. So again: traceability is a mechanism, we, as engineers have to advocate the need for all the necessary instruments, if they are not already available, to ensure that we could trace all the various phases of the product, from the phase of production to the consume.

Karl Th. RENIUS

I fully agree with what you said. Just before your speech I prepared something. First, ISO 9001 says: "quality is means satisfying the customer in a whole". That is the definition. And in my opinion we have two groups of customers or consumers. The first one is saying: "we expect safety as a must in any food, we expect it, it is necessary. If safety is a problem, it is a problem for the producer who has made this food and this is the majority of consumers, in my opinion, and there is out of question of not supporting that. There is a smaller group of consumers saying: We would like to know details about the process, about the food chain to have a better feeling and more confidence on safety and quality . We are willing to pay an extra for that, *sometimes 100% more, sometimes 200% more. I think this is a smaller group but for both groups we need instruments for traceability.*

Prof. Franco SANGIORGI
Italy
The discussion would have been more profitable if we had considered some product that is already traced, almost from one decade, like the milk. At least all the milk that is sold is already traced. The topics about quality are already developed in some existing products. In this case, in all the countries, there is a system able to analyse, to make thousands and millions of analyses at a very low price etc., in order to determine the quality of the product, or rather the characteristics, I would say not the quality, and to give the details in order to achieve a system of payment that is related to the product. That means we can discuss if this system is applicable to other products. This is the real challenge: what we need to apply to other products is the same system that was already developed for milk. What we can say is that there are products that can be easily traced and easily checked as what happens for milk. But there are quite a lot of other products that absolutely impossible or almost absolutely impossible, if we also have to consider the economy, to trace. But this could be the basis of the discussion.

Yoav SARIG
Just a follow up Franco Sangiorgi. I would like to make some practical recommendations. I think these make it much more clear if we can pick a case study, or several case studies; not just selecting the easy ones but some maybe more difficult ones and see what is already available and trace this product from the very beginning until the consumer and list all the phases and state what instrumentation is available to measure all the parameters and what instrumentation is still missing that we can not use. For example, there has already been done a lot of work on traceability on wine. There are companies that can show you exactly all the phases and they have all the instrumentation to do that. Somewhat similar to milk, but with some other products it is somewhat more difficult. Why not ask the Management Committee of The Club of Bologna to nominate a small working group to do this and prepare several case studies for the next meeting and this would probably would clarify for all of us. What is really needed and what really mean by traceability.

Antonio PAGANI
I fully agree. Now the question now is: where would you start this process from? From the consumer? Or from the producer? Therefore, you start from traceability in order to find out what is needed at the end, or would you start this operation with the markets survey to see what the consumer requires for that first? Because if I understood what has been said before correctly, is that we have to comply with what the consumer wants: quality, standards, etc., etc.

Yoav SARIG
I tried to separate the issue of quality from food safety. We do not start from the consumer, because the consumer does not know what the promise of safety means. So we are not going to ask the consumer what he wants. We trace a product, let us pick just for the act of it, let us pick an apple. We trace all the phases, from the growing stage to the post harvesting stage, until the consumer gets it, and trace just documents, not asking what we wants, because we do not know. What we want is to record all the actual phases of the production level, for the objective that if something goes wrong in the chain, if something here happens, then we can trace it back and say: "ok, this is because the orchard was irrigated with contaminate water or the orchard was over-sprayed with chemicals or the product stayed in the storage for too long periods and was exposed to environmental pollution ". This is the sort of information we need and this has to be regulated. The producer will not do this voluntarily and the consumer would know what to ask for. So forget for the time being about the consumer. We care for the consumer but we should do this job for him. He does know what to ask for.

Karl Th. RENIUS
This was my proposal yesterday, to set up case

studies. Perhaps this working group can start this work. I think we all would be happy to have some more material on such a food chain and the discussion can be directed in other more critical areas which are not recognised now.

John F. REID
Yesterday I talked about traceability is being broken into four areas. Compliance and food safety, we talked a lot about, and those issues of cost production and cost avoidance for producers. Compliance in the sense: is the crop 100% organic? In terms of food safety: managing recalls so that we have methodologies and a place where they can do that. The other aspect of this are the performance improvements; so being able that tighter specifications and tracking and branded claims of the fourth one which, is last to relate, to create the value. I guess I am interested in some comments on how we, as people interested in mechanisation, provide tools or capabilities for the producers, so that they can take advantage of this created value. Are the mechanisation systems needed? Or is this just a methodology that we have to implement using information technology that fits into an existing traceability system?

Josse DE BAERDEMAEKER
I think that John's comment was very good, because, in the case of the apples and in the case of a number of crops, there is a lot of documentation or papers available of what has happened during the production and storage, what was sprayed and so on. Getting it in a usable form that traceability can go through all the way to the end, that's an Information Technology problem and also a problem of confidentiality that goes with it. This is, I think, a good challenge. The next question that we also have to study: how fast can we penetrate the market with this? How fast can this be introduced a new technology because this is going to be a new technology, will it take a year, will it take ten years?.

Dr. Yoshisuke KISHIDA
Japan
I wish to make a comment. We need to have some survey about the new marketing and production marketing consuming system which can help the present ability of mechanisation for traceability. That means through the discussion we found we do not have enough technology at present to ensure the traceability of agricultural product. But already, without such a complete technology. Already the producer and the consumer and marketing people started this new system, which can make easier to get the traceability of agricultural products, for example, direct marketing from farmer to the consumer. The consumer can believe the farmers and also marketing people may be sure on who makes this product, when and how he makes it. Traceability problem is related to the production marketing and the consumer systems. Yoav Sarig recommended about the working group, about the things but also I would recommend to ad some survey on the new production marketing consuming systems that can help the lack of ability we have at present.

Dr. Oleg MARCHENKO
Russia
First of all it is my opinion that safety food control, quality food control and also traceability of this chain production should be considered as a necessity. It depends on the level of production. We do not speak about levels of production, the first one is Local level of production, the second is District, the third one is Regional then Federal level of production. I will use Russia as an example. Local production: 90% of potato, 40-50% of milk and meat, 63% of vegetables and wool, were produced by a small plots of land < 0.1 hectares, most manually. So a very good quality and they sell each other this product, because of the great distance to deliver some food , for example, to another region; this is not so easy. So on the local level it is very difficult to install some food, quality or safety control, but they know each other, they sell each other and they like this control, because if you know that is not good milk you will not go and buy it from these neighbours, you will go to other neighbours to buy it. However, on the District level where there is processing of milk, meat, some vegetables, grain, bakery for example, it is, of

course, necessary to have some inspections, as usual. They try to control what is necessary, but on the Federal or Regional level there are of course many problems, because many different companies processing food try to label them, try to advertise them in different ways. Of course there is another way: imported food. All should have Federal inspections, with the government officials. It seems to me evident to consider this problem comparing and depending on the level of production.

Philippe MARCHAL
We have to try to be efficient and to not loose time. This morning it was an efficient discussion with a lot of active questions and we go on with the discussion if you have questions during some minutes. After we go on with the Recommendations of the Club also on the document presented yesterday by Sarig. Now, everybody can take the microphone for a question.

Josse DE BAERDEMAEKER
I think we have to get something done in the Working Group and my question to some of the presenters is: what is the engineering development that still needed and what is the research that still needed to implement traceability, because traceability will be forced on our producers anyway. What is we have to be done from the engineering and research point? This is my question: do we have any ideas at this moment?

Giuseppe PELLIZZI
My impression is that we have now more knowledge of the problem and we can decide everything now and step by step we can arrive in the future, through the Working Group mentioned by Sarig, to define everything especially for the engineers.

Prof. Milan MARTINOV
Yugoslavia
I would like to give an idea and for Yoav Sarig, for the task of this group which is very difficult. We are now almost all faced with the problem of the number of students and we are really in position now and our duty is to make more attractive field of agricultural engineering and to think about the next generation and to maintain a good place as we had in the past, in the last century. I think that the idea of traceability is very good and that is very clear one multi-disciplinary problem but those, who is taking first the stage will be in a position to get more from this activity. I think the task of your task force is very important for the future of AgEng professions. Initiative should come from our profession and in that case the other professions will be at our service it is very important now and this is my answer to your question that of course have to be discuss longer in more details. Another question is to Hermann Auernhammer, could we call this "Group of activities connected to traceability" something like good agricultural practice, good post-harvesting practice, good manufacturing practice, with many possibilities to change that according to the special group of products and special country conditions and special consumer demands.

Luis SANTOS PEREIRA
I have a little bit difficulties in understanding everything that we discussed here. Not because of production in Europe but production outside of Europe and particularly production with small farmers. During a long time, I did not advocate the use of low quality water in irrigation because it is always contaminating everything: soil and final products and I exposed that after a long time we do a network for certification of the product that come from areas where the water is not of a very good quality, but without success. Unfortunately I visited one of these areas, where this was practice and said: "ok people is adapted and use it and so on", but some people died in that week I was there. So, we have no effective means to know exactly how traceability can be applied to these kind of small farming systems. The problems of else despite the fact that they create enormous problems that everybody knows, does not bring the people to adopt any kind of key for the use of the products like the water. So how can we go up/down in these areas to the consumer's ideas. For instance Prof. Renius was saying that safety is a must and some consumers may say that they need more information to know about. However, in

many cases the people do not have the necessary minimum requirements of safety like Jaime Ortiz-Cañavate was saying, they just want food. So we have several steps in these approaches and that is why I am confused and I do not know how to move. I suppose that the fact that we have developments in developed countries is good, but we have to think about how this developments can be useful for the areas where there are more problems. I am still confused, because I have no idea, despite the fact that I am working in these areas, I do see that our colleagues don't consider the importance of these problems.

Eng. Armando RONZONI
Italy

I'm for the first time at the Club of Bologna meeting and I would like to give a short suggestion. It has already been mentioned yesterday that it could be useful to refer to the machine-manufacturing sector to ensure safety through conformity certifications for safety. In 2000 the EU published the green book on IPP (Integrated Product Policy) with the aim to improving environmental performance on a wide range of products. The basic methodology for achieving the complete control of the entire chain from raw material to process, to utilisation until final disposal as LCA (Life Cycle Assessment). In addition, certification is evolving toward an environmental product declaration. I say that, because it might suggest something. This possibility to transfer and adapt this methodology to the food chain and to transfer these principles and procedures to preserve the sustainability and converge on human health for the food chain traceability. So a possible suggestion is that the Club of Bologna could establish links and cooperation agreement with the European Commission and the newly born IFSA Food safety Agency which recently has established its board and Directors etc. And set up a specific committee or work group to elaborate guidelines for traceability aiming to respond on safety environmental protection philosophy and at the same time taking advantage to a certain extent of methodologies already available.

Yoav SARIG

I think that Josse De Baerdemaeker touched a major issue of the topic. I think that for the past two days we have elaborated and I was hoping that at least to most of us it became clear what we mean by traceability. Maybe some still object to what had been performed here but I think for the majority it became much clearer. Now we have to be far more concise and to be concise we know what traceability is. What we need is to answer the question that Josse De Beardemaeker posed. What is the need in engineering? Do we need engineering input? And do we need additional research? In my opinion the answer is almost obvious, we need. The question is: how do we take the next step? Keeping in mind that the Club of Bologna is not a research group and that we do not have the capacity to do all this work we can only initiate that and promote the idea of traceability, according to De Baerdemaeker traceability eventually is going to be imposed on us. So there is no way out. What I would suggest is, and I have already suggested it, is to start with the case study. I agree with Antonio Pagani that it would be a good idea to take some case studies, one or two, from the less developed countries. The issue of small farms is a major issue. We cannot provide all the answers to all the situations, but at lest we should get started. How to do this you to come up with all the needed information it's what is needed. Let me give you an example of what we did in the past and Josse De Baerdemaeker and I participated in a workshop and tried to identify the technological gaps on post-harvest technologies. We gathered the group of scientists – it was under the auspices of the US-Israel bi-national agricultural research fund, that took place in the US and we had about 30 or more scientists from the US and Israel plus several from Europe and Japan, addressing the issues of post harvesting technologies and we even came up with the makers showing for each of the major crops: what is available now, what are their technologies available, are they only commercially used, are they still in the research phase and what is still needed to be researched? I think similarly, by analogy, we should be able to come up with the same thing. However, it is *an enormous task because what are going to be the products we are going to address; are we going to address everything? We cannot possibly do this within the framework of the Club of Bologna. My suggestion therefore is, to give our humble contribution to the case study and hopefully to initiate additional work maybe through the EC by forming a concerted effort group that will take this and work for several years to register all that is available and list out what is still missing. That will be the contribution of the Club.*

Bill A. STOUT

My point is that whatever we do and I think case studies are great. Let us cast it in terms of the human being and the idea that whatever is done in the name of traceability should be for the benefit of humans. We too often talk about nuts and bolts and sensors and so forth but all of this should be for the benefit of humans and I would even say that we should recruit a sociologist or a humanist as part of this task force help us to put our recommendations in terms of that the benefits must outweigh the costs in terms of human welfare. I think that we as engineers fall far short on this point, and that is part of the reason why we do not have enough students in our programmes and that the public and the politicians are cutting our programmes because we've failed to make the case: that we exist to help the humans live a better life. The only justification for traceability or any technology is that it should make life better for human beings.

Francis SEVILA

Yesterday the President was upset because no key or action was going out of the discussion and we told you, Yoav Sarig and myself, that we should do something about it. So we spent some time to write a complete recommendation. So I am going to propose to the club some kind of recommendation. I think that having in mind that part of the mission of this club is to make recommendations to the farm machinery industry. I have shaped out of our discussion todaysome key recommendations to this machinery industry. I suggest to read them in case you agree or disagree: to stay in the market, any industry has to be connected to the world economic web; for farmers part of this connection implies to trace information on their production, the so-called traceability. This leads the Club of Bologna to the following recommendations to the farm machinery industry;
recommendation one: there is urgent need to complete the line of commercial machines with appropriate tools to trace information during agricultural production;
recommendation two: the farm machinery industry has to be a full and equal partner in the necessary negotiation with the other industries of the food chain, such negotiation is needed to define to what level tracing information is needed, the farm machinery industry in this negotiation has to defend the feasibility from the technical and commercial standpoints;
recommendation three: industry has to make sure that the tracing technology is adapt to the farmers working condition not bringing another working load and promoting the so-called invisible technology;
recommendation four: industry has to make sure that cost of this technology is affordable by farmers or by farmer organisations especially when taking into account the developing countries' agricultural situation;
recommendation five: the machinery industry has to complete its expertise and know-how in the design, production, selling and maintenance of the needed information technology as sensors, software and hardware, data management, communication, etc.;
recommendation six: research has to be promoted in order to match the numerous remaining technical challenges to meet the above objectives.

Giuseppe PELLIZZI

Your proposals are very interesting. I have the impression that the first recommendation contradicts a little bit the last and because if you recommend research it implies that there is no availability of sensors and so on. So if you can modify recommendation one a little bit, it could be useful. As second problem I should like to know the opinion of the manufacturers.

John F. REID

I probably am not a very representative person of the manufacturers, because I spent most of my time in your ranks (your side of the table). But having said that, I think that these recommendations are finally addressing some of my concern and interest that we focus on – that machinery needs to support the traceability, not disagreeing with Bill Stout on the importance of the human element. That is going to be defined as a pro-records certifying system and other people are defining that they have a role and will play in this process. Recommendation one is very important because it sets the goal of what is needed for each system and what do we need to provide. In some cases we don't have to do anything because it is already there. But those systems will improve. Given that goal for each of the traceability systems, we can move to the last statement of what the research needs or what is needed to be developed in term of sensors. I think that in some cases there is going to be completely new mechanisation systems to support the transfer of information in single and independent ways. So I really support these recommendations. I really think it is in the direction that the Club needs to head in order to fit into the traceability that is going to take place around us. Now, as far as the role of manufacturers. I think that industry will see that in the past we have made machines that the farmers and the producers have used in their operations without regard to the impact on the overall system and we have been pack and part of it but we have been able to focus on the machine. This is where our profession comes in. Because now we need not be concerned about the biology, the connections to other systems. That is really the role that agricultural mechanisation and agricultural engineers play in the overall food production system.

Jaime ORTIZ-CAÑAVATE

I did not work so hard as Francis Sevila, but I just make a sentence that I think was in what you said in the last two sentences. It is a recommendation that the Club of Bologna encourages farm machinery designers and manufacturers to develop, together with research institutions, sensors for detecting or registering the properties of agricultural commodities in order to promote or facilitate the traceability of this product. This is exactly what Francis Sevila said before in the last recommendations.

Arne MØLLER
Denmark

I suggest that the recommendations should include a sentence about standards for stores and data transmissions to make sure that everything can work together.

Philippe MARCHAL

I have a proposal for the recommendations for mechanisation ask to the companies to also don't forget the market for Africa and for all the countries, the mechanisation for all the countries and they have to take in consideration also the new equipment for this type of agriculture. Because the market is different, the need is different, and the equipment is also different.

Giuseppe PELLIZZI

Can I ask the speakers to give their recommendations to the secretariat in order to prepare a final draft?

Prof. Paolo BALSARI
Italy

I would like to add something to the document proposed by Francis Sevila concerning education; I think we also need something about training and education.

Richard J. GODWIN

What are the mechanisms that the Club of Bologna has? If we have gone through this process, it might seem a bit like heresy, and I don't mean it to be. But how can we expect others to listen to these laudable ideas that we have? What mechanism do we have to make to make it stick? I am afraid I'm lost at that.

Antonio PAGANI

I think there is something missing in the recommendations perhaps, with reference to what Prof. Bill Stout said. His last comment. I mean something should be there about human beings, *after all we don't only have machines. Thank you.*

Philippe MARCHAL
To include the human benefit it would be very useful in recommendations. Perhaps there is an interaction between the link of the Club of Bologna and the Food Safety Agency of the European Commission. On a strategic point of view, it will be useful to come on to that results of the Club of Bologna that will have a connection with the Food Safety Agency of the European Commission. I give this information, this recommendations to the Food Safety Agency to develop a contact on a strategic point of view it will be useful for a work.

Bassam SNOBAR
I think that it is good to give a comment on what are the of mechanisms, the kind of transfers our recommendations to the industries and to the decision makers. What influence has the Club of Bologna on the industrial sector? I do not know.

Philippe MARCHAL
If you are active and you really believe in the recommendations we have built today, we are successful. The Club of Bologna writes the results of the work of everybody here.

Giuseppe PELLIZZI
Yes I think that we have different proposals as conclusions and recommendations. One is of a general type. In fact we will write in the final document and the other is for the Working Group, chaired by Yoav Sarig. I nominate him, in this moment chairman of this Working Group. For instance, the problem of the case study is a recommendation for the working group, as is the recommendation for the working group the case study on cocoa.

Luis SANTOS PEREIRA
I think that cocoa is a very bad example, because most of the cocoa is rain-fed and if it is not rain-fed it is an industry crop and then it is used very good quality water. So the major problem is the products that are consumed raw, as vegetable land side. So we do not have to go outside of Europe to see how traceability can be in vegetables that are irrigated around our towns. So Yoav Sarig may find problems in his own country because they require to have irrigation in order to have vegetables. So Yoav Sarig is probably in a good position to select a good key. It is not necessary to go to these kind of very far, very long chains, where very probably we may not have any problems at all.

Yoav SARIG
I would like to go back to the question posed by J. Godwin. I have been concerned with that for a long time and I fully agree. I think, although I do not have a recipe to remedy this answer, I think what is missing, and this not regards only traceability but regards other subjects as well. That we are missing a more close contact with industry and policy-makers. If we have ever had more representatives, not only John Reid , this is no guarantee, but at least it would have been a start, because they will take this message home and eventually this will be infiltrated to the management and the policy - makers, and by the same token, policymakers from the EC and from the US, do not forget the US. The US is sometimes forgotten and they are the major producers, this is still missing and we should work on that and I think this is the responsibility of the Management Committee.

Josse DE BAERDEMAEKER
I think that Yoav Sarig is right. There is another group of industries that we must include: there is the distribution industry, the supermarkets. I can tell you the story of Europe Gap: where some supermarkets got together in Europe and said "we need some standards and we need some traceability in the fruit and vegetable production" and as of next year Albert Heinz's: "we will not sell any fruit and vegetables anymore if they are not under guaranteed production system that can not be traced back". So they set the requirements and in the UK supermarkets are very strong in this, I think we have to talk to them. But the system will be imposed

on us, they have already their guidelines, I think it will depend on us to see how can we come into play to make life easier for farmers, to make life easier for those that use it throughout the chain.

Jürgen ZASKE
A very practical example. If you want to influence the decision makers and the industry, the politicians and so on we need some information. I would suggest that we publish the revised Conclusions and Recommendations more or less immediately after a meeting and not just before the next meeting. So then we have forgotten everything. We get the documents in a very nice publication when, one year later, our mind is directed to some other topic.

Giuseppe PELLIZZI
I am surprised to hear this. The Conclusions and Recommendations are published in the CIGR newsletter one month later so you can find them immediately.

Philippe MARCHAL
Maybe we can come back to the case study. It seems that cocoa is not the right one. If there is anybody that has some proposal for the case study, let him let us know, if it is not today, even next week.

Josse DE BAERDEMAEKER
As a proposal I think that the fruit and vegetable one is quite good. Because I know in this Euro Gap there are many countries involved – South Africa, Chile, African countries in general, as well as the US and Australia. I know there are many that are a number of things that are common for many countries, North and South.

Hugo CETRANGOLO
We can write two-case study. One on a medium size company that produces corn for human consumption for the European and another country markets. The second one on the meat for the European market mainly from the big distribution. This is very easy for us to write the cases because we are working with them in these activities.

Giuseppe PELLIZZI
Due to the fact that you are a member of the Working Group, could you please provide information on the case study that you suggested. The same applies to beef.

Franco SANGIORGI
I suggest to include in the case studies one that I consider the most important, i.e. cereals traceability. Cereals are produced all over the world and cross-oceans and travelling all over and are subjected to many changes. So we have the chance to be clear with the industry on what can be done at harvesting level, which equipment is necessary and which type of electronics, which type of sampling devices, of analysis, etc.. So we can provide a full package of things to be utilised in order to trace this type of products, both for human consumption and for animal consumption. So I presume that this could be the first, one of the first, or rather the most important, example. But other examples, I heard about the question of vegetables and fruit, etc., are a big difference, because there are different ways of managing this type of products, so the case study here becomes a bit more complicated, because of the different types of marketing.

Philippe MARCHAL
We extrapolate that the leader of the Working Group is Yoav Sarig and he perhaps helps us to collect this information. As a member of the Working Group I have to help you, without any problem. We'll try to share the problem. Our discuss is about strategy regulation or institution. We discuss about case study, we have some about human benefit effect, about education. Do you have all the proposals to complete the recommendations, please.

Josse DE BAERDEMAEKER
One consideration for industry also is that there is a huge software problem involved and that we should get together with software houses and try to find some common grounds and how to implement traceability and use the information technology as well. It must be done between all the partners in industries and agreeing with them.

Philippe MARCHAL

What is the proposal? For Working Group, and I'm taking Yoav Sarig's part, if he has not any problems, it is to have a list of the working groups, not in the Club of Bologna but outside, that have realised works on the subject, as a list and a result of this Working Group. Perhaps in North America, in Europe, in Asia or in Africa all the ways come on this subject try to collect bibliographies and the list of the existing working groups today, so that we do not re-invent what has already been solved and perhaps I have to take in charge as good the fact of collecting the bibliographies on this subject and the list of the existing groups. Please, if you know in your country working groups on the subject, send this information to Yoav Sarig such we obtain, not a complete mirror, but a good information on the existing working groups on the subjects at a world-wide level. Peter Crossley ask me two minutes to inform you about the European initiatives.

Prof. Peter CROSSLEY
UK

Last year I mention that we were setting a pan European program, I'm pleased to say that the processional exists I pass information to select the people here. We have not at the moment partners and we have studied only programmes from Greece, from Germany and from Belgium and we are working to increase collaboration with others European partners in this venture.

Giuseppe PELLIZZI

Mr. Chairman we arrived at the end of our working day and we can conclude this meeting. I ask the people who are interested, to give me their recommendations. I want to inform you that next year the EIMA will be between the 14th and 18th of November. So, I suggest we have the meeting on the 16th and 17th November, Sunday and Monday. Do you agree? I want to express my deep thanks to all of you, and I think that we have had two good and interesting days and we have improved our knowledge of the problem and taken some decision that could be interesting. Thank you very much to all of you, and a special thank to the chairman of the sessions B. Snobar and Ph. Marchal who leaded the discussion in a perfect way.

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Zoltan Lang	HUNGARY	*New FM*
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Makoto Hoki	JAPAN	*FM*
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