CLUB OF BOLOGNA

PROCEEDINGS OF THE 12st MEMBERS' MEETING

Bologna (Italy), 18th-19th November, 2001

XXXII EIMA

Conclusions and Recommendations

Conclusioni e Raccomandazioni

Opening Session

Session 1

Development of agricultural mechanisation to assure long-term global food supply

General background: information and requirements

New technological solutions (materials, performances, quality and capacity of work etc.) appropriate to Emerging and Industrialized Countries

Role of I.T. for an appropriate world market developement

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sotto gli auspici di
CIGR - Commissione Internazionale
Ingegneria Agraria
under the aegis of
CIGR - International Commission of
Agricultural Engineering

CONCLUSIONS
AND RECOMMENDATIONS

54 experts from **42 Countries** and representatives from **FAO**, **UNIDO** and **CIGR** took part in the 12th Club of Bologna Meeting, organised by UNACOMA under the aegis of **CIGR**, to examine and discuss the following two topics:

Development of agricultural mechanisation to assure long-term global food supply

Code of Ethics as a contribution for a proper agricultural mechanisation.

Development of agricultural mechanisation to assure long-term global food supply.

This important subject was divided into 4 main topic areas that were discussed separately. The introductory presentation on the ***"General Aspects"*** by ***J. Pawlak***, ***G. Pellizzi*** and ***M. Fiala,*** provides a thorough analysis of the food requirements in the various areas of the world where specific agricultural practices are adopted as a function of the different local climatic, pedological and vegetative conditions. In some of these areas – and in particular sub-Saharan Africa - the annual growth in food demand is in the order of twice that of local food production, *which is very low because of insufficient use of yield-increasing inputs and lack of proper technical field and post-harvest equipment*. There is therefore a need to identify mechanisation solutions that can help to increase yields while at the same time limiting the degradation of the soil, and minimising production losses both inside and outside the farms.

This in parallel with the efforts to create a system for the international distribution of foodstuffs able to ensure that the offered food effectively reaches the target populations.

In any case, an appropriate mechanisation must take into account the local agricultural habits and the purchasing power of the various populations. For its promotion it is necessary to set up—within the various countries—a network of activities aimed at providing an essential contribution to the rational development of mechanisation. This should include post harvest technology, with particular reference to the storage of the products.

In consequence, there is also a need to establish a broad base of effective educational and training programs for young farmers, and to promote the introduction of I.T., through which the experiences of the industrialised countries can suggest new ideas, which can be applied in the developing ones. It is therefore necessary for the various countries to understand the need to develop and adopt complete "mechanisation systems" tailored to the local conditions, rather than – as has often been the case until now – to offer individual mechanical components designed to autonomously perform only a single task. In this context, an important role will be played by contractors.

A second presentation addressed the topic of ***"New technological solutions appropriate to Developing and Industrialised Countries"*** and consisted of two reports by: ***U. Peiper and Y. Alper*** for the emerging countries; ***J. Gilles*** as industrialised countries.

Peiper and ***Alper,*** writing a report concerning the need of an appropriate mechanisation for developing countries, discussed the general topic of ensuring enough food production for the world population in a proper way, learning the experiences and avoiding the mistakes done by the industrialised countries. In the opinion of Authors, an appropriate mechanisation for emerging countries lies in adaptation of existing machines (as far as design, manufacturing, materials and maintenance are concerned) and methods known by the Ag. Eng.ng Community of the developed ones. An intensive educational and extension work has to be done to improve the yields and profitability of the emerging countries agricultural production. However, modern techniques must be adopted carefully and gradually, minimizing the negative-effect on the environment in each country. The problem, in fact, is to bridge the gap between the existing agricultural procedures and the future once with proper intermediate solutions and to provide tools and methods appropriate to obtain a sufficient food production.

The keynote report by ***J. Gilles*** first of all recalled what will be the requirements of agriculture for the near future (producing a sufficient quantity of food; improving its quality; increasing yields; diminishing non-renewable energy sources; reducing environmental impact and costs; developing agricultural processing methods able to safeguard the environment and to be economically sustainable). For the industrialised countries, all this will require an increasingly intensive use of I.T., in order to optimise the management of agriculture, which is based, both on commercial ventures and family run lifestyle farms. For both types it will be necessary to offer integrated management systems for the sector, which address: the internal relations within the farms, but also the external relations between farms and suppliers, purchasers and public administrations. One such system (which falls under the category of precision farming methods) has been recently proposed with the designation AMS (Agricultural Management Solutions).

A third presentation concerned the topic "***Role of ICTs for an appropriate world market development"*** and has been prepared by ***F. Sevila*** and ***S. Blackmore***. The paper implies a very general and diversified overview: to try to envision future developments in the agri-food system, to consider the development of ICTs in all technical and economic aspects. After an introduction concerning the food world system, it deals, in chapter 2, with the non-machinery users and, in chapter 3, with the machinery related aspects. Chapter 4 moves back to a more general comment on ICTs developments in order to point out the deontological aspects to be kept in mind by designers of future ICTs applications for the food chain and the rural world.

The ICTs have pervaded the modern world, finding an increasing interest also in the developing countries where they can play a very important role for the development of agriculture; but their utilisation requires an adapted deontological approach at the very beginning of the food systems and products.

The last presentation, by ***B. Snobar*** and ***P. Schulze Lammers***, concerned the issue of ***"New educational requirements"*** and was divided into two sub-topics pertaining to university education and technical training respectively.

B. Snobar first of all called attention to the increasing need for education and training – given the extremely rapid evolution of the agricultural-mechanical sector in the 20th century – in order to equip young people with a valid, up-to-date background of knowledge necessary for working in the sector, and covering both the engineering aspects dealing with the design of machines, and the agricultural aspects necessary for making appropriate mechanisation management decisions in relation to the specific agronomic, technical and social needs of the different countries. In view of the fast growing Information Technology, Globalisation and World Trade Agreements, the following educational developments at University level are required:

- modification of the teaching methodology and contents of courses;
- integration and team approach of research with emphasis on the global types rather than the individual and the local types;
- implementation of extension services in a way that less emphasis may be given to traditional simple farm related community services to wider range of services and deeper knowledge on global issues such as world markets, environment, consumer preferences and the art of trade in order for the producers to benefit from the new changes in the world.

P. Schulze Lammers pointed out that agricultural food production needs skilled workers and technicians, and asserted that non-academic education addresses itself to the development of these skills, which are predominant in non-mechanised agriculture. With increasing mechanisation, more operational skills are required, and in the industrialized countries new technology demands expertise and knowledge for the control of mechanised processes and for the diagnosis of errors in electronically controlled processes. There are different systems of learning and training for introducing and using mechanisation efficiently. Competence Based Training and the Dual System are two renowned forms of education, which can be applied to extend the skills of farmers and contractors as users of mechanisation, of technicians maintaining, repairing or manufacturing agricultural machinery, as well as of advisors and dealers. New requirements on education to give incentives for an efficient use of mechanisation must be systematically differentiated with reference to the remarkable regional differences in the level of mechanisation, in production and socio-economic conditions, and the kinds of crops. Regional adoption of globally standardized education systems is a major requirement for a worthwhile contribution of non-academic education to the task of assuring food supply in all parts of the world.

Following extensive and in-depth discussion, the participants:

reassert the need, before proceeding with the simple transfer or sale of mechanical technologies, to understand the specific social, economic, agricultural, pedological and structural conditions within each country, and its degree of development.

agree that, in consequence, machines must be tailored to the specific needs of each target country and must therefore be developed and tested under real working conditions.

underline that, in any case, the development of mechanisation must be pursued on a small scale – and clearly differentiated as a function of each country's level of development, the availability of manpower and the cost of labour – also with a view to encouraging new generations to remain in rural areas.

point out the need for coordinated actions, especially in the less developed regions, aimed at promoting improved use of fertilizers, pesticides, water, new more productive varieties, and at introducing post-harvest technologies which can minimise product losses, thereby gradually increasing the income of farmers and enabling them- over time- to purchase machinery. To this end, as far as in particoular the Afican Continent, a higher involvement of the locally existing international Institutes of Agricultural Research, as well as the establishment of a new Institute of Technology could help to solve the very large problems of long-time food supply within this Continent.

recognise the fundamental role of IT (information technology), whose uptake need not necessarily be dependent on the evolution of mechanisation, as a basic tool for the development of knowledge in the service of more profitable agricultural-food systems.

recommend the adoption of multidisciplinary approaches that can also satisfy all the external requirements connected with the wider adoption of mechanisation, such as training, education, technical support and other basic facilities necessary for its appropriate and rational development.

urge agricultural machinery manufacturers to make every effort to look beyond simple "market forces", offering the necessary preliminary technical support for the development of complete systems that can effectively contribute to guaranteeing food security to the various local populations.

Code of Ethics for the agricultural machinery-manufacturing sector

This important subject has been preliminary discussed during the 11th Club of Bologna meeting held in Tsukuba (Japan) at the end of November 2000. After a deep discussion the participants agreed on the need to go one step deeper and than, to examine and approve a final version of the code to be accepted hopefully and signed by the manufacturers. The preparation of this proposal has been committed to ***Y. Sarig*** leading a work group composed by: ***L. Clarke***, ***I. De Alencar Nääs***, ***R. Hegg***, ***A. Munack***, ***G. Singh***.

The document, following a brief introduction which sets out its objectives, is divided into two main sections which cover the general principles and the specific areas dealing with workers and purchasers. In particular, for what concerns purchasers, the document states that agricultural machinery manufacturers should: answer the expectations of their purchasers; supply safe, high quality products which are able to deliver good performance, long life and compliance with the prescribed technical requirements; guarantee conformity of their products to the environmental and workplace safety regulations of the various countries; supply products complete with full documentation so that the information can be widely spreaded out among purchasers. In any case, the responsibility for operations – which must be appropriate in terms of performance, safety, the health and well-being of workers and animals – falls to the machinery manufacturers.

The participants express, with a large majority, their full ***agreement*** with the proposal – based on the existing codes already in use – to which they suggest some minor amendments.

The ***general recommendation*** is made that each country should draft and adopt its own code of ethics, based on the specific standards already in place within the country itself, thus allowing the purchasers to decide which machines to use, based on the quality assurances offered by the different manufacturers and dealers.

The participants moreover ***recommend*** that the Associations of Agricultural Machinery Manufacturers, in conjunction with the public and private organisations of the sector, including the research institutions and the extension services, actively cooperate to promote the widespread adoption of the Code of Ethics. This with particular emphasis on machinery developed for transfer or sale to the emerging countries, where the creation of technical training and educational structures is becoming increasingly important.

CONCLUSIONI
E RACCOMANDAZIONI

54 **esperti** di 42 **Paesi** e i rappresentanti di **FAO**, **UNIDO** e **CIGR** hanno partecipato al 12° meeting dei full-members del Club of Bologna, organizzato da UNACOMA e sotto l'egida della **CIGR**, per esaminare e discutere i seguenti argomenti:

Sviluppi della meccanizzazione agricola per assicurare l'approvvigionamento alimentare nel lungo termine

Codice etico per il settore della costruzione delle macchine agricole

Sviluppi della meccanizzazione agricola per assicurare l'approvvigionamento alimentare nel lungo termine.

Questo importante argomento è stato articolato in 4 temi principali discussi in successione. La presentazione introduttiva sugli ***"Aspetti Generali"*** predisposta da ***J. Pawlak***, ***G. Pellizzi*** e ***M. Fiala***, ha fornito un'approfondita analisi delle esigenze alimentari dalle varie aree del mondo dove specifiche pratiche agricole sono adottate in funzione delle differenti condizioni locali in termini climatici, pedologici e vegetativi. In talune di queste aree - in particolare nell'Africa sub-sahariana - la crescita della domanda alimentare è dell'ordine di due volte quella della produzione che è molto bassa a causa dell'insufficiente uso di mezzi tecnici di produzione e della mancanza di attrezzature adeguate per le operazioni di campo e la conservazione dei prodotti. Vi è, quindi, la necessità di individuare soluzioni di meccanizzazione atte a favorire l'aumento delle rese, limitando al contempo la degradazione del suolo e minimizzando le perdite di produzione all'interno e all'esterno delle aziende.

Questo, in parallelo con l'esigenza di creare un sistema di distribuzione internazionale degli alimenti di base atto ad assicurare che gli stessi, offerti, raggiungano le popolazioni cui sono destinati.

In ogni caso, una meccanizzazione appropriata deve tenere conto degli usi locali e della capacità di acquisto dei vari agricoltori. Per la sua promozione si rende necessario – all'interno di ogni paese – creare una rete di attività destinate a fornire un contributo essenziale allo sviluppo razionale della meccanizzazione stessa, incluse le tecnologie post-raccolta con particolare riguardo alla conservazione dei prodotti.

Conseguentemente, vi è anche la necessità di migliorare i sistemi didattici e i programmi di training per i giovani agricoltori e di promuovere l'introduzione delle tecnologie informatiche attraverso le quali i paesi industrializzati possono suggerire nuove idee applicabili ai paesi emergenti. E' pertanto necessario che venga compresa la necessità di sviluppare e adottare completi sistemi di meccanizzazione adatti alle condizioni locali, piuttosto che - come generalmente è accaduto in passato - offrire macchine e componenti progettate per svolgere una singola operazione. In questo contesto, un ruolo importante viene svolto dai contoterzisti.

La seconda presentazione ha riguardato il tema ***"Nuove soluzioni tecnologiche appropriate in paesi emergenti e industrializzati"***. L'argomento è stato trattato da due rapporti proposti da: ***U. Peiper*** e ***Y. Alper***, per quanto attiene i paesi emergenti, e ***J. Gilles***, per i paesi industrializzati.

Peiper e ***Alper***, con riferimento ai paesi emergenti, hanno discusso il tema generale di come assicurare alimenti sufficienti alla popolazione mondiale, imparando dall'esperienza dei ed evitando gli errori compiuti dai paesi industrializzati. Secondo gli Autori, una meccanizzazione appropriata per i paesi emergenti consiste nell'adattamento di macchine esistenti (per quanto attiene progetti, realizzazioni, materiali e esigenze di manutenzione) e di metodi noti alle comunità scientifiche della Ingegneria Agraria dei paesi sviluppati. In ogni caso un'ampia attività di istruzione e di assistenza tecnica deve essere svolta, al fine di migliorare le rese e i profitti della produzione agricola nei paesi emergenti, tenendo comunque presente che le moderne tecniche devono essere adottate gradualmente, minimizzandone gli effetti negativi sull'ambiente in ogni paese. Il problema, infatti, è quello di coprire il divario esistente tra i diversi processi agricoli e di offrire soluzioni intermedie fornendo strumenti e metodi appropriati all'ottenimento di una sufficiente produzione alimentare.

Il rapporto di ***J. Gilles*** ha richiamato, anzitutto, le esigenze dell'agricoltura futura (atta a produrre una sufficiente quantità di alimenti di migliore qualità con rese crescenti, più bassi consumi energetici, minore impatto ambientale, costi inferiori e con sviluppo di metodi di conservazione capaci di salvaguardare l'ambiente e di consentire una sostenibilità economica dell'agricoltura stessa). Per i paesi industrializzati, tutto questo richiede un uso più intensivo della tecnologia informatica al fine di ottimizzare la gestione agricola che è basata su aziende sia destinate a produrre per il mercato, sia a semplice gestione familiare. Per entrambi i tipi si renderà necessario offrire sistemi integrati di gestione indirizzati a: ottimizzare le relazioni interne alle aziende nonché quelle fra aziende e mondo esterno (fornitori, acquirenti, pubbliche amministrazioni). Questo tipo di sistema (che ricade nella categoria dei metodi propri dell'agricoltura di precisione) è stato recentemente proposto da J. Deere col nome di S.A.G. (Soluzioni Agricole Gestionali).

Il terzo tema riguarda il ***"Ruolo dei sistemi informativi per un appropriato sviluppo del mercato"*** ed è stato trattato da ***F. Sevila*** e ***S. Blackmore***. Il rapporto offre una visione molto generale e diversificata e cerca di individuare i futuri sviluppi del sistema agricolo-alimentare considerando l'evoluzione di tutti gli aspetti tecnici ed economici delle tecnologie informatiche. Dopo un'introduzione sul sistema alimentare mondiale, gli Autori si soffermano sugli utilizzi del T.I. legati alle macchine, quindi su quelli propri interni alle macchine agricole, sviluppando commenti generali sullo sviluppo di tali tecnologie al fine di puntualizzare gli aspetti deontologici da tenere in mente da parte dei progettisti per applicazioni future al mercato rurale e alla catena alimentare.

Le tecnologie informatiche hanno invaso il mondo moderno interessando anche i paesi emergenti dove esse possono giocare un ruolo molto importante per lo sviluppo agricolo. La loro utilizzazione, tuttavia, richiede un approccio deontologico appropriato fin dall'inizio.

L'ultimo tema, presentato da ***B. Snobar*** e ***P. Schulze Lammers*** ha riguardato ***"Le nuove esigenze educative"*** ed è stato diviso in due sottotemi riguardanti, rispettivamente, l'istruzione universitaria e l'istruzione tecnica.

B. Snobar inizialmente richiama l'esigenza di sviluppare l'istruzione e il training, data l'evoluzione estremamente rapida del comparto meccanico-agricolo nel XX secolo. Ciò significa dover dotare i giovani di valide e aggiornate conoscenze necessarie per operare nel settore, coprendo sia gli aspetti ingegneristici relativi alla progettazione delle macchine, sia quelli concernenti la gestione di una meccanizzazione appropriata in relazione alle esigenze agronomiche, tecniche e sociali dei diversi paesi. In vista della rapida crescita della tecnologia dell'informazione, della globalizzazione e degli accordi commerciali a livello mondiale, sono richiesti i seguenti sviluppi dell'istruzione:

- modifica delle metodologie di insegnamento e dei contenuti dei corsi;
- integrazione e approccio sistemico nella ricerca con particolare riferimento a modelli globali piuttosto che individuali o locali;
- sviluppo dell'assistenza tecnica con minor enfasi ai semplici servizi aziendali e più ampia attenzione ai servizi e alle conoscenze relative a tematiche globali come i mercati mondiali, la preparazione del consumatore, l'arte delle vendite sì da aumentare i benefici dei produttori nel quadro dei nuovi cambiamenti che ci attendono.

P. Schulze Lammers ha puntualizzato le esigenze della produzione agricolo-alimentare in termini di operai specializzati e di tecnici, affermando l'importanza dello sviluppo di una istruzione non accademica la cui importanza è determinante in una agricoltura non meccanizzata. Con lo sviluppo della meccanizzazione si richiede un maggior numero di specializzazioni e, nei paesi industrializzati, di esperti sulle nuove tecnologie relative al controllo di processi meccanici e per la diagnosi di errori nei processi controllati elettronicamente. Esistono differenti sistemi di insegnamento e training per introdurre e usare un'efficiente meccanizzazione. Il training specialistico e i sistemi duali sono rinomate forme di istruzione che possono essere applicate alla preparazione degli agricoltori e dei contoterzisti, così come di tecnici per la riparazione e la costruzione delle macchine, oltre che di venditori e consulenti. Nuove richieste di istruzione da incentivare per un uso efficiente della meccanizzazione devono essere sistematicamente differenziate in rapporto alle specifiche esigenze regionali in termini di livelli di meccanizzazione, di produzione, di condizioni socio-economiche e di tipologie colturali. L'adozione a livello regionale di un'istruzione globalmente standardizzata è una delle maggiori esigenze come contributo alla sicurezza di approvvigionamento alimentare nel mondo.

Al termine della lunga e articolata discussione, i partecipanti:

richiamano l'esigenza di acquisire, preliminarmente al semplice trasferimento o alla vendita di tecnologie meccaniche, le specifiche condizioni sociali, economiche, agricole, podologiche e strutturali di ogni paese e il suo grado di sviluppo;

concordano, conseguentemente, sul fatto che ogni macchina debba essere definita sulle esigenze del paese stesso e che, quindi, debba venire sviluppata e sperimentata in condizioni reali di lavoro;

sottolineano che, in ogni caso, si debba far riferimento allo sviluppo di una meccanizzazione di piccole dimensioni – chiaramente differenziata a seconda dei livelli di sviluppo di ciascun paese, della manodopera in esso disponibile e del costo del lavoro – anche come chiave atta a mantenere nelle aree rurali le giovani generazioni;

evidenziano l'esigenza di promuovere, specialmente nelle aree più arretrate, azioni promozionali coordinate per il miglior uso dei fertilizzanti, dei pesticidi, dell'acqua e di nuove varietà più produttive, oltre che per l'introduzione di tecnologie post-raccolta atte a garantire la riduzione delle perdite di prodotti, al fine di aumentare gradualmente i redditi degli agricoltori facilitando l'acquisto nel tempo di macchine. A questo fine e con particolare riferimento al Continente Africano, un maggior coinvolgimento degli Istituti Internazionali di ricerca agricola esistenti nel Continente stesso, oltre che la creazione di un Istituto di Tecnologia, potrebbe essere in grado di aiutare a risolvere il problema dell'approvvigionamento alimentare nel lungo termine;

riconoscono la fondamentale funzione delle I.T. (tecnologie dell'informazione) la cui diffusione non necessariamente deve essere legata all'evoluzione della meccanizzazione, come strumento di base per lo sviluppo delle conoscenze a servizio di sistemi agricolo-alimentari più redditizi;

raccomandano l'uso di approcci multidisciplinari atti a soddisfare anche tutte le esigenze esterne collegate alla diffusione della meccanizzazione, quali il training, l'istruzione, l'assistenza tecnica e le altre facilitazioni di base necessarie al suo appropriato e razionale sviluppo;

sollecitano il compimento, da parte dei costruttori di macchine agricole, di ogni sforzo atto a superare le semplici "ragioni del mercato", per offrire preliminarmente l'assistenza tecnica necessaria allo sviluppo di sistemi completi atti a seriamente contribuire a garantire la sicurezza alimentare delle varie popolazioni locali.

Codice etico per il settore della costruzione delle macchine agricole.

Questo importante argomento era stato già preliminarmente discusso durante l'ultimo meeting del Club of Bologna svoltosi a Tsukuba (Giappone) alla fine di novembre del 2000. Dopo un'approfondita discussione, i partecipanti hanno concordato sull'esigenza di un approfondimento atto a esaminare ed approvare una versione finale del codice da far adottare dai costruttori. La preparazione di questa proposta è stata affidata a ***Y. Sarig*** che ha guidato un gruppo di lavoro composto da: ***L. Clarke***, ***I. De Alencar Nääs***, ***R. Hegg***, ***A. Munack***, ***G.Singh***.

Il documento, dopo un breve preambolo mirato a spiegare gli obiettivi, è articolato in due paragrafi principali riguardanti i principi generali e le aree specifiche relativi agli impiegati e agli acquirenti. In particolare, per quanto attiene gli acquirenti, si afferma che i costruttori di macchine agricole dovrebbero: far fronte alle attese dei loro compratori; assicurare la fornitura di prodotti di alta qualità e sicurezza atti ad assicurare buone prestazioni, la durata e le rispondenze tecniche necessarie e richieste; assicurare che i loro prodotti siano conformi agli standards ecologici e di sicurezza del lavoro presenti nei vari paesi; fornire prodotti con ben documentate informazioni sì da poter essere ampiamente diffusi fra i compratori. In ogni caso, la responsabilità di operazioni - che devono essere appropriate dal punto di vista delle prestazioni, della sicurezza, della salute e del benessere di addetti e animali - è propria dei costruttori di macchine che sono invitati a sottoscrivere il Codice.

I partecipanti manifestano, a larga maggioranza, il ***pieno accordo*** con la proposta presentata – basata sui codici esistenti e già adottati – alla quale suggeriscono qualche minore emendamento.

Una ***raccomandazione generale*** è formulata sulla necessità che ogni paese produca e adotti un proprio codice etico basato su standards specifici già in adozione nel paese stesso, lasciando agli acquirenti la responsabilità di decidere quali macchine debbano essere utilizzate sulla base delle garanzie dei livelli qualitativi offerti dai diversi costruttori e venditori.

I partecipanti, inoltre, ***raccomandano*** che le Associazioni dei Costruttori di Macchine Agricole, unitamente alle Organizzazioni di settore pubbliche e private, inclusi gli Istituti di ricerca e di assistenza tecnica, cooperino attivamente alla promozione della diffusa applicazione del Codice Etico. Ciò, con particolare riferimento alle attrezzature da trasferire o vendere ai paesi emergenti dove crescente importanza assume lo sviluppo delle strutture di istruzione e training tecnico.

OPENING SESSION

Leading person: ***Giuseppe Pellizzi, Italy***

Aproniano TASSINARI
President of UNACOMA – Italy

The message of welcome I address to you this year on UNACOMA has a special meaning and significance. The tragedy that struck the Twin Towers in New York on September 11 and, with them, the United States, consequently involving the whole world, has led to an examination of conscience among us free men and women, to a reflection on the hitherto victorious social model of the advanced industrial nations and to wondering what should be done in concrete terms, while maintaining respect for differing cultures, to bridge the economic, social and technological gap, separating us from the developing countries. With this, I don't intend to suggest that the Club of Bologna should step out and bear the burden of planetary problems. Yet, I take the liberty of pointing out that, in its first twelve years, the Club has made a significant contribution to knowledge and a more extensive study of possible solutions to problems lying at the heart of our human endeavour, north, south, east or west, on the premise of effective and peaceful co-operation between different and distant geographic areas, differing geo-political situations. Anyone who works in agriculture, directly or as a supplier of goods and services, is more aware than most of how essential its functions are for mankind's very survival. More than other categories of people, he or she is more sensitive to the still anguished problem of the hunger and poverty afflicting so many peoples. Unfortunately, this problem remains unsolved in large part because of the difficulty of making an effective transfer to some countries of the knowledge and technical know-how needed to introduce an agriculture founded on criteria of reasoned productivity -a problem which, however, can in no way represent an alibi for acts of terrorism. I like to think that, as has always happened since its foundation, the Club can continue to represent a place and time in which each can enjoy the use of the other's expertise in the search for the development of technology for agriculture, under the requirements of technical efficiency, economic viability, safety for operators and quality products. Growing participation in the Club by experts from emerging countries confirms the group's va1idity in terms of content and continuity over time, an appointment looked forward to year after year for a debate of ideas, which is always constructive and productive of proposals for new advances. Last year, the Club held three sessions, in Brazil in July for the annual conference of the Brazilian Agricultural Engineering Society; in November at Bologna, the Club's traditional meeting place; and in late November, at Tsukuba in Japan, for the Fourteenth World Congress of the CIGR. In Tsukuba, the theme was the ethical aspects of agricultural machinery construction, and this is picked up again here for an opportune definition in terms of a 'code' as a contribution to 'appropriate agricultural mechanisation'. The other issue on the agenda is the development of agricultural mechanisation for food provisions on the world scale. I think this is of important, even essential importance for the proposals the debate may produce and which we will bring to the attention of the international institutions. With particular warmth, I would like to thank the president, Prof. Giuseppe Pellizzi, for his constant commitment and his well-known competence, and I thank all of you warmly for your appreciated work, welcoming you with my deepest esteem and friendship.

Giuseppe PELLIZZI
President of the Club of Bologna – Italy

Mister President of UNACOMA, Ladies and Gentlemen, dear Colleagues, it is with deep feeling that, before entering into the subject of our meeting, I join the words of the President of UNACOMA in trying to represent your unanimous thoughts of offering to our dear colleagues from the USA who are here with us today our most complete sympathy and our friendship after the treacherous terrorist attacks that struck New York and Washington on 11th September 2001. We want to offer you, dear Colleagues and friends, our deepest condolence and to thank you for being here with us during these days of such a heavy difficulties and losses for all humankind. The attack we have witnessed makes no sense, resulting from unsound minds and an expression of interests disguised as pseudo-religious and claims that have nothing to do with what happened. I *strongly hope that common sense will prevail, that we will reach mutual respect and understanding as well as the wish of fraternity. The world can't continue in this manner, it has to change. Our Club – that gathers 94 Colleagues from 41 countries without any distinction of religion, models of life, political beliefs – is a good example of how it is possible to live together with mutual consideration and the common willingness to understand each other. Please, Colleagues, let me ask you to stand for few minutes of silence in memory of all the innocent victims all over the world.*

Thank you. It is also our duty to co-operate in the erection of a new, better world, more fair and more peaceful; this is the attitude to which we have always complied and with which we want to continue to work. We start in the best way, as testified to by the presence of Dr. Wayne Skaggs – president of ASAE – and our full member Prof. Bill Stout, past president of CIGR. The reason why Wayne Skaggs has agreed to join us in this meeting of our Club – as was the case last year with Harmon Towne in Tsukuba – is essentially because we are trying to organise a meeting of our Club on the occasion of the forthcoming CIGR-ASAE World Congress, scheduled to take place in Chicago at the end of July – 2002. This is a major event, which will enable the Club, under the aegis of CIGR, to take on a new and more important role, definitively establishing itself as an organisation of world-wide relevance. And God knows what a great need there is for truly international organisations of this type, created to unite peoples, increase reciprocal understanding and foster discussion – in this particular case on topics concerning global strategies for the rational development of agricultural mechanisation. This morning, before the start of this session, Mr. Ambrogi, Director of UNACOMA, and myself met President Skaggs, with the participation of E.H. Bartali (CIGR President), B. Stout and O. Kitani (both past presidents of CIGR), A. Munack (incoming president of CIGR) and P. Schulze Lammers (general secretary of CIGR), to define the terms of our day in Chicago. I am pleased to confirm that the session will take place on 27th July 2002, that means one day before the start of the CIGR-ASAE Congress, with the full collaboration of ASAE itself, as well as – obviously – of UNACOMA. And so, also in 2002, we will have two meetings of the Club (Chicago in July and Bologna in November) to discuss the complex but highly topical subject of "Mechanisation and traceability of agricultural production: a challenge for the future". I would like to officially express my warmest thanks to ASAE and UNACOMA for their collaboration and support, and hope that you, dear colleagues, will attend both meetings in as great a number as you are in this room today. The Club has recently lost one of its founder members: Prof. Làszlò Lehoczky, who passed away few weeks ago. Dean for many years of the Faculty of Agricultural Engineering at the University of Gödöllö (Hungary), eminent President of CIGR, Lehoczky was well known for his advanced research activity. But he has to be remembered mainly for his human endowments: understanding, distinction, honesty, goodness, spirit of friendship. We will feel his absence! However, the Club has further expanded: today we have 11 new full members from: Canada (Prof. Abdel Ghaly), Iran (Prof. Morteza Almassi), China (Dr. Li Shujun), Turkey (Prof. Yunus Pinar), Sudan (Prof. Salem Al-Lozi), Italy (Prof. Paolo Balsari), Norway (Prof. Egil Berge), Thailand (Prof. Suraweth Krishnasreni), the United Kingdom (Prof. Malcom Carr-West), the Philippines (Dr. Robert Bakker) and South-Korea (Prof. Won-Kyu Park). As I told you, this brings the number of countries represented, on all continents, to 41, for a total of 94 full members. A very warm welcome to all the new members most of which are here in this room today. I am certain that their participation in the Club's activities will contribute invaluable thoughts and experiences for the definition of the issues that we will be discussing in years to come. And, once again, many thanks to UNACOMA for its support, without which our activities would not be possible. In officially opening this XII meeting of the Full Members of the Club of Bologna, I am now pleased to ask Prof. E. H. Bartali to give the CIGR Award to Mr. Carlo Ambrogi, Director of UNACOMA - an award which was not possible to present in person at Tsukuba last year. Please, El Houssine.

El Houssine BARTALI
President of CIGR – Morocco

President of UNACOMA distinguished guests, dear friends and Colleagues it's my pleasure to be here as President of CIGR and attend this Club of Bologna's meeting and I would like to thank UNACOMA for inviting me and giving me this opportunity. First of all I would like to join my friends who spoke before me. I would like to record and underline that CIGR group network has expressed its solidarity and sympathy with ASAE and the American people for the wild terrorist attacks on New York and Chicago. We all condemn this inhuman and barbarian attack. As the world co-operates with the United States to eradicate terrorism forces, CIGR and its regional and national association, as well as the Club of Bologna, will continue their commitment to building strong international relationships and preparation for the upcoming ASAE-CIGR joint Congress of Chicago in July 2002 is a significant demonstration of this Cupertino. Both CIGR and ASAE are promoting massive participation of the engineering and scientific communities in this congress. CIGR congratulates the Club of Bologna which has carried out excellent work to bring together machinery manufactures, researchers, professionals, developers. This Club has been very active and productive in recent years with all the meetings it has held. I would like to say that it's a great pleasure to learn that the Club of Bologna is planning to have its next meeting in Chicago and I would like to thanks UNACOMA for this continuous support. The Club of Bologna, as I said, produced good material and CIGR News Letter n° 54 of April 2002 includes a very interesting paper by Pagani, Fiala and Pellizzi on the "Guidelines for technology transfer in agricultural machinery". I am happy to learn also that UNACOMA, through Dr. Ambrogi, is considering hosting a farm machinery demonstration in North Africa in 2002; I hope it will be in Morocco. The presence of Dr. Skaggs among us is a good opportunity for us to co-ordinate our efforts for the success of the CIGR-ASAE joint Congress of 2002. I hope that you have received information about this Congress, either through this document that you received from ASAE or through the CIGR News Letter n° 56, encouraging you to consult and informing you the deadline for the submission of papers is December 2001. I would like to thank Prof. Pellizzi for his marvellous work not only in the Club of Bologna; I consider him one of the founders of the CIGR structure as well as the promoter of the CIGR Handbook. One of the volumes is devoted to agricultural machinery. I'd also like to thank Dr. Ambrogi and UNACOMA for giving the agreement that Prof. Pellizzi can attend the presidium meeting that we plan to organise in April 2002, first in order to prepare the Chicago Congress. And I am sure that the Club of Bologna meeting will give a substantial dimension to this Congress. Dr. Ambrogi, CIGR is very grateful for all you have been doing, for your continuous support and I have the pleasure and the honour today of giving you an award that CIGR presented to you during its last meeting at the 14th Memorial World Congress of CIGR that took place in Tsukuba (Japan). CIGR in fact has included in its award system the "UNACOMA Prize" and feels grateful for the agreement from UNACOMA to go ahead and continue this prize. I would just like to read what is written on this plaque: "International Commission of Agricultural Engineering-Recognition of merit to Dr. Carlo Ambrogi Director of Unione Nazionale Costruttori Macchine Agricole - UNACOMA for his continuous support of the Club of Bologna and his world-wide support on agricultural mechanisation to the Club's activities" President of CIGR.

Carlo AMBROGI
Director of UNACOMA – Italy

First of all, dear Colleagues, dear friends thank you very much, I deeply appreciate the number of people of such high level who every year attend this meeting in Bologna. I also very much appreciate the increase in the number of members, as President Pellizzi said. Let me just tell you for a second of my total and deep appreciation for what Prof. Pellizzi said about the terrorist attack; I'd like to stress this personally because President Tassinari and I were in New York on the 11th of September and we directly experienced this incredible, unbelievable tragedy and we are lived with the feelings of the peo-

ple of New York. I thank very much President Pellizzi for what he said about human stupidity. Dear Members of the Club of Bologna, Professor Bartali and Professor Pellizzi, today I'm very honoured to receive this award from Prof. Houssine Bartali and from Prof. Bill Stout - the past president of CIGR. I wish to thank them very much for giving me this award last year on the occasion of the 14th CIGR World Congress in Tsukuba, Japan. Unfortunately, due to previous commitments, I could not attend that notable Congress in Tsukuba that reported the presence of major representatives of several countries. I address my deepest thanks to the CIGR, represented by the president for this important award and I want assure my continuous dedication through UNACOMA to the development of agricultural machinery and mechanisation in all countries. This dedication was reflected over the past years in establishing and subsequently strengthening the Club of Bologna, one of the most authoritative assemblies in the world-wide scenario. This plaque gives to me and all UNACOMA members a new reason for stimulating useful and noteworthy activity. Thank you very much; I am really honoured and appreciate this very much. Thank you.

Wayne SKAGGS
President of ASAE – USA

Thank you. It is my pleasure to attend this meeting of the Club of Bologna on behalf of and to represent the nine thousand Members of the ASAE. Thank you so much for inviting me; I realise that many of you are members of ASAE, so I am pleased to represent you as well as the other members the ASAE in this important meeting of the Club of Bologna. And thank you also for your kind remarks on behalf of my country regarding the tragedies that occurred in recent weeks and for your genuine expression and feelings and support regarding those events. As tragic as they are, the response has been, in our country, to bring people closer together. And what I see here is evidence of what I know already; that is, it's brought civilised men and women of the world closer together. And we can all be appreciative of that, though we regret the very sad and tragic circumstances that caused this. I look forward to participating in these meetings with you. I am an agricultural engineer in the soil and water area. This is not my area of expertise but I still look forward to participating in these meetings with you. I am especially happy to have the privilege to invite you to Chicago next summer to attend the 2002 Club of Bologna meeting there –I know you're meeting there- and also the combined and fully integrated meetings of CIGR-ASAE. We would be happy to host you there. We look forward to your attendance at the meetings. So I think that is all I have to say and I appreciate having the opportunity to address you and to invite you to the meetings next summer.

Bassan SNOBAR
Jordan

In appreciation of the support which UNACOMA is giving the Club of Bologna, which made the meetings of the Club possible, I would like to present to you this wooden box made in my university's (Jordan University of Science and Technology) workshop. In addition to this I would like to present to you a tourist booklet about Jordan hoping to interest you to come to Jordan. In this case we at the university will be happy to host you and all the members of the Club to hold part of one of the annual meetings.

SESSION 1

Development of agricultural mechanisation to assure long-term global food supply

Leading person: ***Bill Stout, USA***

Bill STOUT
USA

Thank you Prof. Pellizzi. Just two additional announcements here. First, as has been said many times, we have one of the biggest agricultural engineering meetings to be held next year at the end of July in Chicago and all the details - as Prof. Bartali said - are in the CIGR Newsletter. There is a stack of these newsletters on the table outside. Remember, December 21, 2001 is the deadline for submitting proposals if you want to present a paper at the meeting of July, and one other detail: we are organising a partnering program in which all international participants can be assigned an American partner during the meeting. I'm going to pass around a sheet that gives you the details. Send your e-mail address, your speciality to John Dixon in the United States. He'll organise a partner for you, somebody to be your guide for the meetings in Chicago. Perhaps you will choose to visit your partner's institution; that's up to you. But please let us know if you're interested. Secondly very briefly, CIGR has a technical journal. It's an electronic journal and I invite you to submit technical manuscripts or, if you have a general overview subject and would like to have it published in the e-journal. The e-mail address is here; please let me hear from you. That journal is growing, it's becoming a significant journal and we thank all of you have participated in it. So I send this announcement around for all of you to get a copy.

The theme of this Session 1 is "Development of agriculture mechanisation to ensure a long-term world food supply" and the first topic is an introduction to the subject "General background information and requirements" to be presented by Prof. Pawlak from Poland who will be the spokesperson for this group which includes Pellizzi and Fiala from Italy. So I give the floor to Prof. Pawlak who will have 20 minutes of time for his speech, thank you.

Development of agricultural mechanisation to ensure a long-term world food supply

Topic 1 – General background information and requirements

*by **J. Pawlak** (Poland), **G. Pellizzi** and **M. Fiala** (Italy)*

1. Foreword

The general title of this subject requires a preliminary study of the food requirements of the world's various areas, of the agricultural methods used in each of them and of the crops grown as a result, so as to be able to pinpoint clearly and unequivocally the mechanisation needs (power, performance, costs, etc.,) for each area. The latter are derived from knowledge of the climatic, pedological, environmental, structural, social, economic and managerial factors of each area to be cultivated. It would, therefore, seem appropriate to offer a brief analysis of the current conditions before presenting the technical reports, as a preliminary to the correct identification of the mechanisation necessary to ensure - in the medium-long-term and within an essentially globalised market - a long-term world food supply.

According to a recent study [1], "at the present time sufficient food is produced globally to feed the current population (6.1 billion). The fact that nearly 800 million people nevertheless go hungry is a problem of distribution rather than one of a technological nature". This mainly affects the following areas: Sub-Saharan Africa, where production is at a standstill; the former Soviet Union and some Eastern Block countries, where the breakdown of the socialist economy has had a negative effect on food supplies to the population; a few other Latin American and south-east Asian countries, particularly North Korea.

However, the forecasts in the rates of food production for the next 25 years (with the population increasing to a total of almost 8 billion inhabitants and the continuing use of currently available specific technologies in the various areas) show a global food production capable of feeding more than 12 billion people. In practice, this means that there will be surpluses in North America, Europe, Japan, China and India, while there will be a food shortage in Latin America and on the African continent in particular. Hence, there is no doubt that parallel to the development of agriculture in poor areas, *it is necessary to create a functional, reliable distribution system operating independently so that the food reaches the populations for whom it is destined*. And this also because there is no guarantee [2] that industrialized countries will continue to produce at the hypothesized levels, therefore one cannot think of resolving the problem through the aforementioned organization of a good trading system. The situation, is then serious, even in relation to environmental problems within the various areas, and to the fact that the hungriest populations lend limited consideration to such problems, which is understandable. Lastly, it must be remembered that current agricultural production has an annual average growth of 1.8%, as compared to the 3% in the '60s and, therefore, at a lesser pace than the demographic growth. Also, the World Bank has shown that in Sub-Saharan Africa the annual food increase needs to reach 4%, i.e. more than double the current figure. This can be reached through a significant progress in breeding that plays a key role in the development of the agricultural sector as well as a significant impact on the appropriate farmer mechanization.

In the face of this complex situation we must ask what role the "mechanisation system" has to play and how it has to be developed so as to be able to contribute to solving the problem. Obviously, this very much depends on: internal and international political conditions; the degree of cultural development of individual populations; the overcoming of firmly established agricultural traditions, and also on local pedoclimatic conditions.

2. Analysis of location factors

2.1. The division of countries

All this justifies a short analysis of the various aspects of the agricultural situations of the world' different areas. The results of this study are reported later on, according to problem. At this point it is enough to underline that this analysis has been carried out by dividing the various nations into 9 main groups [3], which are as follows:

I Industrialized countries whose average farm sizes are over 100 hectares of Agricultural Used Area (AUA): Canada, USA, Australia, New Zealand, and South Africa.

II Industrialized countries based on small farms (Japan, II[a]; Western Europe and Israel, II[b]).

III Central and East Europe.

IV Russian Federation (Eurasian country).

V Former Asian Soviet Republics.

VI South and East Asia and Pacific islands.

VII Near East and North Africa.

VIII Sub-Saharan Africa.

IX Latin America.

Of course, there are substantial differences not only between various regions but also between countries within the same region and even within each country. An example is the variety of different ways in which the land is used.

2.2. Climatic conditions

The division of countries into groups is not fully convergent with climatic zones of the world (**Fig. 1**). Some groups include countries of different continents. This is the case in **group I**, which comprises countries of Africa, North America and Oceania. Most of North America has cold climates with wet winters, and the average temperature of the warmest month is below 20°C in Canada and Alaska and above this figure in the north and mid-west of the USA. In northern parts of Canada and Alaska the tundra climate prevails. On the other hand, in the south-east of the USA, along some parts of Pacific coast of the USA and Canada and in the south-east of Australia wet, temperate climates prevail and the average temperature of the warmest month is above 20°C. New Zealand has a similar climate. Most of Australia's territory consists of dry desert and steppes with periodically dry savanna climates. Warm, temperate climates with dry winters prevail in South Africa.

The dominant climate in Europe, Israel and Japan (**group II**) is damp and moderate with wet winters and the average temperature of the warmest month is below 20 °C. A warm climate with an average temperature of the warmest month above 20 °C prevails in the Mediterranean zone. However, in Scandinavia, as well as in a large part of central and eastern Europe (**group III**), there are cold climates with wet winters; in southern parts of the Ukraine a steppe climate with dry summers and cold winters prevails. Cold climates with wet winters are typical of most of the Russian Federation (**group IV**). Cold climates with dry winters prevail in eastern Siberia, and tundra climates in northern Siberia. In some southern regions of the Russian Federation there is continental steppe climate with cold winters and hot summers.

In **group V** countries (Central Asia - former Soviet republics) desert and steppe climates are typical. Warm, temperate, rainy climates with the driest season during winter are typical of Central, South, East and Far East Asia (**group VI**). However, the climatic zones in this group of countries are differentiated, with a tundra climate in the Himalayas, Karakorum and the Tibetan highlands, dry desert and steppe climates in western parts of China and Mongolia, cold climates with dry winters prevailing in northern China and North Korea. Hot, humid rainforest and periodically dry savanna climates prevail in Malaysia, Indonesia, the Philippines and in most territories of the Oceanic islands. Desert and steppe climates are more widespread in North Africa and the Near East (**group VII**). Only terrains near the Mediterranean Sea and Atlantic Ocean, as well as along the Euphrates and Tiger rivers, have a warm, temperate climate with long, hot, dry summers and an average temperature of the warmest month above 20°C.

Hot, humid rainforest and periodically dry savanna climates dominate in Sub-Saharan Africa (**group VIII**). However, there are also large areas with steppe and desert climates in the north and in the south-west of the region, and a warm, temperate climate with long, hot, dry summers and an average temperature of the warmest month above 20°C in the southern part of the continent and in Ethiopia. Most Latin American countries (**group IX**) have hot, humid rainforest and periodically dry savanna climates, but there are also steppe and desert areas, as well as some with warm, temperate climates with moderate precipitation in all months (southern Brazil, Uruguay, north-east Argentina, southern Chile, some parts of Mexico).

2.3. Soil and vegetation conditions

Soils (**Fig. 2**) and vegetation (**Fig. 3**) distribution is correlated with climates. In Asia and in Eastern Europe soils are evenly distributed across a parallel of latitude. Red soils occupy the largest area on the Earth. Present in equatorial and tropical zones, they are typical of hot climates. Grey desert-soils are typical of desert areas of all the continents. Podzols occupy large areas in northern parts of Eurasia and North America, while brown soils feature in Western Europe, North America and Eastern Asia. The best mould (humus) soils prevail in the steppe and savanna climates of Eurasia, North and South America, Africa and Australia. Climate and the configuration of terrain determine soil erosion.

Water erosion is more of a danger in uncovered, hilly terrains with high levels of precipitation. Wind erosion prevails in areas with dry climates and lack of plant cover makes it more likely and dangerous. *Soil degradation is a serious problem*. One of the causes is inappropriate farming methods (implying also inappropriate mechanisation). Here the main types of degradation are chemical (loss of soil fertility) and physical (loss of soil structure). In irrigated areas 10 to 15% of fields suffer from salt contamination [1]. According to FAO data *1,214 million hectares has been degraded. In this water erosion contributed 61.6%, wind erosion 23.1%, chemical degradation 12.1% and physical degradation 3.2%*. Particular types of degradation were caused by 4 groups of factors in different proportions (**Fig. 4**).

3. Conditions for development

3.1. Production systems

On the basis of the aforementioned conditions there are, obviously, different farming systems which, [4], fall into 4 main categories: i) *plantation perennial*; ii) *tillage*; iii) *alternating*; iv) *grassland and grazing*. For each of these the production techniques used are different and four different levels of mechanisation emerge: i) *hand tools*; ii) *draught animal power*; iii) sim*ple motor mechanization*; iv) *sophisticated technology*. The first two levels are peculiar to Africa (with the exception of South Africa); the first three are found in various countries throughout South America and South-East Asia; lastly, the fourth (sophisticated technology) is characteristic of the countries in **groups I** and **II** (western Europe, North America, Australia and South Africa) [5]. This is clearly correlated with the salary levels in the different areas. Also, in any case, it must be remembered [4] that a biologically efficient production system which, in temperate areas, has to supply approximately 1,000 Mcal per person per year, must:

- provide adequate storage and distribution facilities, given that the climate, and hence production, is highly seasonal;
- provide, with minimum "off the farm" wastage, the processing methods, equipment and cooking needed to reduce crops and animal products digestible by and attractive to man;
- maximize plant growth and minimize "on farm" plant and animal wastage;
- achieve the above by applying the more appropriate input ratios of energy in skill labour, animal work, mechanical work and scientific and industrial inputs;
- be reliable between and within years, months and weeks;
- be consistent over decades;
- be capable of reduction, expansion or adjustment (production flexibility) to meet changes in population or in demand.

As can be seen, without going into excessive detail, it is clear that to deal with the title of the subject, it seems necessary to: *minimize both farm stock losses and "off the farm" processing losses; maximize output with adequate agricultural practices and therefore, suitable mechanization, optimising energy costs; develop flexible agricultural production to adapt to the market demand.*

A farmer's choice of a production system [6] is governed by physical constraints relating to farm resources (e.g.: soil quality), as well as climate influences, financial considerations, and in increasingly, environmental standards. All this involves a decision making process very much influenced by the farmer's knowledge, awareness, skills and aspiration. *There is* consequently *the need to support any initiative for the development of specific educational programmes all over the world.* This means an increasing importance of knowledge, so to assume appropriate decisions, and a reduction of the intensity of equipment and energy. The general trend is in fact in favour, also in agriculture, of a progressive *dematerialisation* [7].

3.2. Use of land

There are significant differences in the use of land between regions (**Fig. 5**).

In Japan and on the islands of Oceania forests dominate. However in Eastern and Central Europe the AUA amounts to more than 50% of the land. The predominant share of AUA is observed also in former Asian Soviet Republics. However, in this region this is due to the high share of pastures with a very low share of forest and woodland. In particular groups of states the share of different kinds of AUA as compared to the total area varies greatly, particularly:

- in **group VII**: the share of AUA varies from 3.3% (Egypt) to 72% (Syria); arable land from 0.1% (Oman) to 34.3% (Turkey); permanent crops from 0.01% (Mauritania) to 12.3% (Lebanon) and permanent pastures from 0% (Egypt) to 42.2% (Syria);
- in **group I** the share of AUA varies from 7.4% (Canada) to 77.4% (South Africa), arable land from 4.6% (Canada) to 18.9% (USA), permanent crops from 0.01% (Canada) to 6.4% (New Zealand) and permanent pastures from 2.8% (Canada) to 64.1% (South Africa).

On average, about 36% of the world's land are used for agricultural purposes. The climatic conditions make it impossible to use some areas for crop production (tundra, deserts). With irrigation it is possible to enlarge agricultural areas if water sources are available. The large-scale use of the waters of the Syr Daria and Amu Daria rivers for irrigation purposes in former Soviet Central Asia caused a serious lowering of the water level in the Aral Sea. Irrigation can also lead to salinity of the soils irrigated. The transformation of forest areas into agricultural ones would be very dangerous, causing negative changes in climate and in the natural environment in general. Therefore, increasing the AUA cannot be considered as a method for ensuring a food supply for the world's increasing population.

Permanent meadows and pastures (PM&P) dominate in the structure of AUA **in regions I, V, VI, VII, VIII** and **IX**, where agricultural production is rather of extensive nature. In Japan and Europe, on the other hand, arable land and permanent crops amount to more than 50% (**Fig. 6**).

The lowest AUA per inhabitant is found in Japan (this is the case of all categories of the area) and the highest one in former Soviet Asian republics (**group V**) where, however, permanent pastures have the dominant share in the AUA. Instead, the highest area of arable land per inhabitant exists in the Russian Federation (**group IV**), followed by **group I** (**Table 1**).

The AUA per inhabitant has a decreasing tendency. There are two main reasons for this: the increase in population and the losses of AUA through population settlement, industrial development, infrastructures etc.

Also in the future, the resources of the AUA will decrease. According to FAO forecasts, in Third World countries (excluding China) a further 20 million hectares of land with agricultural potential will be taken out of use because of other destinations or degradations. Together with the immediate degradation of soils, the question of water must be seen as becoming more and more critical, particularly when linked with soil compaction and erosion. In many regions today the loss of water is as serious as the loss of soil [1].

3.3. Structure of farms by size

The average size of farms differs very much from one country group to another, from very small (Japan (**II**) and Central, South, East and South-East Asia (**group VII**)) to large (**group I**) and very large (Russian Federation) (**Table 2**).

The farm size is correlated with the number of people engaged in agricultural production. Generally speaking, the smaller the average size of the farm, the greater the number of people working (full- or part-time) in agriculture.

4. Mechanisation

4.1 General problems

An appropriate mechanisation must therefore take into account all the above mentioned requisites, which are fundamental and specific to each area, and must be based on groups of machines and systems to be used efficiently and profitably, hence with productivity correlated to labour costs according to [14] basic, well-known principles (**Fig. 7**). In any case, it must not be limited to field equipment, but must also include post-harvest technology, with a particular focus on the storage of the produce. This means that developing countries must focus on the work options offered by machinery without allowing themselves to be blinded by inappropriate means available on the market, and they must pay particular attention to options which minimize energy and agro-chemical inputs, thus enabling them to safeguard the environment while trying to increase yields. At the same time they must also consider [1] that: in very broad terms a farmer relying solely on his own labour can feed himself and another 3 persons, using draught animal power he can feed 6 people and using tractors he can feed up to 50 or more persons.

Fig. 8 shows a graph [4], which highlights the relationship between "soil factors and farming systems". Lastly, it must be remembered that inputs – even mechanical ones – can be grouped into categories according to their intensity. Rich countries have intensely cultivated high yield areas and use sophisticated technologies that focus on ecological management while ensuring excellent cultivation flexibility at the same time. On the other hand, in poorly developed areas with a low population the conditions are the opposite. In any case [5; 15] it is necessary *to create a network of activities (institutional and/or private)* (**Fig. 9**) *aimed at contributing to the progress of agricultural mechanisation.*

Therefore, for the fruitful development of agricultural mechanisation, all involved groups from donor countries as well as from the developing ones and, last but not least, the target group, together should aim at the production of demand-oriented quantity and quality of food, fodder and commercial/industrial agricultural products and energy plants under the following conditions:

to save resources and energy;
to protect the environment;
to maintain soil productivity;
to satisfy social-cultural, economic and political aspects.

Consequently, any farming enterprise requires [6] a multilateral manager capable of addressing numerous issues more or less simultaneously. Once again, there is a big problem of developing educational programmes.

In addition, [16], it is a must to take into consideration that the formulation of the world trend system and the Information Technology (I.T.) revolution have changed the external environment of agricultural development for all countries. In fact, the information and knowledge-based era will create new opportunities to accelerate the transformations of traditional farming into modern agriculture. Therefore, it is necessary to learn the new trends of modern I.T. for agriculture in the developed world and to investigate appropriate ways of promotions of new technologies applications in developing countries, starting from the more advanced ones. *These have the potential to act as incubators for new ideas and sophisticated technologies based on their domestic conditions*. Within this framework, it is stated that *precision farming practice may be seen as a support for cost reduction and environment protection in any country for tomorrow* [17].

One additional point to be considered is the role that contracting companies can play from the technical and economic view points. Their activities [9] require specific types of tractors and implements, more sophisticated and with higher working capacities.

4.2. Labour force in agriculture

As we have seen, [1], the term "Farm power" includes human, animal and mechanical sources. The share of agriculture in employment of the labour force depends on the level of economic development of a country. In many developing countries, up to 80% of farm power in agriculture comes from humans. In Sub-Saharan Africa (**group VIII**)

and in the Far East (**group VI**) people working in agriculture account for more than 60% of the total economically active population (EAP) of countries (**Table 3**).
The proportion of the population engaged in agriculture has decreased steadily due to urbanization. First of all this has been the case with industrialized countries. In the future the process of migration from rural areas to towns will become an increasing feature in developing countries too. Even in Sub-Saharan Africa it is estimated that the proportion of the population in rural areas will fall below 50% by the year 2025.
The economically active population involved in agriculture in relation to AUA as well as to Arable Land (AL) and Permanent Crops (PC) is correlated with the level of mechanisation, the intensity of agricultural production, the size-structure of farms and the situation on the labour market. The percentage figure of economically active population in agriculture per 100 hectares of AUA ranges from 0.54 in **group I** to 95.48 in **group VI**. The differences between groups of countries are slightly smaller where the area of arable land and permanent crops is taken as the point of reference. In both cases the highest indices are found in **groups VI**, **VII** and **VIII**.
In developing countries, the average salary of working people is very low, especially in Sub-Saharan Africa and the Far East. Relatively low remuneration of work is typical also for former COMECOM countries (**groups III**, **IV** and **V**). Instead, in industrialised countries the level of salaries is high. This fact makes the mechanisation of agriculture necessary to assure the agricultural production economically effective and the farming at least sufficiently profitable.

4.3. Farm machines and mechanical power in agriculture

There are about 25.9 million tractors in use all over the world (0.59 tractors per 100 hectares of AUA and 1.88 tractors per 100 hectares of AL). The regional distribution of tractors (and other farm machinery) is very unequal. The number of tractors per 100 hectares of AUA and AL as well as the number of combine-harvester per 100 hectares of cereals varies from one region to another (**Table 4**).
Considerable differences exist not only between industrialized and developing countries, but also within particular groups of countries. However, the low number of tractors and combines in **group I**, as compared to **group II**, does not mean that the equipment of farms in **group I** is insufficient or that of **group II** is excessive. The reason for these wide differences is the size of the farms. The smaller the farm is, the higher the number of machines in relation to adequate area and the smaller the number of machines per 100 farms is. The data in **Table 5** gives an example of such dependencies.
The average number of tractors per 100 hectares of AUA depends on the share of farms of different size in the farm structure of a country. In Poland, the share of smallest farms with the highest number of tractors per 100 hectares of AUA is higher than in Germany. Therefore, Poland has a higher average number of tractors per 100 hectares of AUA, even though in all particular size groups of farms the indices are higher for Germany.
This example shows that the numbers of machines in relation to adequate areas are not a sufficient criterion to evaluate the situation of farm mechanisation in different countries. Also, the farm size structure must be taken into consideration. Therefore, the number of tractors in **group VIII** should not be directly compared to the situation in **group I**, but rather to that of **group II**[a] (Japan), where farm structure is similar (average size of farms about 2 hectares).
Also the power of means of mechanisation should be taken into consideration (**Table 6**). Lower average unitary power can be observed in Japan. It is the result of adjusting the farm machines to the structure of farms in the country.

4.4. Animal power

In developing countries working animals are still an important source of power for agricultural production. In this study only horses, mules and asses have been taken into account. In regions **VIII** and **IX** the number of these animals (as converted in horses) per 100 hectares of AUA and per 100 hectares of AL is the highest (**Fig. 10**).
In **groups III** and **IV** the use of animal power in agriculture now has a marginal impor-

tance. On the other hand, in developing countries other animals besides horses, mules and asses are used as a source of power.

Working animals are competitive with the human population as “users” of potentially convenient areas for food production. It is a paradox that animal power mostly exists in countries with a food shortage and not in the ones with an overproduction of food. In industrialized countries some experts are calling for a return to animal power in countries with a food surplus. They argue that the use of horses as a source of power would be favourable to the environment and could help to reduce the consumption of fossil fuels.

5. Inputs in agriculture

In countries of **groups I, II^{a}** and **II^{b}** field operations are fully mechanised. However, number of hours worked by tractors and combines-harvesters per 100 hectares of arable land (**Table 7**) are strongly diversified.

The inputs of work hours per 100 hectares of arable land depend not only from the level of mechanisation, but also from working capacities of machines in use, from working conditions (size of fields) and intensity of agricultural production. Therefore, in Japan (**group II^{a}**), where the power of tractors and combine-harvesters is the lowest, the fields are very small and the level of production per unit of agricultural used area is high, the inputs per 100 hectares of the AL are significantly higher as compared to **group I**. In the case of combine-harvesters, the inputs per 100 hectares of the AL depend also on the per cent share of cereals in the area of the agricultural land. The lowest inputs of number of hours worked by tractors and combines-harvesters per 100 hectares of arable land have been observed in Sub-Saharan Africa (**group VIII**) where the level of mechanisation is very low. There is no correlation between the annual use of tractors and combine-harvesters and the number of hours worked by these equipment per 100 hectares of arable land. The annual use depends on scale of production. Generally, it is higher on larger farms. It also depends on number of machines per unit of surface of adequate area and on form of utilisation. In cases of multi-farm use it is higher as compared to the individual use system. Therefore, in Japan, where farms are small and the rate of equipment of agriculture in tractors and combine-harvesters relatively high, the annual use is low. In other, generally developing, countries the use of tractors “off the farm” is usual and this gives us non correct figures.

Inputs of energy per unit of AUA depend on level of motorization, per cent share of arable land and permanent crops in the AUA, intensity of agricultural production and natural conditions (climate, soils etc.). Intensive agricultural production and high per cent share of arable land and permanent crops in Japan resulted in highest value of energy inputs per 100 hectares of agricultural used area. At the same time, the value of index of energy inputs per unit of agricultural production is the lowest in Japan (**Table 8**).

In Japan, the relatively low energy inputs per unit of production has been achieved under conditions of a very high use of commercial fertilisers (**Table 9**). The use of agro-chemicals per unit of AUA differs very strongly from a region to another. In Sub-Saharan Africa, inputs of NPK in commercial fertilisers are about 200 times lower than that of Japan. This is one of the reasons of low level yields in Africa.

Japan has also a very high consumption of pesticides and herbicides per hectare of AUA. In Western Europe (**group II^{b}**) the use of these chemicals is also very high but, as an average, lower than in Japan. Instead the consumption of pesticides and herbicides per hectare of AUA in **groups I** and **III** is significantly lower. The reasons for **group I** are the high share of permanent meadows and the pastures in AUA and the extensive type of agricultural production, possible and rational there thanks to high land resources per inhabitant. In countries of Central and Eastern Europe (**group III**), the use of agro-chemicals during the transformation period has been decreased because of rise in prices of these products and the relatively low profitability of agricultural production. In Japan, where the AUA per inhabitant is low, an intensive production system is necessary.

6. Crop production

Central and Southeast Asia (**group VI**) and countries included in **group I** have the highest share in cultivated area of four cereals (wheat, barley, rye and oats). However, countries of Western Europe and Israel (**group II**^{b}) are the second, following central and Southeast Asia, producer of the cereals, even though their share in area cultivated for these crops is limited. This is due to significantly higher yields of cereals in countries of **group II**^{b} as compared to **group I**.

Central and Southeast Asia is also the greatest producer of rice, pulses and potatoes and the second, following countries of **group I**, producer of maize-grain (**Table 10**). Latin America and Central and Southeast Asia are main producers of sugar cane while Western Europe is the main producer of sugar beets.

Yields are, in general, positively correlated with the use of agro-chemicals as well as the intensity of mechanisation, even though the soil and climatic conditions play also an important role. Low level of yields in Sub Saharan Africa is the main reason for food deficit in the region.

Labour inputs per hectare of particular crops depend on level of mechanisation, production systems, working conditions (size of fields etc.) and, of course, on kind of crop and its yield. In Japan, the inputs are significantly lower than in other industrialised countries. The reason is not only the above mentioned very intensive agricultural production system, but first of all it is due to the small size of fields, hampering achievement high operation capacities of farm machines. Besides, most of farm machines in use in Japan are adjusted to existing farm size structure. They are small and they have rather low working capacities. The use of such a kind of farm machines is economically justifiable. The potential of theoretical working capacities of larger machines would not be sufficiently used on fields of small farms and the costs of their use would be too high. Instead, on large farms of countries included to **group I** use of high capacity machines is common. On large fields high working capacities have been achieved. Therefore, the labour inputs per hectare of particular crops are lowest in **group I**. The large size of most farms are also typical for Russian Federation and for the majority of countries of central and eastern Europe and former Asian Soviet republics. However, the insufficient qualitative and quantitative levels of the agricultural equipment in these countries cause that the labour inputs per hectare of particular crops are, in **groups III**, **IV** and **V**, higher as compared to **group I**.

High unitary labour inputs in developing countries are a result of low mechanisation. Highest labour inputs are in Sub Saharan Africa, where the use of hand labour is still common. Labour inputs per one hectare of maize-grain (yield 9 dt/ha) in a case of hand operation amount to 786 hours (women) or 725 hours (men) and in a case of using animal power – 319 hours [25].

7. Animal production

In central, south and east Asia there are more than 50% of the world population of cattle, pigs and goats. In the world's scale the milk cows amount to about 17.5% of the total number of cattle. Milk production is predominant only in central and Eastern Europe (**group III**) with 51% share of cows in total number of cattle (**Table 11**).

Number and structure of farm animals depends not only on natural conditions (resources of feed staffs), but also on other factors (religion). Number of pigs is, of course, very limited in Islamic countries.

8. Selected agricultural products

8.1 Unitary values

The highest yields of all cereals (including rice) and of cow milk are in Japan, followed by Western Europe in the case of cereals and by **group I** in that of milk. However, in countries of **group I** there is the highest production of cereals per inhabitant while in Western Europe the highest per capita production of milk (**Table 12**) is found.

The lowest production of cereals per capita in Japan is due to limited area of arable land in this country whilst the insufficient production in Sub Saharan Africa is a result of low yields. The comparison of yields shows the potential of theoretical increases in production both of cereals and milk in some regions of the World. In the case of cereals, increase of yields in Sub Saharan Africa to the level achieved in countries of group I would result the per capita production in the region comparable to the European one (**Fig. 11**).

8.2. Prices and value of agricultural production

Prices of agricultural products are effected by natural conditions, deciding about the supply of food raw materials, on production systems and on Governments policies. All this causes significant differences between particular regions of the world as far as the level of prices is concern (**Table 13**).
Limited land resources and very intensive production are the direct and indirect reasons of high level of food products in Japan. The care about food self sufficiency causes a strongly supported farming by Japanese Government. Different forms of subventions are present also in other countries. The level of prices has its influence on value of Gross Agricultural Output (GAO). This is one of the reasons for the highest value of GAO per 100 hectares of AUA and per 100 hectares of Arable and Permanent Crops Lands (AL+PC) in Japan (**Table 14**).
The number of Economically Active Population (EAP) and the value of GAO are the main determining factors in the productivity of labour. Broadly speaking, data on labour productivity in agriculture is to be considered as approximate. There are several reasons for this: the calculations for most groups have been based on data from various countries (and sometimes only one) and not from all the countries included in the different groups; there are discrepancies between data from different sources; the level of prices of agricultural products in given countries differs significantly and the exchange rates between national currencies and US dollars do not fully reflect the real values.

9. Conclusions

The analysis carried out confirmed the existence of considerable differences between the various regions of the world in terms of yields, agricultural practices adopted, intensiveness of human labour, production costs, profits obtained etc. This diversity of situations is ascribable not only to the specific climate, pedological cultural and social conditions which exist in the different areas, but also to the varying levels of mechanisation adopted and to appropriateness, or lack thereof, of the methods and machinery currently in use. All this needs to be taken into account when evaluating the local requirements for a new agricultural mechanisation capable of assuring “a long-term world food supply”. After having defined, in line with the above criteria, the most appropriate characteristics for the various machines in technical and management terms, it is then necessary to make these characteristics known, divulging them and recommending them in the various countries to the governments, farmers and manufacturers, so as to effectively accomplish the proposed objectives.
This is undoubtedly a difficult task, but one that must be undertaken because – in the absence of any realistic prospects for significantly increasing the cultivated agricultural surfaces – it is imperative not only to create a functional and reliable distribution system which can ensure that foodstuffs effectively reach the populations for which they are intended, but also to increase agricultural production through:
increasing crop yields especially in the less developed regions;
minimise post-harvest product losses, both inside and outside the farm;
develop production flexibility to be able to adapt to changes in demand;
safeguard the environment, also by optimising the utilisation of energy and other inputs.

All this relies on an appropriate mechanisation. This, however, is an extremely wide-ranging problem, which requires in depth technical analysis and a holistic approach. To solve this problem, mechanisation needs to be considered not just in technical terms, but also as a component in a system where development relies upon establishing a series of essential “collateral” activities within the various countries. These concern networks of: applied research and testing centres; extension services; after-sales services; contracting companies; education and training schools, etc. All this with the ultimate objective - once the political and legislative aspects specific to each region (or country) have been acquired and resolved - of promoting the development of the sector.

For this reason, in proposing the general topic under discussion, it was considered necessary to address, after the general overview briefly outlined above, both the innovative technological aspects, the aspects pertaining to I.T. and finally also the development of a permanent training network for the populations involved.

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Figure 1 – World map of agricultural climate classification [*Source*: [3]]

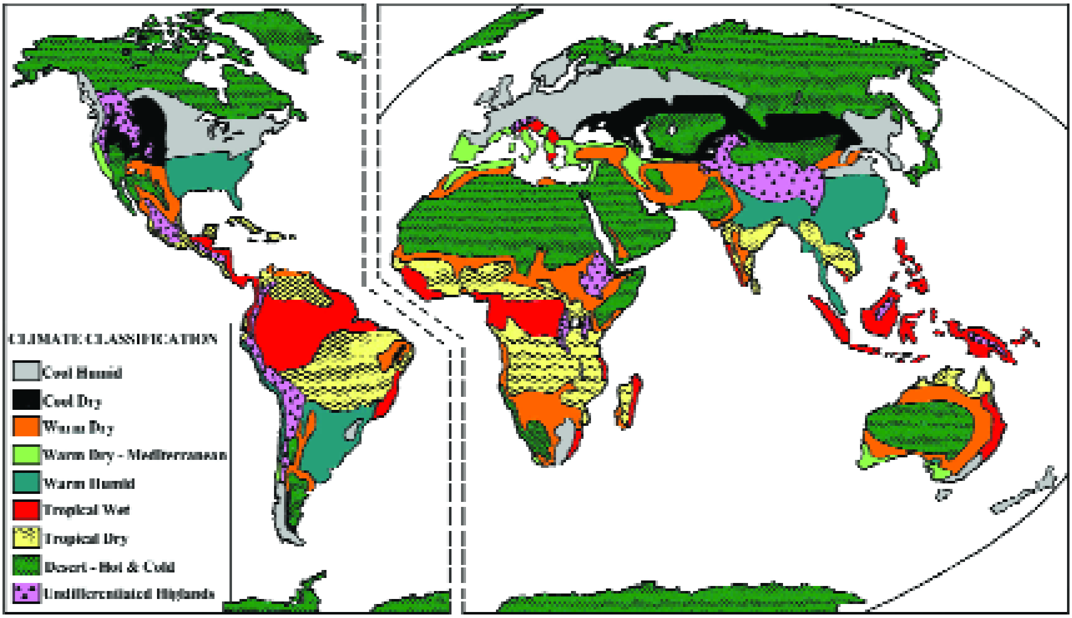


Figure 2 - World map of types of vegetation [*Source*: [3]]

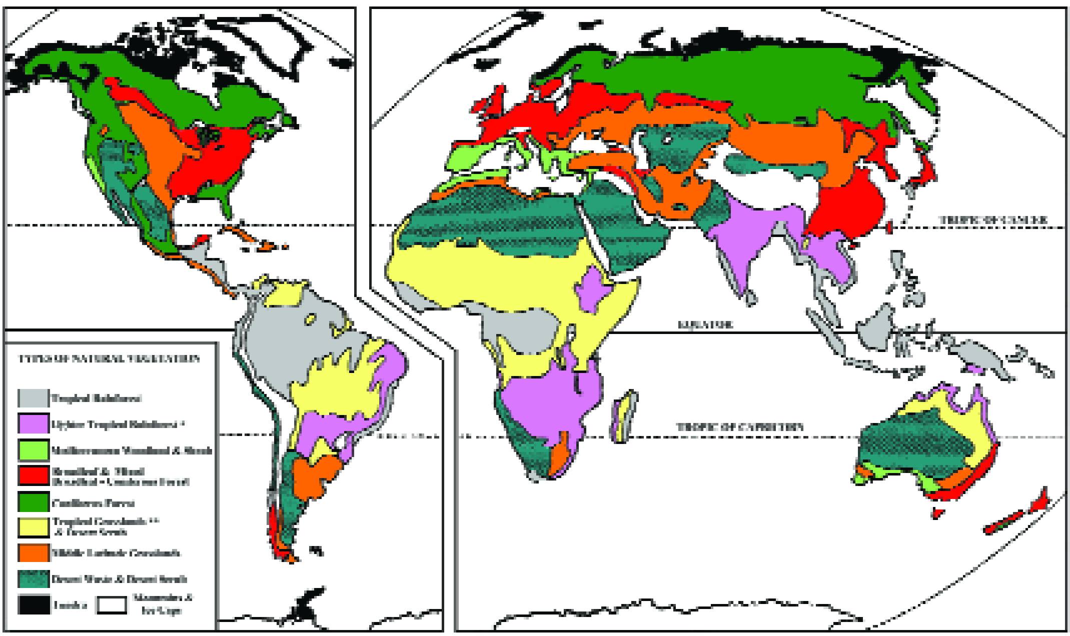


Figure 3 - World map of categories of soil types [*Source:* [3]]

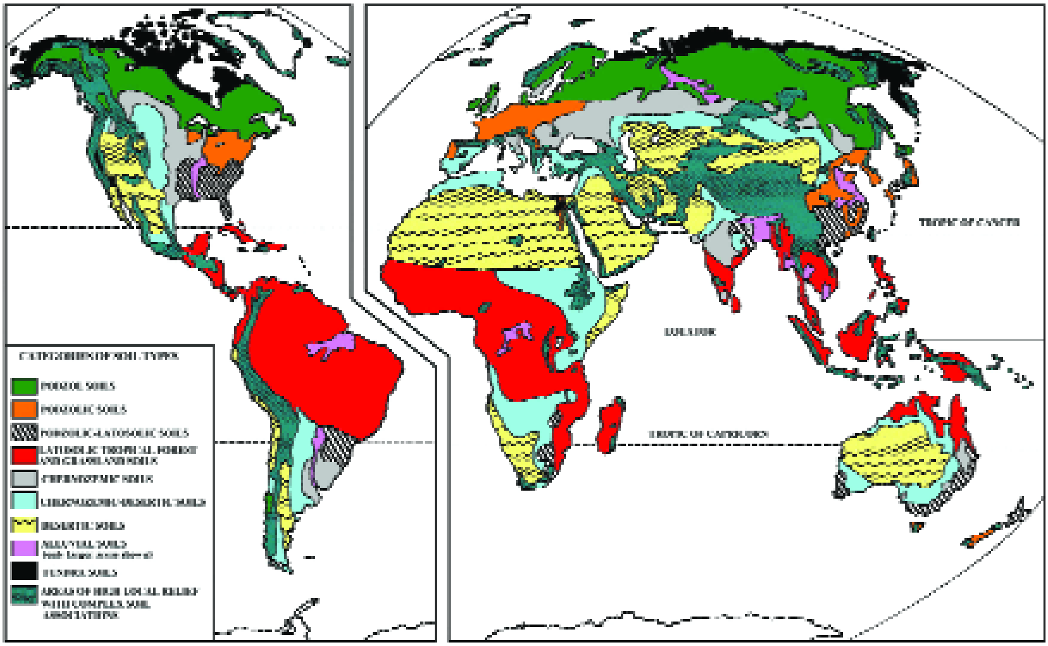


Figure 4 - Land degradation according to cause (%)

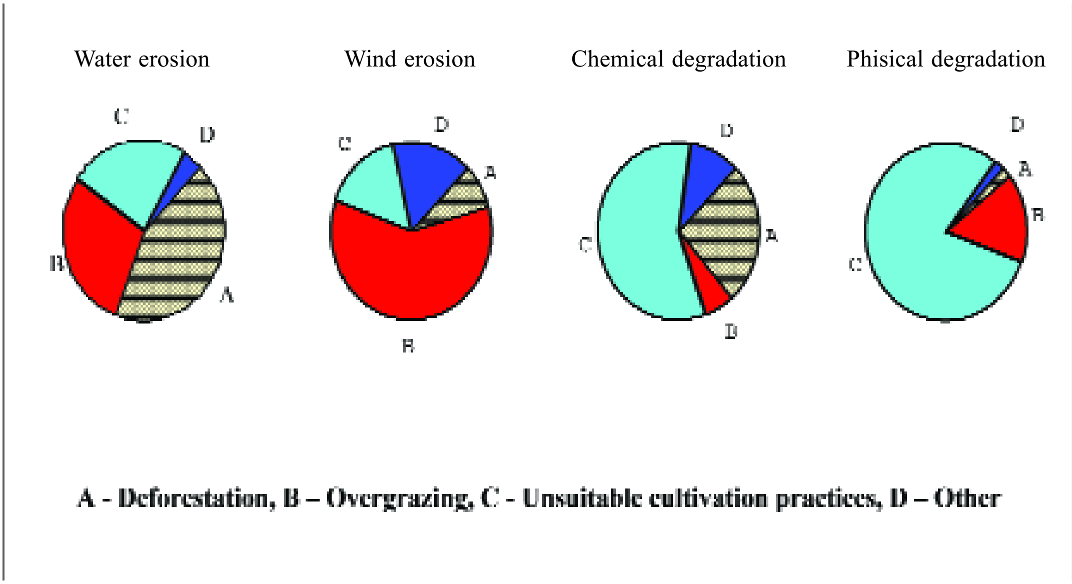


Figure 5 - Land use in different regions of the world

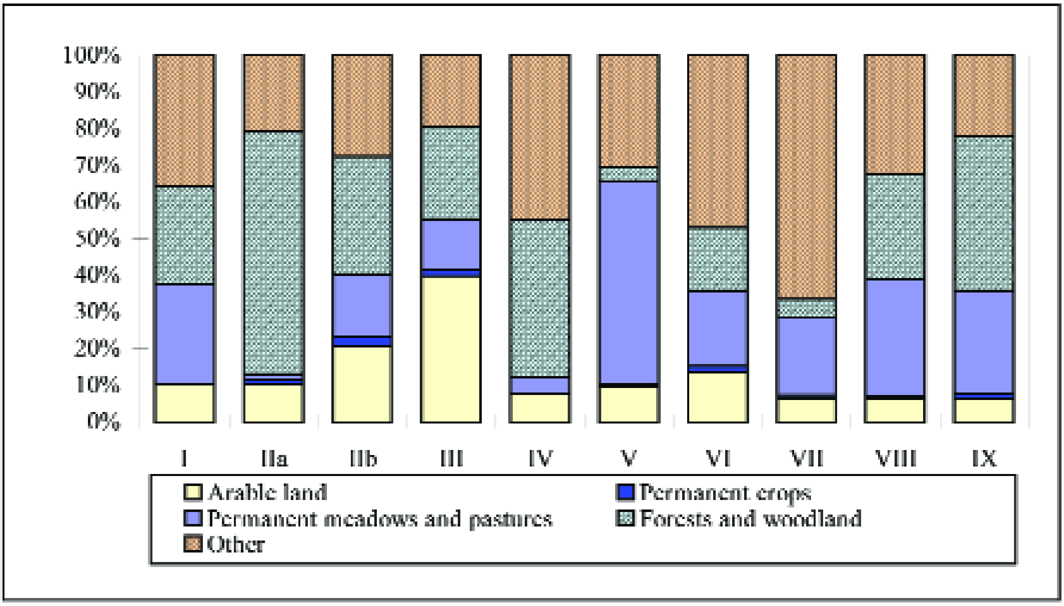


Figure 6 - Surface (billions of hectares) and structure of the Agricultural Used Area (AUA in %) in different regions of the world

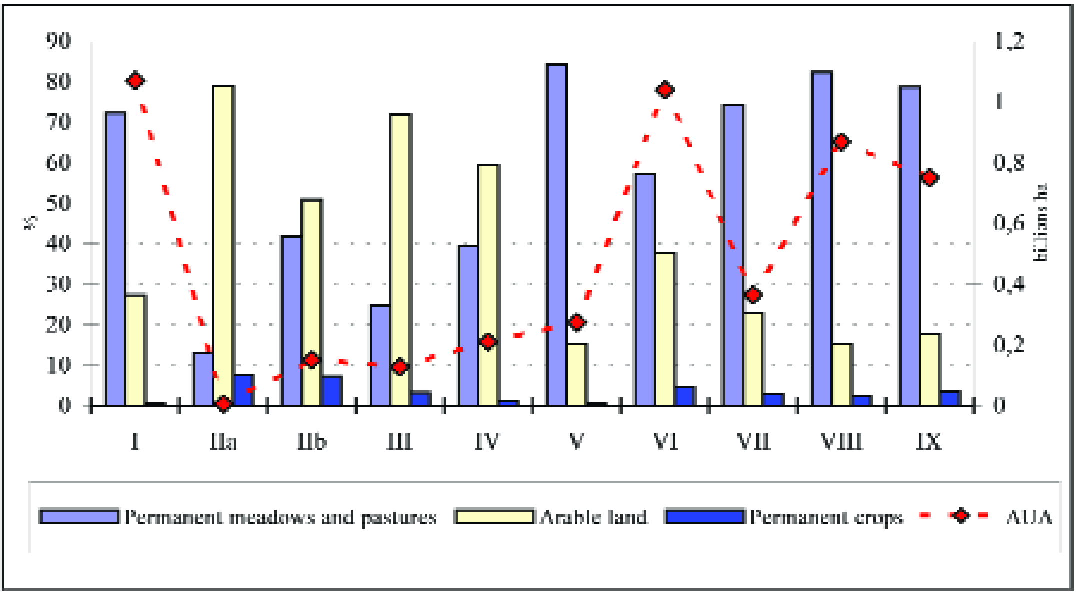


Figure 7 – Correlation between mechanisation levels and costs per hectare of the machines (Sm) and abour (Sl). With the increasing of wages it becomes necessary to use higher mechanisation levels able to assure higher work productivity [*Source*:[14]]

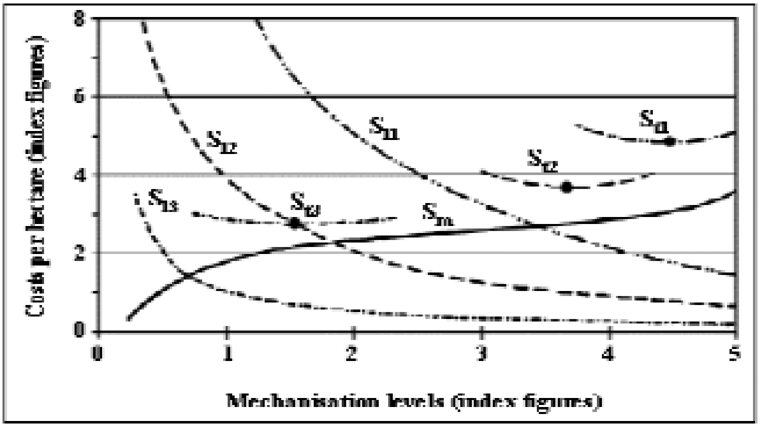


Figure 8 – Relation between soil factors and farming systems [*Source*: [4]]

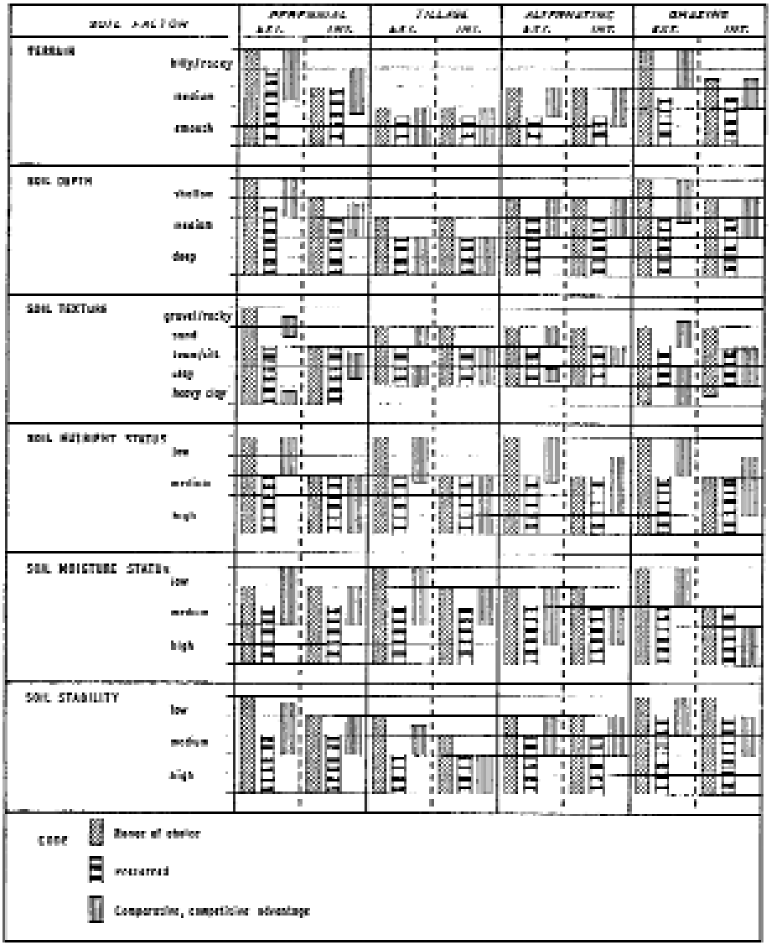


Figure 9 - Network of activities and institutions to be installed in each country/region in order to contribute to an appropriate choice and utilization of agricultural equipment

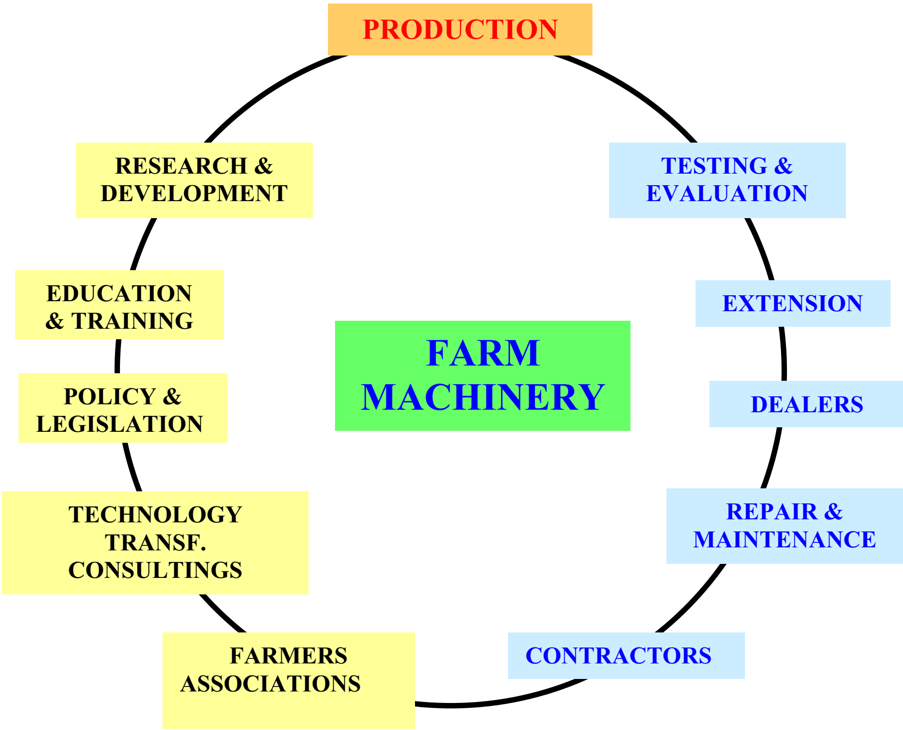


Figure 10 - Working animals in relation to Agricultural Used Area (AUA) and to Arable Land (AL)

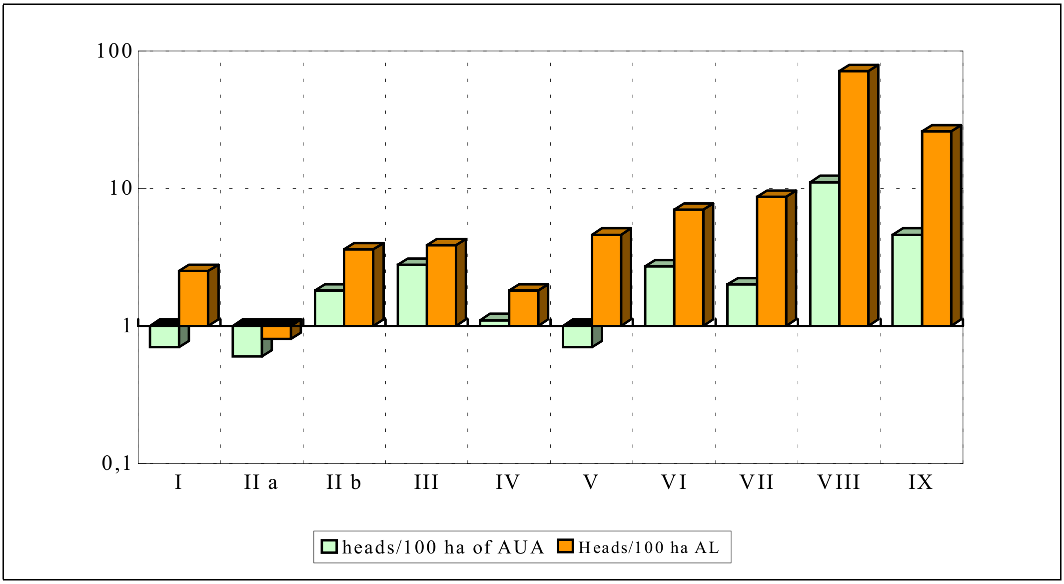


Figure 11 - Per capita production of cereals and milk and average yields of cereals by region

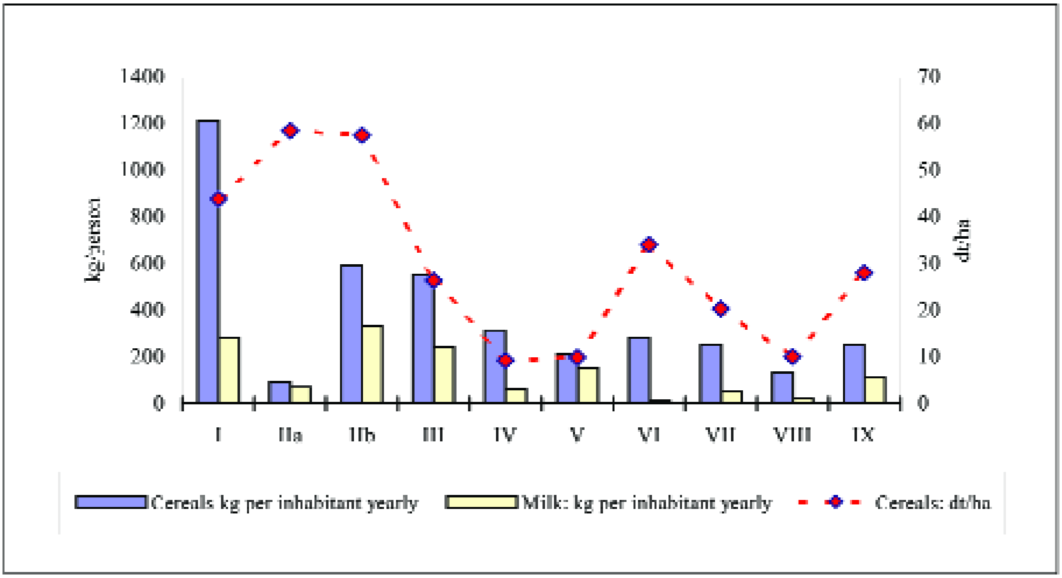


Table 1 - Resources of Agricultural Used Area (AUA) according to region [*Source*: Calculations based [8] data]

REGIONS	*HECTARES OF AUA PER INHABITANT*			**IRRIGATED AREA**		
	Total	Arable land	Perm. crops	PM&P	AUA, %	Arable Land %
I	2.920	0.798	0.014	2.108	2.5	9.0
II[a]	0.039	0.031	0.003	0.005	54.6	69.0
II[b]	0.390	0.198	0.029	0.163	9.6	18.9
III	0,656	0,472	0,022	0,162	4.0	5,6
IV	1.432	0.855	0.013	0.564	2.4	4.0
V	3.849	0.579	0.020	3.251	4.5	29.7
VI	0.330	0.124	0.016	0.190	13.5	35.8
VII	0.994	0.230	0.028	0.737	6.8	29.3
VIII	1.527	0.238	0.034	1.255	0.6	3.7
IX	1.490	0.266	0.052	1.172	2.4	13.7

II[a]) Japan; II[b]) Western Europe and Israel

Table 2 - Average size of farms [*Sources*: Calculations based on [10]; [11];[12] and [13] as well as Authors' estimations]

REGIONS	*HECTARES PER FARM*				**% OF FARMS**	
	Arable land	Perm. crops	Pastures	Total AUA	< 5 ha	> 5 ha
I1	85.5	1.0	116.5	203.0	3.0	97.0
II[a]	1.2	0.1	0.2	1.5	97.0	3.0
II[b]	9.8	1.1	6.1	17.1	53.1	46.9
III	9.1	0.7	2.4	12.2	49.5	50.5
IV	413.7	6.1	255.1	674.8	20.6	79.4
V	143.9	4.9	808.6	957.4	20.0	80.0
VI	1.2	0.2	0.4	1.8	97.9	2.1
VII	1.9	0.2	3.4	5.5	79.0	21.0
VIII	3.2	0.5	16.7	20.3	38.0	62.0
IX	17.1	5.0	67.5	89.6	39.0	61.0

Table 3 - Population [*Source*: Calculations based on [8]; [10] and [18]]

REGIONS	**POPULATION** 10^6 persons	**ECONOMICALLY ACTIVE POPULATION (EAP)**						**AVERAGE salary** US $/month
		Total 10^6 persons	Industry %	Other %	Agriculture			
					%	per/100ha AUA	per/100ha AL+PC	
I	366.3	183.7	17.2	79.8	3.0	0.54	1.95	2100
II[a]	125.6	65.1	21.9	72.8	5.3	62.18	71.67	2600
II[b]	393.1	185.0	21.5	73.5	5.0	5.25	8.93	1500
III	194.3	97.8	25.4	51.6	23.0	14.34	18.52	300
IV	148.1	85.2	35.0	51.0	14.0	4.11	6.78	120
V	71.1	31.6	9.8	64.9	25.3	2.92	18.80	140
VI	3168.5	1620.4	15.6	22.8	61.6	95.48	224.00	90
VII	361.4	132.8	19.3	48.0	32.7	11.89	46.04	110
VIII	568.9	254.8	4.9	27.9	67.2	19.71	110.73	70
IX	503.6	213.2	15.1	64.1	20.8.	5.92	27.80	600

II[a]) Japan; II[b]) Western Europe and Israel

Table 4 - Tractors and combine harvesters by region [*Source:* Calculations based on [8]]

REGIONS	*TRACTORS*			**COMBINE - HARVESTERS**	
	number (10^3)	per 100 ha AUA	per 100 ha AL	number (10^3)	per 100 ha of cereals
I	6002.3	0.56	2.05	866.3	0.86
II[a]	2123.0	42.91	54.23	160.0	7.80
II[b]	6854.1	4.54	8.92	606.9	1,50
III	3482.1	2.73	3.80	298.3	0.73
IV	886.5	0.42	0.70	317.0	0.63
V	444.1	0.16	1.08	75.4	0.49
VI	2763.4	0.26	0,70	1250.4	0.48
VII	1585.8	0.43	1.88	50.2	0.11
VIII	161.6	0.02	0.12	5.1	0.01
IX	1587.5	0.21	1.19	159.6	0.35

II[a]) Japan; II[b]) Western Europe and Israel

Table 5 - Rate of equipment of farms in tractors (situation at 1996) [*Source:* Calculations based on [19] and [20]]

FARM SIZE	**TRACTORS**			
	unit/100 hectares AUA		unit/100 farms	
	Germany	Poland	Germany	Poland
1-5 hectares	27.35	10.79	67.88	27.22
5-10 hectares	22.14	10.51	159.33	74.92
10-20 hectares	15.67	8.77	228.11	118.99
20-50 hectares	9.09	6.41	288.85	174.29
> 50 hectares	2.69	1.66	396.40	548.90
Average	6.87	7.45	204.47	61.79

Table 6 - Mechanical power in agriculture [*Source*: Calculations based on [10; 21]]

REGIONS	**POWER** (kW per 100 ha AUA)				**AVERAGE POWER** (kW)		
	tractors	Walking tractors	Combine-harvesters	Total	Tractors	Walking tractors	Combine-harvesters
I	35.1	1.0	7.0	43.1	62.5	7.0	86.0
II [a]	918.4	121.5	39.5	1079.4	21.4	3.5	12.2
II [b]	205.7	14.7	31.6	252.0	45.3	8.8	78.5
III	106.6	1.0	18.1	125.7	39.0	4.0	77.5
IV	27.3	1.6	11.9	40.8	65.1	3.4	78.9
V	9.9	0.5	2.2	12.6	61.0	3.5	78.0
VI	8.0	14.0	3.6	25.6	30.4	8.9	29.7
VII	21.8	0.1	0.5	22.4	50.3	6.3	36.1
VIII	0.7	0.4	0.1	1.2	40.0	7.5	61.0
IX	11.6	1.5	1.8	14.9	54.9	7.3	85.4

II[a]) Japan; II[b]) Western Europe and Israel

Table 7 - Inputs of work hours per 100 ha of AL and annual use of selected machines [*Source*: Calculations based on [10] and Authors' estimations]

REGIONS	**WORK (**hours per annum per 100 ha of AL)			**AVERAGE ANNUAL USE** (hours)		
	Tractors	Walking tractors	Combines	Tractor	Walking tractor	Combines
I	2002	3	65	975	55	220
II [a]	3796	154	123	70	35	30
II [b]	3150	25	101	353	75	155
III	2345	3	61	617	75	188
IV	844	3	70	1200	40	280
V	1295	4	55	1200	40	300
VI	353	236	95	503	566	300
VII	2258	3	20	1201	394	340
VIII	142	19	1	1200	550	400
IX	1424	60	49	1200	520	410

II[a]) Japan; II[b]) Western Europe and Israel

Table 8 - Energy spent in agriculture and prices [*Source*: Calculations based on [10; 22; 23 and 24] and Authors' estimations]

REGIONS	INPUTS OF ENERGY IN AGRICULTURE			PRICE	
	% of the national consumption	TJ per		Diesel oil (US$ per kg)	Electric energy (US$ per kWh)
		100 ha AUA	1000 US$ GAO		
I	4.4	0.40	13.0	0.319	0.040
II a	1.0	2.86	2.6	0.840	0.150
II b	3.0	1.64	12.9	0.649	0.069
III	7.4	1.36	33.1	0.401	0.037
IV	6.3	0.73	49.2	0.400	0.050
V	7.0	0.25	47.0	0.400	0.050
VI	10.0	0.32	8.6	0.458	0.048
VII	28.6	0.51	19.4	0.531	0.075
VIII	*	0.02	3.4	0.500	0.075
IX	0.6	0.31	17.7	0.307	0.038

II[a]) Japan; II[b]) Western Europe and Israel

Table 9 - Agro-chemical inputs [*Source:* Calculations based on [25; 26; 27]

REGIONS	*FERTILIZERS* ***(kg/ha AUA)***				**PESTICIDES & HERBIC.** (kg/ha)
	N	P_2O_5	K_2O	NPK	
I	13.4	6.2	5.4	25.0	0.3
II a	99.9	120.1	85.3	305.3	9.7
II b	65.7	24.8	28.3	118.8	4.9
III	41.0	12.8	15.7	69.2	0.5
IV	4.7	1.5	1.7	7.9	N.A.
V	2.2	0.9	0.5	3.6	N.A.
VI	41.2	15.5	6.9	63.6	N.A.
VII	9.9	4.4	0.7	15.0	N.A.
VIII	0.8	0.4	0.3	1.5	N.A.
IX	6.1	4.3	4.1	14.5	N.A.

II[a]) Japan; II[b]) Western Europe and Israel

Table 10 - Main crops, a - Cultivated Area, 10^6 hectares; b - Yield, t/ha; c - Labour input, hours/ha [*Source*: Calculations based on [[8]; [14]; [23]; [25]; [29] and [30]]

CROP		REGIONS									
		I	II[a]	II[b]	III	IV	V	VI	VII	VIII	IX
Four cereals	a	59824	220	32399	31397	47238	14552	72139	40361	3635	9700
	b	2.515	3.48	5,30	2.71	0.94	0.91	2.91	1.78	1.52	2.19
	c	10	50	15	20	16	16	90	60	400	80
Rice	a	1473	1801	451	16	146	275	132214	1471	7247	5724
	b	6.70	6,22	6.02	3.31	2.81	2.46	3.80	6.02	1.60	3.19
	c	70	400	100	120	110	110	420	330	1200	400
Maize-grain	a	30579	0	4182	8013	880	413	41470	2610	23182	26102
	b	8.42	0	9.52	4,15	0.91	2.68	3.89	3.77	1.41	2.91
	c	13	0	18	25	20	20	160	90	520	120
Sorghum	a	3694	0	107	36	20	9	13025	986	22639	3926
	b	3.86	0	5.80	1.28	0.60	1.44	1.17	1.57	0.86	3.12
	c	10	0	15	20	16	16	90	60	400	80
Lentils	a	519	0	31	7	1	2	1713	1036	57	31
	b	1.26	0	0.77	0.64	0.75	1.13	0.76	0.89	0.70	0.86
	c	12	0	16	21	17	18	100	80	430	90
Rape seed	a	6998	1	3105	981	139	14	13543	19	153	80
	b	1.42	1,86	3.10	2.21	0.75	0.36	0.85	5.37	0.54	2.35
	c	8	45	11	14	10	10	60	30	400	60
Soybeans	a	29689	83	490	318	404	3	16620	129	872	22082
	b	2.62	1.75	3.21	1.73	0.69	1.33	1.35	1.78	0.95	2.47
	c	8	140	10	15	11	12	160	90	400	130
Beans	a	916	71	208	373	2	25	13962	308	3189	6637
	b	1.77	1.84	0.56	1.27	0.75	1.00	0.575	1.35	0.64	0.72
	c	8	140	10	15	11	12	160	90	400	130
Pulses	a	4612	72	2106	1470	1213	395	35527	4078	13388	7248
	b	1,54	1.85	2.94	1.87	0.82	1.05	0.60	0.89	0.49	0.74
	c	8	140	10	15	11	12	160	90	400	130
Sunflowers	a	1568	0	2255	4664	4166	308	3209	809	744	3507
	b	1.65	0	1.56	1.13	0.72	0.35	0.92	1.36	0.95	1.63
	c	21	0	29	39	35	35	115	89	530	104
Potatoes	a	766	104	1408	4564	3260	395	5086	786	501	1080
	b	35.86	32,69	34.35	14.51	9.60	10.50	15.77	19.47	8.39	14.16
	c	21	160	27	50	40	40	200	140	550	150
Cassava	a	0	0	0	0	0	0	3347	0	10452	2389
	b	0	0	0	0	0	0	13.37	0	8.22	11.69
	c	0	0	0	0	0	0	200	0	550	200
Sugar beet	a	602	69	2056	1994	806	37	518	821	0	52
	b	50.27	53.80	63.17	17.58	13.40	15.89	27.43	38.12	0	59.36
	c	25	190	30	50	40	40	200	180	0	150
Sugar cane	a	1114	23	0	0	0	0	8678	169	913	8539
	b	86.55	63.56	0	0	0	0	62.08	101.98	50.44	64.68
	c	100	750	0	0	0	0	900	800	1500	900
Vineyards	a	354	21	3490	988	70	311	325	1216	107	457
	b	17.81	11.95	7.11	5.24	4.29	4.66	12.12	7.21	12.21	11.29
	c	70	4200	60	120	100	110	600	200	5000	4000
Groundnuts	a	622	12	5	10	0	13	13531	138	8780	693
	b	2.93	2.45	5.8	1.00	0	1.69	1.50	2.31	0.81	1.96
	c										
Cotton (seeds)	a	4777	0	546	26	0	2656	17302	1559	3988	2353
	b	1.95	0	3.08	0.81	0	1.75	1.45	2.77	0.91	1.40
	c		0			0					

II[a]) Japan; II[b]) Western Europe and Israel

Table 11 - Animal production indicators [*Source*: Calculations based [8]]

SPECIFICATION	REGIONS									
	I	II[a]	II[b]	III	IV	V	VI	VII	VIII	IX
Total cattle, thous.	162183	4700	86366	38146	31700	15445	406988	33137	194479	345241
dairy cows, %	*10*	*28*	*26*	*51*	*44*	*44*	*13*	*44*	*16*	*15*
other cattle, %	*90*	*72*	*74*	*49*	*56*	*56*	*87*	*56*	*84*	*85*
Pigs, thous.	77419	9800	121807	60614	17305	1580	567375	530	20665	76519
Sheep, thous.	205425	16	120246	23369	17125	34218	247343	177671	146031	92667
Goats, thous.	8885	29	12501	4318	1632	3061	385870	69242	177723	36733
Chickens, mil	1993	306	1025	428	405	65	5464	1042	705	2045
Heads per 100 ha AUA										
Total cattle	15.2	95.0	57.2	29.9	15.0	5.6	38.9	9.1	12.6	46.0
dairy cows	*1.6*	*26.3*	*15.0*	*15.4*	*6.6*	*2.5*	*5.0*	*4.0*	*2.0*	*6.7*
other cattle	*13.6*	*68.7*	*42.2*	*14.5*	*8.4*	*3.1*	*33.9*	*5.1*	*10.6*	*39.3*
Pigs	7.2	198.1	80.7	47.6	8.2	0.6	54.3	0.1	1.3	10.2
Sheep	19.2	0.3	79.7	18.3	8.1	12.5	23.7	48.6	9.4	12.4
Goats	0.8	0.6	8.3	3.4	0.8	1.1	36.9	19.0	11.5	4.9
Chickens	186.3	6185.6	679.2	336.0	191.9	23.7	522.5	285.2	45.5	272.6

II[a]) Japan; II[b]) Western Europe and Israel

Table 12 - Yields of cereals and milk by region [*Source*: Calculations based on [8]]

REGIONS	*CEREALS PRODUCTION*		**MILK PRODUCTION**	
	Yields (kg/ha)	(kg/inhabitant)	Yields (kg/cow)	(kg/inhabitant)
I	4388	1209.6	6088	280.9
II [a]	5850	95.0	6612	68.1
II [b]	5743	589.7	5841	329.5
III	2973	575.2	2635	211.6
IV	927	317.4	2286	217.0
V	989	214.1	1557	149.3
VI	3410	281.2	802	11.5
VII	2029	254.0	1329	54.0
VIII	1000	131.3	352	19.4
IX	2802	254.2	1150	114.4

II[a]) Japan; II[b]) Western Europe and Israel

Table 13 - Prices of main agricultural products *Sources*: [20; 25; 26; 32] and estimations based on [31]]

REGIONS	PRICE (US$ 100 kg)					
	Wheat	Rice	Barley	Maize	Soybeans	Potatoes
I	31.40	85.16	23.72	22.78	45.59	25.57
II [a]	164.84	304.22	158.67	*	232.42	89.18
II [b]	17.43	49.14	16.33	20.04	26.97	29.12
III	10.62	*	8.70	4.63	*	4.93
IV	8.50	26.00	7.00	10.30	*	4.50
V	8.40	24.70	5.50	14.10	*	4.50
VI	26.10	18.80	19.70	9.20	27.40	1.10
VII	13.30	30.00	10.90	44.50	46.40	2.00
VIII	28.80	*	*	8.50	19.90	*
IX	10.00	31.20	10.20	8.70	17.20	1.00

II[a]) Japan; II[b]) Western Europe and Israel

Table 14 - Gross Agricultural Output (GAO) [*Source:* Calculations based on [[8]; [10], [20], [25] and [27]]

REGIONS	GNP (US$ per inhabitant)	Gross Agricultural Output (GAO)				
		% on GNP	US$ per			
			EAP in Agri-culture	100 hectares		Inhabitant
				AUA	AL+PC	
I	30000	3.0	56589	30624	110141	900
II [a]	24400	1.8	18031	1121136	1291330	439
II [b]	23500	2.0	23321	122415	210259	470
III	2700	10.0	3135	41194	54758	270
IV	3039	7.0	3617	14860	24510	213
V	1350	15.0	1801	5261	33845	203
VI	700	17.4	287	36904	86580	122
VII	2400	11.0	2197	26118	100994	264
VIII	300	35.0	136	6873	38615	105
IX	5200	5,0	2948	17454	81971	260

II[a]) Japan; II[b]) Western Europe and Israel

Development of agricultural mechanisation to ensure a long-term world food supply

Topic 2 – Report 1: New technological solutions appropriate to emerging and industrialized countries - a challenge for agricultural engineering

*by **U.M. Peiper** and **Y. Alper** (Israel)*

1. Introduction

More than 25 years ago, in the midst of the so called "energy crisis" a special meeting in Verona was dedicated to the theme: "Alternative sources of energy and their possible use in agriculture".
The oil producing countries, which tried to profit from false information, created the feeling of an impending catastrophe where the world was running out of the most used source of energy. One of the two persons suggested looking at the crisis as an "energy price crisis" rather than a real energy crisis. Many people were in disagreement. As of today, fossil fuel energy is still with us, and the world community is speaking about reduction in its use for quite different reasons. Today we want to propose that although it is very fashionable and generous to speak about "ensuring long term food supply", meaning mainly to provide food for so many in the developing countries, who, even today, suffer from lack of sufficient food, we actually miss the point. There is no real global food shortage, and it is not likely that there will be a global food shortage, at least by the end of this 21st century. (Fortunately, none of us will be able to see if my assumption is correct or not. So, you may argue with me now, and history will prove who was right.)
My contention is that the shortage of food in some areas of the world is caused, sometimes deliberately, for political reasons, and in many cases by the failure to distribute the available food to those who need it. It is by no means a result of professional failure and can, therefore, not be cured by professional development.
Many well-meaning agencies, like CARE or Concern, advertise pictures of malnourished children or adults all over the developing countries. These agencies ask for contributions to bring food to the hungry. They do not ask for contributions to facilitate higher production. They do not ask for contribution to cultivate more land. They know that food is available.
Even with the agricultural know how of today, the world can support its growing population. We know that manipulating numbers is simple and generalization is of no comfort to the hungry. However, this is the only way we can demonstrate our point. To do so we took the FAO numbers for worlds' cereal production as an example for a basic food supply.
Looking at the numbers we see the enormous gap of production yield between the developed and the developing countries. If, for example African countries would increase the yield of their cereals by a factor of 2, a task which should be easily attainable by proper extension work, this would leave them still at a level which is about one third of that achieved by the highest yield producers. And, if Asian producers would increase their yield by a factor of 1.5, which will bring these countries to the present European yield, we would end up with an increase of the total world production by about 35%.
In this crude calculation we did not consider any increase of cultivated areas, which is still possible, within present knowledge. This is but one example we took arbitrarily from the available data. The picture is similar with other crop data. This is not a dream. It can and must be done! Allow me even to say: it will be done. How sad it is that we shall not live to see it.

As already stated, this is but one example of what can and will be done.
However, the intensification of agriculture in developing countries must be done carefully, avoiding the mistakes that could not be avoided in the natural process of research and development, which brought us to the know-how of modern agriculture.
The developed countries have gone through the same process of technological evolution just like the developing countries do today and will do in the future. The state of present achievement of developed countries can and will be reached by developing countries in

the future and the differences are only time-phase differences. It is the privilege of the developing countries that they do not have to do all the research from square one. It is the privilege of the developing countries that the process of technological evolution can be speeded up, based on knowledge and existing state of art which must be adapted to their needs in a proper way and path but without having to "invent the wheel" again and again. It is the privilege of the developing countries that they can learn from experience and not repeat mistakes, which were unavoidable in the first phase. It is the obligation of the developed countries to transfer the knowledge and the know-how of food production in the most proper way to the developing countries. Agricultural research and development has already caused much damage to the environment in the developed countries. This must not be repeated now. It is wrong even from the economical point of view, since the repair of the damage will cost, in the long run, more than what is saved in short time calculations.
The basis for new technological solutions in any field of human activity must be based on a thorough study of previous activities and practices and their impact on the environment in the broadest sense. Technological solutions, which are intended to solve only a part of the problems, are often harmful to other aspects. There is an infinite number of the second kind. There are only few of the first. In this review we shall try to outline the characteristics of modern agriculture with respect to their impact on the rural and urban environmental quality.
The intensification of modern agriculture has a significant influence on basic national resources and has an adverse effect by using hostile materials, which cause, in many cases, in the long run, non-reversible damage to the environment. On the other hand, agriculture can serve as the tool to preserve natural environment and counterbalance the adverse effect of the industrial development of the 21st century. Research and development in agriculture and in agricultural engineering will play a major role in the urgent need to lead the agricultural community toward an environment-friendly agriculture (EFA) in the future.
The existing know-how and the expected new knowledge will be adapted worldwide for the benefit of all, avoiding the ill effects of the past. Developing countries will adopt EFA as common practice and avoid making the mistakes done in the past along with the development of the modern agriculture, as it is known today.
The following ideas are based on several decades of experience in agricultural engineering R&D and mainly in Israeli agriculture following its structural changes from being the most important economical sector in the early years of the state to its present stage of national economical importance.

2. Characteristics of modern agriculture and future technologies

2.1. Agricultural practices in industrialized countries have reached remarkable performance levels

More food and more fiber are produced per each unit area and per each unit water. Less hand labour is needed for most farming operations. The farming community shrinks significantly in numbers, but, in the same time, produces more food for the increasing world population.
The "green revolution" of the beginning of the 20th century brought the fruits of research to the field with new varieties of basic food crops. It was accompanied by an enormous development of mechanical solutions to perform most agricultural activities. The best example is, perhaps, the cotton picker, which eliminated the need for large numbers of field workers in a relatively short season. But not only the cotton picker reduced the number of field workers. Tractor size and power rose to be able to cultivate large areas in short times. Harvesters became fast and computerized. The results of the revolution are even more evident in intensive protected agriculture, where the yields have often multiplied by a factor of 5 – 10 (**Figures 1** and **2**).(As an example we can take tomato production where the open field yield was 4-5 kg per m2 and the yield in the greenhouse is today 40 – 50 kg per m2, with a more than twelve fold yield to the same amount of water.).
Now we are at the beginning of a new revolution with the possible introduction of new varieties having even higher yields and being

more resistant to insects and pests. The question whether GMO (Genetically Modified Organisms) are allowed or not is not in the scope of this paper. However, it is quite safe to say that the possibility for a new revolution exists.

2.2. Some agricultural activities, mainly for the fresh market fruit and vegetables still require a lot of seasonal hand labor. Workers are mainly needed in the harvesting season for picking and for post-harvesting processes like sorting and packaging

The shortage of permanent workers in the *agricultural* community has developed the movement of migrant workers who move from one area to another following seasonal work. The availability of migrant workers solved the economical problem for both workers and employers, but in many cases caused serious national-social problems, and sometimes also operational problems because of their occasional unavailability for many reasons.

The challenge for future R&D in agricultural technology is to replace the main part of seasonal workers by mechanical means.

On the other hand, manual labour is starting to get relatively scarce in developing countries as well, with the growing movement of urbanization, which occurs worldwide. This movement does not decrease the food consuming population, but, as already mentioned, forces the farming community to produce more with less manpower.

2.3. The quality of the marketable agricultural produce rose to high levels never known before

With the enormous development of transportation means a new industry emerged – tourism – which became the largest industry of the modern world. Tourism means transportation-accommodation-food supply. For the tourist, food supply not only means to cover basic needs anymore, but also has become a fashion of entertainment for a fast growing number of people. Being such, it raised the quality standards of the agricultural product. The requirement for high quality agricultural products is also continuously rising with the general increase in the standard of living. The meaning of quality has also changed through the years. From merely watching the external appearance and shelf life of the produce we are now concerned also by taste, food safety, and presence of chemical residuals on the produce. We are also looking for the presence of materials, which are regarded as healthy food supplements. New varieties of fruit and vegetables, including exotic varieties, add to the consumption habits of industrial society. R&D in agricultural engineering must develop the necessary means to deal with traditional and new products with special care for quality and shelf life all year round from the producer to the end user.

2.4. Technological advancement and global economy increase the advantage of large size production units

The highly sophisticated modern farm has to invest more and more to constantly develop new know-how in order to be competitive on the global market.

This can only be done by large-scale operations, which have the necessary funds to finance the very expensive infrastructure and specific R&D of their own. This trend is changing the traditional family type farming and is opening the agricultural industry to high risk financing funds and big companies. Some of these companies are now involved in the agricultural commodities market from production to marketing. These large size farms are doing applied research of their own, however, they are willing to adapt research results from basic research institutes and are often involved in this type of research from its early stages. Moreover, they are the most important "clients" who are capable of applying the new, often high cost, technologies to real practice. In some cases of very specific niches, the small family farms still hold their leading position and practice sophisticated agriculture of high value.

2.5. The achievements of high-level production in the modern agriculture are often based on unprecedented intensive exploitation of basic national and natural resources such as soil and water. Moreover, modern agriculture uses more and more fertilizers, pesticides and insecticides, which are hostile

to the environment and ruin the ecological equilibrium

In industrial countries we see an ever-rising conflict and competition between urban-industrial and rural communities. The competition on soil increases the value of arable land around urban areas to levels, which cannot be afforded by the farming community. This pushes farms to peripheral areas or changes farms toward intensive high value agriculture, which need less area for production. In many countries, where water is limited, the competition on water resources is even more severe. R&D in agriculture must equip the agricultural community with tools to deal with this competition. The use of recycled water, of artificial growing media and intensive growing systems are but a few examples.

The pollution caused by agriculture is sometimes caused by over-use of fertilizers, pesticides, and by animal and organic waste. These often affect and cause non-reversible damage to the environment and the natural resources.

In some cases national and international understandings and treaties banned the use of some materials. Most known is the ban on Methyl Bromide, the best-known disinfector, which is said to be one of the causes for the hole in the Ozone layer. Although this is not necessarily connected to basic food production, it is a good example of overreaction by the scientific community. Researchers have recently found ways to use MB in a more efficient way so that much less is used and only one or two orders of magnitude less pollutant are emitted to the atmosphere. It is not impossible that if this would be the practice earlier, the ban would not be so urgent. This is but one example, how, with proper investment in R&D, difficult problems can be solved.

Many examples like this may be found in the use of fertilizers and pesticides. One of the most important tasks of agricultural research in general and of agricultural engineering research in particular is to make intensive agriculture an environment friendly agriculture (EFA) in industrialized countries in the nearest future. EFA must find the balanced use of natural resources in a way that will preserve the natural ecological equilibrium while supplying enough and high quality food and agricultural produce for the whole society. The benefit of developing EFA will be for all countries and will prevent the *translocation* of polluting and economically declining agriculture, from the developed to the developing countries, a process that is too often the case today. The development of EFA requires enormous efforts, of scientific infrastructure, of financial and organizational character, which can only be done by the industrially developed countries.

It is the moral obligation of the scientific community, which helped develop the modern agriculture, to develop EFA for the future benefit of global nature and healthy human society.

Many other parameters characterize modern agriculture in the industrial countries. Here we shall mention only the following three:

- modern agriculture became, like most HiTech industries, highly dependent on knowledge and fiscal resources. It has therefore become a high-risk industry from an economic point of view and as a national food supplier it often needs government or public involvement and support;
- the decrease in numbers of the farming community on one hand, and the increase in the size of the industrial and HiTech sector in the GNP on the other hand, resulted in a considerably relative decrease in the political and economical importance of the agricultural sector in most developed countries;
- the importance of agriculture for environment protection increased both as a provider of green recreational space for the urban society as well as a possible recycling plant for urban waste, solid and liquid;

3. Conclusions

Scientific research and development is becoming more and more complicated. Many disciplines are involved in research of each subject, mainly in plant and life sciences and agricultural research it is no exception. Agricultural technology is a part of this complex picture, and, together with the other disciplines, must be prepared to answer the many aforementioned different questions.

The application of the research results is also becoming more and more complicated and cannot be easily applied to the farmers' practice only by the traditional extension service. The newly developed know-how will in many cases first be adopted and completed by specialized commercial companies who, in turn, will put the finalized research results to practice. These intermediate organizations, which become more and more important for the application of multidisciplinary projects, are called in Israel "technological incubators" and are strongly supported by public funds, including government, but always with the involvement of private initiators.

The rising consciousness to environmental quality and the strict regulations in this respect force the scientific community to a devoted and special effort in this important area.

The specific challenge for the agricultural engineering research and development community in modern agriculture will be within the following areas:

- to develop EFA (environment friendly agriculture) capable of producing high quality and healthy food. The EFF (environment friendly farm) will not produce any waste material, which cannot be recycled, and will not use chemicals in a way, which is harmful to the environment. New materials and new methods of application will have to be developed. It will also require the development of materials and methods to recycle waste, urban and rural, in a proper and economic way;
- develop agricultural-industrial production in controlled and protected environments. This type of agriculture will offer the following advantages: uniform all year round production, high quality and healthy food. It will also minimize contamination and environment pollution.

To optimise EFA, R&D is required to further develop structures, buildings, monitors and controllers for the internal optimised growing conditions. Biological sensors will have to be developed to monitor the actual influence of the controlled environment on the plants and animals inside. Computerized control loops will adjust and optimise the environment and the handling of the produce along the marketing chain to the end user.

4. Final remarks

It is the obligation of the agricultural engineering community to develop EFA (Environment Friendly Agriculture) and help implement it worldwide. Successes in doing this will assure sustainable and proper food supply to the worlds population and in the same time leave natural resources intact for many generations to come.

We claim that this is, at least technically feasible. Israeli agriculture proved this.

In short, if humanity is to survive, there are two most important things to consider:

- preserve nature and environment, and
- do not repeat mistakes, learn from experience!

In order to achieve the goal there is still a long and tedious way to go.

From an engineering point of view we are facing no revolution but rather an evolutionary process of learning to fit the correct tools for the different agricultural procedures to the capability of those who want to raise their production and productivity. In order to develop, as an example,

From this

and this

To this

And from this

To this

Intermediate steps are sometimes required. These are either available from experience or must be modified from existing machines, remembering the aforementioned lesson of EFA (Environment Friendly Agriculture). There are many solutions for the intermediate steps and they must be tailor made to fit local circumstances in any case.

It is most likely that, as long as the political situation does not change, development will be slow. Technical development will go hand in hand with social development.

Is it good? We do not know. We only know it is inevitable.

Figure 1 - Cereal yield in different continents [*Source*: (FAO)]

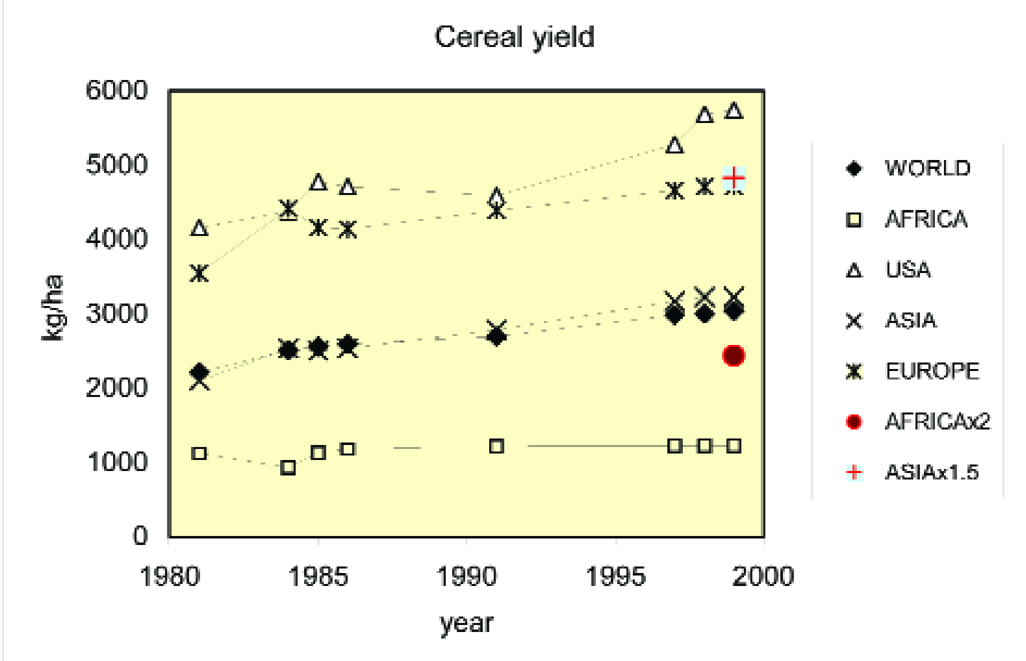
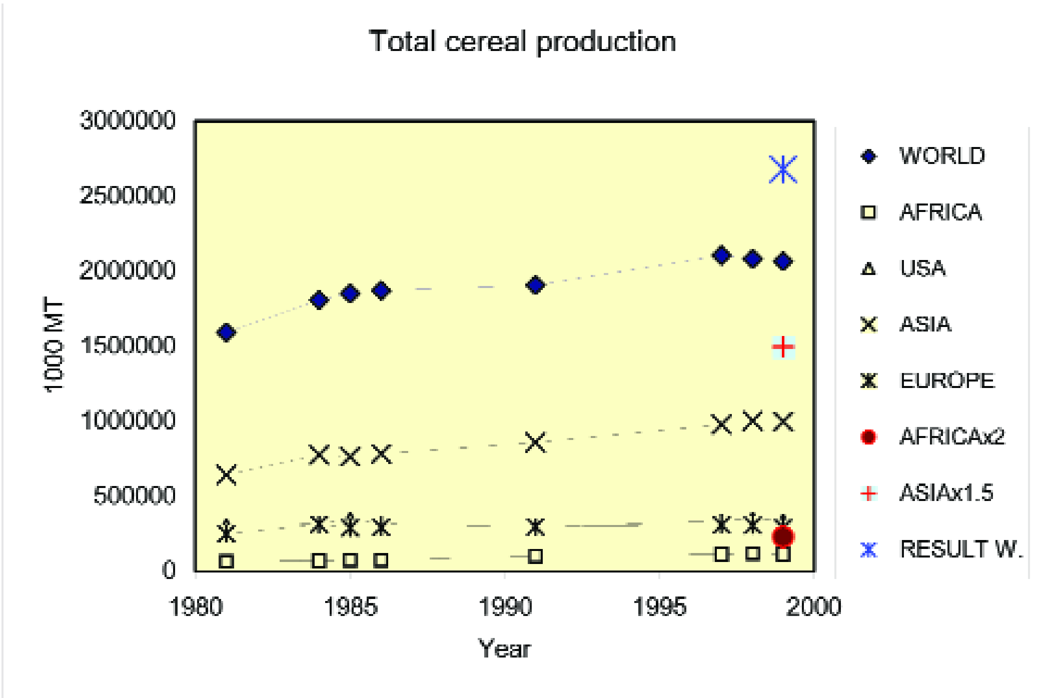


Figure 2 - Total cereal production [*Source*: (FAO)]



Development of agricultural mechanisation to ensure a long-term world food supply

Topic 2 – Report 2: Requirements of the agricultural sector in industrialized countries and the role of the new Information Technologies

by ***Jean Gilles*** *(Germany)*

1. Introduction: requirements on agriculture in future

Feeding the world's growing population will be the key-challenge in the next few decades [1, 2, 3, 4, 5]. Limited or decreasing availability of resources, especially soil and water, make the situation critical today within several areas of the world [6, 7], and reduce the future potential to produce food. In many developing countries, measures against hunger, starvation and poverty are offset by rapid population growth, political instability [8] and decreasing availability of natural resources. Increasingly, the focus of attention will shift toward sustainability of agricultural production systems and environmental concerns [9]. In newly industrializing and industrialized countries, consumer demand will increasingly shift to high value food products like meat and cheese, which require more agricultural resources to feed one person [10]. Finally, food safety concerns in the industrialized world will demand higher standards and requirements [11].

To summarize these trends and developments the future requirements on agriculture are:

- produce an adequate quantity of food to feed a growing population;
- increase the quality of the food;
- produce more from a decreasing agricultural area;
- utilize fewer non-renewable resources;
- less impact on the environment;
- lower costs;
- avoid major fluctuations in quantity;
- use environmentally and economically sustainable methods.

It will not be possible to reach these goals by focusing simply on one measure. All possible political, economical, social and technological measures and improvements must be considered. New technologies play a critical role, especially in industrialized countries [12]. "Technology" in present day agriculture encompasses farm production including mechanization and breeding. In breeding, new developments in biotechnology and gene technology offer many new opportunities, but also risks [13, 14]. Besides these two well-known areas, information and information technology are of increasing importance in world agriculture for both industrialized and developing countries [15, 16]. Information technology will increasingly provide farmers the right information to enable them to make appropriate intelligent decisions.

This report focuses on information technology in agriculture within industrialized countries. It will evaluate the need for and the requirements of a comprehensive information system in the agricultural sector in industrialized countries.

2. Information and management in agriculture

2.1. Structure of the agricultural sector

Figure 1 shows the high level structure of the agricultural sector. In a traditional agriculture and management system, most farmers worked together with agricultural traders. Producers selected from a large number of suppliers and delivered to an anonymous mass market. A high demand and governmental protection systems had offset the market risk for farmers. Production methods themselves were subject to very little regulation, and the prime focus was to ensure food security.

Today domestic food supply is no longer the number one challenge in industrialized countries. Instead food safety concerns requiring quality assurance, globally competitive prices, cost reduction, and the preservation of environmental resources, including the use of non-renewable resources gain importance. Additionally the worldwide trend to more liberal markets and globalization in the agricultural sector increase the market risk for all participants.

The consequence has been a significant amount of restructuring within the whole sector [17]. The number of participants decrease (consolidation) significantly, the remaining participants work increasingly closer together (vertical and horizontal integration) and the growing specialization (division of labor) is essential.

The number of suppliers and purchasers has also decreased dramatically in the last years. For example, two companies control nearly 50% of the world-wide potassium sales [18], while the 5 largest food retailers in Germany sold 62% of all food consumed in 1999 and are expected to sell 82% in 2010 [19].

Between 1995 and 1997, the number of farms in the EU decreased by more than 5%. In 1997, nearly 7 million farms were counted. Only 3% of the largest farms cultivate 41% of the total agricultural area [20]. These statistical figures, however, do not reflect the increasing levels of cooperation between farmers (horizontal integration), which means that the operational units in farming are even larger.

The vertical integration, i.e. the close cooperation between farmers and purchasers (contract farming) is increasing. The majority of the poultry business is completely integrated, leaving only small niches for independent farmers, e.g. in direct marketing. The pig business is currently integrating at a rapid pace and other products will undoubtedly follow [21].

It should be noticed here that the most recent political trends in favor of organic farming and the increasing environmental regulation of agricultural will accelerate these trends. Mandatory documentation and comprehensive tracing systems are much easier and more cost efficient to implement on large-scale farms [22].

2.2. Farm mechanization

The development of farm mechanization reflects the specific political, economic, social, technological and natural environment. These factors will not be discussed here, Pawlak, Fiala and Pellizzi [23] have already given a very detailed and comprehensive presentation.

Nevertheless it should be mentioned that progress in farm mechanization, level of farm mechanization and possible innovations in this area can not be divided simply in developing and industrialized countries. Production systems, economic farm size, the social-economic position of the farmer are key factors for mechanization, i.e. certain structure can be found in both industrialized and developing countries.

2.2.1. Industrialized countries

In industrialized countries two key categories of farmers crystallize, while traditional mixed family farming looses importance:

• Commercial farming

Commercial farmers are strictly profit-driven. High productivity and efficient use of assets are of key interest. For such farmers mechanization is simply a tool, which is selected by economic criteria only. Commercial farms are usually highly specialized. They produce both commodities and specialty products and use very different ways to market products. Commercial farms can be private (family) or corporate owned and derive their income almost exclusively out of farming.

• Lifestyle farming

These farmers consider farming as a lifestyle. For them it is important to live in an agricultural environment and to keep the farm for the next generation. Profitability is not always given preference and farmers accept losses in farming (at least for a certain period of time) to keep the farm and the lifestyle. In many cases non-agricultural income is used to keep the farm running. Lifestyle farmers tend to use more simple, traditional technology, which is easier to manage. Nevertheless comfort is a very important issue in this segment.

2.2.2. Developing countries

In developing countries agriculture is even more polarized [24]:

• Commercial farming

Commercial farmers in developing countries are as business-orientated as their colleagues in industrialized countries. In many cases the use and organization of farm machinery is even more advanced and economically optimized, as most of them must produce without governmental support under world market conditions. Additionally they are usually free of any traditional farming legacy and stringent environmental regulations.

• Subsistence farming

Subsistence farmers farm to produce their own food, i.e. to survive physically. There is only a very limited production for sale or barter to get some necessary goods (tools, pharmaceuticals etc.), which can not be self-produced. Farm mechanization is limited to traditional tools and simple equipment. A structural change or progress in production does not take place. Slight improvements can be achieved by educational measures. The situation of subsistence farmers can only be changed fundamentally by increasing industrialization, which offers more non-agricultural income opportunities and generates capital for investments in agriculture.

In commercial farming worldwide a clear trend to increasing specialization has been observed. Standardized production is increasingly replaced by individual solutions, which are better adjusted to the natural, economic, political and social environment and more productive. However, this requires high management skills and a focus on a very limited number of products.

This trend has a significant impact on farm mechanization. Universal or versatile machines and equipment are replaced by specialized technology, which fulfills the requirements better of a highly specialized production, e.g. self-propelled machines are increasingly replacing tractor-implement combinations. This development started with combines followed by forage harvesters and sprayers. In the last few years self-propelled specialty harvesters (grapes, potato, vegetable etc.), loaders (instead of tractors with front-loaders), self–propelled mowers, feeder-mixers etc. have gained importance. Other self-propelled machines like balers or seeders are already on the scene. So there will not be a general solution for mechanization in commercial farming in the future, but an increasing number of highly specialized (niche) products for industrialized countries. In the meantime mass production of less differentiated basic farm machinery will be concentrated to some developing countries.

2.3. Management systems

In this environment, information, communication, expert knowledge and management skills become critical success factors for all participants in the agricultural sector. Comprehensive information technology (IT)-based management support systems offer new opportunities for improvement. **Figure 2** shows an integrated management system in the agricultural sector.

A comprehensive and integrated information system enables farmers to optimize their farm organization and production (in-house management) and their relations to input suppliers, purchasers and administrative bodies (external relationships). In addition the system offers farmers the opportunity to systematically reduce the impact of their production on the environment.

2.3.1. In-house management

The internal management issues on a farm can be subdivided into three broad areas, namely production, financial and strategic matters. In all three areas information technology contributes significantly towards improved productivity and product quality, offering cost reduction and allowing more environmental friendly production.

In production, real-time information and expert-knowledge are of great importance. IT-based local weather reports support the farmer in daily planning. Comprehensive information systems with integrated expert-knowledge enable farmers to control pests and diseases at the optimum time and conditions and at the lowest possible quantity of chemicals [25]. Such information is already available today for farmers to help reduce risk and costs. Similar systems for other areas of production, such as fertilizer application, selections of breeds or feed ratios, are on the market or under development. More timely information regarding environmental issues can also allow farmers to consider this increasingly important factor. Modern internet-based information and knowledge system are able to provide information tailored specifically to the needs of individual farmers.

Precision farming, i.e. spatial management of yields, soil properties etc., the application of seeds, chemicals or fertilizer and the adjustment of other agricultural measures in direct relation to variations of potential within a field, has been under development for several years [26]. Challenges include the development of adequate sensors and the deduction of agricultural measures from collected results. It is for these reasons, profitability of precision farming is not always a given [27], however, there is clear understanding of the potential to increase productivity, reduce costs and risk and enable a more environmentally friendly production.

The management of agricultural labor is another key subject of farm management. In spite of relatively high unemployment rates in many areas, availability of skilled agricultural labor especially in many industrialized countries is a limiting factor [28]. On one hand, increased automation of farm equipment, IT-based decision support systems and improved supervision systems allow the use of less skilled labor. On the other hand, high productive systems and comfort delivering features contribute to keep skilled, but more expensive labor. Additionally, labor planning and supervision systems help organize labor most efficiently. Finally IT-based training programs have become a cost efficient method of improving the skills and knowledge of management and agricultural labor.

Equipment management is an important issue for very large scale farming operations, contractors, which operate over a large area, and leasing and rental companies. In some cases, fleet-management solutions from the transport industry are already in use, but specific agricultural solutions are still under development.

An area of increasing importance in agricultural management is financial planning and management. Increasing cost pressures force farmers to consider financial matters more than in the past. The comparison of planned and actual values and the evaluation of profitability of planned investments are as critical for farming as for other business. On larger farms, financial planning and controlling is not possible without sufficient IT support [29].

Strategic farm management will assist future development of the enterprise. Asset management to reduce the share of fixed-cost in relation to total cost is becoming increasingly important. A lower share of fixed-costs increases the flexibility of the farming operation and allows a better reaction to market and political changes. Currently most farmers focus on fixed machine costs, i.e. they purchase fewer but larger machines, cooperate with other farmers, rent rather than purchase or outsource certain work. In future it is expected that other assets, such as delivery rights (quotas), land and buildings, will receive more emphasis. Decision making in this area is based results and information from financial managers, tax advisers etc., which heavily rely on IT support.

On many farms, new and more cost-efficient production methods and organizational structures need to be swiftly implemented in order to remain profitable in an increasingly global competitive environment. Additionally, efficient and quick identification of growth-opportunities (growth in size, new business etc.) is required for to ensure sustainable economic development of the business. IT-based management systems can contribute to these areas by providing more timely and comprehensive information, easier access to experts, consultants and other farmers or benchmark opportunities.

2.3.2. External relationships

External relationships include suppliers, purchasers and governmental administration.

Traditionally, the relationship between farmers and suppliers was limited to purchasing inputs. Whereas comprehensive feedback from farmers to suppliers or an interaction between both sides was an exception in the past, in the future it will be commonplace. Web-based services offer a new supply channel, that is gaining increasing acceptance, e.g. in the parts business.

In the area of farm machinery, farmers are interested in higher machine performance, lower cost and reduced downtime, while suppliers want to optimize customer support. Internet-based and wireless communication systems between the farm manager, machine and the dealer or supplier will allow much faster and more targeted interactions. For example, in a case of a machine failure, direct communication between the impacted machine, the farmer and the service point enables online-failure-identification, direct parts order, specific location of the machine and immediate dispatch of the appropriate expert to the machine. This saves time and costs on both sides.

Increasingly, marketing of farm products requires farm management resources. In the

past, products were delivered by farmers to traders or processors without negotiating or comparing prices and terms. Today, prices and delivery terms represent a critical element of farm profitability. Besides many other activities, up-to-date market information via the internet is of increasing importance for the farm manager.
The internet also provides new opportunities to sell products. While web-based sales of commodities, at least in Europe, are still the exception, web-based direct sales of regional and organic products will continue to gain in importance [30].
The demand for documentation of inputs, production processes, products and financial issues and traceability of products is growing rapidly.
Most pig, poultry and vegetable purchase contracts already demand detailed documentation. Other farm products will follow this trend. End-consumer concerns over food safety are the main driver, but other aspects such as homogeneous product properties, guaranteed product properties (right variety, N-content of sugar beet etc.) and cost reduction opportunities are also important. For an increasing number of products, e.g. for baby food production, standards such as ISO 9000 or HACCP are applied. These growing documentation requirements can not be satisfied without the support of an IT-based data capturing, processing and storage system. The key challenge here is to make all aspects work as a system.
More detailed documentation is also required by authorities for support systems, environmental regulations or animal welfare rules and tax issues. While on small farms only simplified declarations are required, authorities demand increasingly detailed documentation for large operations.

2.4. Example

John Deere is currently working on a comprehensive agricultural management system, AMS (Agricultural Management Solutions). Initially, AMS was originally focussed on precision farming, but soon it was realized that a more comprehensive solution was required to add value to the customer. Today, the goal is to offer a totally seamless information management solution. This gives the farmer the opportunity to optimize the complete operation.
AMS consists of hard- and software products. Several components are on the market today, while others are still under development. The modular design and the open architecture (ISO-Standards) of the system allows farmers to select the components according to individual requirements and to add other components at a later stage as business demands. For farm management, AMS offers solutions for precision farming, equipment management, agronomic and information services and business management (**Fig. 3**).

3. Conclusions

The agricultural sector in industrialized countries is being shaped by many of the same technologies transforming other industries, but is also subject to unique political, social and economic constraints. Agriculture itself is expected to produce an abundance of cheap, safe and healthy food, but at the same time take account of environmental concerns and look after rural landscapes and welfare of farm animals. Therefore, the agricultural sector in industrialized countries has become increasingly consolidated and integrated (vertically and horizontally). Participants of the sector have become increasingly specialized, which is typical for a modern economy (division of labor). This is reflected in the increasingly diversified farm mechanization, i.e. model differentiation, special tailored machines and self-propelled equipment.
Besides the "classic" technologies in farming, i.e. production including farm machinery and breeding, information and information technology are increasingly critical success factors. An integrated comprehensive and fast information flow between all relevant participants is absolutely essential.
Comprehensive integrated IT-based management support systems offer new opportunities to improve productivity and profitability of farms and the whole agricultural sector, but also enable the sector to fulfill better social and environmental demands. So modern information technology will become a key element in the agricultural sector, and will be key contributor for achieving the stated above goal for WW agriculture.

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Figure 1 - High level structure of the agricultural sector

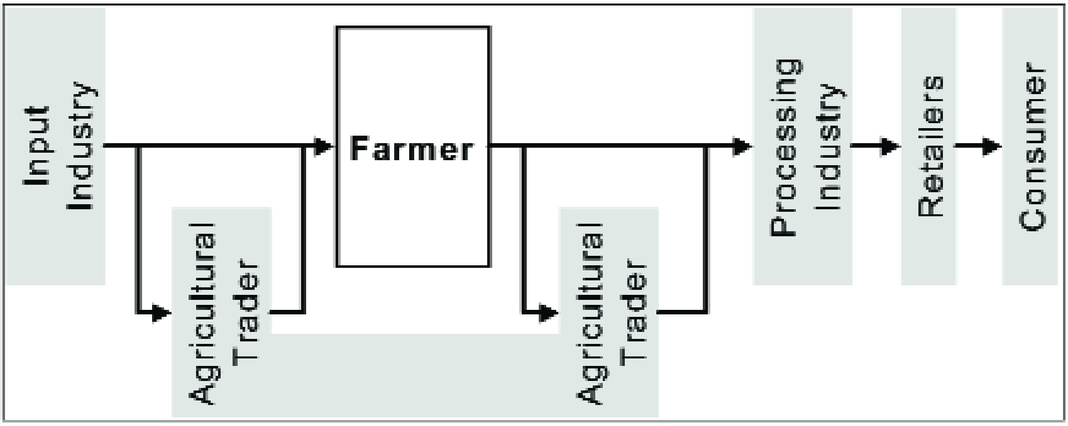


Figure 2 - Integrated management system in the agricultural sector

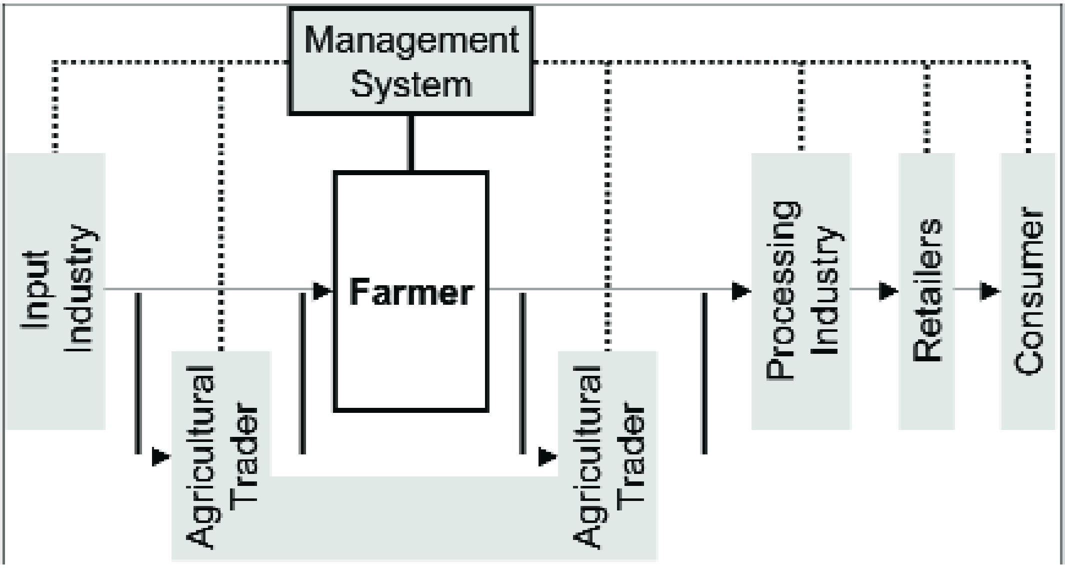
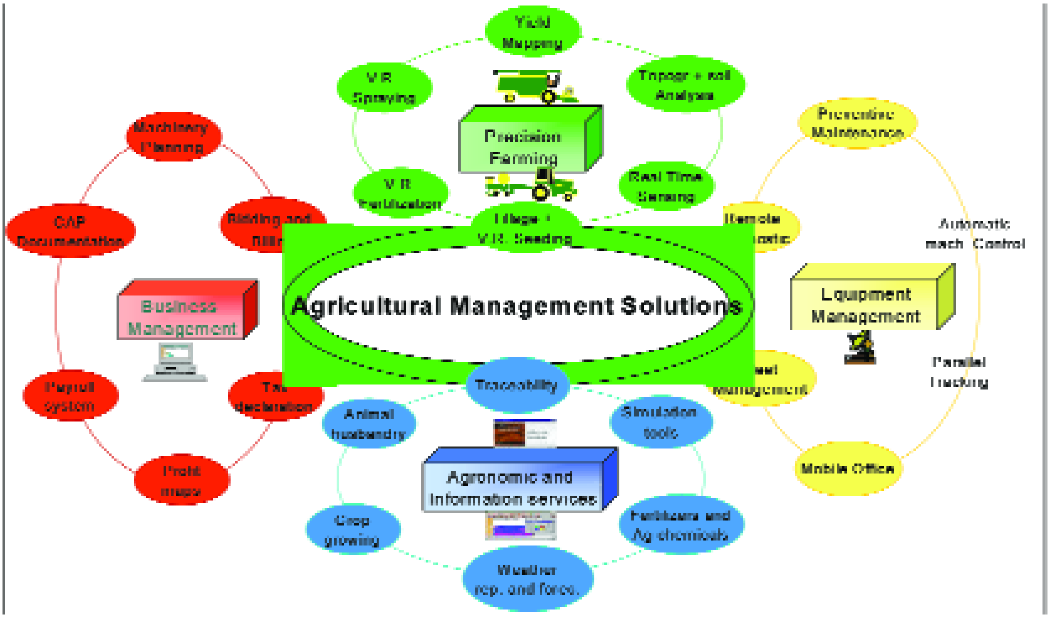


Figure 3 - John Deere agricultural management solutions



DISCUSSION

Bill STOUT

We have had three excellent presentations. Now we have about thirty minutes scheduled for a first discussion period. The procedure for discussion is I will ask for volunteer or people who want to make a question or make a comment and then we will ask you to use the microphone because this is being recorded and to state your name before you state your question so we can identify who it is who's speaking. Who would like to lead off? Do we have somebody who has a burning question? Renius is going to be first.

Karl Theodor RENIUS
Germany

I was highly impressed by these three presentations. I agree with you Bill. And I think one interesting point was addressed in all three papers and that was that the developed countries have to jump on the same project of technology evolution as developing countries still have to do. This was said by Peiper. I think it may be interesting to make a comment that there was a very good publication in 1953 by Fourastie - La productivité, Paris. He presented the three-sector model in which he states that farm mechanisation is a must for the development of the nation, improving living standards and welfare. We had exactly one week ago a comment by the president of the German Society of Farmers – his name is Mr. Von den Bussche - and he said, and this is an interesting comment addressed to Mr. Gilles's presentation regarding the definition, that low-tech agriculture is an economic factor of poverty and hi-tech agriculture is a factor of human welfare. This may be a motivation for all of us to work and still to continue with this interesting work of the Club of Bologna.

Axel MUNACK
Germany

I was also interested in the same view and I have a general comment on developing countries that have some sort of privilege… not to repeat the same errors made by the developed countries. However, I just was asking myself, do we really have enough to offer them? And I think also that the developed countries have a lot of unsolved problems; so I think we cannot state that the sustainability has been employed for the development of our countries. The economic problems, with sustainability, over-production and so on have not been solved. Acceptance by consumers is shrinking. It's the closest, I think, to a social problem. We have to face this problem. And so this also includes genetically modified organisms, which will be a key issue for the developing countries. I think the acceptance of these new technologies is larger than in some of the developed countries. I was in China ten days ago at a world conference and one of the problems was the intellectual property issue which is combined with these genetically modified organisms. So I think we have to ask ourselves very precisely what are the solutions that developing countries should take over from the industrialised countries? Do we really have enough solutions to offer them? I think it is the question to be answered. The technological aspects, I think, more easy to solve. Also on the same issue I'm thinking about, hi-tech agriculture being superior to really low-tech agriculture, the technological transfer is not such a big problem and requires adequate strategies for agriculture.

Giuseppe PELLIZZI

I want to refer a few comments to the Peiper and Gilles papers because I think that both of them are a little bit outside the main subject, that is: "Development of agricultural mechanisation to assure a long-term world food supply" and there are many very specific subjects. For developing countries I have not heard one word on storage facilities or on type of mechanisation. We spent forty years making a lot of mistakes in assisting developing countries in mechanisation. If we go to Africa or to other developing regions we find cemeteries of machines that have been sent by the developed countries to the developing ones. These machines were never used because these were not adapted. So we are here in a session that has to recommend something to the manufacturers; we are under the umbrella of agricultural machinery manufactures to whom we need to provide *suggestions. I know very well that each country is completely different from another; so, i.e., Thailand is different from Africa and so on. But there is no doubt that we have to strongly recommend that the developing countries need for simple, low cost, strong machines, simple to maintain and easy to drive, have to be completely different from the machines of the developed countries. I know that when I say this I will probably meet the criticism of the manufacturers; but there is no doubt that the problem - and this is connected also with the Code of Ethics - is that the manufacturers cannot decide by themselves which type of machine is necessary for agriculture, but they have to offer machines and farmers have to decide. I mean that we have to give suggestions in order to reduce the costs. In a country where the labour cost is low we need to have simple, low-cost machines. I was surprised when Peiper showed us a cotton picker for two reasons: one is that the pickers are very sophisticated machines not useful for developing countries and the second is that cotton is not food. So you are completely outside of the subject, Uri.*

Aad JONGEBREUER
The Netherlands
I want discuss the Peiper paper when where he makes the distinction between commercial farming and lifetime farming. In the commercial farming I miss a little bit of necessity to meet the standards of sustainability in some part of the world, especially in Europe, where also commercial farmers have to meet the standards for the environment, for instance, in use of animal, chemicals and the emission standards they have to meet. Also the standards of food safety. I think that also the economic criteria of sustainability will play a heavy role in future. The second comment is from the point of view that the producers have deliver abundant and cheap food. It is my conviction that, especially on the point of cheapness, the standards which the commercial producers have to meet must be translated in money and that this increases the cost price. I think that a reasonable price is necessary for the possibility for sustainable farming in future.

Uri PEIPER
I think that the developed countries have a lot to offer to the developing ones. This is a response to Prof. Munach's remark and mainly in the fact that we have the experience and we know, at least partly, what should not be done. This is in contact with the remark of our president. The solutions for the developing countries should be tailored to each and every country, to each and every region in a country, to each and every social situation in every country and it is impossible, at least… I don't know of anybody who would dare to give a general solution what to do in all developing countries. The picture I gave on cotton, of course, I could give the same picture on grain which would be as impressive. So it's just taken as an example. I think that Prof. Pellizzi correctly mentioned a lot of cemetery of machinery in many countries. We have all seen these cemeteries. There is another example. In some countries we can sometimes find farms which are run by people from developed countries and, as long as management is there, these farms are prosperous and sometimes even in hard competition with farm in the developed countries. I can give many examples; one example that our economy is very much suffering from and this is not exactly food but flower production in Kenya. Obviously, they don't eat them but you know that there is a famous pray saying that the farmers have to provide food in order to live and flowers in order to get something to live for. So, flowers are very important too and it is an agricultural commodity; many farms make a good living with flowers. So it's very often a problem of management and of selecting the right machinery which in many cases is available on the market, or was available, and the precise solution has to be tailor-made for each and every case.

Antonio PAGANI
Italy
I would like to back, as many others did, to Mr. Peiper's paper because it contains a couple of sentences I liked very much; particularly one saying that there is no need to reinvent the wheel. In my opinion something that has not been stressed enough so far is the fact that there is no need to talk necessarily and only about new technologies for devel-

oping countries; new by developed countries' standards. Nor there is a need to talk about purposely designed and purposely conceived machinery from developed countries' industry, machinery for developing countries. So these are the two extremes and, as Prof. Pellizzi said, very often in the past they didn't work. Technologies from industrialised countries, dropped in the developing countries, didn't work at all and were not accepted. And everybody here knows why… because all the other components of the environment were not ready to accept these machines. I'm talking about human resources and knowledge of natural resources and climatic conditions and traditions and practices and local habits. So, perhaps, to start with, we should focus on the application of existing and well tested technologies, those applied in developed countries. But we have to agree on the meaning of "technology" in this case, without confusing it with "machinery". In my view -and I don't know whether you agree- technology is machinery plus the way you use machinery, you apply machinery. So what should be done is to say: here we have a machine which has been utilised and has performed satisfactorily in a developed country's environment. Let's see whether it may be applied, utilised, economically, environmentally with the necessary level of sustainability of life in the developing countries. I checked with Prof. Pellizzi before, whether I was allowed to mention a little project we are involved in, and I got his agreement so I will not bother you for long but I would like to mention this project, sponsored by the Chambers of Commerce of the Emilia-Romagna region, this very region. This region is being implemented in Tunisia a programme focused, among others, on a specific area of olive tree cultivation. In Tunisia they have about sixty million olive trees with fantastic production, I cannot tell you how exactly many million tons of olives they are producing. But, broadly speaking, the final product, olive oil, is not of very high quality and this is not because they don't have the proper machinery. In fact they have the most modern tractors, they have the most modern processing plants for olives to be turned into olive oil. Nevertheless, the final product is not at all of acceptable standards. And this is why: because the process from olives on the tree to the olive oil in the bottle is not technologically sound. So what has to be introduced there is a "methodology of work" by utilising existing machinery, existing equipment and existing plant, and, wherever necessary, adapting this machinery and equipment to local conditions. But trying to experiment with the overall process of going from olives on the trees to oil in the bottle. Without reinventing the wheel. Then whenever the need arises for a purposely designed machine we will go for it, but not starting from the point of designing a machine for developing countries. Why? We have to try first to see whether what we have, what is available, what is well known and tested, can be utilised there, taking into account –as I said at the beginning of my intervention- taking into account local environmental conditions, starting from human resources to management capability, to soil conditions, weather and climatic conditions. Thank you very much.

Jurgen ZASKE
Germany
Coming to a definition, which was used by Uri Peiper, what agriculture should do, Mr. Peiper, producing food and fibre and I think that's very traditional definition. So I would like to suggest to look for another one which is, of course, to produce food and chemicals, I think, chemicals for industry. And I'm thinking, let's say, of changing from petro-chemical refineries to bio-refineries. That means producing things that are very valuable, for instance basic materials for plastics, or, let's say green solvents and things like this. I think this is a very important element for the future, but it should be produced by agriculture. And another aspect is in energy, I think, in rural areas to produce energy either to be burned directly or bio-fuels and things like this… or having windmills in rural areas producing energy. I think these are much wider aspects. I'm not mentioning services which are very interesting in densely populated countries like those in Central Europe, tourism and other things. So this was one aspect. For the other I would like to pick up what Prof. Pellizzi mentioned. Technology, what was mentioned by Mr. Pagani; it should not be a top down approach which we tried

in the past, and I think we have worked a lot on it in co-operation from FAO. I think it should be different; also it shouldn't be bottom-up with top-down aspects. And we have information technology, we have global markets and I think many of the problems solve themselves, don't need any help from our side. What I am wondering is, who is going really to develop and offer technology. If I look at the rate of eighty percent of subsistence farms in black Africa, just to take an example, they don't have low-tech, they have no-tech, needless to say. And, on the other hand, we are discussing all the aspects of modern machinery and post-harvest technology and polishing apples and things like this. There is a lot between, and how can we solve the problem? And in the past, you know, we tried to export machinery and we did it wrong. But why not look at what the Japanese are doing? They are developing and producing cars in the market even in the American market, I think. So my question to Mr. Gilles is what is John Deere doing in this respect? Are they developing and producing machines, and not only offering standard or stripped standard tractors. Maybe Gilles can just answer this question. There have been attempts, in think, in the past by Tanzania to produce or manufacture or assemble threshers if I recall right. Then I think there are also combines produced in China. But is their general approach, is their philosophy really to help, let's say, at least threshold countries in developing their industry to supply the neighbouring countries?

Jean GILLES

I would answer that, for sure. John Deere doesn't pretend to solve all the world problems. I hope you guys don't expect that! But then, we have a number of projects, and I have a statement in here and I think I'm going to read it, make sure I'm going to be first. But in the meantime, mass production of less different basic farm machinery will be concentrated in some developing countries. And we have our share, our participation in that. We have a joint venture in India, we are producing tractors. We have not designed specifically new tractors but these are tractors from the family that is employed worldwide but is a very simple, robust type of product. We had an Indian presentation here two years ago of tractors from there. I fully agree with a comment made early here, you know. It's nice to think in terms of giving, you know, real low low-tech tool. But you really need to do is have people with the ability to implement a total process. When we are producing tractors we fully realise we don't do the full process and there are others who need to help us. But the tractors in places like India already have very high demand. You have, you know, I think 240,000 units sold in times like now. But they are very simple technology, and when we get to that development of very simple technology it's clear to us we have to be local. That's why we are present in India; that's why we have places in China where we are participating. Now the big problem in there is, what I say, in some developing countries is that every developing country in the world thinks it should be the place where we are global. So there will be places, you know, where this production is taking place and it will have to be distributed in many places. I can't exclude that Indian tractors will have some reasonable characteristic for some African application over time, for example.

Derek SUTTON

U.K.

Just to pick up, in fact, on all our previous speakers. We've come back to this point from time to time in our discussions at previous sessions of the club. And I think it's important that we remember that we are providing the tools for users, producers, to use, and we must provide a range of tools for them to choose from and to enable them to choose that which is appropriate to their circumstances, their economic, social, technical, agricultural, whatever. And this particular issue is drawn home to me with a vengeance. At a recent presentation by the John Deere U.K. company on their latest super-automatic tractor. I'm not quite sure what your acronym is for it, but it is a tractor which does just about everything for you. And the only thing I think John Deere doesn't do is provide the trained monkey to actually sit on the seat! But it is interesting because you've touched upon the Indian tractor, a comparison. I mean an Indian tractor, as we've point-

ed out in our discussion, will cost what, I don't know, five or six thousand dollars, perhaps. But the John Deere fully-automatic tractor which, as Prof. Pellizzi said earlier on, is perhaps a possible solution for a non-trained individual to operate. But it costs maybe a hundred thousand dollars. So you have the economic factor as one which we must never forget. And it has to be an economic solution that is appropriate to the particular producer. If he is a small producer who is only a subsistence producer then clearly he will not have access to capital. But, as many of you have already referred to, there are large operations, commercial farms, where the one-hundred-thousand-dollar solution may well be appropriate because it can be utilised in such a way that the cost of production is thereby reduced.

Heinz D. KUTZBACH
Germany
So I would say our item was to ensure long-term global food supply and I have to have the case that each country world-wide has to reach, more or less, self-sufficiency in food production. This goal has to be reached, of course, step by step by use of fertilizer and plant protection means, new variety, to increase farmers' income, to allow him to buy machinery, step by step. I feel that this machinery has to be designed and that special countries, using available technology, according to the special requirements of that country. The industrialised countries have to help by knowledge concern, not by equipment concern, for example by joint ventures and by educational support.

Jurgen ZASKE
There is to examine your key just pick up in fact on over previous speakers. We can go back to this point from time to time another discussion on the previous session of the Club and I think to the probably member, that we are providing the tools for uses produces to use and we most provide every inch of tools for them to choose from, and to enable going to choose what which is the property to their circumstances and I think nomics are shouted agriculture whatever and this particular issue is drum an hand to me with a dangers, a reason presentation by John Deere UK camp on the latest, super-automatic tractors and I'm not coach a what acronym before, but it is tractor which does just about every thing for you and I think really final with John Deere does due it provide the trend monkey to act as a saver on the sit. It's interesting because you touch the problem of Indian tractor compares, a maining Indian tractors whose pointed out of the discussion will cost what ever you find six thousand dollars perhaps. The John Deere fully automatic tractors which, as Prof. Pellizzi said to harry on, is perhaps a possible so it shouldn't for a non trend individual coach rate but its costs may be hundred thousand dollars.

Malcom McKAY
Australia
I want to be a little bit controversial, I think, maybe not. And I am going to ask our manufacturer friend to respond, as well as others. We heard long and excellent presentations this morning talking about the issues and the difficulties of agricultural production and securing the continuity of that production. But are we not in danger of excusing ourselves for not actually being as successful as we might have been? An analogy I'd like to draw is one that is only relevant in some parts. We talked about the fact that developing countries need to go through, or will probably go through some of the same development processes that developed countries have gone through. And yet we see something like mobile phones, where we see a whole series of generations of technology being completely transformed, jumped across the process. We see that it is possible to put in place the financial systems, the technical systems, the actual pieces of equipment that work universally across the world. You take your hand phone to any country in the world practically, except the U.S.A., it'll work. And this is the sort of technology where we, as agricultural engineers and manufacturers, say, and we heard it again today, that everything must be different, it must be designed specifically for the circumstances. And yet here's a piece of technology that, sure, it's different, but it's been able to overcome all those sorts of issues. One of the thesis that I support is that the reason it's done that is

because there has been an incredibly large investment in the engineering and the systems that support that technology which is not the equivalent to the sort of investment that's being made in agriculture. And I'd just like to see what sort of response…. Is it that our machines, our agricultural machines, just aren't good enough to perform under all the necessary conditions where they need? Whereas some other technologies, where there has been a different sort of development, a different level of investment, are actually good enough to perform under a whole range of different conditions.

Bill STOUT

A very provocative statement. I suppose part of the answer to that lies in the economies of scale. When you look at agricultural machinery versus telephones there's a rather big economy of scale. But, I'd invite our industry friends, representatives from a number of companies here. Why don't the companies do more to try to meet the diverse needs of their potential customers around the world? Is it just simply a marketing problem? Is it that you cannot afford to invest in engineering for a small niche market? What don't we see more attention given to the diverse needs around the world? Nobody wants to comment, so we won't pursue that.

Jurgen ZASKE

What I feel we have to differentiate is what private industry can do and what governments must do. In the very beginning in developing countries you cannot expect that industry is establishing all the workshops, all the training programs and all the research which is necessary. I think this must be done by government, on their side, and industry must do, let say, establishing the trade and the imports and all these aspects. So there are two aspects, two lines to follow, to establish, let's say, a sustainable mechanisation idea.

Makoto HOKI

Japan

I would like to ask one thing about your question. Are you sending invitations to private companies enough? Just wondering, you know. We should send invitations to private companies to have more participation. Many private companies are interested here but probably they don't know. This is not the thing. I'm not sure, I don't know. We have to send invitations and many private companies will be interested, I think.

Bill STOUT

I believe, maybe my industry friends won't agree with this, but I believe that industry is driven by the profit motive and that if they can identify a potential profit they'll be there with a product. And I have to conclude that if they're not there, they don't perceive the potential profit to be sufficient to justify the risks and the investment.

Egil BERGE

Norway

First, I would like to give an appreciation for the papers presented to us this morning. There was lots of work behind them and very much information contained there. The one by Pawlak, Pellizzi and Fiala documented the great differences in resources and climatic conditions and also the human resources. I should add the limitation of the political and administrative resources needed for an optimum working system. We also have to remember that food is first priority which explains why we see such great differences between, for instance, Japan and Israel and the other countries in the same surplus situation where food has almost no value. And also remembering that world trade in agriculture commodities is marginal. Most of it is used where it is produced. For most commodities less than ten percent is in the open market. Then the question arises, is a fair world market for food possible? And I remind you about the situation that came up to the surface on the 11th of September. And some people are very serious about is this fair or not. And I think it will take a lot more time before we can put all of it in the same market. Now it is divided and it's always been divided. And next is to carry this over to the, and have some consequence, for the market for machinery. I that maybe it has and I take it as an indication that the company of John Deere and Mr. Gilles shows that they are producing machinery that's going to be used *more. So that what is on the open market is only half of the total, maybe.*

Bent BENNEDSEN
Denmark
I would like to take up some of the challenge that Prof. Pellizzi issued here this morning. And my attention goes to the equipment and perhaps the future of the equipment. We've seen all the speakers addressing the environment and environment seems to be fertiliser and pesticides. It seems to me that there's an important environmental factor that we've forgotten which is energy. If we're looking at something like soil tillage. We were discussing in my group the other day how much energy is actually consumed by agriculture. After some investigation, I asked to Mr. Godwin from U.K. and he came back saying that in his mind something like ninety percent of the energy used in agriculture is actually used in tillage. And it's used to repair whatever damage has been done by heavy machinery driving over the field. I mean, looking yesterday in the specifications down here it seems that our equipment is getting bigger and bigger and, hence, heavier and heavier and requiring more and more energy to repair the damage we have done to the fields. And I thing that's one of the lessons we should learn and definitely not transfer to the developing countries. Of course I have some answers to that problem but that might be anticipating the presentation that will be given later on. I mean the idea is to make machinery smaller and more intelligent and that will help the Third World because I have the feeling that high technology doesn't have to mean a high training level among the operators. I mean, definitely replace a low training situation with the operator with hi-tech equipment.

Wayne SKAGGS
First I guess I should say that I want to make my comment as professor of agricultural engineering rather than as president of ASAE. Secondly, I must recognise that I am a guest here, I need be careful in staying in bounds and I need to talk about equipment and about food. I will qualify on the latter for sure and the former, it may be somewhat questionable but if you consider the sensor area I think it will conform. And I want just to make an observation. There seems to be broad recognition that there is a need to consider environmental impacts in our food production. And, in order to be sustainable, it's implicit that those environmental impacts, or the cost of them, need to be incorporated… we need to incorporate the environmental cost as a part of the total costs of food production. I believe that's been recognised by several speakers already. The implication, though, has been, it seems to me, that we in the developed countries know how to do that, and, furthermore, that we are doing it. So it follows that if we could export this technology or export this understanding to the developing countries everything would be great, or, in the words of the current generation, it would be cool. I don't believe we've arrived at that point. I do not believe we are able to do that at this point in time. And I can point to several examples that show me, at least in practice, that we're not doing it. We have big environmental problems, water quality problems, in our Gulf of Mexico, in our coastal rivers. And those are due to, primarily, loss of fertiliser nutrient, we think. So we've got a ways to go to totally incorporate the cost, the environmental cost, in the cost of food production. That may not be, on the face of it, an equipment problem. But I believe that we don't have at this point in time the basic knowledge to address many of those problems. We are knowledge limited. And in order to address those problems it will require equipment to scale up the knowledge as we develop it. In your area probably sensors is the most limiting, may be the most limiting thing but we're even father back than that, I believe, in terms of understanding the chemical and bio-chemical reactions that occur that cause these problems. So I'm of the impression, opinion, that we haven't arrived at the point that we know how to deal with a lot of these problems, that we are knowledge limited and that we have much to do in the future. Having said that, I must admit to you that I'm a researcher so what I'm saying may be somewhat self-serving in that I'm implying that there is much work for us to continue to do. But I do believe that this is the case. And I think that we are… still lacking in knowledge, in terms of basic knowledge, and we

are still lacking in our ability to apply the knowledge we have. And finally I don't think there's a question about this but just to give my example the fact that this is not provincial, it's not only in the United States, I just came here from Padua University where I talked with colleagues about the similar water quality problems in the Venetian lagoon. I know those problems are worldwide and they are not confined outside our venue.

Makoto HOKI

I am the president of the Asian Association of Agricultural Engineering. I have two comments related to Dr. Zaske's speeches and maybe to Prof. Berge's comment. One is the traditional food and fibre production and I'm thinking this is the time for us to change this food production to biomass production because not to make any waste of the production. Another comment concerns the fact that we have to have a bottom up system, not top down system in dealing with agricultural mechanisation or food production or biomass production. We should minimise a government involvement in dealing with this system. I think we have to promote a public-private relationship or, in other words, I think we have to promote better relations between public and private companies, including communications in this. And the program is what machines to choose. This is not a problem. Who is to choose machines? This is the problem. We have to leave this to farmers, who are private sector, what machines to choose and what technologies to be introduced in dealing with and solving problems.

Lawrence CLARKE

FAO

Very interesting to listen to the three presentations and also very interesting to listen to some of the comments that I hear. As FAO we have been intrigued as to why some countries have mechanised, or are in process of mechanisation, and why some countries are remaining relatively static. As part of global perspective study which FAO are in the process of doing, which will result in a publication in a year's time, we're looking at mechanisation from that point of view. And we had to ask to ourselves the question: is mechanisation pushed by technology? Perhaps I'm going to be a little controversial at this meeting. I feel that the opinion is that technology is pushed and that mechanisation occurs because we need to provide better machines. In actual fact our findings are that it's the other way around, that there are other economic factors which determine whether countries mechanise or not. And the four ones are per capita GDP, dynamics of population, the rural-urban population ratio, the percentage of the GDP that agriculture occupies – in most countries which are mechanising the percentage is relatively small and growing smaller - and the third one is intensity of irrigation. And so I think that as engineers, we are looking too narrowly at the situation. We're saying that we have to develop machines which are more suitable for developing countries on the assumption that they will then mechanise. The data that we're looking at seem to indicate that that will not happen unless there are other economic factors in place. To give some indication of that, we are reaching some preliminary conclusions. And to do this, we've had to take mechanisation… look at mechanisation to see what actually can we measure, what is an indication of mechanisation. And for that we have taken a relatively simple factor of the harvested area of land as an indicator of the mechanisation. At the moment, on a global basis, land was cultivated roughly a third by manual means, a third by draught-animal power and a third by tractors. Our projection is that by 2030 about fifty percent of the harvested area is expected to be tilled by tractors. Now that figure disguises a lot of regional differences. We think that most of the countries which will mechanise, which will move towards tractors, will be in Asia. But the real problem area is in Africa. In contrast, humans are, and will continue to remain, the main power source in Sub-Saharan Africa. Almost two-thirds of the harvested area is prepared by hand at present and the physical area will remain broadly constant until 2030. And the area cultivated by draught animals and tractors is expected to increase both in physical and proportional terms but at a much much lower rate than the rest of the world I'm here in a group of engineers. We think about it in engineering terms, *we think about technology. But I think that we should also broader our thinking to have a look at all the other factors that go towards the reasons why countries mechanise and why they do so.*

Yoshisuke KISHIDA
Japan
I have a comment to Dr. Clarke and also a comment to Giuseppe Pellizzi. When Pellizzi told about tractor graves in developing countries I was reminded about the last time I met him, in Irri, about thirty years ago. The discussion sounded to us: "How can we improve farmers' condition in developing countries; how can we promote the mechanisation for small farmers in the developing countries?" Thirty years have past. After the meeting, I decided to publish this title. The propose is how we can make smaller the gaps in between, smaller farmers in the developing countries and rich people in the cities. But after thirty years, I observed the gap is just expanding, between the poor farmers, and in the last thirty years I observed that many farmers escaped from farming, just shifting to the cities, and especially in developing countries. That means that the power of the city people is increasing rapidly and they make every kind of a policy for agriculture. On typical things I can cite the U.S. By voting they select the senators, maybe if they select one hundred senators, ninety-eight percent of the senators are voted in by the city. They make policy. The main task is how we can supply cheap and better quality products, for the city. They don't discuss about the situation of the farmers. Japanese, even in the U.S. or Canada, young people don't want to remain in the agriculture sector. This is a very general tendency. How can we stop this tendency? How can we improve this tendency? Otherwise, city people will consume every kind of natural resource, with cheap prices. And how can we improve this situation through agricultural engineering? This is, I think, still the single most important topic we have to discuss. But it is a very very difficult task to solve, almost impossible. But anyway we have to try to improve the situation of the small farmers in the developing countries through optimum mechanisation. Yesterday I visited the EIMA pavilions and I found the very interesting company. The company is an implement company, a small scale company of fifteen employers. But this ninety-eight percent of the production is custom-made. And before, the company customers were nearby this company. But now, through Internet, they can communicate directly with farmers.

Development of agricultural mechanisation to ensure a long-term world food supply

Topic 3 – Role of I.T: for an appropriate world market development

by ***F. Sevila*** *(France) and* ***S. Blackmore*** *(Denmark)*

ICTs, Information and Communication Technologies, are spreading in all parts of the everyday and night activities of the human beings in many parts of the world. Approaching their "role for an appropriate world market development" implies a very general and diversified overview:

- we have to look at what is going on nowadays but also to try to envision future developments in the agri-food system;
- we have to gather views and comments made more generally on the developments of ICTs in all aspects of the economy, because they apply naturally to rural and agricultural activities.

This paper intends to gather this variety of views on the development of ICTs. First, as an introduction, we will demonstrate that the food system and the rural world are only part of the overall information and communication society we are living in, trying to illustrate some consequences of such a deep evolution. We will then separate our discussion on ICTs developments in two parts: chapter 2 will deal with the non-machinery uses (computers, internet, world wide web) and chapter 3 will focus on machinery related aspects (data management, precision farming, automated machinery). Chapter 4, as a concluding effort, will move back to a more general comment on ICTs developments in order to point out the deontological aspects to be kept in mind by designers of future ICTs applications for the food chain and the rural world.

1. The food system and the rural world are just part of our information and communication society

1.1. The food system is information based

Evolution of the agricultural and food system can be described from various point of views:

- globalisation implies that not only food goods and products are circulating across the world but also the information needed by the imperative of trace-ability and by the management of capital and finance around them;
- the development of the network concept and tools for the functioning of the agricultural and food companies which deregulate the traditional modes of activities supervision;
- the drastic shortening of delays and circuits for design-production-distribution-maintenance-after sale implying real-time and massive management of data and information;
- the increase awareness of the importance of knowledge and know-how in the capital of companies and corporations - with at the same time major progresses in the understanding and the ergonomy of the intellectual work more and more assisted by computer software including artificial expertise;
- in face of the increasing need for intellectual labour into the agricultural and food system, there is an obligation of a better taking into account of the needs of each individual at the working place, as continuously expressed and influenced through her/his connection to the global world wide web. The fluidisation of the working force implies also a better management of the information and knowledge at each working place;

more than any other industry the food sector as to face waves of doubts on the social relevance of the science and techniques which sustains or which is developed in its various processes: transparency of public knowledge and continuous communication ability is becoming a crucial challenge.

Information is appearing as the key issue for each of these points of view on the evolution of the agricultural and food system. Which means that the food sector is simply one part of the information and communication society we are evolving in.

1.2. The information and communication society

The information society is the latest stage of an economically developed society: the main activities and institutions of which are based upon use and development of information and communication technologies. For Castells [1] we are living through one of the most fundamental technological and social changes in history. The revolution in information technologies took shape in the early 1970s and diffused throughout the economy, society, and culture in the last quarter of the 20th century. It has profoundly transformed the way we live, work, produce, consume, communicate, travel, think, enjoy, make war and peace, give birth, and die. It has also transformed, as have all major technological revolutions, the material foundations of human life, time, and space… The resulting informational society is a system where wealth, power, and culture depends on knowledge and information processing in global networks, managed and organised through intensive use of information/communication technology.

Since communication as well as information is involved in the definition of information society, there are two main dimensions to be considered in it: a social one, related to the communicational aspect, and an *intellectual* or *cognitive* one, related to the informational aspect.

1.3. What is communication? What is information?

As mentioned by Chamming's [2], we can give a definition for communication as "an exchange of the content of mental experience through articulated signs or symbols." On the other hand, we can take into account the common definition in which communication is simply the "exchange of information." Thus, information defined analogically can mean 1) *the content of mental experience, as exchangeable in communication*. This definition stems from the combination of the two definitions above. It can also mean 2) *what is dealt with by computers and is flowing through networks*. This second meaning is the one implied in the expression "information society".

1.4. How communication is evolving in the society

This evolution is of critical importance with regard to the development of Information and Communication Technology into the agricultural and food system. Since late 19th Century, there have been a succession of inventions in the field of communication technologies: telephone (1876), cinema (1895), radio (1895), television (1925), and last but not least, the Internet (1969). As those technologies are still existing, this succession order does not correspond to a logic of substitution in which the latest invention would replace the former one, but to a logic of complementarity in which each one has its specific function. However, this complementarity is related to tensions and conflicts resulting in a confrontation of usual media for communication of information compare to the Internet. This confrontation is very significant when dealing with diffusion and control of information flow in the food sector.

The three main supports of the processing and circulation of information, namely audiovisual media, computers and telecommunications are fused in the Internet which leads to the phantasm of virtual worlds. In this three-party meeting, audiovisual media bring the seduction of flows of pictures passively received; telecommunications, the instantaneous and ubiquitous connection of everybody; and computers, the transformation and the processing of every data in digitised signs.

Audio-visual media deliver a *flow* of sonorous animated pictures trying to seduce the audience and to keep him in a passive attitude, whereas the information available on the Internet is *stocks* which appeal to the curiosity of the surfer and stimulate his autonomy. Internet is a tool incomparably more favourable for the development of autonomous and free access to information on food than television, bringing connectivity, interactivity, dialogue and autonomy.

On the opposite, there are some other aspects to take in account. Although communication networks like the Internet are opening to fascinating possibilities, they also entail frightening dangers. Man is not good enough to avoid that the development of the person and its freedom involves high risks; person needs to be protected from potential abuses exerted against it by others, or even by itself. The Internet is actually a powerful planetary network, which allows everyone to be contacted without the usual constraints of space and time; but the counterpart is that everything you do on the net can be known. Big Brother is within hand-reach, but where are the international authorities capable to define and to regulate the right use of the global network, especially when dealing with industrial commercial protection of data, or with individual privacy protection? We will come back to the consequences of such questions in chapter 4.

2. The development of ICTs in agriculture and the rural world as characterised by the E-commerce

E-commerce means the buying and selling of goods and services, and the transfer of funds, through digital communications. It describes also information provision and exchange, online advice, inter-company and intra-company functions (such as marketing, finance, manufacturing, selling and negotiation) that enable commerce. It may use electronic mail, EDI, file transfer, fax, video conferencing, workflow, or interaction with a remote computer.

2.1. E-commerce in the developed agriculture

A survey by the US National Agricultural Statistics Service (NASS) reported at least 30% of the U.S. farms had access to the Internet in 1999, as compared to only 13% in 1997. Farmers are becoming more computer literate, creating a large economic potential for E-commerce in agriculture. Many commercial farmers now retrieve product information, do comparison-shopping and place orders of chemicals, seeds and fertilizers on line. However, Internet access not only allows farmers to manage input supplies, it also permits them to reach their customers more directly. Recent studies in the USA have found that more than 56 million Americans now shop on line and are diversifying their purchases to home and garden and food items [3]. The increasing popularity of online shopping make direct marketing of farm products via the Internet an attractive alternative to conventional marketing methods already used by farmers.

We can approach the developments in the use of the Internet within the agricultural industry in Europe (here defined as the European Union's 15 member states, plus Norway) from the standpoint of E-commerce purposes. Establishment of the level of PC ownership, and connection to the Internet in Europe can be evaluated through various ways. Figures for these factors are changing rapidly in many countries and may be out-of-date even before publication. Also, data may be unavailable or inconsistent. Nevertheless, **Table 1** gives an illustration of trends. Note that, though the numbers of farmers connected may be relatively small, in some cases this represents a significant proportion of agricultural production (eg. in the UK it is claimed that farmers cultivating approximately 60% of the total arable land are Internet connected).

2.2. Various generation of Internet development in agriculture

Use of the Internet has developed as a result of demand within the agricultural industry, but also following anticipation of that demand by various providers of Internet-based services. Most theorists agree that the agricultural industry is ideally suited to use of the Internet in a variety of ways. However, it has not always been clear which services are really in demand and therefore a wide variety of services has been created, not all of which suit the target market, and not all of which may thus survive in their present form. At the same time, the agriculture industry is not fully aware of the potential offered by the Internet. In addition, the different elements within the food production chain do not always have the same needs or a common need. Hence services have emerged serving different parts of the chain, or attempting to provide services to the whole chain. The food production chain is fragmented. A key question is whether the Internet can foster further integration in the chain. The types of service that have been developed have been categorised broadly as follows [4].

2.2.1. First generation

The first generation makes up the majority of Internet services in agriculture. It includes the following types of service:

- static web-sites (e.g. company sites or farmers' niche market sites);

- information sites (regularly updated information on news, weather, input price, market price etc.);
- on-line advice (non-interactive), for example about animal or plant diseases;
- intranets and electronic mail facilities.

Types of providers include:

- farmers' associations (e.g. LRF in Sweden);
- government agencies (e.g. UK MAFF);
- educational, research and advisory establishments (e.g. INRA in France);
- "Portals" (e.g. Agronet in Finland).

Some "Portals" are operated by the associations, agencies etc mentioned above. Others are run by commercial entities, funded usually either by advertising revenue or by subscription, or a mixture of these. The advantage of Portals is that they group some or all of the services listed above in one place (or give easy access to them), thus offering 'customers' a 'one stop shop' to Internet-based services - a major advantage in the agriculture industry. Portals are particularly attractive to farmers' associations as a means to bind together their members. An advantage of the 1st generation type of Internet services is that of relatively low cost, the technology they require being relatively simple and inexpensive. The added value they provide is, however, relatively limited and the cost savings involved are marginal.

2.2.2. Second generation

The second generation of services, perhaps in recognition that the added value provided by the 1st generation is limited, attempts to provide a type of E-commerce going beyond the relatively static provision of information and advice. Services provided include:

- ability to buy and sell agricultural inputs/products on-line, via a variety of systems (for example: catalogues; farmers' markets; auctions);
- grouping of buyers/sellers (aggregation, e.g. for bulk buying);
- the above linked to 1st generation services (e.g. more interactive farm management advice);
- commercial 'gallery' of services.

Types of providers include:

- providers of existing 'Portal' services, plus new 'Portals' (e.g. AgroPortal, under development in the Netherlands);
- independent service providers (e.g. AGRIFIRST and Agriclic in France, and Farmpartner in France and Germany);
- individual entities or groups within the food production chain (e.g. groups of agricultural co-operatives such as Raiffeisenverband in Germany).

The basic idea behind the 2nd generation is to remove or reduce cost within the food production chain. The most common type is the price catalogue showing farmers a large range of inputs, available to sale on-line all advertised as 'best value' (i.e. cheaper than via alternative supply routes).

2.2.3. Third Generation

Despite the sophisticated software developed to run the 2nd generation systems, and the significant investment behind those projects, there are still question marks over whether they are providing sufficiently valuable services, and are therefore sustainable. Above all the question that arises is whether 1st and 2nd generation services deliver value to the whole chain. For example, in many countries the offer of a catalogue of farm inputs available to farmers on-line is seen as a threat to the existing agri-distribution chain. This has led to some resistance to Internet service development. 2001 has seen the first attempts to create "consortia" that seek to group players in the food production chain around a single "hub" offering a variety of software systems and several services, including all types of E-commerce.

Ultimately one ideal will be that customers (at retail level) will be able to have via the Internet, a quick, easy and cheap means to the whole 'history' of a product that appears in the shops. This will be in terms of its origin, production systems employed, quality, and guarantees of all these. There are examples of such sophistication in some parts of the production chain e.g. in the sugar, potatoes and meat industries.

2.3. Ability of the on-going E-commerce developments to fulfil the agriculture industry's aspirations

The Internet has fulfilled the expectations of the food production chain only partially so far. For information provision, particularly news and weather information, the Internet works well. Intranets have also already proved themselves. However, data on numbers of page visits, "hits", "downloads", even of subscribers, give a misleading impression of the value of Internet use. "Real", "material" E-commerce - the exchange of goods via on-line systems - is still limited. Some figures suggest that only 0.5% of goods are traded on-line. Homogeneous 'commodities' such as fertilisers, lend themselves quite well to Internet trading. Recognisable agrochemical or seed brands, plus low-cost machinery and equipment, also trade relatively well. However, marketing of higher value machinery and products requiring a strong element of added advice and/or after sales service have not moved in significant numbers to the Internet. There is an uneven level of activity. Figures for PC ownership and Internet connectivity conceal a low level of real E-commerce. The UK appears to be ahead, with Germany trying to catch up. French agriculture has been relatively slow to adopt the new technologies. France is characterised by a large number of pilot projects sponsored by major players. Many factors, from structural differences to the existence of successful systems, e.g. Minitel, explain the lack of uniformity across Europe [4].

2.4. The state of E-commerce in developing agriculture

It is widely accepted that the ICT gap between the developed and developing countries is growing. For instance all 54 African countries are connected to the Internet. However, the latest figures [7] indicate that from a total of approximately 1,000,000 Internet dialup subscribers in Africa (less than 1% of world Internet intended users), 20% are located in North Africa, 65% in South Africa, leaving 50 countries to share 150,000 accounts (http://demiurge.wn.apc.org/africa/afstat.htm). Moreover, although no relevant studies have been found, it is speculated that users are more likely to be located in urban areas than in rural ones. Given the importance of agriculture in developing countries, reversing the rural disadvantage in E-commerce should be a high priority for development.

In Africa, the private sector, foreign companies and development organisations have driven Internet diffusion, while non-government organisation (NGO's) had played a smaller but a significant role [5]. Particularly, private small and medium entreprises (SMEs) in Africa are recognised as potential driver in the information economy due to their flexibility and adaptability [6]. Thus potential opportunities for Business to Business (B2B) development should include the formation of strategic alliances of local private SMEs with foreign distributors as a way of accessing new markets and quantify business issues like branding, pricing and distribution of their products. However there is a large number of NGOs that aim to promote ICT and E-commerce diffusion in developing countries. All these attempts are meeting barriers.

Two broad categories of barriers can be identified with respect to E-commerce development in developing countries [7]:

1. national barriers stemming from inland insufficiencies: lack of viable and cost-effective information and communication infrastructure; low legal environment to ensure pluralism in the information and the communication sector; state of the economy; business low knowledge of ICT capabilites for development; physical and virtual isolation.
2. Cross-national barriers attributed to the necessary coordination and administration between two countries: resistance to change; economic issues, like cost justification of global E-commerce, inflation rate and currency exchange; political issues with limited public access to the Internet in certain countries; cultural issues like language; legal issues like acceptance of electronic signatures in some countries.

3. The development of ICTs in agriculture and the rural world as characterised by the evolution of the farm equipment

3.1. The data management at the farm level

Since the beginning of the 80's, the use of software at the farm level is moving from accounting and management purposes to process control, automation and technical decision support applications. The machinery and equipment of the farm is now included in the information system.

This spreading evolution of the use of IT leads to a radical change in the farm data system conception and architecture. In broad terms, we have started from a "closed" information systems, which lasted roughly until now. We are facing today the fast-growing development of "open-systems".

Within the farm itself, some field-buses will be used, an example being the CAN bus for mobile equipment. These field-buses will make possible to exchange a huge amount of data between control devices, process computers and management computers. ISO standards 11783 (data interchange for mobile equipment), 11787 and 11788 (data interchange between stationary equipment) are designed with the goal in mind of having open-systems, in a multi-manufacturer environment.

At the same time, the economic environment of the farm acts to push the use of EDI techniques for data interchange. These EDI techniques are becoming essential for the farm management because they will support commercial and technical relationship between the farm and its partners (advisers, suppliers, customers). This implies the use of:

- internal EDI: for instance within the farm EDI between technical process computers and the management computer;
- external EDI - between the farm and its partners;
- a number of factors contribute to this evolution toward a wide use of EDI and of field buses [8];
- technical innovation, especially the very rapid development of Precision Agriculture technologies. To obtain the best possible use of inputs, there is a need first to map in-field variability (tractors and combines could function as data triggers) , and then to analyse data and to apply variable rates of inputs on-the-go. Data interchanges include:
  - on one hand, internal EDI (EDI between tractors and implements, between tractors and the farm management computer);
  - on the other hand, external EDI (between the farm's equipment and contractors' equipment, between the farm management computer and the cooperative's computer or the advisor's computer).
- demand for traceabilitv of products, crop cultivation processes and inputs. This new requirement stems from both rules and regulations, as well as from consumer and market demands. Farmers must be able to produce reliable records of which inputs and techniques they use on crops (kind of inputs, rate and date of application of these inputs), and on livestock conditions (nature of feed, use of drugs). Until recently data registration have been carried out by the farmer for his own management needs only. Demand for traceability implies that farmers are able to register data in a standard manner despite the variety of software they use for management purposes or the way in which products are distributed and sold. There is, therefore a considerable need for a complete, consistent chain of traceability from the field to the consumer.

The development of field-buses on mobile equipment will be a great help for the automatic recording of reliable technical data in the crop production sector (this could be done without an increase in driver work-load, and with a reduction in non-recorded data). This change meets the requirements both of Precision Farming and of traceability of fieldwork done on crops and inputs used.

3.2. Precision Farming

Precision Farming (PF) is a systems approach to managing crops and land selectively. PF has been defined as "The management of spatial and temporal variability to improve economic returns and reduce environmental impact". This type of management approach utilises many forms of information technologies to help understand the complexity of spatial and temporal variability found on all farms. Management is the essential factor to achieve a stated outcome for the farm. A number of management strategies have been identified and developed to improve the overall efficiency, while taking into account specific crop, soil, economic, environmental and risk factors. Managers need to identify their own strategies and practices that allow them to deal effectively with the variability found on their farm in line with their personal values.

Three types of variability have been identified. The first type is spatial variability, which can be seen as changes across the field. An example would be where one side of the field yields higher than the other side. The second is temporal variability, where factors change over time. This can be seen when a crop starts by growing well but results in a poor yield. The third type is predictive variability. This is not a physical term like the other two but is the difference between what the manager predicted would happen and what actually happened. The classical example of predictive variability is where the manager predicts that a certain yield will be achieved if a certain amount of fertilizer is applied, but the crop does not achieve it because the weather changes. Each type of variability must be measured, assessed and possibly influenced, according to how significant it is.

Before the steam engine, and later the diesel engine, farms were managed on a small scale. After mechanisation, the field sizes increased, and now we have economic pressures forcing the scale even larger where a few people are running a number of farms. This means that the scale of management has changed from a few acres (the area a horse can plough in a single day) up to thousands of hectares. When farms are managed at this level it is difficult to have intimate knowledge about the soil types and field conditions. Precision Farming technology has allowed managers to have a better understanding of field parameters at the sub field level while running a large farm. As these large farms are highly mechanised, additional instrumentation to measure the variability (e.g. yield mapping) and controllers (e.g. spatially variable fertiliser application) to help manage the inputs, can be easily added.

3.2.1. Measuring Variability

The first stage in the PF process is to measure important factors that indicate or affect the efficiency of the growing crop. The two main approaches are to create yield maps through instrumenting the harvesting system or assessing soil parameters by sampling. Both techniques give information about different parts of the cropping system. Yield maps are historic and cannot be used while the crop is growing, but record the actual yield during harvest. Soil sampling can be expensive but many soil parameters such as texture and horizon depths do not change over time, so is a good investment. Measuring soil nutrient status must be treated with care as repeatability, let alone accuracy, is difficult to achieve. Sampling strategies based on a simple grid tend to be expensive and better-targeted sampling techniques are being developed [9]. Asset surveys can also be carried out to record physical features, such as field and crop boundaries, high trees that may cause shading, compaction in gateways, etc. Other high-density rapid assessment techniques are becoming more important such as remote sensing and aerial digital photography or non-contact sensing such as electro-magnetic induction [10]. Aerial digital photography can give real-time information of the crop canopy and allow management to be modified while the crop is growing.

3.2.2. Assessing the Significance of Variability

Once the variability has been measured, it should be assessed to see how significant it is to the manager. Normally this is done by looking at the spread of the yield histogram or seeing if the extreme values lie outside acceptable thresholds, such as indices for soil nutrients. One technique is to reclassify yield data into ‘gross margin’ maps [11] as shown in **Figure 1**. This technique deducts the variable costs from the income, which varies spatially with the yield, resulting in a gross margin map that shows which areas generated more income than others. Some gross margin maps have shown areas that actually loose money. Given enough detail, a similar map based on inputs could be produced to show environmental impact such as nitrogen fertilizers in a nitrate sensitive area.

3.2.3. Management of Inputs

Most traditional systems over-apply inputs such as seed, spray and fertilizer to reduce the risk of crop failure. With better assessment techniques, the inputs can be reduced or redistributed to optimal levels and the risk of failure can be managed. This results in making the overall production system more efficient.

Regardless of the country or crop, efficient management of an agricultural cropping system is complex. To improve the efficiency, computer based Management Information Systems (MIS) must be sophisticated enough to deal with this complexity and the manager's strategies and practices [12]. The management input and computing support is the same in each country and each crop. Some crops may well have special considerations that should be taken into account when designing the MIS, such as planning the harvesting logistics when supplying crop to a processing factory.

Current positioning systems (usually based on the Global Positioning System) can now attain sub-metre accuracy. Although we can measure variability at this level it is not yet practical to manage at this level. The size of the management unit depends on the ability to measure, understand and manage it. The smallest management area may be limited by the machine width. A draft methodology for dealing with this in-field variability has been proposed [13].

Precision farming has now developed to such a level that the underlying principles are being identified [14]. These principles show that PF can be applied to any country and any crop but the way in which PF is implemented (and hence the cost) will vary according to the local situation. But it is the management strategy adopted by the farmer that has the greatest economic and environmental impact.

3.2.4. The adoption of precision farming technologies

Technology adoption can be examined across time or space [15]. Either way, the pattern of PF technologies adoption has been uneven. Despite the rapid growth of global commerce and the widespread availability of equipment for Variable Rate Applications (VRA) and yield monitoring, adoption rates appear to differ sharply from one country to another, at least based on the informal data available [16]. Yield monitors are being adopted rapidly in Argentina, but less so in Brazil or in France. Site-specific fertilizer use is rare in Argentina, despite the growth of yield monitor use. In Malaysia, site-specific fertilization is being applied to rubber plantations, but not to rice fields. Even within a country such as the United States, PF adoption rates vary by a factor of ten - from 11.3% of farms in the Midwestern "Heartland" to only 1.1% in the South-eastern Seaboard in 1998 [17]. In general, we observe that in favoured areas adoption of yield monitoring or VRA fertilization has surpassed 5 percent only in the United States and Canada. It would appear that adoption rates in the 1-5 % range (again, only for favoured sub-regions) may pertain in Australia, Brazil, Denmark, United Kingdom, and Germany. With the exception of a few yield monitors in South Africa and some VRA fertilization in isolated plantation agriculture enclaves, adoption of PF technologies do not clearly appear in Africa and Asia.

The basic patterns observed so far in adoption of precision agriculture technologies are likely to continue into the foreseeable future. Technology adoption will expand fastest in land abundant areas where human and financial capital are available and the use of labour and variable inputs is already quite efficient. This category includes the United States, Canada, Australia and parts of Argentina and Brazil. In areas with greater population pressure and less land for agriculture, but ample human and financial capital (e.g. Western Europe), adoption will expand more slowly unless and until environmental benefits are better documented. Elsewhere, there will likely be adoption in enclaves where land and capital are available and well-managed. Examples are plantation agriculture in parts of the tropics as well as large farms in northern Mexico and perhaps South Africa.

3.3. The current stage of Information Technology in the farm machinery as illustrated by state of the art in tractor autonomous navigation

Among the wide variety of applications of

ICTs to farm machinery already on the market, or at advanced research stage [18;19], one can illustrate the state of the art on ICTs development by the current products and opportunities available for vehicle navigation ([20] and **Figure 2**): parallel swathing. Precision positioning systems based on GPS technologies that reduce overlap between spray vehicle passes. The commercial need is for systems that function in straight- and curved-path tracking.

- parallel swathing: precision position systems based on GPs technologies that reduce overlap between spray vehicle passes. The commercial need is for systems that function in straight- and curved – path tracking;
- crop-edge tracking: in cultivation, forage and combine harvesting, tracking row crops or crop edges while an operator is in the machine or on the row, is technology for development;
- precision path tracking: planting based on a navigation map is an operation requiring a high-accuracy positioning sensor such as real-time kinematic GPS. For conventional planting, row markers are extended to indicate the guidance course to follow. Precision map-based systems require no row markers so field efficiency is increased by reducing turning time losses. If system accuracy is guaranteed, eliminating row markers can reduce planting equipment costs;
- turning assists functions: systems that automatically turn a machine at the row end reduce unproductive time an operator spends aligning equipment for the next field pass;
- remote guidance: remote control guidance systems can remove the operator from dangerous tasks. Japanese industry has developed such a mower tractor for uses such as steep hillsides along highways. Wireless computer networking is inexpensive and can provide line-of -site vehicle observation and control;
- operator aids for the handicapped: assisted guidance tools allow disabled farmers to perform field operations using navigation technology or cooperative automation;
- multi-vehicle cooperation: cooperative navigation between machines can enhance productivity for operations typically coordinated between operators in different vehicles. Coordinating unloading between a moving combine and grain cart is an example. Master-slave multiple harvester control is another.

3.4. A scenario of developed agriculture in 2025 and its consequences for ICT in the farm equipment

3.4.1. Current trends of agriculture as indicators for the future

Trying to predict what is going to happen in the future is notoriously difficult and prone to errors. Even luminaries like Bill Gates is reported to have said, “Who will ever need more than 640 Kilo bytes of memory?” Most modern PCs now have more than 100 Mega bytes of memory. But a tried and tested way is to look at what has happened in the past, consider the present, and project the major trends through into the future then we can consider the implications. Although this cannot take into account sudden technological breakthroughs or political turns, it gives us the framework in which we can explore a likely scenario.

What are the current drivers that promote change in today’s agriculture? Apart from political intervention and technological breakthroughs, it would seem there are two: economic drivers and environmental drivers. As world prices for food products fall and production subsidies are phased out, many farmers today are under increasing financial pressure to remain a viable business. Farmers are trying different ways to reduce the cost of production. Many farmers are taking advantage of economies of scale in their farms such as increased farm size, larger fields and bigger tractors. This is leading to a more industrialised type of agriculture, which is at odds with the second driver – environmental considerations.

High production agriculture has utilised agrochemical inputs such as fertiliser and sprays to increase and protect crop production. Recent food scares (PCBs in Belgium and BSE in the UK) have highlighted public concern about food safety that supermarkets are now willing to pay a premium for food products that have a record of all the treatments carried out on them. This public need for apparently clean and healthy foods have also been demonstrated by the rise in organic food production to such an extent that demand for organic produce outstrips production. Similarly, the public perception of herbicides and pesticides is so low that legislation in Denmark has been put in place to limit and tax the use of agrochemical inputs to minimise their use.

Both of these drivers promote a more efficient type of agriculture that is sustainable in the short and long terms. This type of crop production must be economically viable as well as environmentally sound. One way of achieving this has been embodied in the development of Precision Farming.

3.4.2. Envisioned evolution of ICTs

It is inevitable that any forecast of agriculture is going to involve a significant amount of information technologies. Moore's law states that processing power doubles every 18 months, so by the time we reach 2025 the computing power is probably unimaginable. What do we do with this computing power now? Effectively, the more computing power we have, the more complex problems we can solve. So as processor speeds have just gone through the 1 GHz barrier (in 2001) what complexity can we deal with when we have a 65 Tera Hz (65 Tera hertz = 65000 Giga Hertz) computer? Presumably we will also have the associated memory, display and storage facilities to match this awesome processing power. Perhaps by then we will have developed programmes that can model the real world in better ways than we do now. [21] Most computer programmes are still highly deterministic (finite state machines) that reflect the views and values of the programmers, but with this power we should be able to have more sophisticated self-modifying software that can adapt itself to the individual needs of the users as well as improved modelling of the real world.

3.4.3. Management Information Systems

The embryonic Management Information Systems (MIS) we see now are no more than glorified databases. When we effectively remove the processing constraints, add in the data availability from the internet, integrate real world sensing systems, we have the possibility to develop an ideal information system that can give highly personalised management information on demand. We should be able to have answers to questions like: What are the optimum fertiliser rates for this field, taking into account recent weather, current crop price trends, actual soil nutritional status, risk of pest attack? etc. We can see the complexity rising exponentially with each factor we add, but these are only some of the factors a farm manger takes into account when making a decision. Although computers cannot and will not be able to predict the future with any real certainty, they can help us deal with these complex issues. What we need to develop alongside the hardware is the ability to embrace complexity without becoming swamped by it.

3.4.4. Future machinery systems

If we take a systems approach to forecasting what crop production will be like in 2025, we need to make some assumptions.

1. Land will still be used for crop production and hence will need mechanisation.
2. IT progresses at the current rate enabling more intelligent systems [22, 23].
3. Economic and environmental drivers still promote efficient use of inputs.

Over the last decade new information technologies, such as GPS (Global positioning System) and GIS (Geographical Information System), have been introduced that has allowed the scale of management to be reduced from farm level, down to field level and occasionally to sub field level. With the advent of new information technologies, such as behaviour-based robotics, this process can be continued into the future by looking at an even smaller scale such as plant scale technology or Phytotechnology. (From the Greek phyto, which means plant) These new Phytotechnology units will be small autonomous systems that can behave in a sensible manner for long periods unattended, caring for the individual plant from seeding through to selective harvesting. With this level of sophisticated equipment, it is likely that higher value crops such as in horticulture or forestry will be able to justify such an investment first. Very little new hardware will be needed but the challenge will be in defining and implementing sensible behaviour and developing the systems architecture to support it.

If we try to utilise IT to the full extent we could replace many of the high-energy inputs such as fuel, herbicides and fertiliser, with more intelligent processes to achieve the same ends.

3.4.5. A new concept of small autonomous vehicle

To further improve the efficiency of developed agriculture, horticulture and forestry, found in northern Europe a new concept is promoted: it proposes multiple small autonomous machines are more efficient than traditional large tractors. In order to meet this hypothesis a small tractor with intelligent control is required. These vehicles will be able to work longer hours at a slower rate, giving the same, or even greater, overall output as conventional systems. Each vehicle would be capable of working 24 hours a day all year round, in most weather conditions and have the intelligence embedded within it to behave sensibly in a semi-natural environment such as horticulture, agriculture, parks and forestry, whilst carrying out a useful task. Moreover, it may have less environmental impact if it can replace the over-application of chemicals and the high usage of energy, such as diesel and fertiliser, by control that is more intelligent. Additionally, it will require smaller incremental investment and will have lower labour costs. Finally, it may have very low soil compaction that would lead to a more sustainable production system. [24]

The requirement for a more integrated approach to the varied agronomic operations that take place, starting with primary tillage and ending with crop harvesting, can be demonstrated by undertaking a systems analysis of the processes associated with the management of spatial variability (**Figure. 3**). The decision-making process is complex but ultimately results in the production of a field operations map that contains the necessary control and guidance instructions required for a specific agronomic operation. A number of specific processes are involved. Managers call upon their personal preferences and previous experience (1 in **Figure 3**) as well as agronomically sound interpretations (5) of data from the farm information system (2). In the field, the operator (3) may adjust various parameters on the machine and controller (4). These should be recorded as well as any other pertinent factors regarding the actual use of the machine, such as discrepancies, faults and blockages. The controller should also record the actual treatment, which may differ from the desired treatment, as this maybe useful management information when treating the field next time or trying to understand reasons for subsequent variability [25].

If a suitable intelligent control system that exhibits sensible long-term unattended behaviour in a semi-natural environment can be developed then a completely new mechanisation system can be designed. To be able to achieve this the vehicle must have certain attributes and behaviours.

The main design parameters for this proposed vehicle are that it is:

- small in size (and therefore unmanned);
- light weight;
- exhibit long-term sensible behaviour;
- capable of receiving instructions and communicating information; [1]
- capable of being co-ordinated with other machines; [1]
- capable of working collaboratively with other machines; [1]
- behave in a safe manner, even when partial system failures occur; [1]
- carry out a range of useful tasks. [1]

[1] These parameters are not discussed further here but a more detailed description can be found in reference [24].

3.4.6. Autonomous behaviour and the key role of ICTs

The main behavioural requirement of this vehicle is that it will have sensible long-term unattended behaviour in a semi-natural environment such as horticulture, agriculture, parkland and forestry. This sensible long-term behaviour is made up of a number of parts. Firstly, sensible behaviour needs to be defined, which at the moment is device independent. Alan Turing defined a simple test (the Turing test) for artificial intelligence, which is, in essence, if a machine's behaviour is indistinguishable from a person then it must be intelligent. We cannot yet develop an intelligent machine but we can make it more intelligent than it is today by defining a set of behaviour modes that make it react in a sensible way, defined by people, to a predefined set of stimuli in the form of an expert system that can learn. Secondly, it must be able to carry out its task over prolonged periods, unattended. When it needs to refuel or re supply logistics, it must be capable of returning to base and restocking. Thirdly, safety behaviours are important at a number of levels. The operational modes of the machine must make it safe to others as well as itself, but it must be capable of graceful degradation when subsystems malfunction. Catastrophic failure must be avoided, so multiple levels of system redundancy must be designed into the vehicle. Fourthly, as the vehicle is interacting with the complex semi-natural environment it must use sophisticated sensing and control systems, probably in an object oriented manner, to be able to behave correctly in complex situations.

Behaviour in general terms is a thematic set of reactions to a stimulus. Behaviour-based systems provide a means for the vehicle to execute a behaviour e.g. navigation, by endowing the vehicle with behaviours that deal with specific goals independently and coordinating them in a purposeful way [26]. Four main behavioural modes for this vehicle have been identified as: navigation, exploration, self-awareness and implement task mode.

1. The vehicle must be able to navigate safely to a desired position. We estimate that the vehicle will be in navigation mode around 80-90% of its time, as positioning itself and its working tool is the vehicle's main requirement. The vehicle must be able to plan an efficient route to the target point taking into account known objects, tracks, paths, gateways etc., as well as being able to react to unknown objects or situations. This high-level behavioural mode subsumes other lower level behaviours such as route planning and object avoidance.
2. The vehicle will be fitted with local environment sensing systems, which will enable it to explore and record an unknown environment. If the vehicle is initialised in an unknown area with an empty GIS, it can start to populate the GIS with its own data. In the exploratory mode, the vehicle will record data from all its sensors at the current position. If it assesses that it is safe to move ahead it will then move slowly recording relevant data as it moves. Once an area has been explored and surveyed, more optimal deterministic route plans can be made to carry out further detailed surveys. A good example would be a self-adaptive soil survey based on the position and the results from the sensor. Fewer readings could be taken from seemingly homogenous areas, while more intensive sampling can occur in areas of heterogeneity.
3. The vehicle will also be fitted with self-sensing systems built into it to keep a check that all the major parameters are within normal limits. Some of these parameters will be fuel level, engine temperature, tilt angle and outside temperature. It may be beneficial to add a small weather station as well so that it can return to base or close down if conditions get too bad. This behavioural mode is not mutually exclusive to any of the other modes so may be run entirely in parallel as a separate process.
4. Each implement will have its own special requirements for calibration and error checking. It is envisaged that each implement task will have sub-behaviours and that all the processes can be properly calibrated or checked. This will allow the task to periodically carry out a self-check to ensure all functions are working correctly.

If an implement task recognises that the weeding tines are worn or that the camera lens is obscured it can carry out remedial action or instruct the autonomous tractor to return to base for servicing

The outcome from introducing such a mechanisation system could be a very different way of achieving the same goals. Efficient, cheap production of crops with minimal environmental impact has been the farmer's goal for many years, but the opportunities offered by advances in IT now make it realistic to consider new alternative ways of achieving it. Most mechanical, hydraulic, electrical and computing systems are available today, but with the prospect of 'unlimited' computing power, we need to design new systems and control architecture to take advantage of it.

These new machine concepts can now start to be formulated with on one assumption and that is this computing power can be harnessed to give the machines (both MIS and autonomous vehicles) the desired behaviours. The main advances will be made in developing an information system architecture that allows emergent behaviour that can be recognised by people as useful. The associated cost will be relatively low as existing hardware can be used and the cost of processing power is always reducing. The only real development is in the architecture and software. If this is a valid assumption, a new generation of agricultural equipment can be designed, with integrated management support that gives an understanding of the economic and environmental impact of each action carried out. If environmental issues are of concern then environmental management practices must be adopted.

4. Enforced attention to IT ethics issues: deontology in systems design

It is shown in this paper that Information and Communication Technologies have pervaded the modern world, and thus the food and agricultural sector. It appears also from the future prospects which are proposed that this will be more and more the case with the credible futuristic concept of 'unlimited' computing power. In front of this fascinating technological venture, people are growing more aware of its concomitant threats and disadvantages: a number of social, psychological, ethical drawbacks have been already pointed. Strong ethical problems are met [27]:

- from confidentiality of personal or corporate information, to ownership of data flowing in the openness of the world wide web;
- from uneven access to the key information between social group, corporations, countries, to the eventual biased view on reality related to the virtual representation of facts and systems;
- from the hidden messages and influential so-called "logic" carried out by the ICTs sold or in use on the market, to the potential of power taking by "Big Brother" type of undesirable partners.

Most of the engineering project management methods have been dealing until recently with mainly technical and management aspects of the procedures [28]. Introducing social and human aspects in the designer scope of perception have been a matter of concern during the last decade [29]. When dealing with the ICTs aspects of engineering design we have now to introduce first components of a deontological code of practice, especially for the ICTs projects involved in the food and agricultural sector as previously mentioned.

In [30] Mumford says "Ethics is a means for enabling everyone concerned with the introduction of new technology to consider human as well as technical factors when embarking on the design of a new system. .... Participation enables a shared learning process to take place in which systems designers and users can jointly contribute to the design process. Each of these groups has different interests and objectives and these can be brought out into the open and discussed as part of the participative process. As mentioned in [31], in the past, and also today, the values of technologists and managers have influenced them to look primarily for efficiency gains when they were introducing technical systems and they have frequently designed these systems to achieve such goals as a reduction in staff numbers and tighter financial and operational controls. They have therefore focused on structural elements in the change situation and used machines to replace people and to monitor more closely the work of those people who remained. Yet because people are an integral part of all work systems, and because people have values, attitudes, and psychological needs, a neglect of their interests can throw a change situation into a state of disequilibrium; so, instead of the change producing the desired increase in efficiency, the new system operates more inefficiently than was anticipated and gains may not outweigh the costs of innovation.

Legislation has already been passed in many parts of the world to take care of these ICTs threats and disadvantages. Data Protection Act is a prime example of such legislation which deals with problems concerning citizens, governmental agencies and other organisations. The British Data Protection Act (1984) states that system design must be judged by how well it fulfils eight principles stated or interpreted in terms such as:

- persons providing information should not be deceived or misled as to the purpose for which the data will be used or disclosed;
- personal data shall be held only for one or more specified and lawful purposes;
- personal data held for any purpose or purposes shall not be used or disclosed in any manner incompatible with that purpose or those purposes;
- personal data held for any purpose or purpose shall be adequate, relevant and not excessive in relation to that purpose or those purposes;
- personal data shall be accurate and, where necessary, kept up to date;
- personal data held for any purpose or purposes shall not be kept for longer than is necessary for that purpose or those purposes.

It appears that the legislation for the information age is closely related to the state of mind in deciding whether someone may be guilty of a violation of legislation with regard to the use or misuse of information. When reviewing legislation in various states the terms in which such violation is described include one or a combination of these words: recklessly, knowingly, wilfully, willingly, intentionally, purposely, maliciously…

In his *"Ethics for the Information Age"* [32], Oz makes the point that "Many educators have complained that higher education institutions produce information systems professionals who are qualified technically but are ill-prepared to deal with ethical concerns". In discussing the evolution of ethical codes he reminds us of the words of Thomas Jefferson who said: "Laws and institutions must go hand in hand with the progress of the human mind ... As new discoveries are made, new truths disclosed, and manners and opinions change with the circumstances, institutions must advance also, and keep pace with the times."

The invention of printing has shown that technical innovations can originate deep social revolutions. That could be the case for the whole information and communication technologies, which converge in the Internet. The question is: what is to be done to make sure that the result of such a revolution - if any will benefit to the Common Good, which is nothing else than the whole conditions of the development of economical activities as the food sector? An adapted deontological approach at the very beginning of the food systems and products, at their design stage, is essential.

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Table 1 - Numbers of farmers equipped with PCs and connected to the Internet (data derived from various sources and therefore not strictly comparable)

COUNTRY	NUMBER OF FULL TIME FARMERS	FARMERS USING A COMPUTER	FARMERS CONNECTED TO THE INTERNET
Czech Republic	175 000	30 000	4 000
Denmark	60 000	48 000	30 000
Finland	80 000	50 000	40 000
France	330 000	110 000	25 000
Germany	170 000	75 000	55 000
Ireland	40 000		10 000
Italy	260 000	80 000	10 000
Japan	426 000	144 000	52 000
The Netherlands	100 000	60 000	50 000
New Zealand	40 000	22 000	
Norway	70 000	52 000	40 000
Poland	2 000 000	100 000	5 000
Spain	1 000 000	45 000	10 000
Sweden	30 000	24 000	14 000
United Kingdom	80 000	60 000	30 000

Figure 1. - Gross margin map with yield scale (1GBP=12DKr) [[1]].

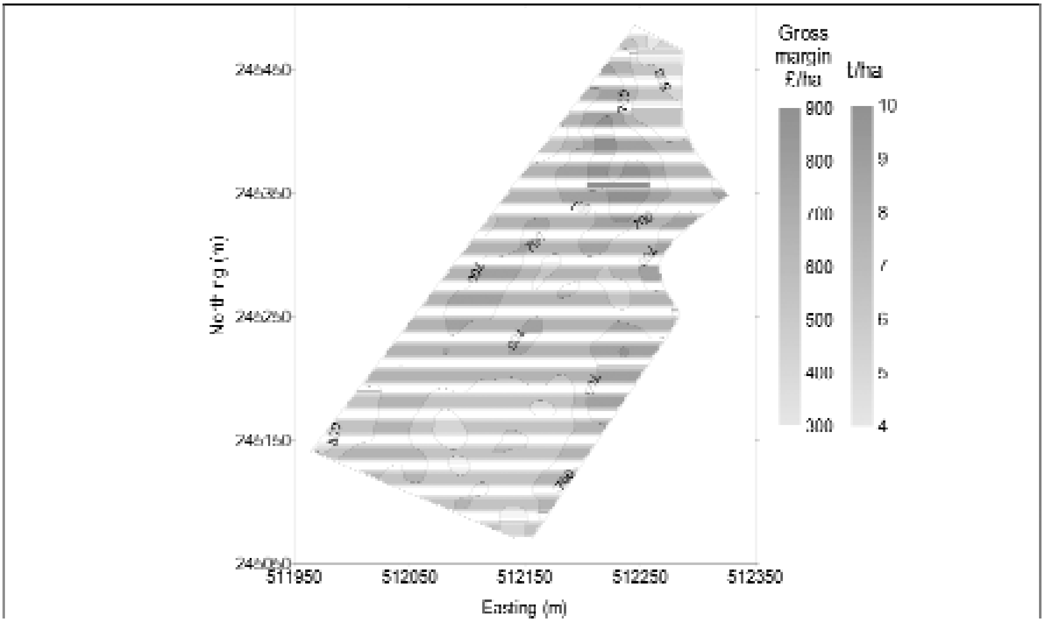
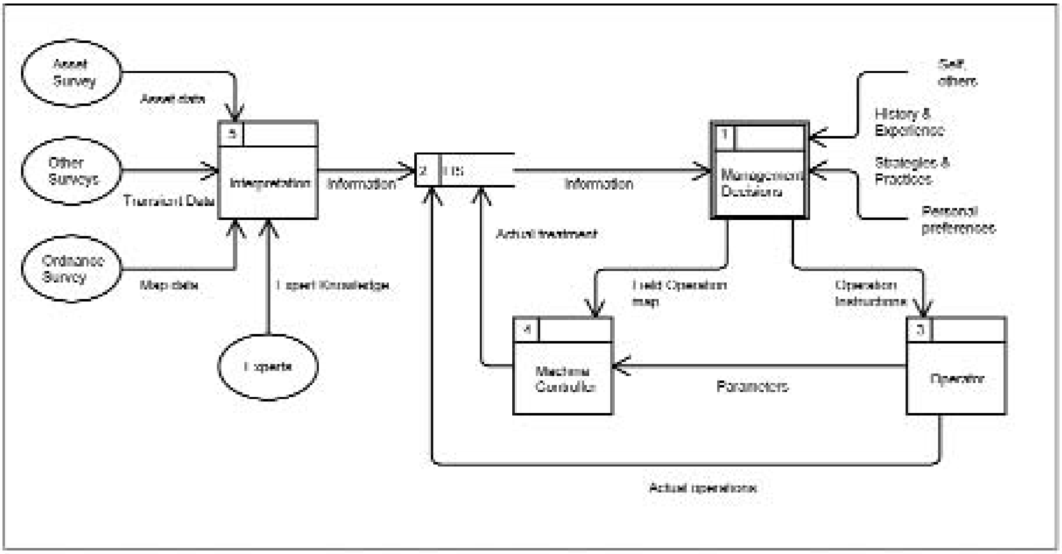


Figure 2 - The John Deere "driverless" orchard tractor has been publically presented in 2001. This type of tractor is intended to safely apply chemicals without operator assistance

Figure 3 - Logical data flow diagram of the management process



Development of agricultural mechanisation to ensure a long-term world food supply

Topic 4 – Report 1: New educational requirements (extensionists, dealers, farmers, workers, ect). Role of the agricultural mechanization higher education

*by **B. Snobar** (Jordan)*

1. Introduction

The mission of the Agricultural Mechanization Educational Institutions is to teach, research and provide extension and other farm related community services in an integrated approach for the resolution of agricultural issues leading to the development of agriculture to assure long lasting global high quality food supply using environment friendly production, processing and handling technologies at affordable prices for all people.

In its last Agricultural Report of the 20th Century, Doane's ranked the top 10 agricultural impacts of the 20th Century. The research and educational programs in the U.S., led by land – grant university system was the number one factor that transformed agriculture in the Century. Agricultural Mechanization was ranked second. Agricultural mechanization development allowed a significant increase of the cultivated areas and the yields. The remaining 8 impacts were ranked as follows:

- third, hybrid seed corn;
- fourth commercial fertilizers;
- fifth, chemical pesticides;
- sixth, modern animal science.
- seventh, government farm programs;
- eighth, transportation infrastructure;
- ninth, globalisation of markets;
- tenth, conservation tillage.

Agricultural Mechanization was ranked number seven among "The 20 Greatest Engineering Achievements of the 20th Century" which were announced by astronaut/engineer Neil Armstrong on February 22 of 2000.

It was stated that "the machinery of farms (tractors, cultivators, combines and hundreds of others) dramatically increased farm efficiency and productivity in the 20th Century". At the beginning of the 20th Century it took 4 farmers to feed 10 people. Today farm machinery allows planting and seeding the crops in few days and one farmer can produce enough food to feed more than 100 people.

2. Educational Institutions of Agricultural Mechanization

The educational institutions teaching agricultural mechanization are of three levels:

- Vocational Schools (last 2 or 3 years of the high school);
- Colleges (1 to 3 years after high school);
- Universities (BSc, MSc and PhD).

So far the teaching content and methodology used at these three levels of education are considered to be traditional. However, new educational concepts were introduced and some changes were made in the last 10 years at the university level in order to deal with the challenges and requirements of the 21st Century. Yet, further discussions at local, regional and international levels are still needed on the new educational requirements at the university level for all fields of sciences and knowledge in general and in agricultural mechanization in particular in order to assure long-term global food supply.

Traditionally, the universities are concerned not only in teaching but also in research, extension and services unlike the vocational schools and colleges. Therefore, we will restrict our thoughts on the new educational requirements for the development of agricultural mechanization to assure long-term global food supply on the university level emphasizing that the requirements at the other two levels needs to be looked at as well.

3. Duties of the agricultural mechanization Educational Institutions at the University Level

The duties of the agricultural mechanization departments, faculties or universities are:

3.1. Teaching

Teaching includes courses in the basic science such as biology, chemistry, physics, mathematics, statistics, mechanics, thermodynamics as well as the courses in the specific fields. These courses are classical traditional courses in their contents and in the methodology of teaching. Recently, an attempt was made and is being made in order to modify the curricula of the agricultural mechanization university degrees. One of the major changes was implementing the interdisciplinary systems science approach. To emphasize this the traditional name of the department of Agricultural Engineering which includes the Agricultural Mechanization discipline was changed in most of the universities to Biosystem Engineering.

What is expected from the graduates majoring in Agricultural Mechanization.

If we can agree on a reasonable answer to this question, we will be able to design a curriculum capable of preparing the graduates to face the challenges and contribute towards the goal of reaching a long-term global food supply.

Back to the mission of the Agricultural Mechanization Educational Institutions which was stated in the introduction. If the teaching part of this mission is accomplished the graduated professional will be able to:

- implement the acquired knowledge in: facilitating the production of high quality food proper handling of the produce;
- dealing with production and post harvest constraints;
- deal with the environmental issues;
- deal with the socio-economical issues;
- deal with the marking constraints;
- deal with the water shortages;
- understand and use the latest technology;
- use the Information Technology tools and means.

If these are to be accomplished, the curricula should include courses and knowledge in an integrated manner (module) in which the whole subject on Biology or Mechanics or Soil etc. Could be taught in a one unit by several instructors during which the basic and the practical aspects and research results could be given to the students as one unit on a particular subject.

The social, political, economic and marketing courses should be integrated in the curricula. International relations and markets and consumer awareness and preferences and habits should be included in the content of some courses. Globalisation not localization or regionalization should be considered in the university educational systems.

3.2. Research

One of the most important mission of the university educational systems is conducting research leading into the improvement of the living conditions of people without discrimination and without infringing on the right of other living soul taking the environmental issues and the preservation of natural resources issues into consideration. In order to do so here are some of the suggested research projects need to be conducted in the field of Agricultural Mechanization:

- global warming;
- developing instruments capable of measuring the quality of fresh and processed food;
- perform the agricultural operations with least cost and minimum negative effects;
- develop a single multipurpose harvester capable of harvesting several vegetable and fruit crops with no losses or damages to the produce (as the case of the grain combine);
- develop mechanical or biomechanical method to control pests;
- develop water saving irrigation systems;
- develop a system capable of measuring the environmental parameters at all times in the field in order to minimize the negative effects;
- develop weather detectors and weather prediction and warning systems.

3.3. Extension

Providing extension services and farm related community services to the farm community and consumers as well as training students and others to become extension agents are one of the mission of the educational institution of Agricultural Mechanization.

The goal of the extension part at the universities in general is to provide services and discuss problems facing the farmers and farm community on the hope that these problems could be solved through the professional knowledge of the extension specialist or through additional studies and research and investigations. It is customary that the extension specialist will concentrate in their knowledge on the issues of a particular area or region. Under the new changes in the world order, the extension specialist should be able to deal with the farming community and the agricultural issues at country or regional or global scale. This way farmers could benefit from the extension services for marketing their products and for knowing the consumer preferences in these areas. Therefore, the extension programs should be revised to meet these requirements.

4. Summary

In order for the agricultural mechanization to play a role in the development of agriculture to assure long-term global food supply and in view of the fast growing *Information Technology, Globalisation* and *World Trade Agreements*, the following educational changes are required:

- modification of the teaching methodology and contents of courses;
- integration and team approach of research with emphases on the global types rather than the individual and the local types;
- modification of extension services in a way that less emphases may be given to traditional simple farm related community services to wider range of services and deeper knowledge on global issues such as world markets, environment, consumer preferences and the art of trade in order for the producers to benefit from the new changes in the world.

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Table 1 - University level education in Agricultural Mechanization (classical and new)

	TEACHING	RESEARCH	EXTENSION
CLASSICAL	Individual courses taught by individual instructor using one specific textbook.	Narrow and directed towards a specific problem in a specific zone.	Narrow and directed towards local farmers in specific zone on specific subject.
NEW	Integrated courses in which several instructors are participating in teaching the one subject using several textbooks reports and research results.	Should address problems of wider scope to benefit larger communities in several counties or regions.	Should address issues of global natures in addition to the locality specific ones particularly on the quality, transport, prices, consumer preferences and environmental issues.

Development of agricultural mechanisation to ensure a long-term world food supply

Topic 4 – Report 2: New educational requirements (extensionists, dealers, farmers, workers, ect). New Educational Requirements on Non Academic Education

by ***P. Schulze Lammers*** *(Germany)*

1. Forward

In the previous part of this paper the role of higher education in agricultural mechanization was discussed. As mechanization is an indispensable part of developing the efficiency of land use and, in consequence, of producing food for the growing world population and as modern agriculture is knowledge based, farmers and farm workers need skills to efficiently apply the machinery currently used, and they need to be educated to be able to use new technologies, if they intend to advance agricultural production.

Since the traditional goal of farming was producing food by just using natural resources, over the time more and more technical aids were developed to increase food production. The most obvious strategy has been to replace human labor by new technologies with higher performances. For example, technical means greatly improved the cultivation of crops, reduced post harvest losses and led to a higher quality of agricultural goods.

Professionals working in the field of agriculture to ensure food supply have a unique ethic responsibility. This responsibility does not only comprise efforts to devise new technologies – these should also be made accessible to agricultural businesses outside institutions such as universities or agricultural colleges. Therefore, a proper implementation of innovations in agricultural mechanization is as much part of the mentioned ethic obligation as researching and inventing new technologies.

In the last three decades saving natural resources and protecting the environment developed into central aspects for agriculture as well. Professionals in the field of agricultural machinery need to consider environmental aspects when devising new technologies. Education in general and agricultural education in particular also have to consider these new responsibilities, and this can primarily be achieved by enabling farmers to use new technologies which have been designed especially with regard to aspects of environmental protection and saving of natural resources.

While due to a well developed international research community education on the academic level can claim an international uniformity, non academic agricultural education is, if organized at all, conducted in all sorts of manners. In many cases, however – and this particularly holds true for underdeveloped regions of the earth – education is still a matter of passing on outdated technologies and procedures to the younger generation, which depends substantially on local and regional tradition.

Particularly in this non-academic sector agricultural education in the developed world as well as in the third world is far from being standardized in in a common form. Before looking at various models of non-academic (agricultural) education, a few technical terms need to be clarified to provide a common frame of reference, which can later be used to identify the requirements of educational programs to make efficient use of advanced agricultural mechanization.

2. Discussion of terms

Training is interpreted as denoting the transfer of knowledge and skills of a more practical nature.

Education is the theoretically inclined teaching process. Education is always connected with some sort of educational institution (school, college, etc.). Note that in many training courses both the educational approach and the training approach are combined, whereas the purely educational approach is often criticized for its lack of practical work.

Vocational training indicates that the theoretical content is reduced to a minimum and that the development of practical skills is the predominant objective.

Apprenticeship is a combination of training on the job at farmsites or company facilities and theoretical education in classrooms.

Extension Services are university based training courses for people working in agriculture, either as an advisory service or as informal training.

Note that the different education procedures can be divided into *formal* and *informal* ones. In this respect, formal denotes a course which leads to some kind of degree or title and which is usually organized and supervised by governmental institutions. Informal courses are not organized in such a way.

3. Systems of vocational training applied for agriculture

At the time being three major training systems are in use for non-academic training around the world. They can be characterized as follows:

- *Competence Based Training (CBT):* the idea of CBT is to teach in modules which can consecutively be chosen and which are freely eligible. However, today CBT is not defined as an international standard, and therefore it can be defined as a highly flexible informal education system, which is particularly apt to introduce new programs of training in new technologies. The major advantage of CBT is that it is open to trainees from all sorts of backgrounds (i.e. no special qualifications are needed) and that the education is consecutive, from basic modules to very specialized contents. CBT emphasizes training on current skills and learning just in time not restricted to the period of juvenile apprenticeship. Additional training can be supplied on demand, which gives learners the chance to adjust their skills to current needs requested from the industry or agriculture.
- *The Dual System (DS):* combines two parts of training. The first part is a theoretical education in schools, whereas the second part emphasized the vocational aspects of education in the business facilities (farms, workshops, etc.).

  The focus of the Dual System is a broad fundamental training, which will serve as a basis for future requirements (life skills). Currently required skills are to some extent also part of the programs. Learning new skills in the course of a career has to take place in the working environment by learning on the job.There is a really simple way of finding out whether an education system would be classified as a DS. If all of the following questions gain a positive reply, the system counts as a DS:
  - Are there schools with related curricula?
  - Are the companies having facilities and staff for training?
  - Is there issued at the end a transcript and a degree?
- *Participatory Learning (PCL):* mostly an informal course, the system of Participatory Learning reflects the current requirements of regional conditions and focuses on the inclusion of activities of learners in the training program. Both theoretical as well as onsite practical aspects of education can be found here, as is manifested in numerous publications, which describe Participatory Learning as combining theoretical education with active components in class on the one hand and training in operational skills to be able to apply the theoretical knowledge on the other hand.

Obviously, each of the described major education systems contains elements of the others. However, they are applied in different structures. Different countries basically focus on one of the systems but alter them to some degree in their respective circumstances. The myriad of educational systems which are, therefore, effectively in use raises the question whether any one is better than another or what the deficiencies of the various programs are.

4. Weak spots of current agricultural education

For India education is not integrally related to development programs and that it is isolated from the farming community [1]. Both aspects refer to higher education. Hence the education of non academic personnel needs to match the professionals working in administration and research jobs and professionals working in agriculture or adjacent sectors. The interface between higher education and training for operational or vocational skills

needs to be defined and met by the educational systems on both sides.
The contribution of education to agricultural production has been classified into worker and allocative effects [2]. Allocative education focuses on teaching farmers the ability to acquire, analyze and understand economically useful information, which will put the farmers into the position to make sensible decisions with regard to input used (e.g. mechanization) and commodity-mix. Based on Welch's classification, the influences of allocative education are examined [3]; the Author concluded that a strong continuous investment in education in rural areas in Sub-Saharan Countries will have a significant impact on improving crop productions in that area.
A strong deficiency of professionals specialized in energy generation and rural electrification for countries having non electricity availability in rural areas are indicated [4]. This implies that the issue of rural electrification has been neglected to a great extent in the past. Furthermore, as they detect, the little emphasis on economics and business matters hampers graduates from educational programs in AgEng and mechanization to start up new business.
A demand for education in public schools via programs and instructions related to the application of mechanization has been observed [5]. In German vocational schools programs on agricultural mechanization do exist, but these programs - for many of the learners - cover to wide a scope to cope with [6]. In conclusion the Author suggests rather to train the managerial ability to delegate tasks to service enterprises with specially trained personnel.
Due to more electronics and data processing in agricultural machinery, it has been discovered the need to train farmers as machine managers, and to increase education for adults [7]. The latter is also of a study [8], which underlines the necessity of strengthening farmers' motivation for education through radio and TV stations, this will ultimately increase the production of agricultural food.

5. Training and education requirements and agricultural mechanization

In all work organizations, human labor is probably the most important and valuable asset, and skilled workers are essential for the success of the enterprise. This assessment is also valid for agricultural work organizations, which draw heavily on all kinds of traditions, among them all sorts of traditional ways of farming. The skills and the knowledge inherent in those traditions get transferred from generation to generation, at times without much adjustment to a more advanced level of mechanization.
Modern agriculture, however, if performed successfully, has been characterized by quickly incorporating and thus exploiting the benefits of new technologies. This process, however, cannot rest on the passing on of rather old traditional farming skills. Rather, it very much depends on a decent, up-to-date education of the agricultural professionals of the future. Beyond that, many aspects in the periphery of such new technologies need to be considered in terms of education as well. For example, mechanized spraying systems for fertilizers are only useful if the farmer has been instructed how to use fertilizers sensibly, or advanced machinery can not be used efficiently without a decently equipped maintenance service, the workers of which also need an appropriate education before they can be a part in the clockwork of agricultural mechanization.
Generally speaking, several cornerstones of education in the field of mechanization can be listed, which are globally valid throughout the number of existing systems:

- provide different levels of education for different requirements of the respective profession (possibly also approved by the Government);
- adjust education programs to particular regional needs;
- combine theoretical education and training of crafts skills;
- educate farmers in new technologies and other aspects for successful farming (for example basics in economics);
- educate people in other branches so that businesses and companies in the periphery of agricultural mechanization can work properly.

In the recent past, the important aspect of training provided by agricultural machinery manufacturers has been recognized. In this way, trainees will receive the necessary operational skills they need to properly use and maintain the new technologies they have invested in. Since the producer does everything in the interest of his company, such informal education procedures should be conducted in an environment of economic competition. Since industry training is focused on product information it can only complement a fundamental training on agricultural machinery, which is preferably controlled by state organizations.

All of the above is necessary for a successful education on mechanization of agricultural procedures. However, all the focus on theoretical education must not be allowed to put operational skills to the background, as these are still to a large extent at the core of performing agricultural mechanization.

6. Future education in AgEng and mechanization

It can not be expected that systems of non-academic education can be standardized for the whole world. Regional and developmental differences call for specially devised programs for different regions of the earth in order to meet the requirements on educational systems in agricultural mechanization in the future. The following three groups lend themselves for an adequate classification:

- first group: Developed countries with a highly mechanized agricultural production;
- second group: Developing countries with lack of food for self supply;
- third group: Underdeveloped countries with a quickly increasing population and lack of food.

6.1. First Group

In developed countries, all education on mechanization is primarily orientated to the protection of the environment and natural resources as well as to economic and managing capabilities. Therefore a demand for higher education takes the leading role and must be considered the central issue for future developments of education systems in the first group. Decreasing demands for manual skills are accompanied with an increasing need of knowledge in failure detection of electronic and hydraulic components. Skills in information technology will gradually replace operational skills, too.

Agricultural mechanization will make increasing use of information technology. However, the scope for agricultural food and feed production cannot be assessed realistically without manual work, for example for cultivating crops and for animal keeping. Therefore, the demand for such skills should be met by integrated education systems which avoid the traditional subdividing of careers into lower (such as operational) skills and higher level careers based on academic education. The modern farmer more and more becomes a multi-faceted businessman who needs skills from engineering to management, from biochemistry to accounting.

Looking at technological aspects, establishing centers of excellence to introduce new technologies into agriculture will be the most promising means to promote advanced technologies. Centers of excellence which are dedicated to research and development should take a leading role in education and in training, focusing on the following skills:

- economic and ecological use of agricultural machinery;
- tools and methods of precision farming;
- use of information technology (I.T.);
- capabilities to use mechanization efficiently (I.T. control methods);
- data management and expert systems.

In developed countries adult training and life-long learning are essential parts of education in agricultural mechanization since only a continuous education will continuously introduce new technologies on a large scale, and since such an ongoing education will deliver the environmental responsibilities the farmer has when using new technologies.

6.2. Second group

Particularly in the second group, maintaining the balance between improving professional farming and protecting natural resources and the environment has become a central aspect of efforts in agricultural mechanization. This means that especially the group of agricultural professionals must receive a decent

education and it is the responsibility of the state to set up the according facilities.
Such an education should initially focus on a group of advanced farmers who are willing to increase their knowledge and to use it in their everyday work. In this way, a pool of information is created, which other farmers could also profit from when conferring with their educated colleagues about their businesses. Already mechanized farms will have a better product output, which will then motivate other farmers to follow in their footsteps and implement new technologies as well.
As long as the education system is poor and even trainers show basic deficits, an active role of academic personnel is desirable to train trainers. As most countries have universities with agricultural engineering curricula, graduates from these schools can take over the part to disseminate knowledge among farmers, technicians and dealers on an appropriate level. However academic training is not suitable to teach operational or craft and manual skills which are still necessary in agricultural production, manufacturing and maintaining of agricultural machinery and farm equipment. Developing such skills needs specific training facilities which are different from academic schools. However, as training in operational skills should not terminate the education level of individuals, interfaces and possibilities to step into higher education systems need to be developed. In this way the farming and other professions related to agricultural mechanization can be raised to higher levels in terms of salaries as well as prestige, which will reduce the attractiveness of the supposedly better job situation in urban areas.
A specific incentive to overcome insufficient mechanization could be implemented by the effort to make work more humane. In this field ergonomic contributions can lead to a higher efficiency of man powered operations and mechanized processes controlled or supported by manual labor. Avoiding drudgery is an incentive to introduce new and more efficient mechanization procedures.
In the undertakings described above, countries from the second group will profit from recent advancements in information technology. As information technology is available almost anywhere, farmers and other professionals involved in agricultural mechanization in those countries can make use of I.T. to obtain information instantly. This advantage is, of course, also available to agricultural professionals from countries of the third group.

6.3. Third group

The third group of countries is characterized by poor operation aids and low levels of mechanization and infrastructure, a part of which are the education facilities of the respective country. Therefore education and training programs need to be developed in line with all the necessary conditions to advance agricultural production because mechanization, can make considerable contributions for an enhanced agricultural production only by advancing plant and animal nutrition, plant protection and hygiene as well as upgrading seeds and races in parallel. It is not the aim of this paper to describe the entire education program, which is necessary for an adequate agricultural mechanization.
A fact is that training and education are predominant issues when aiming at a highly efficient level of mechanization. Thus education on mechanization must go hand in hand with improving the entire agricultural knowledge of farmers so that all the areas, which are vital for improvements, are affected by new educational programs. For example, knowledge on specific regional conditions is one of the major items to be considered. As machinery for all kinds of agricultural production already exists in many areas, the choice of technologies suitable for the specific surroundings is a key factor for the efficient use of machinery. Therefore, the education level of the farmers is a decisive factor when it comes to decision making in terms of purchasing machinery which is suitable for the respective conditions.
As in such countries the education and training facilities are in very poor conditions in terms of budget and equipment, it is vital to develop a clear and cost-effective suggestion on how to develop education systems. In case of training in agricultural mechanization, which aims at [9], as it is used for higher education systems, is recommended. The first activity is to analyze the existing *situation*. After that sensible and useful *inputs* like

resources, contributions and investments that are made in response to the current situation have to be investigated in order to achieve the best *outputs* that are possible in the specific setting. Such outputs are activities, products, methods and services that reach people and users. Outputs lead to *outcomes*, which means the results and benefits for individuals, groups and communities. The model forces participants (from developers and trainers to farmers) to concentrate on what is expected from the training or the education system, and it highlights the difference between what is done and the impact this might have.

7. Conclusions

Education and training in agricultural mechanization are crucial elements in controlling processes of which mankind expects a sufficient supply of food world-wide. Many different systems of education and training are currently applied, and there is no recommendation for one omnipotent system which would guarantee a successful promotion of improving attitudes, knowledge and skills, which would then increase the efficiency of mechanization in agriculture in the entire world.

Respecting regional needs of education programs and facilities and training farmers to use machinery efficiently are the predominant issues in non-industrialized countries. Setting up centres of excellence to investigate and to disseminate knowledge by training and education are the key ideas for developed countries. In addition, the concept of life long learning needs to be enhanced to make the continuous adoption of new technologies feasible. In the future, information technologies will support life long learning by easy access to information databases even in undeveloped countries. However, an information only becomes valuable if it is relevant for a decision. Therefore, the ability of farmers and professionals dealing with agricultural mechanization to do the right thing at the right time must be fundamentally developed in any education system.

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DISCUSSION

El Houssine BARTALI

I would like to thank and congratulate all the speakers for their excellent presentations and make a few comments. With respect to the representation of Africa in CIGR, let me precise that we have already a regional association of CIGR, which is the South East African Society of Agricultural Engineering (SEASAE). In addition, CIGR was recently joined by a network of fourteen francophone countries from West Africa represented by the School of Rural Equipment of Ouagadougou (EIER). Therefore, when we take into account the existing membership of Morocco, Egypt, Nigeria and South Africa, CIGR is really expanding its audience and improving its representativity within Africa. Regarding the issue of the development of agricultural mechanisation to ensure long term global food supply, I would like to point out that the situation in developing countries is generally characterised by the existence of very small farms, low yields and high losses. This situation is furthermore complicated by natural constraints like drought recurrence, water resources scarcity, low energy input, insufficient and inadequate mechanisation. The development of agricultural mechanisation in these countries requires also the improvement of rural infrastructure and commercialisation patterns of agricultural products. The distribution of farms in developing countries shows the existence of different categories of farms. Some of which are able to apprehend new technology and use up to date equipment irrigation, greenhouses and fertigation for example. But the majority of farms are scattered small or medium size ones located in unaccessible areas. Proposals to meet the needs of such farms in agricultural machinery should include a package of solutions that would improve traditional methods, introduce intermediate technology and be based as much as possible on a participatory approach. It seems to me that we need to make the results of the Club of Bologna meetings known to more agricultural machinery users and farmers. For example, in the area of grain storage improvements aiming at reducing losses, the club of Bologna can take the initiative to use the Online International Network for Post-Harvest Operation, (INPHO) which is managed by FAO as a means to disseminate appropriate technologies and equipment in this field. Upgrading of research development activities, training of agricultural machinery users, extension staff through continuous education is also an important component. On this point, I'd like to mention the JICA agency had recently funded the creation of a center for training in agricultural mechanisation which is located on the campus of the Hassan II Institute of Agronomy and Veterinary Medicine. This center is now providing valuable support to users and extension technicians in indifferent areas such as irrigation, milking or plowing equipment to mention but a few. Finally, I think that the professional sector is unfortunately not well organised in developing countries. There are not enough accompanying measures to help agricultural machinery users purchase the appropriate equipment needed, get the spare parts and after sale service and get advises for different problems they might encounter. As an example, the Moroccan association of importers of agricultural machinery, the major association in this field in the country, is almost inactive nowadays. Successive drought years that has hit the country led among other things to financial difficulties of several farms, the demand on agricultural machinery equipment has significantly decreased. This association which used to provide advisory service and support to its members is now just unable to do so. My question is: in order to ensure uniformity we should have agitation or steering on the slurry spreader and probably on the source in order to get a uniform mixture to spread. How can we sense the slurry quality, how can we control the quality and when do we start to have a control system?

Josse DE BAERDEMAEKER
Belgium

I want to give a couple of remarks about what some people also have said earlier on sustainable agriculture. It is a big word that we are using. But there are every different opinions and definitions for sustainable agri-

culture when you go through Europe or talk to growers or politicians . At the same time, we are leaving a role to play for politicians who make the laws, the rules and the regulations. We see that there is a greening of our politicians. Some of them like to impose strict regulations on agriculture, while others say that what we would like to see most is that half of the countries will be reforested. So, these are different opinions on agriculture; and I think that these politicians influence the minds of consumers. This also affects the European programs on agricultural research. Agricultural engineering research is not very well regarded in the European Community. Agricultural mechanisation is frequently considered as the cause of all problems of erosion, of pollution, even of over-supply of food. I think, Dr. Zaske said rightly, that the only driving forces in the developed countries may be government programs that will be supported by money from all green governments in the north. This has a big implication on what can be done in those development programs for improving agricultural production and mechanisation. I think then that the definition of sustainability will be of very large importance. Probably this is a little bit of an handicap for companies, because companies that have produced new technologies are looking for a global market for it. This global market is probably not so easily accessible especially when we see the anti-globalisation movement. We will have to consider its implication on the role of the mechanisation in development and in the future food supply. It also has implications for teaching agricultural mechanisation in the future.

Bill STOUT
If I could use the prerogative to have some comments, I like to introduce the controversial subject: energy use and global climate change. This controversial it's uncertain, but there are powerful forces up there that are trying to impose restrictions on use so far of yields, in order to reduce emissions that are leading to global warning. You probably know that the Kyoto Protocol which has been developed several years ago, regrouped eighty-six countries participating in it and, in particular, the industrial countries, to reduce greenhouse gas emissions by 5% below ninety-nine levels, which is a drastic reduction. My country has opted not to participate in that, but we haven't heard last word yet, and just ten days ago in Marrakech, Morocco, they had the seventh meeting of the committee of the parties. And they worked out the further details, the implementation of this Kyoto Protocol and it requires fifty-five countries to ratify it, in order to become legally binding. So, I just put it on the table, as a cloud, that might have a future impact on mechanisation programs. My point here will be: we don't know the future and we have to pay attention to this and participate in the political discussions that have been taking place. I just presented a paper in Mexico ten days ago in which I attempted to give an overview of this. I will be happy to send a copy of that paper to any of you that will give me the e-mail address.

Arne MOLLER
Germany
I believe that the trend for technology to the developing countries, could be stimulated if we could increase contacts in the agricultural sector between developed and developing countries. In this way we may exchange people from one company to the other and I wonder if Club of Bologna could truly identify companies in the developing countries interested in such proposal as partners.

Ladislav NOZDROVICKY
Slovak Republic
I would like to do some comments to Mr. Gilles and to Mr. Sevila presentations, Mr. Gilles has mentioned in this presentation John Deere Agricultural Management System; I am ass which is focussed on precision farming. Also Mr. Sevila was speaking about the information system for precision agriculture. As far as I know, John Deere is reaching high technical levels establishing, together with others key partners in the USA, a big joint-venture company called VintagePoint Network which is located in Fort Collins in Colorado, USA. This joint venture company is collecting and processing a lot of informations and testing results as a service for farmers. It is a pretext called as cyber-space; existence of this joint adventure company means

that a precision farming information system will not stop at farm level. And now my question is: do not get farming system at high levels has some risk for misusing of information? I mean, first of all, economic informations, because a lot of informations, which are consented in one single place always means a big power.

Jean GILLES
I can't give you the details of the varies ventures Deere has around the World; I wonder to be sure, however, that there is a misunderstanding. My presentation did leave me to prestigious farming and so I show this slide, that said precision farming whose awarded the forces equals. Youth agriculture or management systems so I think anything was not explained in Deere or the high level they can you reach. I also explain that we need to have systems opened an interfacing; I think the scare in order that always for any participant that somebody is trying to get power or dater or other ship would try to provide the framework for a system, because we believe system is going to be next area, that economy allow higher level of productivity efficiency in farming. This all the restore, I think.

Francis SEVILA
I'm quite happy with this question. Because we deal here with the ethical problem that I mentioned in my conclusion. Managing the ownership of information is as complex as managing the ownership of intellectual properties. I remember visiting farmers in the Southern Cornbelt in the USA, that they have been using precision farming technology from many years ago. One of their comments was to say that they were really not sure that they were making money out of these technology. Pretending to cooperate with seed producers, fertilising producers, they get more information on the farm, what they could have from their usual way of getting information. So, on the contrary, I would say that, if an individual farmer can have the tools to gather information, it's a good way to prevent others to have power on yourself. Now, if you sell contracts to the companies to use your information to help you managing your farm, is part of the contract to deal with the ownership of this information and you are perfectly right to say that this is a key point.

Jurgen ZASKE
I would like to comment on what you have said before, but first of all I must state that you were very successful in shaking us up after that wonderful lunch. You did this successfully, even without any pictures, since your presentation came from the heart. Secondly, you have made an announcement of a related conference. It was not mentioned so far where the next precision farming conference will take place. This will be in Berlin, in summer of 2003. Those who will come to Berlin will have a good chance of visiting not only our capital, but also the beautiful region which surrounds Berlin. This precision agriculture conference will be the first in which precision livestock farming will be included. I think this is a very interesting approach, especially considering the situation of animal production in Central Europe. Our Scandinavian colleagues support this idea too. What we have to do first is to define "precision livestock farming". We have a clear definition for precision agriculture, but for livestock farming it is still missing. Coming back to your presentation: it was interesting to hear, what the future in precision agriculture might be like, mainly in countries with large-scale farming, such as Australia or the United States. I would add Eastern Germany, and the neighbouring countries of Central and Eastern Europe (CEE), with their large farms, too. I think during the next five years a lot will happen in the field of precision agriculture, especially in Hungary, in the Ukraine etc. Nevertheless, I feel that it has not been stressed enough, that precision agriculture will be a method to manage a large number of individual small and medium size farms too. Precision agriculture allows the precise management of fields by multi-farm use of machinery under contract, including accounting. For instance, in Southern Germany there is a strong tendency of contracting services to farmers with elements of precision farming such as DGPS. In East Germany, of course, where the farm size ranges up to 7000 hectares, precision farming will be the future in any case.

Osamu KITANI
Japan
I had the impression that most of the speakers are thinking about the apprehending for other big scale farm mechanisation to the developing countries. In the year 2015 the World population will reach 9.3 billions and the population in the developing region will cover 90% of the World one. At that time, the farming in the developing regions of the World could be very important, because if we force the big scale farming, we will drive so many people from the farms to the big cities and make the rural areas almost biggest. So at present as you know, more than 75% of the World population is engaged in the small-scale farming. Consequently I think that, in the future, the small-scale farming will be more important, also if it is not easy to secure the economy for these in comparison with the bigger scale farms. But we have to do it otherwise, World will become a worth and thrums anyway. The next point on which I want to discuss is that we need new farm mechanisation with less impact on resources. By mentioning this, I directly stress not only the aid of saving resources designing appropriate machines in agri-systems, but also the opportunity to develop new systems, for example to make new machinery systems. At the same time we should have more input of information thus then the resources to the future mechanisation and, for that system, we need new distant running systems in the area of agricultural mechanisation. On this topic, I have talked with Mr. Clarke of FAO who could have some prototype of this new system, new distant running system with probably some part with wireless, system and others. It would be, in some cases, more cost effective from economical point of view. We need this kind of new information system for the rural mechanisation in the future.

Ahmad TABATABAEEFAR
Iran
I'm coming from an area where we consider a small scale farming, less then two hectares. In some part of Iran you might come out with 83% of farming area less then two hectares and where you are dealing with this kind of farming system, you have to think to an appropriate technology, able to meet the cultural, social, economic and political aspects as well as farmers needs. This is what they need to bring the appropriate technology to them. The other comment is bringing up improved project in developed countries to developing countries, with enough long lasting management in order to transfer technology, as well as management. That's the other possibility on which we can work, between two systems and get some improvement. Last but not least, water needs and water supplies are the key for our agricultural survival. 2-3 years ago, we had drought and some farmers did not even pay any attention to harvest, because it was wasted. They did not have money; did not get anything out of the field. So water supply and water needs must be told research area, as far as method of irrigation or recycling anything that could help water needs in a State where 3000 m^3 per hectare become 300. Consequently we need to think about methods of irrigation that will free to use water needs.

Karl Theodor RENIUS
I would like to come back to a comment made by Prof. Kutzbach. He said, self sufficiency should be put much more into the foreground, when we discuss long term food supply for developing countries. I agree with him. If we analyse relevant publications and our Club of Bologna presentations on the subject, we can conclude, that Africa is going to become by far the continent number one, regarding long term problems with self-sufficiency of food. I think everybody may agree to that. According to my experience with developing countries, I feel, that education and training is one of the major problems, where the high developed countries could help for local self helping. We have often invited students from Africa to come to Technical University of Munich and to study charge free, but only a few could come due to the high level of living costs in Germany, mainly Munich. Sending agricultural engineering teachers to Africa is also very difficult because of several reasons - one is in my opinion the local political instability. Coming back to the statement of President Pellizzi, that we should do more to solve this problem,

I would like to put an idea on the table. We all know that the factor number one for productivity and wellfare in agriculture is mechanization. My proposal is therefore to consider the foundation of an African Institute of Technology, mainly dealing with education and local research in Agricultural Engineering for Africa. It could be supported by FAO, EU, CIGR, Club of Bologna, ASAE and other societies as well as by local African authorities. This school could give basic lectures, but also invite specialists like the Club of Bologna is doing now successfully for so many years. The CIGR Handbook could indicate competence of our global family of experts and there are further other supports such as the well accepted AMA Journal edited by our Club Member Yoshie Kishida. I am convinced that such an African Institute of Technology could increase the chances for this continent by concentrating and pooling activities, representing a "gravity center of movement" and that the Club of Bologna is the right platform to serve as an nucleus for it. Self sufficiency of Africa is a problem which is not self solving.

Egil BERGE

I think you have a good idea similarly to that of the Asian Institute of Technology of Bangkok, where Asian countries are together with development, supporting organisations in Europe and other continents, putting up a graduate school. I think to speak about the graduate school because on the basic level there are educational systems in most African countries. I think it could be a good idea to follow within Africa. On where to put it should be a decision of the whole organisation of the African States. So may be that our Club could present these issues for consideration of the Organisation of the African States

Lawrence CLARKE

As Prof. Renius has just been saying, for Africa the crucial point is coming. Agricultural production has to increase in Africa. In the last 20 years production increases have been running at about 2% a year; the population has been increased at around 4% a year. We have now reached the stage, where the food requirements of the population is greater than food production. i.e. Africa as a continent is entering a food deficit situation. We and FAO deal with emergency projects in Africa and we see an inexorable increasing trend in requests for emergency assistance.

Milan MARTINOV

Yugoslavia

I would like to thank the speakers for the interesting presentations; they encourage me also to ask you to consider one proposal related to the education. I find the education crucial for the development of agricultural mechanisation and this proposal could be declared as one extension of former activities of lot of you. I would like to remind you to the problem of harmonisation curricula, that was considered when Prof. Pellizzi was the President of the CIGR. The very valuable issue of the "Handbook of Agricultural Engineering" was also very important for improving education. A next step may be on line with the profile of the Club of Bologna and concerns the centrality of Information Technology by which would be possible to create teaching material in a very easy electronic form, like power point presentations, that means to reduce text material not text books with lecture sources and to give it free for every one who is interested for this advanced teaching material. Why electronic form? Because it could be used completely or reduced, in any case contributing to the harmonisation of education everywhere; if we will work in english could be also in that form translated in each language for someone who doesn't want to use english and also covering local needs for some Universities. It could be used also for short courses and for lifelong education and also it is very easy to transform the front page and use in the web-site of the University or in other web-sites. It could be also improved from here and it would give contribution to this topic of development of agricultural mechanisation in the future. Please consider this proposal; it should be also selected a few of courses, may be 4 or 5, able to contribute to the improvement of education not extracted from the very beginning, for example soil tillage.

Yunus PINAR

Turkey

To assure long term global food supply, Turkey agriculture has also to mechanize. Since, Turkey is an important agricultural country having approximately 28 million hectares of agricultural area. I think that you know, a project called as GAP in Turkey, in English called as Southeast Anatolia Project, which is larger than a lot of European countries. In this region, especially cotton, paddy, vegetable and other plants could be grown. It is expected that the agricultural products, which will be obtained in the GAP region, would be enough for all of the Middle East Countries. Particularly cotton harvest and vegetable farming needs mechanization in the GAP. Cotton picker will be widespread in a short time. So, it would be necessary manufacturing cotton pickers, already. For this region, high power machines and tools for instance tractors and their every kind of equipment will also be necessary. With this project, Turkey needs machines and tools to be used for large areas. According to my idea, foreign agricultural manufacturers have to be interested in this project. If so, it would be very useful for both foreign agricultural manufacturers and Turkey, and also, certainly global food supply, I think. This region needs new agricultural machines. In addition, I would like to give an information, that is the following. The President of Israel, Mr Weizman, has been interested in this project. And, when he came to Turkey, firstly had gone to that region, I think 2-3 years ago. Israel knows this project and it is interested in this. Another important topic for Turkey and at the same time for the world is that Turkey produces approximately 65-70% of the world hazelnut production, today. Turkey's trades of hazelnut are between 70-80% by year. Hazelnut production of 95% produced in Turkey was exported to European countries. What I mean in that, actually, Turkey is the most important country in the world on hazelnut production. Then Italy, USA and Spain come. But, in spite of this situation, in Turkey, hazelnut mechanization is at a low level, particularly concerning the harvest mechanization. There are two important problems on obtaining from the ground and threshing hazelnut. Now, hazelnut was picked by hand and this is an operation too difficult and expensive. In Turkey to pick up hazelnut, harvesters (or pickers) must be manufactured and widespreaded. But, before that, hazelnut agriculture has to be investigated, because, hazelnut plant and its agriculture in Turkey are very different from Italy or USA. In Turkey, hazelnut plant is like bush and field surface is grassy. That is, the field surface is not only soil. And, it is grown generally in slope field. Whereas in Italy and in the other countries, it is like tree and grown at plain. Field surface has not too much grass in these countries. In the region where hazelnut grew, drying is a problem because the harvesting season goes along with rainy. So, hazelnut dryers are necessary. Also for other crops growing in the same region, that is the Black Sea Region. In Turkey, the little machines and tools are generally too much expensive compared to the other machines and countries. So, we can't say that mechanization was very good in Turkey and the machine prices effect on mechanization is too much. To mechanize agriculture, small machines manufacturing must be increased and prices must be decreased absolutely; these type of machines are manufactured generally by joint Italy-Turkey companies. So, on this matter, Italian manufacturers may do an effort in this direction.One more problem concerns the fact that in Turkey, tractor power per hectare, agricultural area per tractor and total farm machinery population per tractor are: 1,56 HP, 34 ha and 4,06 respectively. That means that, tractor power is sufficient, but the yearly use periods of tractors is too low. So, educational courses must be organised by some foundations, for instance FAO may do it. Particularly, Black Sea Region and Southeast Anatolia Region have low level on mechanization. Consequently, these regions may be considered with priority by educational programmes. In these regions, there are no parallelisms between tractor power and farm machinery population. According to tractor population, tractor equipment is insufficient. Moreover, kinds of farm machinery are not enough. In Turkey, on paddy mechanization, there is an important problem: to develop rice mechanization and to increase yields; paddy transplanters, suitable for Turkey, are necessary. Up to day, *unfortunately, these machines have not been used. This is very important for paddy farming in Turkey. Whereas, Turkey has sufficient areas very much can be grown paddy. As a result, what I mean, a programme must be applied on mechanization of paddy transplanting. Training and educational levels of personnel working at the manufacturing industry are too low. There are important problems on raw material obtainment, agricultural machinery manufacturing and marketing. For solution, firstly, the manufacturers must be powered by financing, manufacturing technologies must be integrated and manufacturers must be informed on marketing.*

Peter CROSSLEY
U.K.
Prof. Dick Godwin wanted me to mention that we are setting up a new MSc program, in Agricultural and Environmental Engineering which is a pan-European type of degree program and so we are trying to extend our activities in teaching as well as in research closer to the pan European multinational area even more. I have a couple of questions related to the new education of farmers, which was presented yesterday. One question for Prof. Snobar and one for Prof. Schulze Lammers. First of all, the question is concerning research, and some very interesting suggestions on topics for research came from Prof. Snobar yesterday. In UK in particular – and I'm wondering to what extent this is similar elsewhere - we find it increasingly difficult to have an open funding for research. We tend to get research funding from government or governmental agencies, which means we have to accord with their priorities, and also from companies who may have several objectives. My question really is: is this likely to be a problem, in terms of research, to furthering if you like the worldwide objectives to have research in Agricultural Engineering? The second question for Prof. Schulze Lammers is in terms of the third group in developing countries. One thing which we have found in particular from our research in rural transport, which relates to agriculture in terms of multi-user machinery for transport; we find there is a very significant role being played in places like Kenya for example by the Jua kali, the informal sector of small medium enterprises, who are responsible for manufacturing and in particular maintaining and repairing equipment. The informal sector is often ignored and I'm wondering whether Prof. Schulze Lammers feels, and that other people may feel, that there is a role for training these small medium enterprises. Particularly not having expertise in technological knowledge but also in management skills, that is one of the limitations we found - as mentioned by Prof. Pellizzi - in dealing with the customer.

Bassam SNOBAR
The question on research funding is a regional problem mostly in developing countries. When we look at the funding and the allocation of research funds in the developed countries we could estimate that 2% of the GDP is allocated for research while in the developing countries the estimation is 0.02% that means 1/100 of the first one. In this area funding for research should be placed under the responsibility of the governments and should be considered the environment to provide cheap services to the farmers and consumers. Universities are responsible as well; for example we have a co-operation in Jordan with Silsoe Research Institute from the EU. EU has ready a good amount of funding giving to the developing countries in collaboration with one or two European countries. So I can't really say more about funding which has to be included in the official budgets of the governments and should be provided as well as from commercial companies dealing with products exporting and importing and so on.

Peter SCHULZE LAMMERS
The main problem of informal training is the organization of this type of activity. There are many ideas of how to shape and structure informal education and training of farmers and other groups related to agricultural engineering but it is stated in many reports and experience documented that the organization of formal training with fixed structures as equipment and permanent staff with imple-

mentation in proper phases of life the like formal professional education following the public schools is much more easy to organize. In addition I want to comment the statement of Arne Möller confirming that exchange of personal is an important measure of professional training and part of education.

Axel MUNACK

I have a remark concerning the presentation of Francis Sevila and Simon Blackmore. Every time I hear about that concept of these small intelligent machines I feel fascinated about that idea and I am confident that this type of machines can be very useful to solve urgent environmental problems like soil compaction. It can be developed further for the use in treatment of various plant species and can also be fruitfully applied to the concept, which was presented yesterday by Osamu Kitani concerning small farms. So I think this is in many respects a useful concept. However, let me point out that there are several problems to be solved. First is the problem of energy. How to provide the energy for such small machines? Here we could apply in future some new fuel cells, hydrogen powered. This new emerging technology can be useful, but it is not developed far enough for today's applications. Then we have the problem of sensors. If you will have 10 or 20 machines were today the farmer uses one, then you have 10 times or 20 times the amount of sensors or equipment. So we must make developments in order to go down with the prices for sensing equipment. A further problem lies in the reliability: if you have the same degree of reliability but you use 10 times or 20 times more machines, then the number of faults and errors also goes up by a factor of ten or twenty. So it's really a task for agricultural and mechanical engineers to build small, very reliable, advanced, but flexible and capable machines. I think we have now here a great new challenge for mechanical engineers and all the companies, which are sitting with us at this table, and I am looking forward to hear about some results in several years.

Derek SUTTON

With reference to the proposal made by Karl Renius, I want to inform you that I have contacts every year with various Universities like Nigeria and Tanzania which are producing actually very good products and I think we need to help them do better. But Africa is not a country, Africa is a continent and there are many differences – as it has been underlined in the first report by Pawlak, Pellizzi and Fiala - between African countries, as the difference between Europe and Africa. So we need to take into consideration these differences and the fact that some have done better than others. We are not perhaps paying a lot of attention to the real developing countries small farmers problems. We are a little bit driven by a sophisticated technology and perhaps we do need to understand better the real problem of small-farm sectors. So I would like to propose that we explore the possibility of identify somehow under the auspices of the Club of Bologna, a trouble fund to assist those who are not able to join us, not only from Africa. This could probably be done by the UNACOMA organisation with the guide and decision making ability of the President and the Management Committee, perhaps.

Bill STOUT

I might mention that CIGR has a regional association incorporating the Southern and Eastern African Associations of Agricultural Engineering including countries from Kenya to Zimbabwe. As we move into this discussion, we should keep that group in mind has to be very competent in it.

Pawel KIC

Czech Republic

I work at the technical Faculty of the Czech University of Agriculture in Prague and we started at our Faculty on the '50 with only one specialisation on mechanisation of agriculture. About 10 years ago, we recognised that our graduates are quite successful also in other branches related to agriculture, not only directly in Agricultural Engineering. So we recognise it could be very useful to prepare new courses and new study programs *which will cover many other branches related to agriculture and which could help to educate the people for the really needs of our country offering the possibilities to find a job to young generation. Consequently about 60 new courses, which cover 5 study programs have been organized. The first one is traditional, on agricultural engineering and mechanisation. The second one is more related to the food industry, tailored on mechanisation and machinery; we call it "technology equipment of the buildings for agriculture and food industry". The third one is related to the transports, play a very important role in agriculture and related field; this study program is called "route (road) and city transport". In many cases we speak about a negative influence of agricultural engineering to environment and so we recognise we should do something in opposite to solve this question from the Agricultural Engineering point of view; so we prepare the fourth study program which is "cost technology for waste management and waste treatment". And last, but not least, we prepare also a study program, which is a combination of techniques and education in economics; we call it "trade and business in machinery" and our graduates in this study program are successful in business, like dealers. It's our experience; these study programs are very popular among the young people and actually we have - in 5 years study program - about 1000 students. It is very important to emphasize that every year, about 200 people who are graduated at our faculty, without problems, can find job.*

Bent BENNEDSEN

Prof. Martinov spoke about the initiative on fair organisation in agricultural education. I think it is right to try to enhance that this work is continuing (already active) and last year in Warwich, it has been presented a paper summarising the differences in Agricultural Engineering curricula. Now we are taking this good help considering this step further and printing again its publication, which suggests some curricula for Agricultural Engineering studies. If all the European Universities are working on the same base, there will be a lot of possibilities for specialisations, so we will increase the possibilities for students and teachers mobility among the Universities. We are starting suggesting some curricula we can match the different study-program and curricula and then take action steps to works organisation. This is the chance of the specialisation and, with this chance, it will became possible to realize the idea of Prof. Martinov, also to exchange the teaching material

Jaime ORTIZ CAÑAVATE
Spain

I want to make a short comment related to the Topic 2 of this Session. I think it is necessary to supply technology for developing countries to assure long-term global food supply. But the type of Agricultural Mechanisation to apply has to be chosen by the farmers of those countries themselves. It can not be imposed by the criteria of foreign experts. The World solution would enforce planification from outside. So this has to be an help for these countries.

Arturo LARA LOPEZ
Mexico

I would like to say that the good groups I have in my country have been successful on developing machinery; it is appropriate for the conditions - not only in the field but also in the industry – when the groups have very good engineering background and are very well linked to the society problems. So my suggestion is that, if we want to help developing countries it's important to assure a very good basis in engineering sciences, into the curricula that we have tried to promote, because they have given us a very good support for entering, not only on the science for local manufacturers, but also on having a very good understanding of new technology. In addition, I want to mention that we have very few students following agr. engineering curricula in many countries; we can see that there are students moving to areas where they have a good chance for employment, like administration or things like that. I think that in the past, Governments supply many jobs for professional people in agriculture. Now the situation is very different; consequently it is very important to incorporate the knowl-

edge of a administrator and business in agriculture, in a vision of the engineering, because we can probably give them the opportunity to start and rejoin an employer all the time.

Horia BEGHES
Romania
All what I have heard is very interesting and I'm sure that it's very useful for us, especially for developing countries. But it's absolutely necessary that in developing countries will be applied a kind of technologies and suitable machines to avoid the products oscillation due to environmental conditions. For example when it rains too much it's very bad, when doesn't rain it's also very bad; in fact agricultural productions are very sensible to these climatic changes. Of course, from developed countries we have to apply the available technology able to control or reduce these phenomena. This is also a problem of education. The paper presented by Francis Sevila, was really very interesting, but I think that for farmers from developing countries, is still a dream and I hope it will be the possibility to apply some of these questions on instruction and information in farming.

Antonio PAGANI
I would like to go back to the former session and, in particular, to the reference that was made to Juakali, the kind of Juakali we can meet in the Ujiama Villages in Tanzania. Just to say that, as everybody knows here, since the '70 many initiatives in this sector have been implemented, such as training of informal sector artisans and upgrading technical and managerial skills of informal sector operators, but I think that we all acknowledged that so far nothing has dramatically changed or improved. The reason been, as permanent Secretary of Industry of one of the Eastern African countries told me once, that is like a dance school; we keep training people to dance valzer, to dance cha-cha-cha, to dance tango, but we never invite them to our parties. So this people gets more and more skilled. Sometimes they receive a skill, a training that is not adequate to their means. A classic example is that of the working bench with an anvil: we explain that anvil's level -and, everybody knows here- should be at the level of the of elbow of the operator. But this practice is soon abandoned because of the fact that in many African countries the operator works at the ground level on a railway track piece. And, in these conditions, ergonomically, his performance is at the top. So, having done number of mistakes and having been involved and having been doing this mistakes myself, I came to the conclusion that, unless we find the mechanism whereby we link the informal sector somehow to the formal-one, whatever training we do, it is useless, so we have perhaps to focus more on a system of sub contracting, rather then letting medium and large size enterprises exploiting the informal sector by an agreement that very often is not fair. So we know that the informal sector in many African countries if exploited in the proper way is a goldmine as far as skill and capability. But if we don't take advantage of that in the proper way, we keep training them but to nobody advantage.

Bill STOUT
We are arrived at the end of this Session 1 and I want to thank the speakers for their excellent presentations as well as all of you for your discussions; many good ideas have been put on the table and now the challenge for us is to incorporate some of these ideas in the "Conclusions and Recommendations" which we'll talk about this afternoon. Now I turn the session back to the President Pellizzi for any comment he may want to make before we take a coffee break.

Giuseppe PELLIZZI
I just want to express my deep thanks to all of you who have participated to the discussion and to my friend Bill Stout for his excellent leadership. I should like to give you a recommendation: each of you has a yellow sheet; please check your address, e-mail and so on and if you have some remarks, give to the secretary in order to avoid mistakes. After the coffee break the floor will pass to Prof. O. Kitani, serving as Chairman of the Session 2.

SESSION 2

Code of Ethics as a contribution for a proper agricultural mechanisation

Leading person: ***Osamu Kitani, Japan***

Osamu KITANI
Gentlemen let's start Session 2: "Code of ethics as a contribution for a proper agricultural mechanisation". At first the short report on your front prepared by Sarig, Clarke, Nääs, Hegg, Singh and Munack will be presented to you. This Subject was discussed in the last meeting in Tsukuba and, at that time, three reports were presented and are now included in the in the proceedings you have received. But I have seen that almost half of you were not in Tsukuba, so I ask Prof. Munack to present this situation. Prof. Munack will have 20-25 minutes for his presentation and after that we will have time for discussion, before and after lunch.

Axel MUNACK
Dear Colleagues: I'm not sure that I can use the entire amount of time that is scheduled for the presentation of the Code of Ethics, since I'm not the best person to present this material. In fact, I have had only three days to study the final version of the paper. We did not have an intensive discussion of the material in the group; so, to my opinion, there are several items still to discuss and I hope that our discussion here will be as lively as it was in Tsukuba. As the Chairman already said, we had three papers on this subject in Tsukuba, however only one paper was presented by the Author himself. This was Mikio Kinoshita from Kubota Company, who gave a quite good insight into the strategy of Kubota with respect to environmental policy. He pointed out that the Tsukuba plant of Kubota has fulfilled the ISO 9002 quality system and that, since 1994, ISO 14001 is playing a significant role in the company's strategy with respect to environmental policy. Also workplace safety management was introduced and plays an integral part of Tsukuba's plant management. So we were given a good overview about the approach of Kubota's Tsukuba plant with respect to environmental and safety policies. The other two Authors were not present; so the paper by Yoav Sarig was presented by Richard Hegg and the paper by Alessandro Scotti was not presented. However, I think there are several parts in these two papers which built good bases for the Code of Ethics as it is presented here as initial formulation by Yoav Sarig, after inclusion of some comments by the group members that are mentioned in the authors' list. In my opinion, the paper of Alessandro Scotti had a very nice conclusion and since I cannot find better words, I have to read it. "Industry's sensitivity to moral problems is certainly increasing in modern society and attention is ever more directed towards aspects which were previously only given slight attention from an ethical point of view. This greater sensitivity, can be seen both as regards the human society, as well as towards the well being of the individual customer. Among the ethical aspects of the society, it must be remembered that the company no longer just has an ethical responsibility for production, which it manages directly, but now has a wider responsibility for the whole manufacturing process including, for example, those areas which are outsourced. It has an equal responsibility for the lifetime of the product. Such factors such as environmental impact are taken into consideration depending on the various product uses. Amongst those ethical aspects concerning the customer, the growing consciousness of the need to safeguard the operator should be emphasised, not only those aspects which are more obvious, i.e. protecting his physical well-being, but also those which were taken as less important a little while ago, such as improvements in the farmer's social conditions and reduction of physical and mental stress". This is a very good conclusion of what apparently was not presented in Tsukuba. Since you all have the minutes of the Tsukuba meeting, you can easily access the full text by yourself. The topic of a Code of Ethics was then further discussed in Tsukuba, where an important remark in the contribution of Yoav Sarig addressed that, in the United States, it was found that 76% of corporations surveyed by a leading business membership organization had already a Code of Ethics. Along these, many very well known machinery manufacturers like Caterpillar, Deere and so on are to be found. Thus it can be stated that there exists some consciousness in the industry, that there should be a Code of Ethics. If the Club of Bologna can give guidelines for such a Code, which are finally uniquely agreed upon within the agricultural industries, we could make a good step

forward. Let me make a citation from the Conclusions and Recommendations of the Tsukuba Meeting: "the participants confirm that the ethical problems in any business - and therefore also in the agricultural machinery sector - are no longer limited to the production sphere. They have to include downstream the trading and marketing sectors and they must also take into account the social, technical and economic needs of the end user and hence of agriculture and the environment in the case in point". And "the participants unanimously approve that the Club should undertake to draft a Code of Ethics to be distributed in all the countries. It must be adopted as a permanent compulsory Code of Ethics to be rigorously respected." This was the recommendation of the last Club of Bologna meeting in Tsukuba. I would like to add two further aspects from the discussion. One is that we agreed to address a corporate sustainability aspect, with equal stress on ecological, economical and social aspects and, secondly, we agreed that internal problems of the industry should not be treated. As further guideline and result of the last meeting I want to recall that we should not attempt to generate a Code of Ethics for Engineers, but a Code of Ethics for the Agricultural Machinery Industry. Codes for Engineers are also well known - ASAE, for instance, has a Code of Ethics for Agricultural Engineers, and I think we should not make an attempt to duplicate this. A Code of Ethics for the Agricultural Machinery Industry would be a new thing - at least, a common Code of Ethics for the whole Agricultural Machinery Industry. These considerations finally led to the draft that you have also in your hands. I will now go through the text and also would like to address some changes that I propose. Of course, it's unusual that someone who is in the group and presents the work of the group, at the same time proposes some changes. However, as I said, there was no discussion of the final text – so I don't feel committed to the text word by word. Maybe I can also initiate today's discussion by my proposals for some changes. We start with a preamble and in this preamble we address the specialities and the uniqueness of the Agricultural Production Sector, which has a special responsibility also for the environment. Consequently, the text addresses this speciality. The next section of the draft consider general principles, specific areas of practice – concerning employees and customers – and, finally, the application of the document.

Code of ethics for the agricultural machinery-manufacturing sector

by ***Y. Sarig*** *(Israel),*

with the co-operation of:

L. Clarke *(FAO),* ***I. De Alencar Nääs*** *(Brazil),* ***R. Hegg*** *(USA),* ***A. Munack*** *(Germany) and* ***G. Singh*** *(Thailand)*

1. Preamble

The agricultural machinery-manufacturing sector is important and unique, in the sense that it is involved with the important task of producing food for mankind. Hence, the responsibilities of this sector go beyond the obvious commercial considerations. Its products have a direct and vital impact on the quality of life for all people and contribute to the income of the agricultural community from the use of these products. The agricultural machinery products have also an indirect impact through their effects on ecology and the environment. Because of these special responsibilities, agricultural machinery manufacturers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.

Integrity should be the foundation of the agricultural machinery manufacturers, manifested in their relationship with their employees, customers, suppliers, shareholders, competitors, and their communities and with each other.

The agricultural machinery manufacturers pledge their compliance with all laws and regulations, foreign and domestic, applicable to their business, and their support of, and adherence to the following principles. Through voluntary compliance with these principles, the agricultural machinery manufacturers acknowledge that such compliance is in the best interest of this industry and its stakeholders.

2. General principles

- The agricultural machinery manufacturers and dealers, doing business throughout the world (if, and where applicable), shall operate in conformity with accepted engineering standards and should not to be involved in the production of machine that are not consistent with the general principles of this Code of Ethics.
- An agricultural machinery manufacturer shall work to promote a free market economy maintaining a business environment able to put a stop to bribery and corruption.
- An agricultural machinery manufacturer shall operate in conformity with accepted engineering standards and should not be involved in the production of machines that are not of a design amenable to the safety, health and welfare of human beings and animals.
- An agricultural machinery manufacturer shall endeavor to provide data, such as published standards, test codes and quality control procedures that will enable the users to safely use the designs, products, or systems for which he/she is responsible.
- An agricultural machinery manufacturer shall build his/her professional reputation on the merit of his/her products and service and shall not compete unfairly with others; his/her areas of work shall be restricted to his/her areas of competence.
- An agricultural machinery manufacturer shall operate his/her business in ways that are protective to the environment and that conserve both energy and natural resources, in addition to compliance with all applicable environmental laws and regulations of the country in which he/she operates. Under no circumstances should these issues be compromised for the sake of achieving a competitive advantage.

3. Specific areas of practice

3.1. Concerning employees

The agricultural machinery manufacturers will:

- treat all employees with dignity and respect, and provide equal employment opportunities, based on bona fide job qualifications, without regard to race, color, religion, national origin, gender, age, disability or any other characteristics irrelevant to the job;
- strive to ensure health and safety of work-

ers and maintain company facilities as a workplace free from recognized health and safety hazards. In addition, provide any safety training that may be deemed necessary or required;
- strive for social justice and promote freedom of association and expression in the workplace.
- provide training and education facilities for continuous professional development of their employees;
- ensure consistency with universally accepted labor standards, including those related to the exploitation of child labor.

3.2. Concerning customers

The agricultural machinery manufacturers will:

- strive to meet, or exceed the reasonable expectations of their customers, within the economic constraints of the company.
- ensure the supply of high quality, safe products, which meet the performance, durability and reliability needs of the customers;
- ensure that their products conform to the ecological and work safety standards of every country in which they are sold;
- provide well-documented product information concerning both safety and working quality product support, service and spare parts, if and when needed.

4. Application

The signatories of this document are committed to implementation of the principles contained herein within their individual firms, through the development of adequate operational procedures and practices.

DISCUSSION

Axel MUNACK

When I was preparing my presentation here, I also had some ideas which could or should be discussed and I would like to mention these.

First question is: do we really have the best title for the Code of Ethics? I think the second part of the title needs some discussions; it was originally formulated as "Code of Ethics as a contribution for a proper agricultural mechanisation". To my opinion, the contribution of our Code of Ethics is not the agricultural mechanisation, which is very application-oriented and already implemented at the customer's side. Our aim is more the producers side; the producers are those people who should sign it. For them, agricultural mechanisation is the final stage of what they are doing, but they have to consider the whole production and marketing chain, together with training the employees and so on. My proposal is to discuss alternatively the title "Code of Ethics for the Agricultural Machinery-Manufacturing Sector". Next I come to the paragraph concerning the free market and corruption and my fear is that Agricultural Machinery Manufacturers have problems to sign this. Just let us read the text as it is formulated: "An Agricultural Machinery Manufacturer shall operate within the framework of free market economy ..." and so on. In this context I'm asking: since there are several countries in the world which do not have a free market economy, should we deny to sell our products to these countries? An alternative formulation would be: "An Agricultural Machinery Manufacturer shall work to promote a free market economy ...". This is an aim, but it's not a must; and it is an aim to that the agricultural machinery manufacturers may agree unanimously. Then the passage "... ensuring that any individual, organisation or a country does not deny access to his or her products ... " How can any manufacturer guarantee this? If any country says: I do not want John Deere to sell in my country - what can the company do against such a practice? To my opinion, it is not possible to fulfil the sentence; so I'm proposing to leave this out.

The last part is "... maintain a business environment which mitigates against bribery and corruption." I think "mitigate" is not a very strong formulation; we could express what we want a little bit more directly by saying "... maintain a business environment that puts a stop to bribery and corruption."

These were some proposals for changes that I regard as useful or necessary; now I am looking forward to a vivid discussion of the text.

Philippe MARCHAL

France

Just to verify if my understanding of the question is correlated to those Ethics for agricultural machinery. The presentation of Axel Munack is very accurate and correct, but he focussed only on the relation between manufacturers and customers and ethics perhaps will be also connected in other relations between, for example, research organisations and manufacturers, or extension services and researchers, among, may be, all the organisations contributing to the development of the machinery. I think that it is also important to have ethic in such all the partnerships between organisations and manufacturers as well as between manufacturers and customers. Perhaps you can extend the discussion to all these partnerships.

Axel MUNACK

Of course, the task to formulate a Code of Ethics is not restricted to industry and the production sector. It is also addressing engineers in industry and, furthermore, traders and some other people involved in the subject. However, we discussed this problem for a quite long time in Tsukuba. You may also argue that a Code of Ethics in the United States may be different from such codes for Canada and for Europe. If we follow such arguments, then I think we would never succeed in finding a Code of Ethics that is accepted more or less on a worldwide basis - or it would be a document, which is a very small one. The discussion of the Tsukuba Meeting led to the agreement to restrict the Code to the industrial sector and define the Agricultural Machinery Producers as first *group to be addressed. This group can directly be addressed by the Club of Bologna, because we are on the same level in some sense. We further have the direct link to the UNACOMA and so we can address through them the Agricultural Machinery Producers and ask them for their opinion to this document. On the other side, if we address the single engineer, then we would bypass more or less the manufacturers. Maybe, the single engineer would see conflicts to sign such a Code in his workplace, if it does not coincide with the factory's Code word-by-word. Summing up, I think it's the only practical way at the moment to formulate a proposal for a Code of Ethics of the Agricultural Machinery Producers and discuss this with these organizations to which we have access – I mean UNACOMA and the manufacturers.*

Karl Theodore RENIUS

My personal reaction is that the work has been well done and I personally agree to every sentences you presented. I would like to recommend to open a discussion with industry, because the weight of the Code will be higher if we have a broad support from manufacturers

Jaime ORTIZ-CAÑAVATE

I want to congratulate with Yoav Sarig and his working group for this excellent and very concrete report. I want just to make some short comments on the title of the document; I agree with Prof. Munack that it should be "Code of Ethics for agricultural machinery manufacturing sector". A second comment is referring to the last sentence which stresses the need for a well documented product information; if this will act especially concerning safety, I suggest to provide more information in comparison to what is normally supplied by the manufacturers only encouraging safety of the products. So this information, I think, should put more emphasis in the safety using agricultural machinery.

Milan MARTINOV

I studied last year very carefully the former material made by colleague Sarig, and I was enthusiastic about one statement that was written. That it's one obligation to the farm machinery industry to support technology transfer and international co-operation with developing countries. It was very clear notified in the former material and I can't find the same statement of principles in the new one. Concerning the question of the title I would suggest to keep the old one "Industry of Agricultural machinery". The all is related to agricultural machinery actually. On the other hand we should have to think about a lot of other things like education, training too.

Egil BERGE

I am very impressed about the ability to make a good summary of such a complex item like this. I agree with all points, except the opinion of Axel Munach on the general principles on the market; and so my proposal is that paragraph three should be formulated into something like "an agricultural machinery manufacturer shall operate within recognised national and international trade frameworks and maintain a business environment which give no room for bribery and corruption".

Pierre F. J. ABEELS

Belgium

Of course the ethical aspect is a difficult one and I believe the Authors have done a nice summary, but I have a feeling that there is something very important missing. It's the responsibility of the customers when are using the machines. Now we have rules for building machines, for offering machines, for marketing machines, but the user should use machines and tools in conformity with environmental and biological appropriate conditions to improve food quality; they have decided where some responsibility is on. It's quite different, because we know the characteristics of the machinery offered on the market, but the customers put, for example, some concrete at the rear of the tractor just to fulfil some particular tasks and that's not normal; and after it they complain that the machine is not well built, well conceived and so on. So, please, introduce some responsibility also on the other site in order to be more well weighted when we judge a machine, a process or an engineering idea

Lawrence CLARKE
I think that what is written here is really a common statement of moral principles which we all strive to achieve, and I think in that respect it's a very good summary. I agree with the points that Axel Munack has raised and I would just like to add a further point which I think is going to be also quite difficult and that is concerning the treatment of employees with dignity and respect. He says that equal employment opportunities should be provided without regard to national origin. There is some ambiguity there because does that mean nationality?, or does this actually mean the origin of the person. If it means nationality, we know that almost all countries have legislation regarding work permits on things like that and the decision as to whether a company can employ different nationalities very often is outside their control. So I think that this is a point that needs clarification. The second point I would like to make is connected with what Derek Sutton has said and it's something that's troubled me I must say right from the beginning and that is the question on which auspices is this Code of Ethics going out? Is it going out as the Club of Bologna Code of Ethics? Is it going out through local associations, or the ASAE? Is it going out through the manufacturers associations? How are we going to take it forward? Is the Club of Bologna going to take on responsibility of sending it to companies and suggest they sign it and send it back to the Club of Bologna? How are we going to do this? How are we going to follow up? How are we going to take it forward? I personally think that the easy part is the actual drafting of the Code of Ethics; I think the difficult part is now to come, and is how are we going to take it forward? And of course linking into that is the question of transgressions. If somebody notices that the company is acting outside the Code of Ethics, how are we going to propose any follow up to that? Can we propose sanctions? How are we going to propose or suggest that sanctions should be applied I think this requires a lot of thought for the next stage.

Giuseppe PELLIZZI
With reference to the intervention by L. Clarke. I think that the Club of Bologna has to define a Code of Ethics. That I will be sent to the manufacturers and everywhere. This is the reason for which I suggest that at the end of the discussion, each of you prepare a key note sentences, with your remarks on the text. We will do the best for modifying the text presented and we will send it to all of you; who can agree or not and if you will have other modifications or suggestions, please send us, so in a few months we will arrive to a final document.

Jan PAWLAK
I propose to add to the point suggested by Prof. Munack: after machinery manufacturer also "dealer"; this is just to go one step deeper after Prof. Abeels proposal.

Lawrence CLARKE
Yes ought to very clear response by Prof. Pellizzi, but the next related to something that said yesterday and notice how far or is the Club of Bologna going to embrace? Or try to include in the future more companies from industry, all companies from industry? Because I believed that this, then, would have to go hand in hand with a general publicising a general when is creation of the aims and ideals of the Club of Bologna. I'm in the Club of Bologna as well know initially and the must of the members of UNACOMA and for a drought in Unites States and in Europe. Then when we have a look at the global situation regarding industry then if you going to send this Code of Ethics out on a global bases then I think the Club of Bologna will then after move into a more global situation.

Giuseppe PELLIZZI
First of all, I'm a little worried on the globalisation, after the Geneva problems we had few months ago. But I am not sure that the manufacturers will agree with this Code of Ethics and this is the reason for which I want to be completely independent. Secondly, I have asked many times to manufacturers as well as to the representatives of the national associations of manufacturers to participate to our meetings. The only participant is from

John Deere and Japanese factories and I want express my deep thanks even if I have some difficulties in understanding Gilles position in comparison with mine. We have tried to have FIAT and other Italian manufacturers, but no one came; we have tried to involve someone from Deutz-Fahr Group with negative results. I cannot understand but I think that they don't want to be involved. So, if this is the case I prefer to remain completely free in our open discussion.

Yoshisuke KISHIDA
I suggest to correct the Ethics Code; I think the main companies have already their own Code; also institutions and many manufacturer associations have an own Ethics Code. We should correct this general frame, before to establish sentences to put into our document.

Malcom CARR-WEST
U.K.
Other speakers have already made many of the comments that I intended to make. I would very much welcome this Code of Ethics, but I would like to ask whether it is intended as draft for companies to adopt in full or whether we are suggesting the company should use this, as the basis for writing their own Code of Ethics. I feel also it doesn't address the problems expressed by many people in the application about agricultural machinery and I feel, may be, we need a separate Code of Practice that deals with those working in the advisory, research and science areas which would be very difficult to the manufacturing area.

Makoto HOKI
In my position of President of Asian Association for Agricultural Engineering, I have two short comments to do. One is this: general principle may be commonly accepted, like it happens, for example, for Japanese companies that, I think, are just following more or less this type of Code of Ethics. Without this they cannot survive but, on the contrary, probably we have countries in the World in which - and this is well related to Prof. Berge's comment about a free market economy situation - the free market economy is after controlled by the Government. So, I think, depending upon the level of economic development, sometimes it is possible to have some controls, and I believe almost all countries in the World have some control systems, basically due to the free market.

Uri PEIPER
When I read this document, I can hardly find only in two or three points the word "agriculture". That Code of Ethics is very broad one and it covers a lot of aspects, but it has to take into account that Agricultural Engineering works on the interface between human and nature. I think this point should be stressed much more; there is something, in point number 6 of general principles; you can find the environment question and the implication of agricultural engineering manufacturing on the environment and I think this point should probably be the first and then this will make a real Code of Ethics for Agricultural Machinery, rather than from general Machinery which is applicable for any other field as well.

Axel MUNACK
Apparently, the John Deere Company does not belong to the "bad guys", since this company is well known for having implemented such a Code for a long time. So, maybe, Mr. Gilles is not the best suited addressee for our aim. We are looking for a Code of Ethics also for those companies which didn't formulate or implement such a code for themselves, and we think it is worth while to try to formulate such a Code in order to get an approval on a very broad basis for it. I would also like to make a comment to several proposals in our discussion, where the inclusion of dealers and even customers into the Code of Ethics was suggested. To my opinion, this is, at least in the present stage, quite difficult to realize. When the manufacturers are going to sign this Code of Ethics they, of course, cannot sign for the customers, and also cannot sign for the dealers. So we would have to extend our activities to a complete different group of addressees. This could be a second step –

but, as first step, we should restrict ourselves to a group that we can address and with that we have channels to discuss this matter. So, again, my proposal would be in the moment to restrict our activities to the Agricultural Machinery Manufacturers.

Karl Theodore RENIUS
Assisting to this discussion I think that, because of political reasons, the importance of Code of Ethics, formerly, must come from the industry. I agree with Jean Gilles that it's not a right picture if we, the Club of Bologna, make this Code and give it, then, to the industry. We can do some work on that, thinking about that and making us familiar with these problems, but finally, formally the input should come from industry; otherwise we would have more problems.

Jurgen ZASKE
I think we cannot improve much debate anymore. It's not functional, obviously. I think we have promoted good ideas on the subject and that it's almost perfect. The problem that I see is the application and nobody can be forced to sign the Code, so the problem is how to make it known world-wide. I think it would be a good instrument, we have to make it known within the manufacturers associations in order to have their comments on it.

Yoshisuke KISHIDA
It's related to what Dr. Clarke said, At how use you do this? How should become basis on this Code of Ethics we are now preparing? My opinion on this kind of axiom should be only diffused a kind of recommendation and guide for us. This Code of Ethics should be made by each company and each association in different countries. We can not make first to use our Code quickly and, also, may be I like to suggest, Club of Bologna, should have its own Code. AgEngineers, who are promoting the propagation of the mechanisation on the World through the Club of Bologna should be able to establish their own Code of Ethics. Then, may be, we can send our opinion to another organisation.

Philippe MARCHAL
Perhaps, everybody here agrees to promote ethics in agricultural machinery sector. But, like Dr. Clarke underlined, the problem is now how to promote it and I suggest to split the problem into two different directions, that are: to promote Ethics in education and the Code of Ethics of the Club is a good educational instrument; to promote- answering for manufacturers, for institutions, etc. - individual Ethics and to draw on this basis a collective Ethics. Today, we have a lot of national laws, internal regulations, etc.; the problem is then to respect these constrains. Other wise I'm not sure we will be able to promote Ethics really and efficiently.

Karl Theodore RENIUS
I think we still have the general problem that Mr. Clarke addressed. I think we could perhaps reduce the problem if we introduce in the preamble a sentence confirming that our Code considers and includes many existing Codes, which have been created or have been already developed. If we do that, we could perhaps reduce this problem of recommending the industry something so to get them into the bottle and to summarise everything to include and to be one part not two parties.

Bill STOUT
I agree with every thing which that has been said around the table and it seems to me we have not the authority to impose anything on anybody except ourselves. We can do something for the Club of Bologna and we have the authority to put it for treasure Code of Ethics but not authority beyond. I know we put some afferent to this. I think we should publicise those ideas in different ways through the proceedings that the Club makes and through CIGR; let's publicise these good ideas and then, if they provide a marvel or provide new ideas that some companies, like Deere and other international companies we will have reached our goal. So let's publicise what we are doing in these ways and then hope that we have some voluntary acceptance of them; but we have not authority beyond our Club.

Osamu KITANI
Gentlemen, I think we had a good and pretty enough discussion already. So I would like to ask you only some important additional comments to the opinions extended in the morning. Prof. Munack do you have a conclusive comment or opinion to make?

Axel MUNACK
I think, everything has been said in the comments and I'm concluding with a remark, as the Chairman Prof. Pellizzi proposed. When we have included the discussion remarks into the draft of the Code of Ethics, then, as a next step (as also pointed out by several other speakers), we must come into discussion with people who are supposed to sign the Code of Ethics. So we have to address some of the associations for producers of Agricultural Machinery. Our Chairman should be the best person who can initiate this and can disseminate our proposal to the UNACOMA and some other associations.

Then we have a good chance to continue with our discussions during the joint ASAE meeting / CIGR World Congress where we also have the next Club of Bologna Meeting. The Chicago event will be one of the biggest events ever had in Agricultural Engineering; many people from the Agricultural Engineering Community will attend. This should be an excellent forum to have a continuation of our discussion.

Lawrence CLARKE
Perhaps we should take this on a little bit further and ask for a suggestions as to how we might take this on to the next stage. I don't know if you are agreeable but I would like to suggest that for example one way in which the Code of Ethics might reach manufactures particularly outside West Europe and North America is through national associations of Farm Machinery Manufactures. I know, for example, the Indian Association Farm Machinery Manufactures and the Pakistani Association of Farm Machinery Manufactures. If we come up with some suggestions at least we have something to write down on paper and which is going to take the process forward.

Karl Theodore RENIUS
In the first step I would like to recommend to get a support from European and American companies, so from high developed countries and if they are together with us in one group we can pass to the next step and to go to these countries which have been recommended.

Giuseppe PELLIZZI
Thank you Prof. Kitani for your chairmanship and your help. Thanks also to all of you who have contributed to discuss the subject. We will go step by step; slowly in the future, in order to define something that could be accepted by all. Of course, this is a general contribution we want to offer; we have not the possibility to discuss now the Conclusions and Recommendations. I tried only to summarize the papers and I have received today your comments, so I will prepare the Conclusions and Recommendations to be published later. I want to confirm you that we will have a Meeting in Chicago on 27th and 28th of July 2002 and, then, another Meeting here on November 16th, 17th in Bologna. The general Subject of these two Meetings is "Mechanisation and traceability of agricultural production: a challenge for the future". I mean that when we speak on traceability of production it's important that we consider the problem of mechanisation; how machines have to be realized for instance, for the pesticides distribution, for the fertilisers distribution, as well as for a post-harvest activity in order to provide products that could be well known for their traceability. The short description that Mr. Peiper gave us yesterday about ozone could be one of the answers to this problem. So we will have this subject for both Chicago and Bologna. This Subject will be subdivided into 5 Topics, the first of which will offer us a general view of the problem and will be presented by Prof. De Castro, former Minister of Agriculture in Italy and professor of Agricultural Economics, and Prof. Pierce from USA, director of the Center for Agricultural Systems in Washington. A second topic is "The role of mechatronics in product traceability" with the contribution of Prof. Auernhammer (Germany) as far as crops production and Prof. Irenilza De Alen-

car Nääs (Brazil) as far as animal production. Then a contribution by Mc Kay (Australia) and Reid (USA) as far as the problem of "Sensing and data collection system for agricultural equipment". This last topic will be discussed in Bologna together with another topic "Systems integration and certification" with contributions by Prof. Bodria (Italy) and Dr. Zaske (Germany) and, last but not least, "the point of view of the farmers", what the farmers need with contributions by Dott. Guidotti (Italy) representative of contractors association, together with Dr. Pagani that you know as a member of the Club. This will be the activity for the next year so I give you the appointment for Chicago while we are exploring the possibility, in the future, to organize something in Morocco in connection with the problem mentioned by Prof. Renius. I enjoy very much to have here new members from Turkey, Iran, Italy, UK and so on and I thank all of them. Thanks to all of you and have a good trip for returning to your houses.

Modern trends of technical maintenance of agricultural production in Russia

by ***O. Marchenko*** *(Russia)*

1. Introduction

The key problems in the upcoming five to ten years are increasing the quality and reliability of domestic techniques and their specific costs. Solving them will be essential for restoring farming machinery and tractors while saving resources.

In this connection, modern trends in the technical maintenance of agricultural production have been considered with a focus on modern farming systems and new ways of producing crops which attract leading-edge technologies and highly efficient machinery of domestic and foreign manufacture.

2. Summary of the efficiency of farm production in Russia 1997-2000

Soil and climatic conditions in the various Russian regions make up the key factor influencing the efficiency of farm production. Almost all these regions pose risks to farming and differ in soil fertility, landscape and crop productivity. For example, in 1999 against a background of a sharp reduction in the application and mineral and organic fertilizers and chemicals and fuel in Russian agriculture, average wheat yields came to 2-2.5 t/ha in only six regions of the country compared to the nationwide average of 1.17 t/ha (**Fig. 1**).

In 1991, an average of up to 90 kg/ha of mineral fertilizers and at least 4 t/ha of manure were applied to 115.5 Mha under cultivation, including 61.8 Mha under grain and grain-leguminous crops. In the period 1997-2001 the amount of mineral fertilizers used averaged out at 15-19 kg/ha and manure came to 0.9 t/ha, four to five times less. In the period 1991-2001, land under crops was reduced by 30 m ha and this land is not now in use.

Long term observations disclosed that in the majority of the regions three years out of five are characterized by adverse weather conditions and poor crop yields. Thus, over the past five years grain output came to 88.6 m t and 82 Mt in the favorable years of 1997 and 2001 and to only 47.9 Mt, 54.71 Mt and 65.5 Mt in 1998, 1999 and 2000, years of adverse climatic conditions.

The integration of the economy of the Russian Federation into the world economy has buoyed modern trends towards the technological and technical maintenance of agricultural production. These modern trends are as follows:

3. The diversification among farm producers in the various regions in profitability and solvency as well as supply of farm resources and technique

A common factor throughout the country's social-economic situation, among the various regions and within each region, is the tendency of farms to differentiate in terms their efficiency in production and farming and financial activities.

Sharp differences in the supply of farm resources and techniques has defined the level of the efficiency and profitability of farm production. There are eight regions with levels of profitability of more than 10%; eight with levels between 3% and 10%; other regions with low productivity and profitability. In 1999 there were 5,672 farm producers in 15 regions showing profits, 50.6% of the total in Russia. Farm incomes in 16 regions has averaged at more than US$ 200/ha and, in 18 other regions, at US$ 130-200/ha.

A comparison of the supply of resources, the intensity of their use and the availability of machinery in the 45 regions in the advanced agrarian sector (out of the 89 Russian regions) confirms the strong differentiation in potential opportunities resulting from 10-15 priority regions using 40-60% of all farm resources (**Table 1**).

The trend of growing profitability and the solvency of individual farms since 1999 has been noteworthy in 20 of the 45 priority regions in Russia with the most advanced agrarian sector. This is especially true for farms vaunting low-cost cereal grain production (with the profitability of grain at 50-80% or more). The number of these farms in each of the priority regions has been calculated at 15-30% of the total on average whereas normal profitability of production comes to no more than 10-15% because of low efficiency in livestock production. On other farms in the priority regions and on the majority of them in the other regions in the country a further deterioration of the social-economic situation can be noted. This trend cannot be reversed without restructurization and unless substantial public and commercial support is forthcoming and interested investors are brought in.

4. The specialisation of multi-branch farming enterprises, development of regional approach to the production of most profitable farm products

This practice confirms the ongoing tendency to reorganize multi-branch farming enterprises and their specialisation because the economic problems of Russian agriculture have forced farm producers in various regions to change multi-crop rotation systems to place priority on producing the most profitable crops in accordance with regional soil and climatic conditions. In future, this will be the basis for the regional approach to making farm products profitable and competitive in regions with similar soil and climatic conditions.

5. Extension of high technology and new techniques in farm production

One of the factors behind the declining efficiency of traditional technologies applied to crop production is high specific fuel consumption (50-80 kg/ha for winter wheat, oats and barley, for example, and 130-170 kg/ha for corn or silage production), two to three times higher than in advanced countries abroad because of the state of machinery and equipment and wear of tractor engines.

At the same time, deliveries of diesel fuel to Russian agriculture have been reduced by up to 40-50 kg/ha on average and consignments of mineral fertilizers and manure are regularly below optimum levels.

In this connection, farming enterprises are forced to resort to simplified technologies and reduce the number of technological operations and quality of performance thus loosing time. This results in low productivity and large crop losses.

The specific cost of technological materials per hectare is not very significant but with simplified technologies, crop productivity is low, operating costs are raised and production stays low in efficiency or is unprofitable (**Fig. 2**).

In recent years the positive trend of increasing farm production efficiency has been characterized by the expense involved in extending high technologies in the form of modern and complicated domestic and foreign machinery. An example of this can be clearly seen in the Krasnodar region.

Thus, on the top farming enterprises in this region, average cereal grain yields rose from 2.41 t/ha to 4.2 t/ha from 1998 to 2001 and those of wheat from 2.83 t/ha to 4.6 t/ha (**Fig. 3**) as the result of on-time and adequate deliveries of fertilizers and chemicals for plant protection (on favorable terms and for the following year's crops) and at the cost of using highly efficient domestic and foreign machinery.

In the Krasnodar region the gross output of grain and grain-leguminous products grew from 3.53 Mt to 8 Mt to account for 10% of gross grain output in the country in 2001, with wheat accounting for 14%.

Increases of grain prices in 1999 by 3-3.5 times, up to world prices, the introduction of advanced resource-saving technologies and machinery groups and preferential deliveries of technological materials have ensured high profitability for farms while reducing the price of grain and boosting the solvency of the majority of farming enterprises in the Krasnodar region.

These sound results have also been achieved in the six or eight regions of the northern Caucasus, Central Chernozem area and the Volga region. All the while, the majority of Russia's regions turn out agricultural products which are not competitive and their farms are low in profitability or unprofitable.

6. Development of Machine Technological Stations (MTS) service networks

At present, there are more than 900 Machine Technological Stations (MTS) which make up the service network in Russia's main regions. This development confirms that the

MTSs can most effectively provide assistance to farming enterprises experiencing difficulties in handling works requiring mechanized power and those made difficult by the drastic shortage of techniques available. The effectiveness of the activities of the MTSs consists of:

the performance of work with much greater labor productivity and with fewer specific outlays of material and financial assets, with spending going for operators' professionalism, a better work organization and the use of highly efficient machinery the purchase of which is not feasible even for the larger and profitable farming enterprises;

providing updated technologies for farm crop production and adapting them to the specific region through advanced science while assisting in integrating these technologies on the farm.

For Russian agriculture, the resources needed can be cut by ten through the creation of the MTS network and by providing them with highly efficient machinery with public or business support and using leased machinery, while attracting domestic and foreign financial resources forthcoming from businesses and foreign firms.

By way of example, there is the modern combine harvester Polesje, with 250-300 HP, manufactured by PO Gomselmash in Belarus, which has been widely used in 55 Russian regions and in Belarus, Ukraine and Kazakhstan as well; these more than 6,000 combine harvesters have been very successfully used by the MTS. These harvesters were designed by Russian and Belarussian experts and scientists on the basis of new technologies and with the use of highly efficient foreign components for use on farms employing intensive grain-fodder crop rotation, those with high yield cereal grains, corn, silage, sugar-beet, alfalfa and hay. The sticker prices of Polesje combine harvesters is half that of self-propelled foreign makes and their cost can be recouped within 1.5 to 2 years (**Fig. 4**).

There has also been the MTSs experience in Russia's main regions in the intensive use of foreign machinery and mobile mechanized teams which move this machinery from southern areas to the north and east. The total of foreign machinery involved here is about: 8,000 tractors (0.97% of all in use); 1,300 grain harvesters (0.65%); 1,900 forage harvesters (3.2%); 200 sugar beet harvesters (1.6%).

However, in spite of the higher output provided by foreign machines as compared to domestic products, their economic efficiency in using them in conditions in Russia is low because of their high price and operating costs. In some Russian regions, for example in the Republic of Bashkortostan, foreign-made grain harvesters are used intensively by the MTSs where grain crop yields are not very high (1-2 t/ha).

In this case, for example, at least two years are needed for the accelerated depreciation of a grain harvester used on up to 1,000 ha per year.

It is thus possible to conclude that in conditions in Russia, foreign techniques can be effectively used in regions with high grain crop yields or in combinations with domestic techniques.

7. CIS countries' cooperation in farm machinery manufacture and developments in Russian regions

Russia and Belarus, for example, closely cooperate in industrial production involving modern techniques. This cooperation includes exchanges of resources, equipment and components from Russia and complete machinery made in the large Belarus plants PO Minsk Tractor Plant, PO Gomselmash, PO Bobruyskagromash, etc.

Belarus delivers more than ten models of modern tractors, 20 of forage harvesting machines with various transport capacities, 8 models of machines for distributing mineral and organic fertilizers and many other machines, including a number leased on financing provided by the Russian Federation. As a rule, this is a modern and highly efficient technique widely used in Russian agriculture and in other CIS countries.

Against the backdrop of a critical decline in production techniques, the aging of machinery and tractors in use and reduced deliveries of agri-resources, the highly profitable farming enterprises were able to maintain basic machinery and update key machines at the rate of 5-7% annually. The overwhelming majority of farms in Russia, however, with considerable indebtedness, cannot afford the techniques and agri-resources they need and thus remain unprofitable.

At present, and in light of the slow growth of farm machinery output in Russia in 2000-2001, some regions' administrations have been forced to make unconventional decisions. There is, in this connection, a steady trend towards the development of farm machinery manufacturing at the regional level and the production of machinery through cooperation for narrow regional specializations. These efforts include opportunities for gaining regional grants and applying price controls for farms in these regions.

Thus, small-scale production of machinery which is, for the most part, obsolete, is targeted on the needs of agriculture in these regions.

However, the example of the manufacture of out-dated trailed forage harvesters at the regional level has shown that this practice does not solve the problems involved in harvesting high quality forage but results in the over expenditure of materials and high labor costs. The reliability of machinery manufactured at the regional level is, as a rule, low because of the absence in Russia of basic components for the farm machinery industry. This means that neither the goods supplied to these manufactures nor their final products are reliable and that the normative life of these machines in service cannot be ensured (**Table 2**).

As in the past, the basic forage harvesting machines in use in Russia are key machines manufactured by plants with international and federal standing producing such makes as: JSC Rostselmash – Don 680, JSC Dalselmash – Armur-680, and JSC Kirov Tractor Plant – Maral-125, as well as PO Gomselmash of the Belarus Republic with its K-G-6 Polesje combine forage harvester, etc.

8. Creation of joint ventures for manufacture of key farm machinery

For the organization of joint manufacture, the strategy of Russia's basic plants takes a favourable view of totally modernizing domestic tractors and harvesters by using state-of-the-art components with high technological content of foreign manufacture for the conversion of their production. The efficiency of these components has been confirmed by experience at the world level.

Experience has been gained in using imported components to equip domestic grain and forage harvesters. In this way, JSC Rostselmash has modernized its DON-1500B grain harvester and its DON-680 forage harvester by installing diesel engines built by Caterpillar of the United States, hydrostatic transmissions made by the German companies Sauer and Linde, hydraulics manufactured by Danfoss of Denmark, drive components from Denmark's Roulands and other components (metal detectors, knife sharpeners) from the German firm Mengele, etc.

Tests performed with modernized harvesters have shown that their reliability has risen to 0.97-0.98 to ensure productivity gains of 5.3-5.4% and a reduction of 61-84% in expenses for spare parts.

The positive results of employing imported high tech components in designing new machinery have been demonstrated by the experience of PO Gomselmash (Belarus) in work to equip their modern combine forage harvesters, the K-G-6 Polesje, with 250, 280 and 300 HP engines manufactured by the American company Detroit Diesel Corporation, hydrostatic transmissions from the American firm Eaton, hydro motors and wheels from Poclain Hydraulics of France and power transmission components from the companies Optibelt and Walterscheid, etc.

These steps have made it possible to double the reliability of K-G-6 Polesje combine harvesters, as regards breakdown during operation, while holding the market price of the machines to an increase of only 15% to keep it at virtually half that of similar foreign-made harvesters.

However, the joint assembly and manufacture of foreign machinery in Russia, outside its location, turns out to be inefficient mainly because of the inability to lower the cost of the machinery. An example of this was the experience of the Russian-German joint production of the Maral-125 forage harvester with technological and performance parameters which do not exceed those of the KSK-100A serial forage harvesters but with a manufacturing cost which is 1.4 times higher.

9. Development of financing and farm credit infrastructure, integrated Management Companies and Agri-Holdings

Public financial backing for farm producers is fundamental for effective farming and increasing their profitability and solvency. Priority should be given to public support and the attraction of favorable financing and commodity credits from businesses for the production of crops (cereal grains, sunflowers, corn, sugar beets) forage for livestock, for the cattle breeding sector, for the adequate production of farm machinery and the development of technical services.

For this reason, emerging farm credit and financial infrastructure must be improved and leasing companies must be developed for the purpose of creating favorable conditions for farming enterprises and eliminating the "circuits of intermediaries", those who now profit most from farm production processes (**Fig. 5**).

There can thus be the creation of "points of growth" in the individual regions built on farming enterprises in line with the principles of the market economy.

The process should also be accompanied by the formation of a system of service groups, regional trade networks including distribution centers, commodity bases and warehouses, dealers, technical repair shops, MTSs, etc.

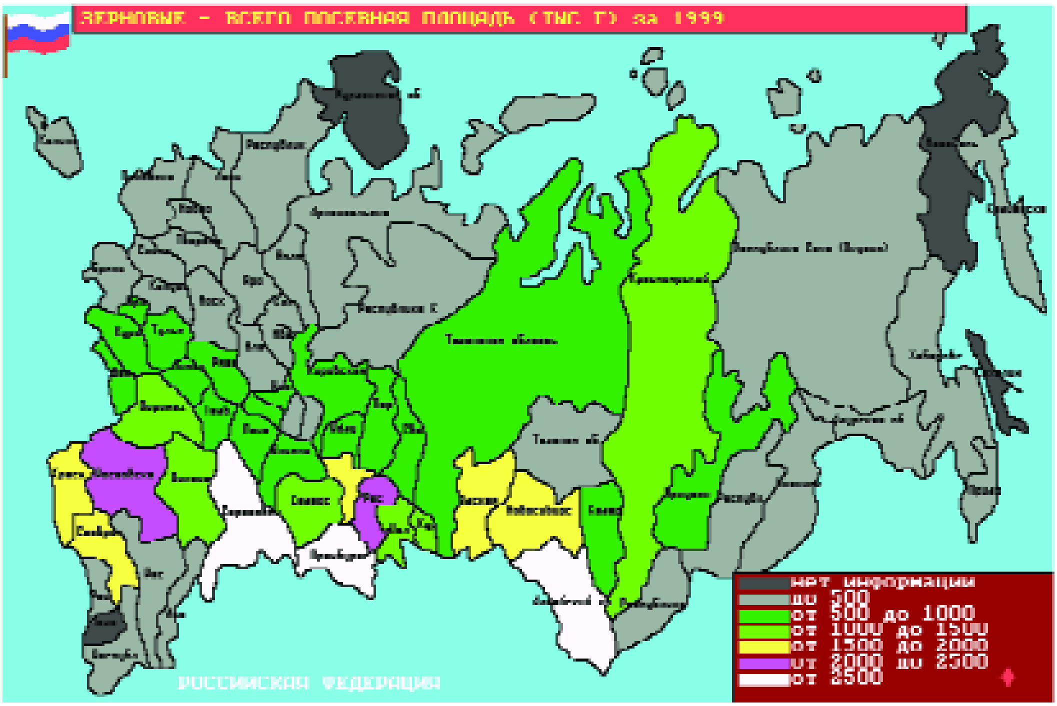
Of most importance is the creation of favorable conditions for the development of such integrated structures as Management Companies, Agri-Holdings and others geared to the integration of farm production, processing and the management of farm products, foodstuffs and the raw materials for agriculture to meet rising demand. This would make it possible to concentrate profit and financial assets for supporting the restructurization of farming enterprises low in profitability or unprofitable to bring them into the integrated structures (**Fig. 6**).

At present, such integrated structures and farming associations which attract foreign investment are up and running in some Russian regions (Krasnodar, Stavropol, Samara, Belgorod and others).

10. Conclusion

An attempt has been made to evaluate modern trends in technical maintenance in farm production in the Russian Federation in light of integration in the world economy and, above all, in light of wide cooperation in the manufacture of farm machinery in the CIS countries while also attracting foreign manufacturers and investments.

Figure 1 - Differentiation of cereal grain crop areas (thousands of ha) and cereal grain crop yields (hundreds/ha) in Russian regions



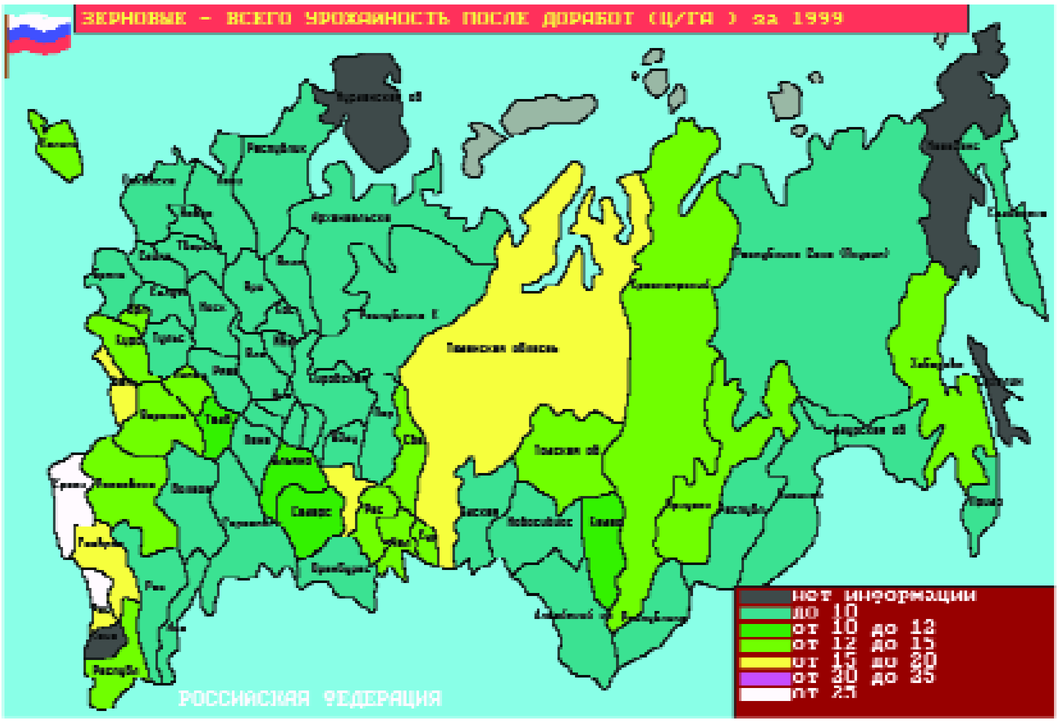


Figure 2 – Yield of Food wheat on Simplified (1,5 t / ha) and Basic (3,5 t / ha) technologies and Total cost and Yield cost of grain (2000)

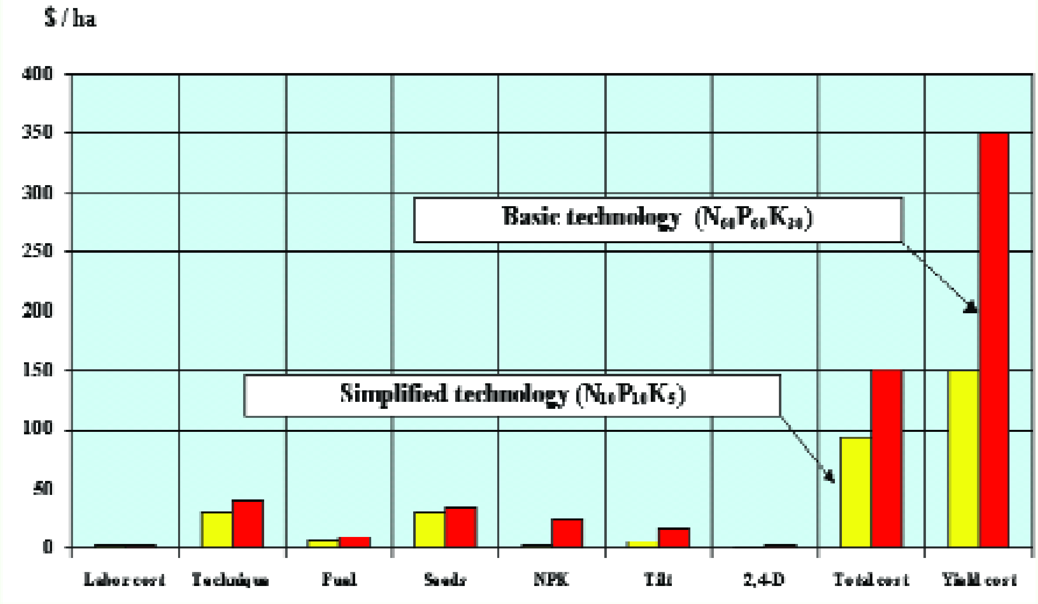


Figure 3 – Total cost for Food wheat producing on Basic Technology (3,5 t / ha)with use of Forestic and Foreign Technique (2000)

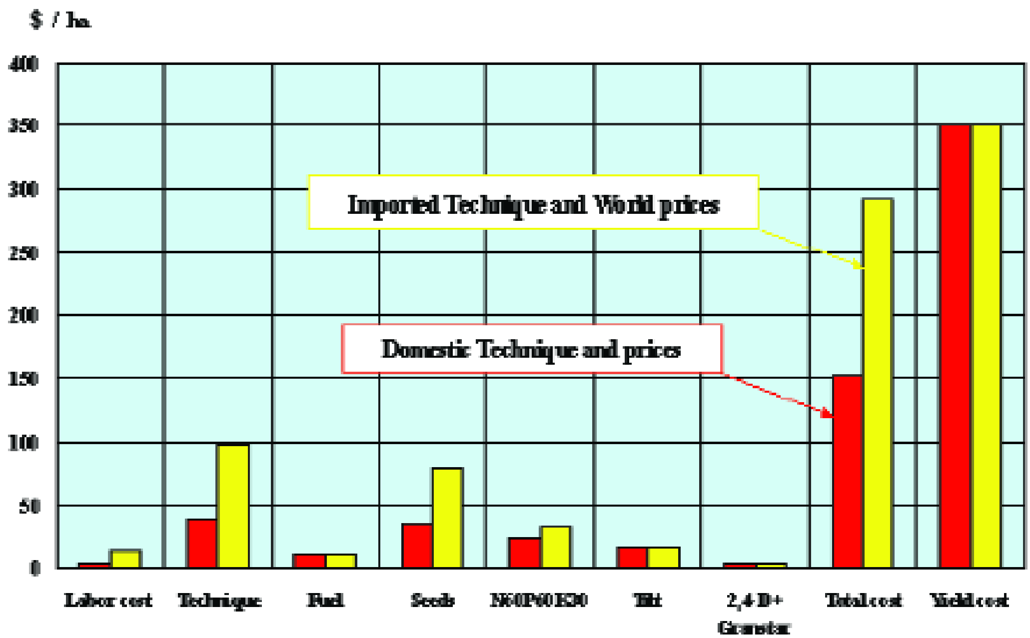


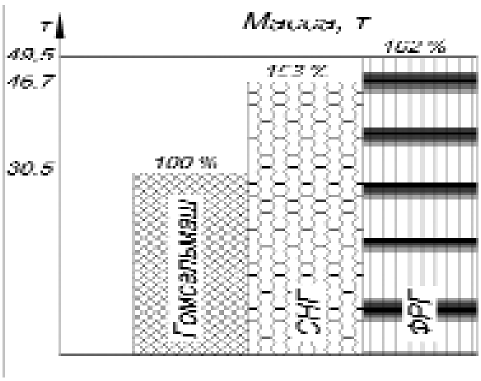
Figure 4 - Highly effective combine harvesters on Universal Power Unit base UES-2-250A Polesje at 250-300 hp

Forage harvester complex A-G-6 "Polesje" with chopper and adapters for cutting green grass, haying and silage from grasses and corn.
productivity up to 90 t/hr

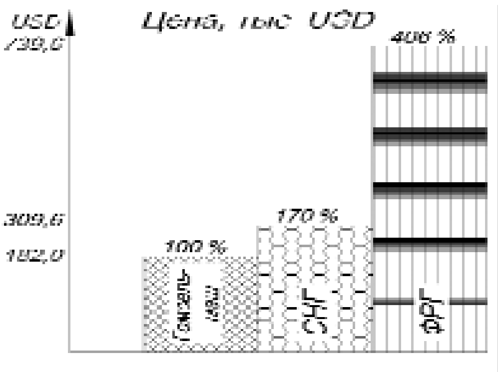
Rotary mower-crusher APR-6 "Polesje" with detachable conditioners for crushing of grass and stacking two swaths.
productivity up to 6 hectare/hr

Sugar-beet harvester ASN-6 "Polesje" for one pass cuts tops, digs out, cleans and stacks roots in a row between wheels of power unit.
productivity up to 2 hectare/hr

AZR-10 combine grain harvester "Polesje-Rotor" with front mounted header and axial rotary thresh drum-separator also attached behind to UES by the block of air-cleaning with a grain bunker.
productivity on a grain up to 20 t/hr



Savings of at least 16…20 tones of construction materials



Saving at least of productivity on a grain up 127,000 $

Main indices of efficiency of combine harvester on the base of UES Polesje for forage, grain, sugar-beet and grasses for hay and haylage

Figure 5 – Increase of agricultural production costs and interests of middlemen in production, storage and processing

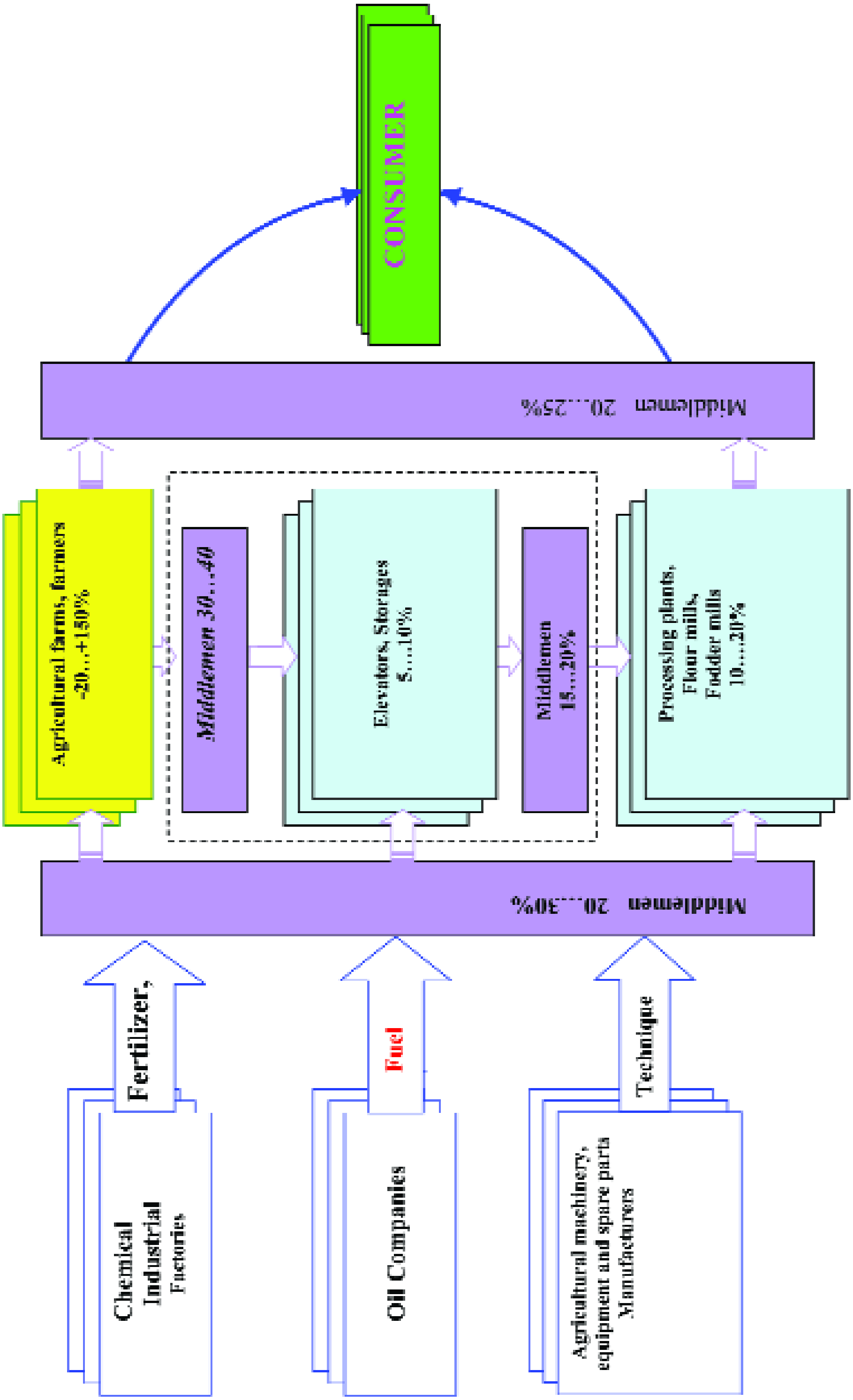


Table 1 The differentiation of farm resources supply and techniques for Russian priority regions

Farm - resources, technique,	Numbers of priority regions	Farm-resources used in priority regions, % of total amount
Mineral fertilizer	9	52
Machines for fertilizer application	20	40
Chemicals for: diseases control; pest control;	5 5	70 63
Machines for chemicals application	10	40
Diesel fuel, lubricants	12	50
Tractors	15	44
Grain harvesters	15	53
Forage harvesters	15	47
Sugar-beet harvesters	10	81

Table 2 Cooperation in the manufacture of harvesting machinery, preparation and distribution of forage in the regions of Russia and the CIS countries
(numbers of models)

Country, **Region**	**Combines**, (selfpropelled mounted trailed)	**Mower, Mower-chopper**	**Rakes, Tedder-rakes**	**Forage balers**	**Fodder choppers, distributors**
Far East	Amur-680	1			
East Siberia	Enisey-880	2	1		1
West Siberia		3	1	3	2
Ural	KSS-2,6, KPI-2,4	9	11	1	8
North-Caucasus	DON-680	8			9
Povolzhje		5	1	1	7
Central Chernoz.	KSS-2,6	1	1	1	5
Volgo-Vyatsky		3			2
Central	Prostor-400	21	11	2	12
Northern		1			
North-Western	Maral-125		3	1	
Total Russia	**10**	**54**	**29**	**9**	**46**
Belarus	K-G-6, KSK-100A,				
Total –8 models	21	6	3	6	
Kazakhstan	KSS-2,6	3	1		1
Kyrgyzstan		3	5	8	3
Latvia		1			1
Lithuania		2	5		
Uzbekistan	KPK-2,4	5	1		
Ukraine	K-G-6, KPI-2,4	10	2	4	13
Estonia		2			1
Total CIS countries	**22**	**101**	**49**	**24**	**71**

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Legenda: **MC**=Management Committee Member **FM=**Full Member **AM=**Associate Member **AM=**Associate Member
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Code of Ethics as a contribution for a proper agricultural mechanisation

Leading person: Osamu Kitani

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