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CLUB OF BOLOGNA

PROCEEDINGS
OF THE 8th MEETING
OF THE FULL MEMBERS

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CONCLUSIONS
AND RECOMMENDATIONS

48 **Experts** from 25 **countries** attended the 8th Club of Bologna Meeting — held under the auspices of CIGR - from the 30th October to the 1st November. The Club members discussed two main topics: (1) **Contractors: new machines to increase the efficiency of field operations;** (2) **Role of electronics and decision support systems for a new mechanisation.** The recently introduced **Postgraduate Certificate/MSc in European Agricultural Engineering (EUTRAC)** was also briefly discussed. The meeting reached unanimously the following:

Conclusions and Recommendations

1. Contractors: new machines to increase efficiency of the various field operations

This subject — previously discussed in 1992 — was considered in relation to conditions in different geographical areas, with contributions from the following key-note speakers: *A.M. El Hossary* (Egypt); *A. Lara López* (Mexico); *H.D. Kutzbach* (Germany); and R. *Guidotti* (Italy) who reflected the views of agricultural contractors.

The papers presented and the discussion that followed emphasised the growing technical and economic importance of the role played by contractors in carrying out field operations. This is the case in both the industrialised and developing countries although there is wide variation between countries in the number and distribution of contracting enterprises.

Whilst full contract-farming of specific crops (i.e. where the contractor undertakes all operations from soil preparation to harvest and transport) is not yet common in many countries there is increasingly widespread availability of contract services for the more common operations. These involve specialist machinery for operations such as harvesting and transport of cereals and forage as well as the other main field crops. Other operations for which contractor services are widely available include soil tillage, seeding and agro-chemical application (pesticides, herbicides and fertilizers). All this has a considerable influence on the agricultural machinery market. In fact, in most of the industrialised countries contractors undertake over 60% of all cereal and forage crop harvesting machines.

After a wide-ranging and thorough discussion the meeting agreed that contracting services could reduce costs and improve farmers income and help sustain their livelihoods. In order to maximise the technical and economic advantages of contracting services however, it is necessary to ensure that the enterprises are highly efficient and utilise the most appropriate equipment and adopt the most rigorous operational and management procedures.

As far as the technical aspects are concerned, it was emphasised that there was a need for a wide range of appropriate machines to be available specifically designed for use by contractors. These should incorporate high work capacity, manoeuvrability, comfort and safety of operation (to reduce operator fatigue), simplicity of maintenance, high levels of automation, low fuel consumption, minimal levels of pollution, and be capable of achieving high quality work at high speeds.

The organisation and management of contracting enterprises is equally important. The careful selection, training and supervision of highly skilled operators, mechanics and support staff is crucial. The enterprise owner or management must also be able to specify, operate, maintain and manage machinery and equipment appropriate to the technical, agronomic and financial requirements of the farmer. Machinery must be operated according to all prevailing rules and regulations especially those related to safety. Charge rates must be appropriate to the nature of the work and the value of the end product. Reliability and meeting the needs of the customer must be priorities as

with any business enterprise in order to gain and retain the confidence of that customer the farmer.

The participants **recommended** unanimously that:

a) Technical aspects

- Both self-propelled and tractor drawn machines need to have high work capacity and precision in order to improve the timeliness of operations and increase work rates.
- Maintenance operations need to be reduced, simplified and wherever possible automated so that some may be under-taken during transit of machines from one farm to another.
- Wider use of internal automatic machine components (hydraulic, variable trans-missions, etc.), controls and safety de-vices should be used.
- Problems such as soil compaction should be reduced through the increased use of sensors and instrumentation to monitor soil and weather conditions.
- Precision farming including the wider use of electronic performance and quality monitoring systems e.g. DGPS for yield mapping, should be promoted.
- Although contractors machines should he robust for efficiency and reliability they should be replaced as frequently as necessary in order to offer the farmer access to the latest in advanced technology.

b) Management aspects

- Contracting services, as with any business enterprise, should be effectively organised and managed and be of sufficient size to be able to offer the range of services the farmer requires, with up-to-date well maintained machines, well trained and supervised staff and rigorous management systems to ensure quality work at an acceptable price and a profitable enterprise.
- Appropriate standards in the contracting enterprise sector may be enhanced by voluntary or compulsory membership of professional or trade associations or a national register, which can monitor standards of quality, safety, etc.
- The development of the contracting sector will require agricultural engineers who are able to ensure that services are provided promptly and efficiently with charges based on both quantity and quality of work. This will require improved statistical data and the development of better methods of evaluating the quality of machine performance.

2. Role of electronics and decision support systems for a new mechanisation

This subject was considered on the basis of four key-note reports presented by: H. *Auernhammer* (Germany); *J.K. Schueller* (USA), who expressed the point of view of research; *A.R. Rider* (USA) and *W. von Allwörden* (Germany), who presented the point of view of industry.

All the participants **recognised** the growing importance of electronics in modern mechanisation and underlined the relevance of this subject to the one previously examined concerning contracting. In fact, electronic devices and decision support systems are most widely used in larger, high capacity tractors and machines of the types typically used by contractors.

At present electronic systems are used in only a few basic areas such as control functions for the reduction of operator fatigue, the improvement of machine performance, process control in the optimisation of the relationship between the machine, soil, plants and animals.

The first two examples were the basis of electronic systems when they were first introduced 25 years ago as an interface between the operator and control functions on tractors, implements and machines. The

other example represents the latest trend in which electronic systems and sensors permit a dialogue between the machine and it's working environment. The aim is to en-able precision farming techniques to be adopted that will allow biologically, economically and environmentally sustainable production systems to be established.

The main tractor manufacturers have solved many of the problems of applying electronics within the tractor, such as for engine control and monitoring, transmission systems and electronic communication and control networks for the mounted implements or equipment (through BUS systems). They are now working on decision support and control systems to monitor the agricultural processes and to protect the environment (yield mapping, patch spraying etc.).

In the light of growing farm size and the increasing use of contractors the participants underlined the need to develop and promote electronic solutions based on satellite positioning and navigation systems to support machinery operation and management. This will require systems able to interact between management information systems (MIS) and mobile process systems (MPS) and the increasing use of robotic control methods based on DGPS.

The informative papers presented by the manufacturers gave a good account of recent progress and outlined current developments aimed particularly at reducing operator stress and improving equipment performance. The discussion indicated that there arc still some difficulties in delivering the various innovations to the end user in an acceptable and cost effective way and to differentiate between the needs of the industrialised and developing countries.

In conclusion the participants unanimously **recommended** close collaboration between industry and research organisations in the development of such aspects as innovative sensors and actuators in precision farming systems able to work in real time and decision support systems capable of better control and monitoring of various agricultural processes. There was also a need to develop better international standards in the various technologies such as in diagnostic systems, universal interfaces to GIS, high performance BUS systems compatible with the existing mechanical solutions and limitation of electromagnetic emissions etc. order to realise the potential of these innovations further work on the economic as well as the technical aspects may he necessary. Promotion to farmers and other users will also be needed.

Finally, the participants underlined the importance of safety and environmental factors and emphasised the need for developing countries to adopt more robust less complicated electronic technologies in the first instance.

3. EUTRAC: Postgraduate Certificate/MSc in European Agricultural Engineering

Following a short introductory presentation by N. Warner (UK) and R. Ramharter (Austria) the participants **expressed their support** for the multinational co-operation programme promoted by the Royal Agricultural College of Cirencester (UK) and involving the Institutes of Agricultural Engineering, of the Universities of Hohenheim (Germany), Milano (Italy) and Wien (Austria).

The aim of the 2-year long course leading to a Postgraduate Certificate in European Agricultural Engineering is to produce agricultural engineers with a knowledge of the industrial sector of at least 2 EU countries selected from the 4 participating countries mentioned above.

Following discussion the participants **recommended** the expansion of the programme to other European Countries and requested a progress report from the course organisers at a future Club meeting.

CONCLUSIONI
E RACCOMANDAZIONI

48 **Esperti** provenienti da 25 paesi hanno partecipato all'8° Meeting del Club of Bologna – organizzato con gli auspici della CICR – per discutere i seguenti due temi:
(1) Contoterzismo: nuove macchine per migliorare l'efficienza delle operazioni di campo;
(2) Ruolo dell'elettronica e sistemi di supporto decisionali per una nuova meccanizzazione.
Una breve seduta introduttiva è stata inoltre dedicata al problema dell'introduzione di un **MSc europeo in Ingegneria Agraria (EUTRAC)**. Dopo un'approfondita discussione i partecipanti hanno unanimamente raggiunto le seguenti:

Conclusioni e Raccomandazioni

1. Contoterzismo: nuove macchine per migliorare l'efficienza delle varie operazioni di campo.

Questo argomento – già discusso preliminarmente nel 1992 – è stato studiato con riferimento a diverse aree geografiche ed ha offerto contributi scritti presentati dai seguenti relatori di base: A.M. *El Hossary* (Egitto); A. *Lara Lopez* (Messico); *H.D. Kutzbach* (Germania); *R. Guidotti* (Italia). Quest'ultimo ha espresso il punto di vista delle associazioni di contoterzismo.

Le relazioni svolte e la discussione che ad esse è seguita **confermano,** anzitutto, il crescente ed insostituibile ruolo tecnico ed economico dei contoterzisti per lo svolgimento delle operazioni di campo. Ciò, con riferimento ai paesi sia industrializzati, sia in via di sviluppo, anche se le situazioni attuali appaiono molto diversificate quanto a effettiva presenza di queste imprese.

Assai scarsa in tutti i paesi risulta tuttora la presenza di contoterzisti chiamati a sostituirsi integralmente agli agricoltori per svolgere tutte le operazioni di campo – dalla lavorazione del terreno, alla raccolta – relative a determinate colture. Per contro, risulta che le operazioni più comunemente svolte dai contoterzisti riguardano la raccolta dei cereali, dei foraggi – compresi i relativi trasporti – e delle altre principali colture erbacce. A tali operazioni seguono, per diffusione, quelle di: lavorazione del terreno, semina, distribuzione di fitofarmaci e di fertilizzanti. Tutto ciò condiziona il mercato delle macchine agricole. Infatti – almeno nei paesi industrializzati – oltre il 60% del mercato di macchine per la raccolta dei cereali e delle colture foraggere da insilamento riguarda il contoterzismo.

Stanti queste positive premesse, i partecipanti – dopo ampia e approfondita discussione – sono stati c**oncordi nell'affermare** che, al fine di massimizzare i vantaggi tecnici ed economici del contoterzismo, migliorare il benessere degli agricoltori e incrementarne le entrate relative dirette e in-dirette, occorre garantire sia il soddisfacimento di particolari esigenze tecniche e funzionali delle macchine utilizzate, sia la soluzione di problemi organizzativi propri delle imprese agromeccaniche.

Circa il primo aspetto tecnico, si sente l'esigenza di disporre di macchine specificata-mente realizzate, appropriate in termini di: capacità di lavoro, sicurezza di funziona-mento, semplicità manutentiva, ampia automazione, facile manovrabilità, bassi consumi energetici, rispetto dell'ambiente, migliore qualità di lavoro e riduzione dell'affaticamento degli addetti.

Il secondo aspetto, invece, riguarda la parte organizzativa e strutturale delle imprese di servizio che non possono essere improvvisate e che devono: avvalersi di tecnici (meccanici, conduttori) altamente specializzati; essere in grado di ottimizzare la scelta delle macchine in termini di appropriatezza alle esigenze strutturali, pedologiche, agronomiche ed economiche degli agricoltori; essere opportunamente inquadrate in termini legislativi ed economici, sì da poter dare affidamento agli agricoltori.

Per tutto quanto sopra, i partecipanti unanimi **raccomandano** che:

• dal punto di *vista costruttivo*, le macchine – semoventi o applicate ai trattori – siano in grado di offrire: una capacità di lavoro tale da aumentare la tempestività degli interventi e le aree dominabili nei tempi utili; la semplificazione delle operazioni di manutenzione, opportunamente automatizzate, da effettuarsi con minor frequenza e – ove possibile – anche durante le fasi di trasferimento interaziendale; la massiccia introduzione dell'automazione a livello sia di organi interni (come, a esempio, e per le trasmissioni idrauliche a variazione continua), sia della sicurezza e del controllo operativo. A tal fine: vanno risolti i problemi di compattamento del suolo; va incoraggiato l'impiego di sistemi elettronici di controllo attivo per la verifica del lavoro svolto e della sua qualità, inclusi i sistemi satellitari differenziali (come il DGPS) atti a rispondere alle esigenze dell'agricoltura di precisione; vanno garantite la robustezza e, al contempo, la possibilità di un rapido raggiungimento della obsolescenza tecnica onde dare all'utente in ogni momento quanto il progresso tecnico è in grado di offrire;

• dal punto di *vista organizzativo*, le imprese, strutturate modernamente, siano: di dimensioni sufficienti a garantire il miglior servizio agli agricoltori; dotate di macchine moderne e bene mantenute, condotte da tecnici esperti. Ciò allo scopo anche di assicurare una buona qualità del lavoro. Una garanzia ulteriore, poi, deriverà dall'iscrizione obbligatoria a un pubblico albo delle imprese agro-meccaniche, men-tre a una più ampia diffusione del servizio contribuirà un rigoroso controllo tecnico-economico delle stesse con bilanci trasparenti. Le condizioni per lo sviluppo del settore devono comunque essere create ad ogni livello in stretta collaborazione con gli ingegneri agrari per assicurare un'efficienza all'intero sistema la cui attività de-ve essere pagata in base agli aspetti quantitativi e qualitativi del lavoro. Si sente l'esigenza di approfondire le statistiche e di definire metodi standardizzati di valutazione della qualità delle prestazioni.

2. Ruolo dell'elettronica e dei sistemi di supporto decisionale per una nuova meccanizzazione

Questo tema è stato esaminato sulla base di quattro rapporti presentati dai seguenti autori: *H. Auernhammer* (Germania) e *.J.K. Schueller* (USA), che hanno espresso il punto di vi-sta della ricerca; *A.R. Rider* (USA) e *W. von Allwörden* (Germania), che hanno espresso il punto di vista della grande industria.
Tutti i partecipanti hanno, anzitutto, **riconosciuta** l'importanza crescente dell'elettronica a servizio di una moderna meccanizzazione ed hanno rilevato il collegamento di questo tema con quello, precedentemente esaminato, relativo al contoterzismo. Infatti, dispositivi elettronici e di supporto decisionale vengono sempre più massicciamente incorporati nei trattori e nelle macchine operatrici presentanti elevate capacità di lavoro, ampia utilizzazione oraria e quindi, come tali, di prevalente utilizzazione da parte dei contoterzisti.

Attualmente l'elettronica è impiegata in quattro aree base che riguardano rispettivamente: la riduzione dell'affaticamento degli addetti; l'aumento delle prestazioni delle macchine; il controllo di processo; l'ottimizzazione del rapporto col suolo, le piante e gli animali.

Mentre i primi due aspetti hanno costituito la base – quando si iniziò circa 15 anni fa' - dell'elettronica applicata ai trattori e alle macchine agricole, i secondi due costituiscono la tendenza più moderna in quanto – consentendo un dialogo fra macchine e ambiente – mirano ad attuare la tecnica dell'agricoltura di precisione indispensabile per la realizzazione di un'attività rurale economicamente e biologicamente sostenibile.

Le più importanti case costruttrici di trattori, infatti, risolti i principali problemi di applicazione elettronica interna ai trattori stessi – come è il caso delle trasmissioni – e atti a dialogare, a mezzo di sistemi BUS, con le macchine operatrici ad essi accoppiate, sono attualmente orientate ad avvalersi di si-

sterni di supporto alle decisioni per migliorare il processo c difendere l'ambiente.

I partecipanti, peraltro, **riconoscono** — tenuto conto dell'aumento delle dimensioni aziendali e del crescente impiego di contoterzisti — **la necessità** di sviluppare e divulgare soluzioni elettroniche atte a far uso dei sistemi satellitari di posizionamento e navigazione sì da consentire la realizzazione dell'agricoltura di precisione, così come di favorire una corretta gestione aziendale sviluppando soluzioni atte all'interazione fra i sistemi informatici gestionali (MIS) e i sistemi mobili di processo (MPS). Il tutto, anche in vista di una robotizzazione delle diverse operazioni governata da DGPS. I rapporti dei costruttori sono, in proposito, illuminanti consentendo di apprezzare gli sforzi compiuti e i temi futuri di sviluppo basati su soluzioni sempre più integrate ed atte a migliorare la prestazione delle macchine operatrici ed a ridurre la fatica degli operatori. Tutto ciò, pur riconoscendo qualche difficoltà a rendere disponibili le di-verse innovazioni agli agricoltori e l'esigenza di differenziare il problema — nei suoi aspetti applicativi — fra macchine destinate a paesi industrializzati e a paesi emergenti.

Per quanto sopra, i partecipanti **raccomandano unanimi** di compiere ogni sforzo per sviluppare — in stretta collaborazione fra industria e mondo della ricerca — le tematiche riguardanti, in particolare: sensorie attuatori legati all'agricoltura di precisione operanti in tempo reale; sistemi decisionali di supporto atti a meglio monitorare e regolare i vari processi. Il tutto, definendo al contempo standard internazionali sulle diverse tecnologie c soluzioni quali, a esempio, sistemi diagnostici, interfacce universali ai GIS, sistemi BUS ad alte prestazioni compatibili con le soluzioni meccaniche esistenti, limitazione delle emissioni elettromagnetiche ecc.

Affinché, tuttavia, tali innovazioni consentano di raggiungere gli obiettivi operativi e tecnici che stanno alla loro base, occorre anche compiere un'ampia attività di standardizzazione, di divulgazione e dimostrazione presso gli utenti verificando la affidabilità delle tecnologie elettroniche applicate e, al contempo, il vantaggio economico reale derivante dalla loro introduzione.
I partecipanti, da ultimo, **richiamano l'importanza** — per un razionale e ottimizzato impiego delle macchine — di migliorare le combinazioni trattore-operatrice, incorporando nei sistemi anche l'osservanza di misure di sicurezza, nonché sistemi decisionali atti a favorire l'impiego ottimale del trattore e/o dell'operatrice con pieno rispetto dell'ambiente. Infine, **sottolineano** l'esigenza che, per i paesi emergenti, si pensi a soluzioni dotate di tecnologie elettroniche più semplici, economicamente convenienti, affidabili e di lunga durata sì da favorire in essi lo sviluppo della meccanizzazione.

3. EUTRAC - Master europeo in Ingegneria Agraria

Sulla base di un breve rapporto preliminare presentato da *N. Warner* (UK) e *R. Ramharter* (Austria) i convenuti **apprezzano unanimi** il programma cooperativo multinazionale offerto — sotto la guida del Royal Agricultural College di Cirencester (UK) — dagli Istituti di Ingegneria Agraria delle Università di Hohenheim (Germania), Milano (Italia) e Vienna (Austria).
Scopo del corso, di durata biennale, è di produrre ingegneri agrari con una buona conoscenza della realtà industriale di almeno due paesi dell'Unione Europea, scelti fra quelli su nominati, per acquisire un Diploma post-laurea in "Ingegneria Agraria Europea" rilasciato e reso valido dal Royal Agricultural College di Cirencester.
I partecipanti concordano nel **raccomandare** l'allargamento del programma agli altri paesi europei e l'utilizzo dei futuri neodiplomati da parte delle industrie nazionali e internazionali di macchine agricole, riservandosi di approfondire il discorso, al fine di valutare i progressi effettuati, in una prossima riunione del Club.

SESSION 1

Contractors: new machines to increase efficiency of the various field operations. A critical analysis

Chairman: Prof. Jan PAWLAK, POLAND

CONTRACTORS: NEW MACHINES TO INCREASE EFFICIENCY OF THE VARIOUS FIELD OPERATIONS. A CRITICAL ANALYSIS

by **Heinz Dieter Kutzbach**
Germany

1. Introduction

Reducing production costs and improving farm productivity are the principal motives for multi-farm use of machinery [1]. Further increases in costs, coupled with decreasing product prices, will boost the trend towards shared use of machinery (**Fig. 1**). The practice of self-mechanisation in smaller operations, which is particularly widespread in Germany, leads to low levels of machine capacity utilisation and hence to higher production costs as compared with other countries of the European Union. 40% of production costs are accounted for by the depreciation and maintenance of machines and buildings [3].

On the other hand, the total number of farms in Western Germany dropped by two thirds: from 1.65 million (1949) to 525,000 in 1995. Approximately half of these farms earn only a secondary income. The limited time which these farm owners have available also tends to promote multi-farm utilisation of machines. To a lesser extent, they ask neighbours for help or hire contractors for special services such as ploughing, plant protection or harvesting. In general, there are various forms of multi-farm machinery utilisation (**Fig. 2**).

In *co-ownership* two or more farmers purchase and use the machine collectively; each farmer drives the co-owned machines.

In leasing, too, several farmers drive the leased machine, which is given to the farmer without a driver against payment of a rental charge.

In *interchange* the farmer uses his own machines to do work for another farmer, who will compensate later on by doing another operation of equivalent value.

In *cooperation* the participant farmers use their own machines to carry out different farm operations for other participant farmers.

Contractors perform the work for the farmer, with both the machinery and the operator supplied by the contractor.

Contractors arc also gaining importance in Germany. Since 1980, the total turnover has increased from 1.05 bn DM to 1.35 bn DM [4]. In particular, in the German state of Bavaria, which is known for its well-organised cooperation schemes, turnover in 1995 was five times greater than in 1980 (160,000/29,000 DM). While the number of farmers per contractor dropped from 150 to 120, the average turnover per customer increased from 1,300 DM to 5,000 DM in 1996.

2. Why contractors?

The difficult price situation has been forcing farmers to further rationalise their operations: they sell their own poorly utilised machines or decide not reinvest in new machines. They can use the free capacity for other purposes and hire contractors, who not only perform single operations but also offer complete process chains, such as harvesting, corn silage including chopping, transportation and preparing the silo for good high quality fodder. Sometimes the complete crop production chain from tillage to harvest is given out to a contractor. In addition to the cost savings, there are other reasons which promote the use of contractors. Their high machine and area capacity enables contractors to complete the operation in a short time, within the optimal period, even when the contractor has to work for several customers. In some cases, the contractor may provide supplemen-

tal work to that of the farmer himself, in order to overcome a peak labour period. Con-tractors, with their specialised teams of machine operators and comprehensive experience, are increasingly being asked to provide extension services. **Figure 3** shows how, for plant protection, in 60-70% of cases the contractor has a significant part in making decisions about products and timing. Also in fertilising and seeding, to give another example, contractors make the decisions in 40-50% of cases.

Figure 4 shows the principal reasons why farmers hire contractors. For 82% of farmers, contractor trustworthiness is the most important consideration, followed by: good experience, adequate machinery, timeliness, price-performance ratio, skill, personal preference. Thanks to their skilled operators and their experience in performing a specific operation on many different farms, contractors are able to ensure high quality of the harvested products and protection of the environment.

3. Contractors in Germany

In Germany, the number of contractors is estimated at 3500; of these, 200 operate in the eastern states of Germany. There are no statistics available which give an accurate figure, and it is also difficult to make a clear distinction between a contractor and a farmer who works with his machine for a neighbour. A survey conducted by a German contractor magazine [5] found that contractors employ an average of 15 workers. Half of these are temporary workers; and of the permanent workers two are members of the family.

Although contractors do not work only for farms, this sector still accounts for three quarters (3/4) of their turnover (**Fig. 5**). Additional business, mostly with seeds and plant protection products, accounts for another 7% of turnover. Municipal tasks now account for a share of about 11%, and this is expected to increase in future. In this sector, composting and landscape maintenance will be the most important activities [6].

Germany has a total farming area of 16.9 mill. ha, half of which is managed by contractors. An analysis of farming operations shows a concentration on harvesting of corn and grain and plant protection, which covers about 1.5 mill. ha (**Fig. 6**). Putting these figures in relation to the total crop production areas, contractors are harvesting one third (1/3) of grain, 70% of sugar beet and 90% of corn (silage) (**Fig. 7**).

By comparing the total turnover of agricultural equipment manufacturers in Germany with the investments in new machines made by contractors between 1990 and 1993, we can conclude that the contractor share accounts for about 20% of the total number of machines (**Fig. 8**). Whereas the contractor share for plant protection, seeding and fertilising equipment, tillage and farm tractors is only about 10%, contractors purchased 60% of combines (grain harvesting) and 60% of choppers (harvesting silage and hay). The following discussion will therefore focus on these last two machines.

4. How to increase the capacity and efficiency of field operations

There are several possible ways to increase overall area capacity (**Fig. 9).** Increasing machine capacity may seem to he the easiest, but is costly. Machine capacity normally increases with machine size, for example with an additional bottom on the plough or an increase in the width of the threshing or chopping drum. Machine capacity can also be increased by good design of the individual elements and their interplay [7]. Machine capacity may be limited by operating conditions, weather, moisture content of the product or soil, shape of the plot and so on. The operating conditions are normally fixed and cannot be altered by the farmer or the contractor. However, having a higher

machine capacity available makes it possible to wait for better conditions. Machine capacity is also influenced by the operator's experience and skill. With optimal setting of elements, and driving at optimal speed, capacity can he increased drastically. Information systems and automatic control help to optimise machine operation.

The logistical management of machine utilisation also affects the efficiency of field operations. Local conditions such as plot size and farm/field distances are difficult to change, but they have a great impact on efficiency, especially on seasonal rates of work. Also, unproductive time elements such as machine preparation time, adjustment and unclogging time, filling or unloading time, stoppage time, turning time and operator rest time reduce the efficiency of field operations. For contractors, optimising the logistics of machine utilisation is essential to achieving a sufficient profit. Modern telecommunications helps to overcome bottlenecks, and to coordinate a number of combines or forage harvesters and the trailers which are needed to transport the harvested product to storage. A third possible way to increase efficiency is to develop and introduce new types of field operations which require less time and effort, such as no-tillage.

5. Critical analysis of new developments

5.1 *Logistical management of machines*

The Global Positioning System, which is discussed in greater detail in subject 2 of this meeting, represents a major challenge for agriculture. Environmental protection and automatic control, with the ultimate goal of unmanned machinery in future, are some of its possible applications. The company Claas has developed the AgroCom system, incorporating an AgroLog Monitoring feature which can assist contractors in the logistical management of their equipment [8]. A computer is installed on each machine, and records the position and operational data of that machine. On a combine, for example, the information on ground speed, threshing drum speed and header position is used to determine whether the machine is operating in the field or in transport. Telecommunications are used to transfer these data — including the actual speed, area capacity and machine identification code — to the contractor's central computer. The central computer displays the position and operational status of each machine on the screen, along with the relevant map (**Fig. 10**). This allows the contractor to optimise the deployment of his machines, and enables him to react promptly to new orders or machine breakdowns.

Although a pilot project has shown a significant increase in fleet performance, and despite the falling costs of electronic devices, the technology content remains high. This may lead to technical problems in the introductory phase, and is dependent on the future availability of CPS. However, because fleet management systems of this type will also he used in the truck transport sector in the future, there are good prospects for future contractor business.

5.2 *Unproductive time elements*

Among the various unproductive time elements, machine preparation time is one which can be optimised through suitable design of the machine. For example, mounting the header onto the combine harvester is a time consuming operation which also strains the driver. Foldable headers are now available (**Fig. 11**) which reduce this time and are easy to handle. This represents a considerable advantage for contractors who are faced with frequent changes from one plot to another, with road transportation in-between the plots. The additional cost is paid back when these plot changes occur more than 3 times per day [9]

To reduce maintenance time, forage harvesters are generally equipped with an au-

tomatic device which sharpens the cutting blades during road transportation. It is also necessary to adjust the shearbars. Figure 12 shows an automatic shearbar adjustment driven by a small electric motor. The remaining distance between the cutting blades and shearbar is controlled by means of a knocking sensor.

5.3 *Design and size of machines*

Capacity increase — Because contractors require high performance on field operations in order to reduce their costs, machine capacity has risen steadily in the past. Assuming that engine power is in relation to machine capacity, we can use engine power to characterise this capacity in-crease (**Fig. 13**). The power of the biggest combine has reached 275 kW, and that of the biggest forage harvester 354 kW. This increase in machine power is expected to continue in the coming years. Moreover, the market share of bigger machines, in relation to the total numbers sold, is also expected to increase.

Contractors are thus faced with the increasing risk of losing a considerable portion of their machine capacity in the event of the sudden breakdown or failure of one big machine. Preventive maintenance, daily servicing and overnight spare parts delivery, together with good manufacturer service, are becoming increasingly important.

Self propelled machines — For these big machines, the engine, drive train and driver compartment costs have a lower incidence on the overall machine cost. That is the reason why more and more self-propelled machine models are appearing on the market. For combines, the transition from pull-type to self-propelled designs took place decades ago. Especially for smaller plots, which require frequent road transportation for plot changes, self-propelled combines have captured the market. The many advantages, such as optimal technical adaptability to field operations, a good view of crop intake, infinitely variable hydraulic transmission, good manoeuvrability and brief preparation times, have led to the introduction of self-propellers for other machine types as well. This trend is particularly marked in forage harvesters. Pull-type and tractor-mounted choppers have lost importance.

For sugar beet harvesting, 6-row harvesters are becoming widespread. Whereas in France harvesters and loaders are used as tractor-mounted implements, in Germany self propelled 6-row hopper harvesters have been acquiring a growing market share in recent years. They are principally used by contractors, cooperatives or co-owner collectives. Self propelled 2- or 3-row harvesters are also available (**Fig. 14**). They arc attractive for farmers who can still deliver their beets to the factory themselves, and who have sufficiently work capacity which cannot be utilised otherwise. The problem with the big 6-row hopper harvesters is that the hopper capacities of the largest harvesters are only sufficient for field lengths of approximately 700 m when yields reach 500 to 550 t/ha. Self propelled harvester loaders, which gather the beets from the swathe, are an alternative. Another solution is the use of harvesters with an intermediate hopper with a loading capacity of 2 to 14 t. They convey the beets to an ongoing transport wagon, thereby eliminating the need to stop to change the wagon.

For potato harvesting, there are 2- or 4-row self propelled harvesters on the market with hopper capacities of up to 5 t, which are capable of performances as high as 1 ha/h. However, achieving these high performance levels in practice requires the permanent availability of transport wagons and high storage capacity. Self propelled potato harvesters offer advantages under unfavourable operating conditions. However their daily and annual utilisation is limited by the potato quality required for processing. This also affects the costs. In contrast to sugar beet harvesting, the costs of

self propelled machines cannot be offset by a markedly higher output [11]. Self propelled machinery is available for other field operations as well, such as plant protection, grass mowing and baling (**Figs. 15** *and* **16**).

The powers and total masses for some self propelled machines are shown in **Figure 17**. Forage harvesters are characterised by the highest engine powers but relatively low masses. Combine harvesters have lower engine powers but somewhat higher masses. The number of self propelled sugar beet harvesters is as yet limited, but total masses have reached very high levels.

These huge machines have reproposed the idea of multi-usable carrier vehicles. There is a wide range of such carrier vehicles available, with 3 to 6 driven tires, relatively high engine power and large total mass (**Fig. 18).** They have been specifically developed for slurry application, but can be fitted up for sugar beet harvesting or other purposes. These are highly sophisticated vehicles, which may find a market for special applications in contractors operations. Their success will depend on the necessary preparation times and the overlapping of possible field operations.

With tyre loads of up to 7.5 t/tyre, there can be problems with soil compaction even if voluminous low-pressure tyres are used. These big tyres may prevent compaction of the top layer, but can still cause compaction of the deeper layers. Research has shown that compaction is strongly dependent on soil type, soil moisture content and weather conditions. On dry soils, even these high tyre loads will not compromise the yields. However if the soil is moist, the user has to be very careful.

Combine harvesters — Substantial capacity increases have been achieved for combine harvesters as well. Since the introduction of the TR combine by Sperry New Holland in 1976, there has been a proliferation of different types of threshing and separating elements aimed at increasing machine efficiency. Conventional combines (with straw walkers) and non conventional combines (without walkers) are differentiated by the effect of the walker on working methods, function and design. In non conventional combines with tangential threshing cylinders, the capacity limiting walker has been replaced by rotating separating elements. These can he tangentially fed separating cylinders (CS, Claas), a single axial twin-flow separating rotor installed crosswise (TF, New Holland), or two separating rotors installed lengthwise (CTS, John Deere; Lexion, Claas) (**Fig. 19).** In non conventional combines with axial rotors, the axial rotor does the threshing work in the front segment and separates grain and straw at the rear. The cut crop can be fed into the axial rotor tangentially (Gleaner, AGCO) or axially, and the rotor can he installed crosswise or lengthwise in the combine. Machines with one (AF, Case) or two axial rotors (TR, New Holland; ARCUS, MDW) are available on the market (**Fig. 20**). Descriptions and evaluations of these different designs and individual functional groups can be found in the literature [12].

The design and introduction of non conventional combines has required a further evolution of conventional combines, with their proven and reliable tangential threshing devices and straw walkers. Combine capacity has been increased principally through the addition of an extra separating cylinder between the beater and the straw walker, which relieves the walker of a part of the grain. After the well-known solution developed by Ford New Holland, other manufacturers have offered similar solutions.

Claas has chosen a different solution, in which an accelerator is fitted before the threshing drum (**Fig. 21**). This APS-system is used in the Lexion, too.

Generally, the axial rotor performs threshing more by friction than by impact. This

consumes approximately twice the threshing energy as compared with a tangential threshing cylinder, and produces shorter straw pieces which are less suitable for haling. On the positive side, grain breakage is reduced and the throughput for a given combine volume is increased. Axial rotors offer advantages in the threshing of corn and soybeans, but are unable to thresh such a wide variety of crops as tangential threshing cylinders.

Stripper headers developed by Klinner at the Silsoe Research Institute and marketed by Shelbourne Reynolds from the UK are an alternative to a normal cutter bar grain header. A combing rotor strips the cars from the stalks and feeds them into the threshing unit (**Fig. 22**). Small volumes of straw (MOG, material other grain) drastically increase combine capacity (as much as doubling grain throughput) and markedly reduce fuel consumption in relation to the harvested grain. However there are certain harvest conditions under which the stripper performs poorly, and a standard header must also be available for certain crops like oilseed, rape and field beans. Therefore the stripper entails an additional investment. Front-end losses can be high, and vary depending on rotor speed and hood adjustment. But good results in rice harvesting seem to promise successful applications with rice crops 113).

5.4 *New field operations*

Super conditioning — Super conditioning of grass has the function of accelerating drying to permit harvesting of pre-dried grass within a single day. A self propelled harvester has been developed which incorporates a conditioner followed by a matting device (**Fig. 23**). The conditioner features three specially ribbed cylinders with high peripheral speed combined with a large central cylinder. Different cylinder speeds lead to maceration of the grass surface with a high drying rate. The cylinder pressure is adjustable to permit optimal adaptation to the harvest conditions. The matting device presses the stems together and forms a mat which is deposited on the stubble for quick drying. Harvesting the pre-wilted grass at the moisture level required for ensilage within one day prevents the mowed grass from rewetting during the night, thus avoiding additional losses [14]. Large plots and a good weather forecast for at least one day are among the requirements for wider use of this machine.

Conservation tillage — Conventional tillage with a mouldboard plough has a low area capacity and accounts for roughly 20-25% of the total fuel consumed by the entire crop production chain. It offers the advantage of good weed control, but has causes many negative effects on the soil ecosystem (**Fig. 24**). Soil structure, soil fauna and translocation processes arc negatively influenced.

Conservation tillage is characterised by a reduction in tillage intensity, with crop residues remaining on the soil surface. For seedbed preparation and sowing there are a wide variety of machines available, which can operate well in spite of crop residues and offer a high degree of flexibility with regard to agricultural demands. Tillage intensity is decreasing from the use of the chisel plough to rotary harrow air-seeding. No tillage is necessary for direct sowing. Long-term tests conducted by the University of Giessen at different locations, with the usual crop rotation, have demonstrated various interactions in the soil-ecosystem (**Fig. 24**).

If inverting of the soil is avoided and crop residues remain on the soil surface, the soil structure will be stabilised as a result of biological processes, and trafficability for vehicles will improve. A biogen, vertically oriented pore system helps reduce soil susceptibility to erosion due to higher infiltration of water. Furthermore, herbicides remain in the top layer of the soil where they are bound by the organic residues, so there is almost no danger of their leaching out. In addition to this, the more favourable micro-

bial conditions lead to faster degradation of herbicides. The results of intensive research show that comparable yields can be obtained using conservation tillage or even no-tillage methods. Therefore it seems possible to meet both economic and ecological requirements.

Despite these advantages, conservation tillage and no-tillage systems in particular are not very common in Europe, although several No-till drills are available in Europe [16]. These methods require: adapting crop rotation, weed control and plant protection; appropriate fertilisation; professional machinery with high demands on operation, maintenance, reliability and work quality. Direct-sowing coulters must guarantee a precise seed-insertion depth and must not clog even on very compact soils with a thick layer of crop residue. In addition, the switch from conventional to conservation tillage — and even more so to no-tillage — requires a great deal of experience, because it entails not only a change in machinery but also the introduction of a new cultivation system [17,18]. Because of its economic and ecological advantages, direct sowing will probably also gain wider acceptance in Germany and other European countries. In North and South America, as well as in Australia, no-tillage is widely used.

5.5 *Automatic control*

Automatic control systems relieve the operator of the need to precisely track the adjustment parameters according to the actual operating conditions. Because the role of electronics is discussed in the second subject of this meeting, only two items shall be mentioned here.

Automatic steering on corn rows, which was developed by Claas years ago and subsequently transferred to other harvesters like sugar beet harvesters (**Fig. 25**), drastically reduces the strain on the driver. It also makes it possible to work in the evening twilight. In addition, with automatic steering the working speed in corn rows is about 10% higher than without. Of course, automatic steering puts stringent requirements on safety and the reliability of system as a whole. In future, Differential Global Positioning Systems may supervise the automatic guidance of machines. This could ultimately lead to unmanned, robotic machines.

Global Positioning Systems may help to automate machine adjustments through the mapping of relevant parameters. For this purpose, data about the area currently being worked on are recorded as the machine carries out the operation (for example yield mapping) [19,20]. On the basis of this information, the expected conditions in the area ahead, which the machine will be working on next, are calculated on-line (**Fig. 26**). The travel direction of the combine harvester is determined from the current position P_2 and the previous position P_1. The next working position P_3 is calculated at a distance s_v in front of the combine harvester. The preceding yield data for a circle of radius r_y around P_3 are determined. In an initial step, the arithmetical mean of the yield data inside the circle is calculated, and this value is used as the expected yield at position P_3. This prediction restores the course of yield alteration in a good way (**Fig. 27**). An optimal working velocity with a suitable feed rate at the combine is calculated on the basis of the known cutting width and the expected yield.

This pre-calculation method offers new way of optimising the adjustment of mobile machines. In a combine harvester the yield is used as parameter because it does directly influence the capacity. This is an additional application of yield mapping, and permits the inclusion of harvesting as well as fertilising and plant protection in a particular field production. Pre-calculation can also be used for other mobile machines, for example to calculate the ploughing draught force in advance in order to improve the draft control system of the 3-point hitch.

6. Conclusions

Contractors are gaining importance in performing various field operations. For example, in Germany contractors harvest 90% of maize silage and 70% of sugar beets, and over 60% of new machines for harvesting grain and silage arc bought by contractors. The specific requirements of contractors have led to a steady increase in machine capacity and to more self propelled machines. These big machines can cause soil compaction due to their heavy weight, and entail a high financial risk in the event of breakdown. DGPS and modern telecommunication may help contractors to optimise the logistical management of their various machines, and assist the driver in machine adjustment.

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Fig. 1 - Development of prices of means of production and products [2]

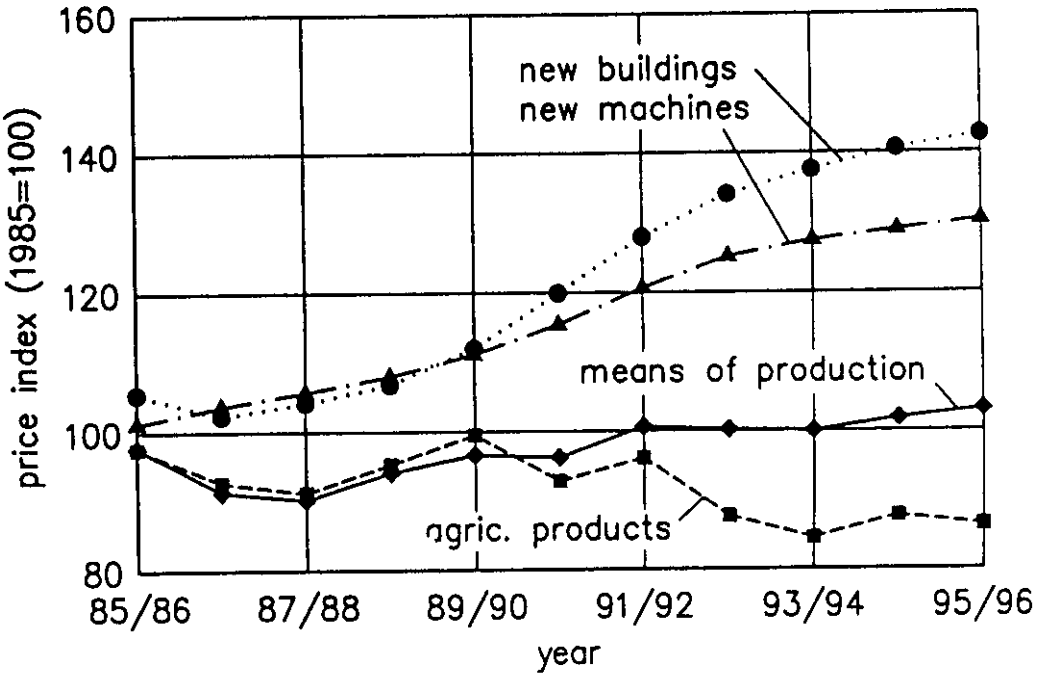


Fig. 2 - Organization forms for utilization of machinery

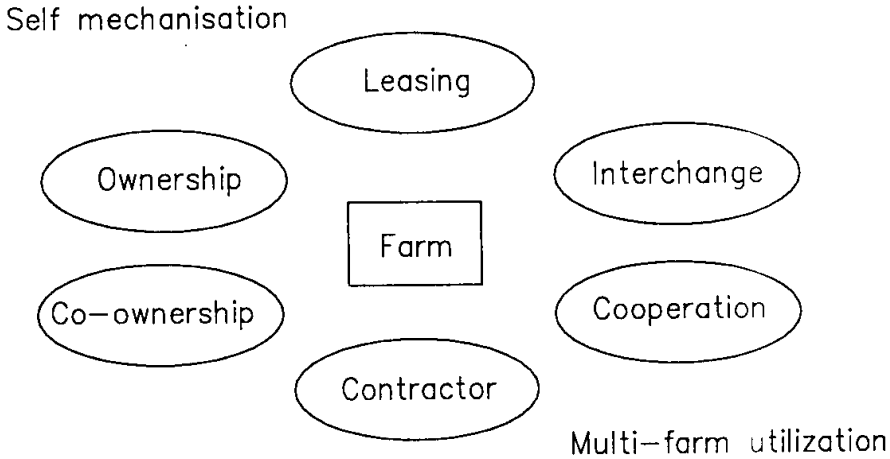


Fig. 3 - Contractors extension intensity [5]

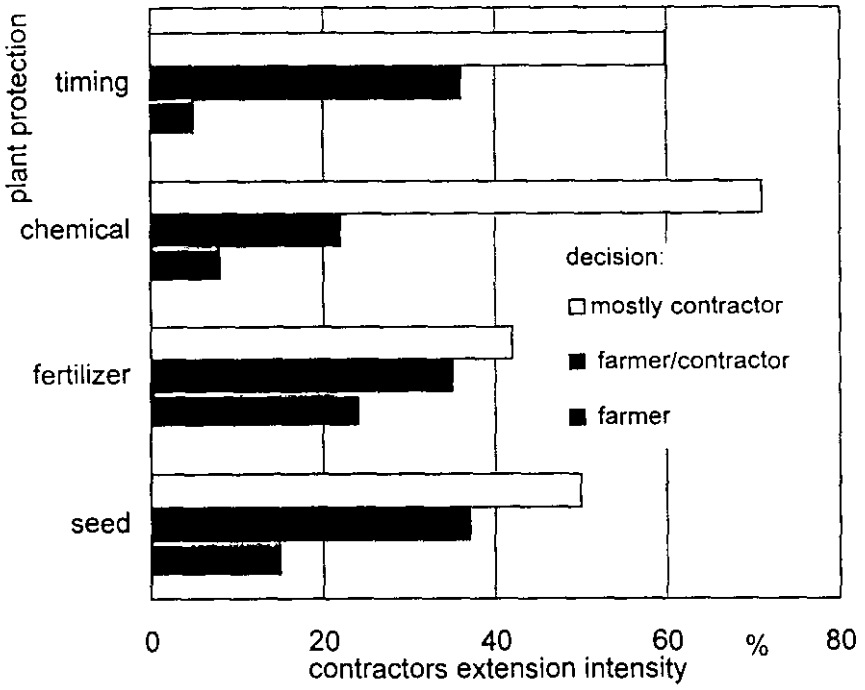


Fig. 4 - Reasons to hire contractors [4]

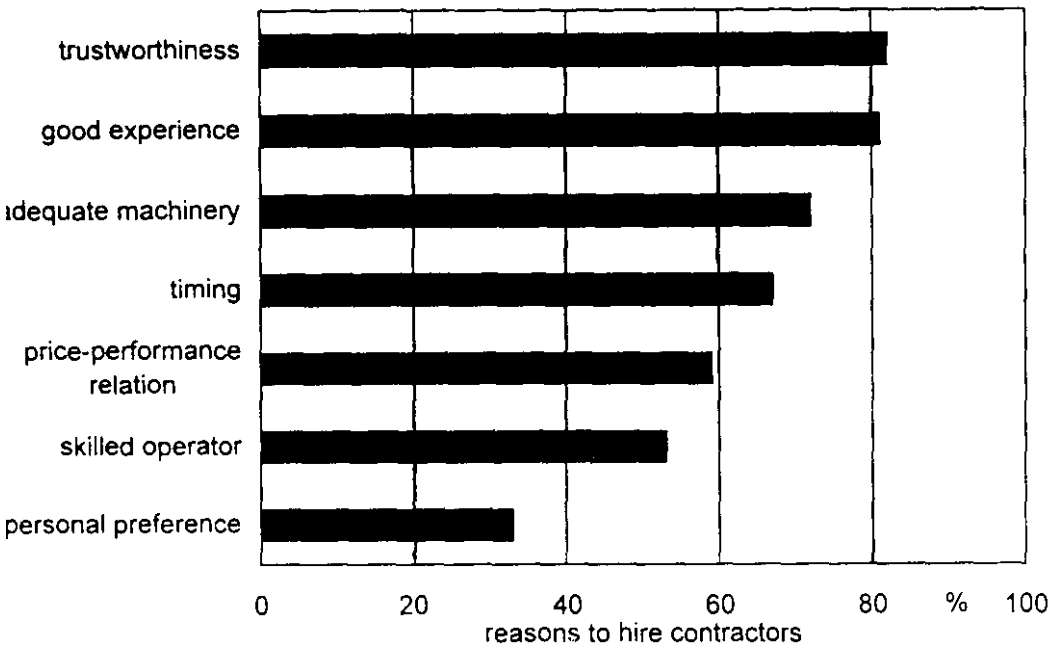


Fig. 5 - Distribution of contractors turnover [5]

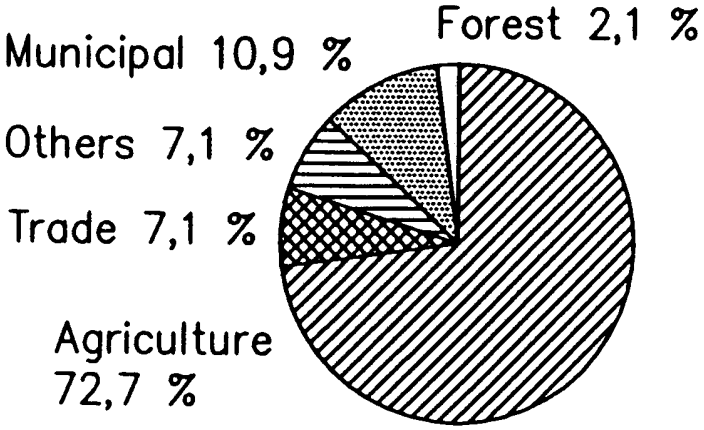


Fig. 6 - Contractors area [5]

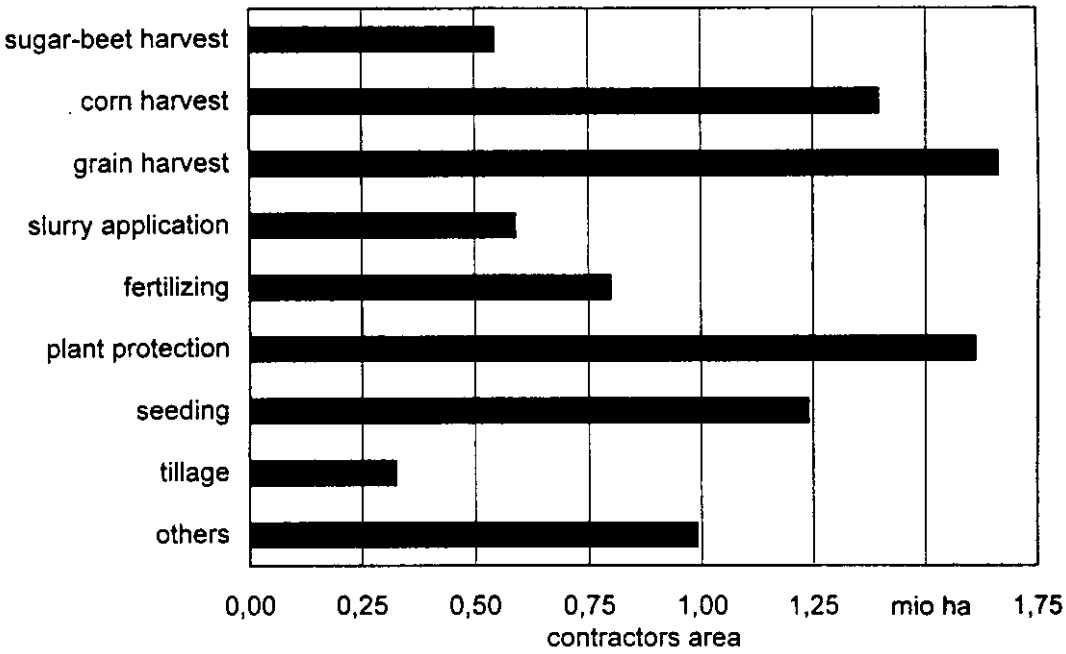


Fig. 7 - Contractors arca share [5]

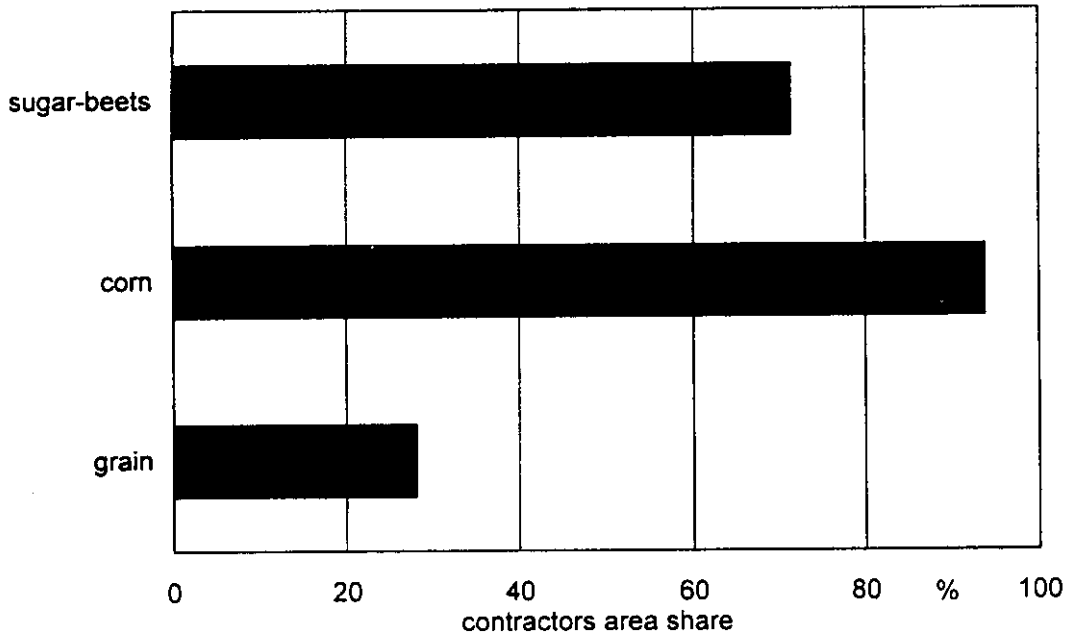


Fig. 8 - Contractors investment share [5]

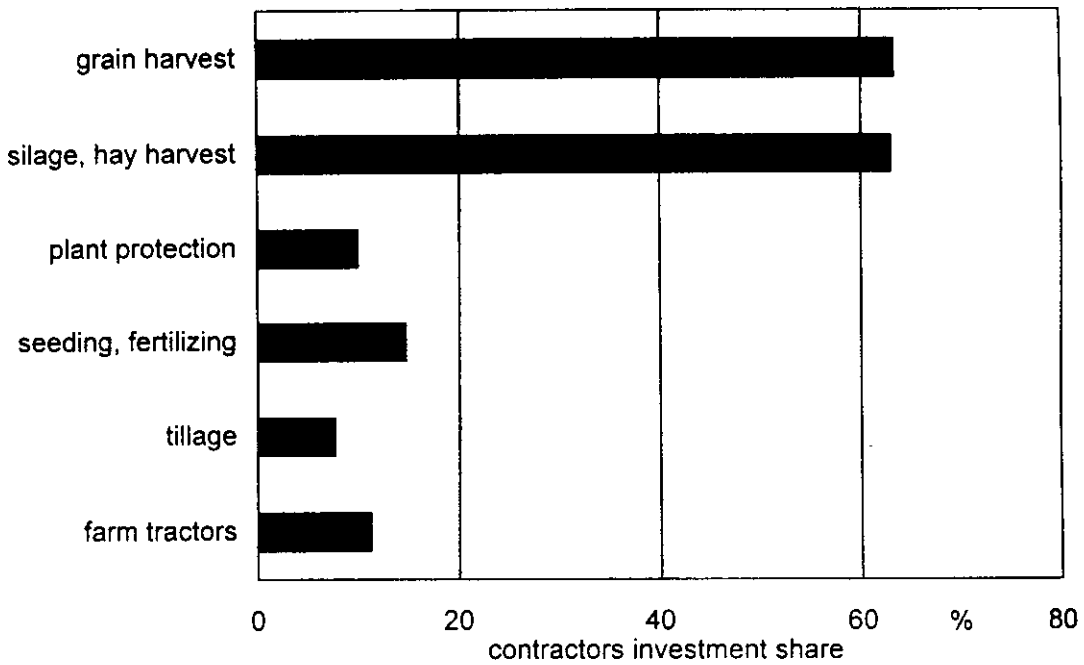


Fig. 9 - Possibilities to increase overall area capacity

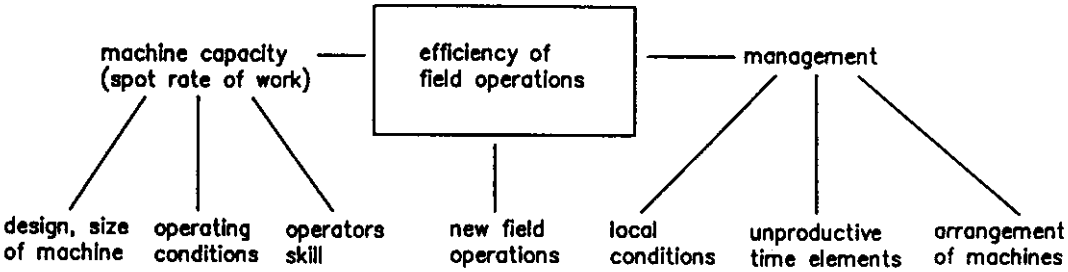


Fig. 10 - Agrolog Monitoring PC-software to show position and status of machines [8]

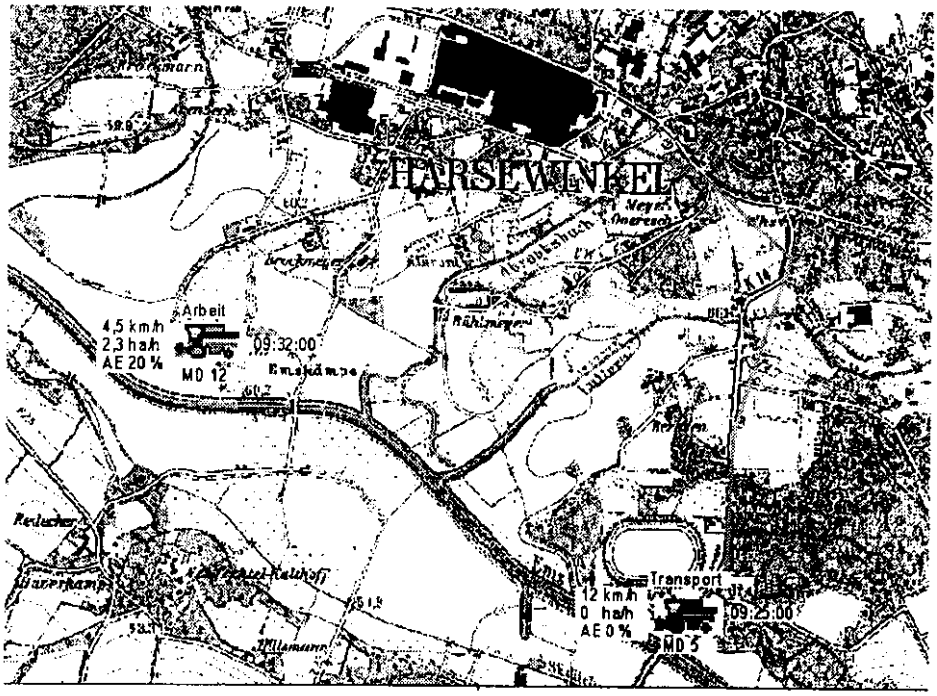


Fig. 11 - Foldable corn header (Claas)

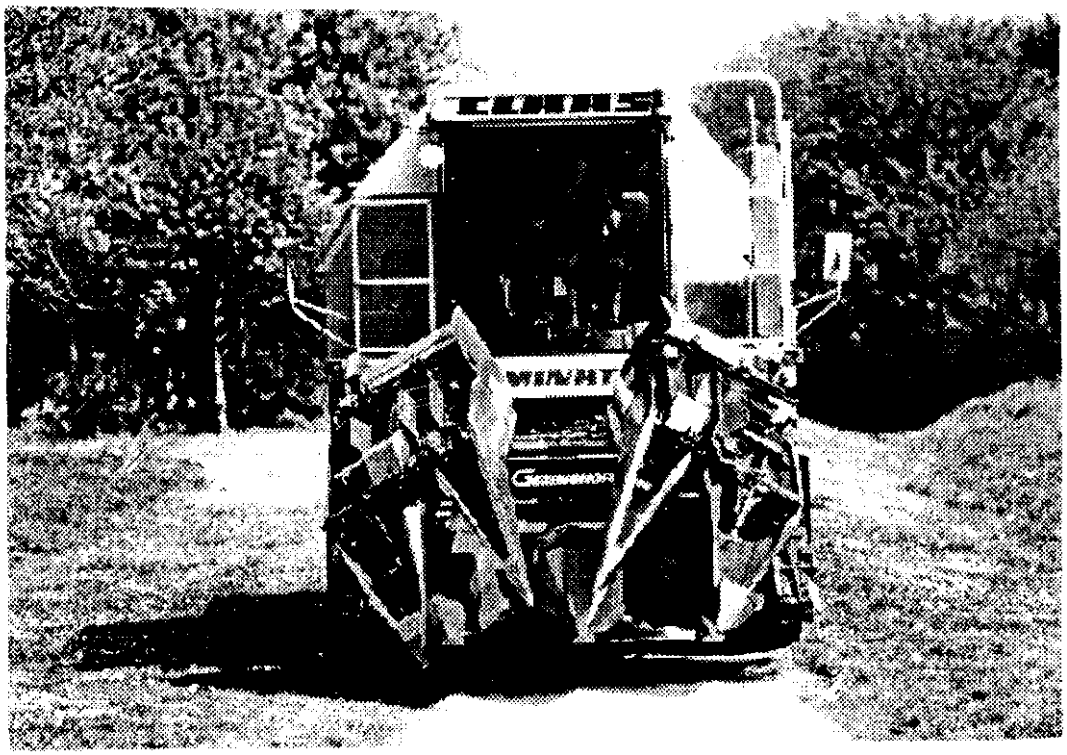


Fig. 12 - Automatic shearbar adjustment (New Holland)

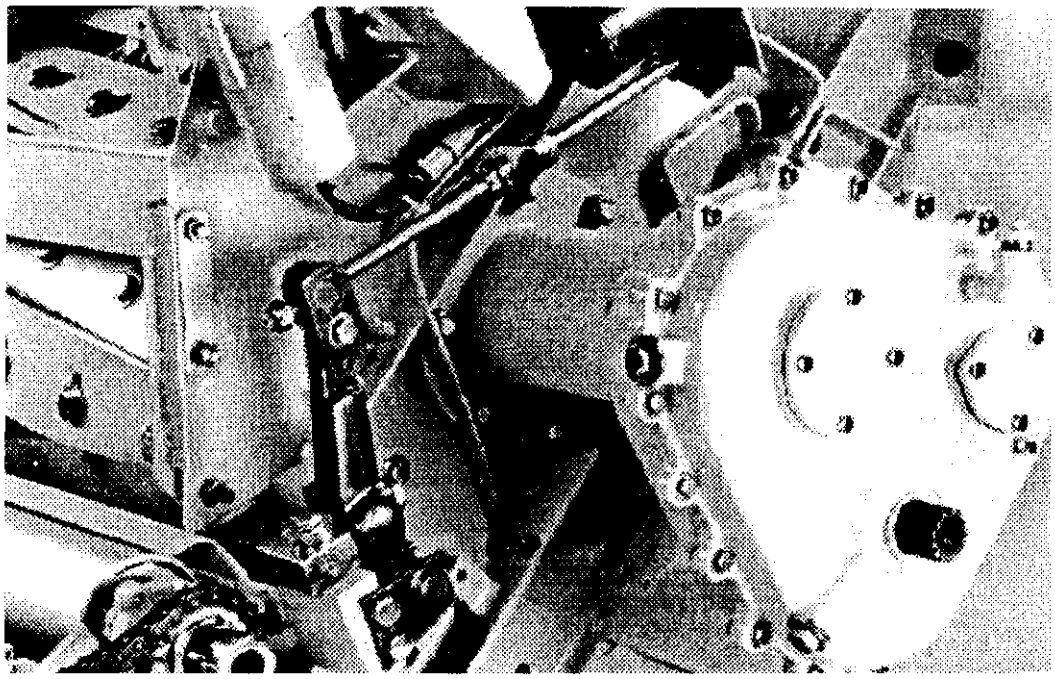


Fig. 13 - Power of combines and forage harvester

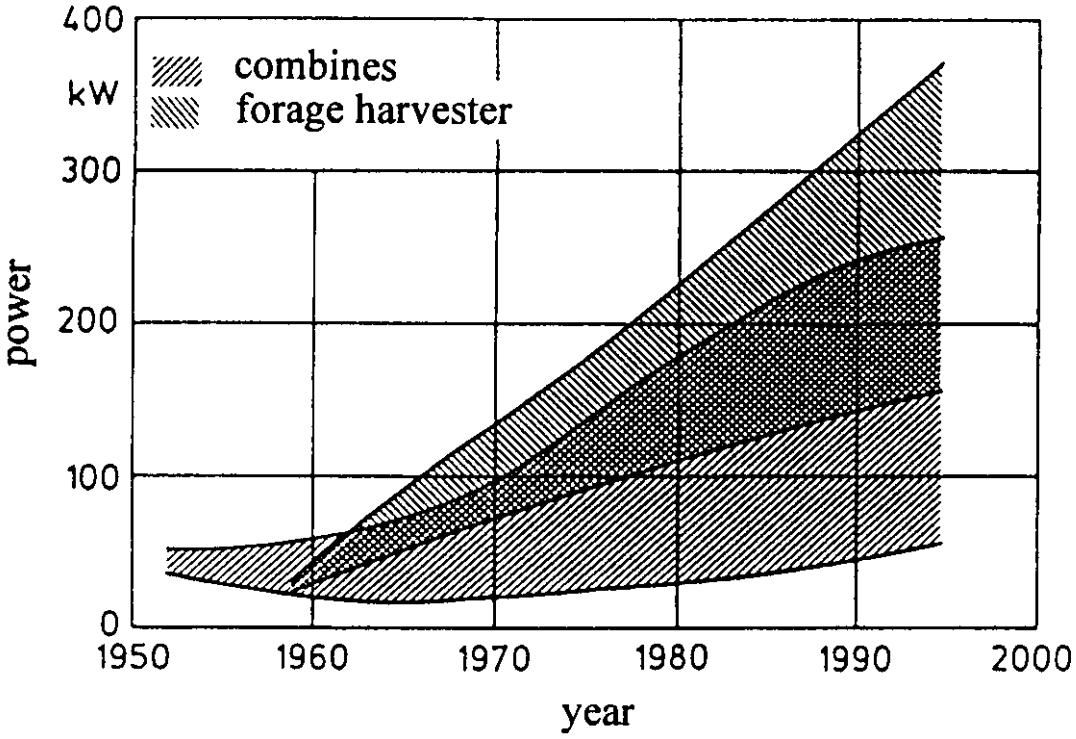


Fig. 14 - Self propelled sugar beet harvester (Stoll)

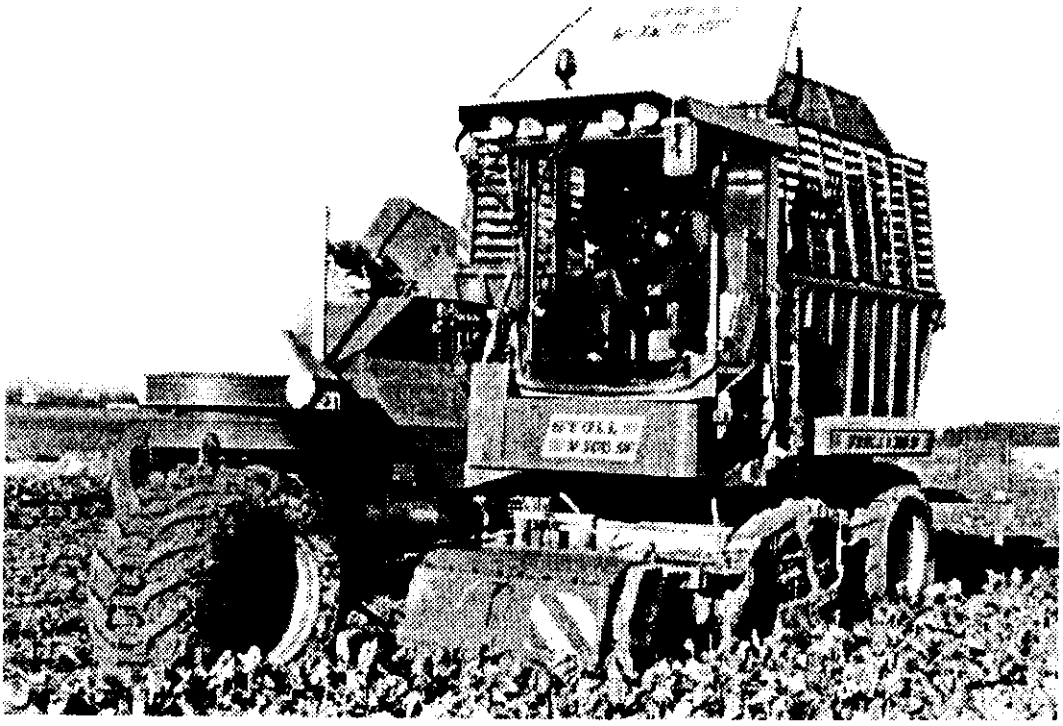


Fig. 15 - Self propelled big baler (Deutz-Fahr)

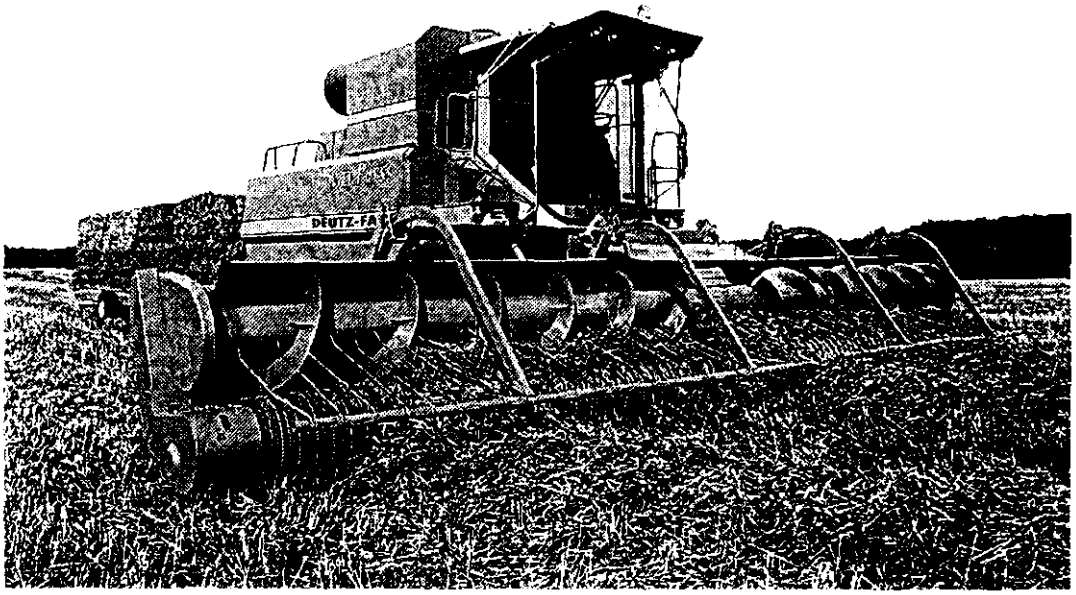


Fig. 16 - Self propelled mower (Krone)

Fig. 17 - Power and load of self propellers

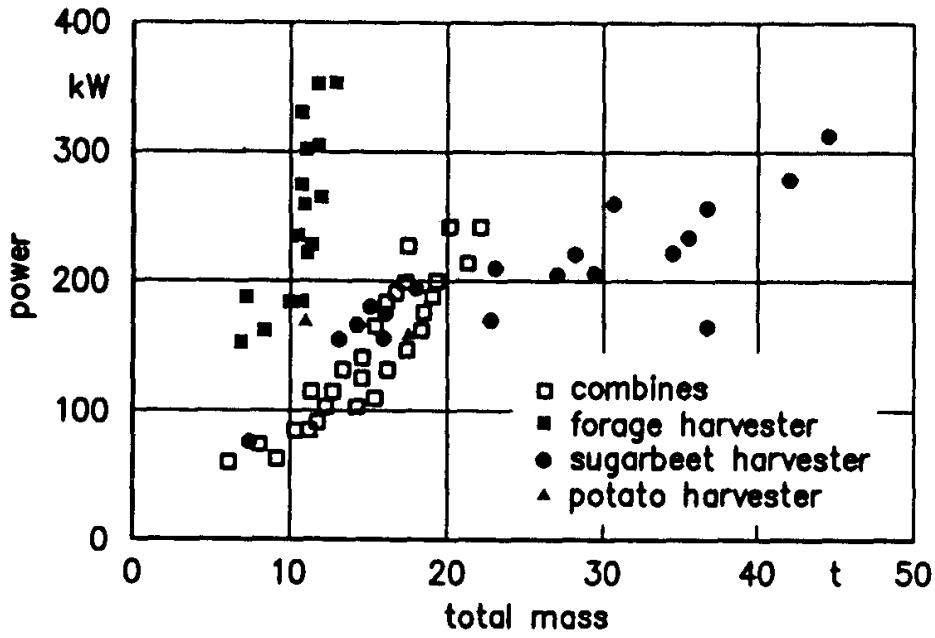


Fig. 18 - Power and load of carrier vehicles

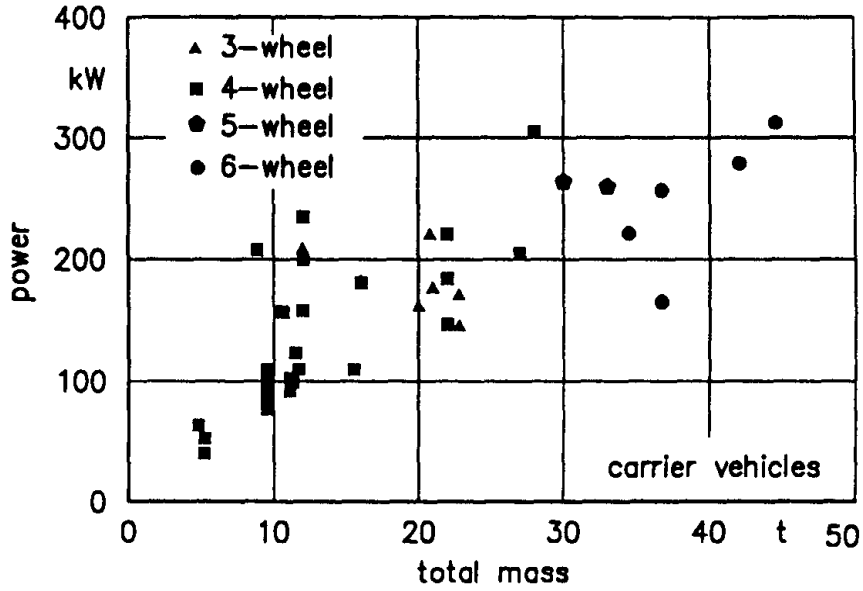


Fig. 19 - Lexion (Claas)

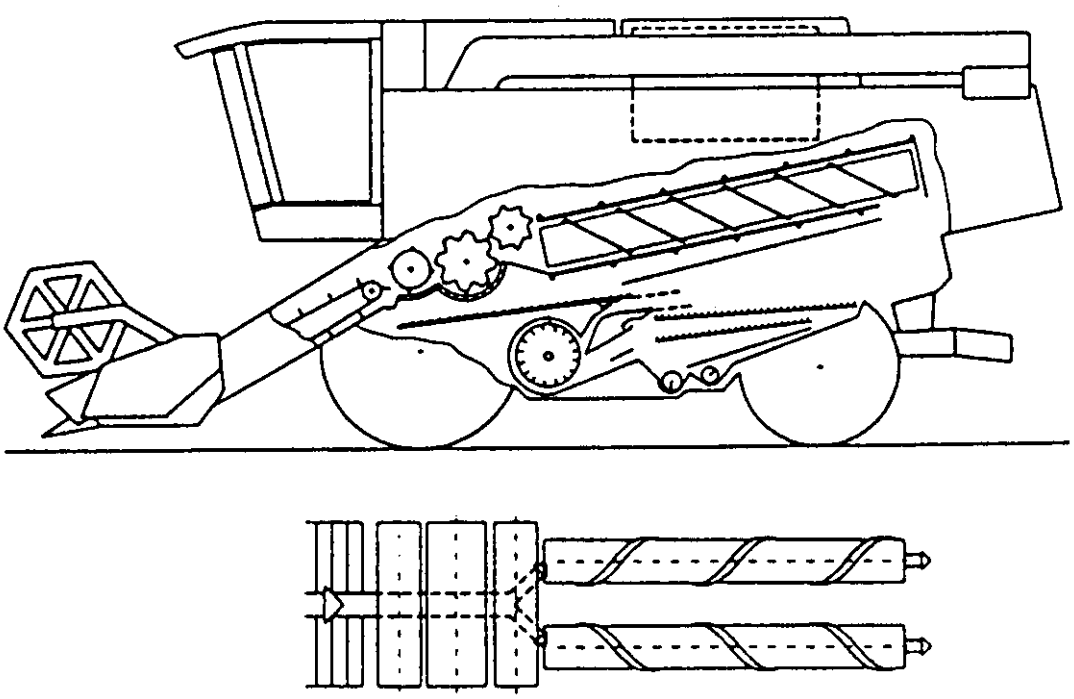


Fig. 20 - ARCUS (MDW)

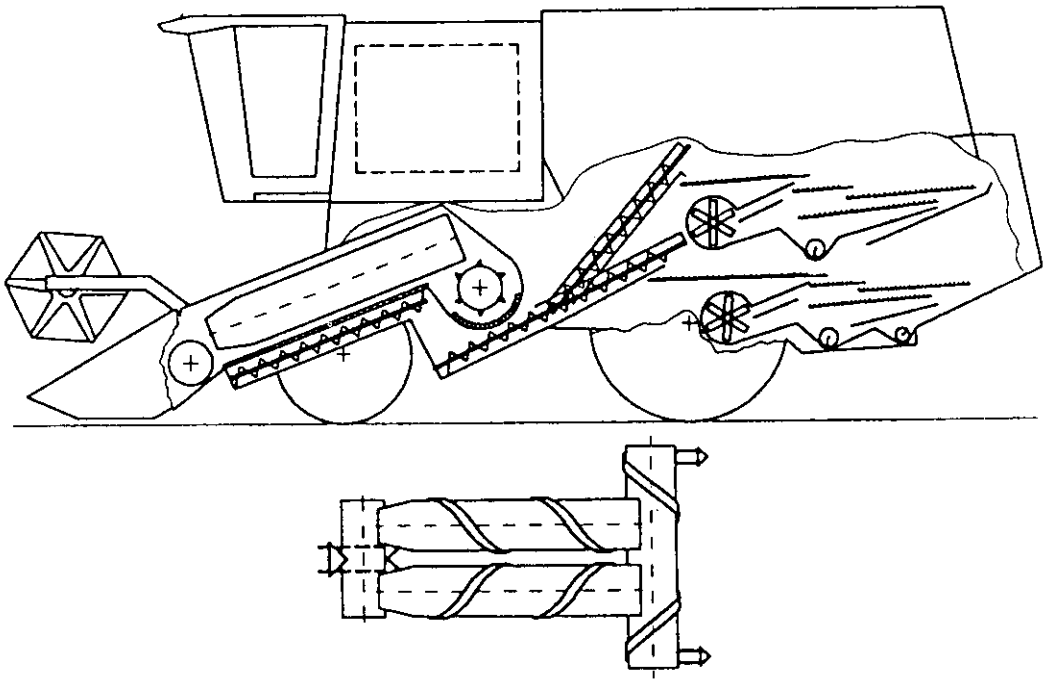


Fig. 21 - Threshing units with additional drums (left: New Holland, right: Claas)

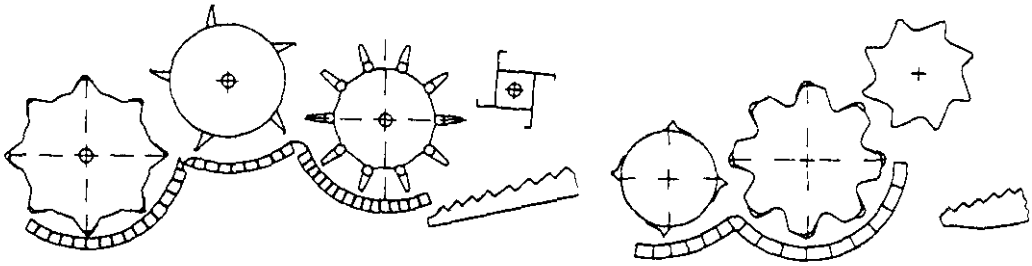


Fig. 22 - Stripper header (Shelbourne-Reynolds)

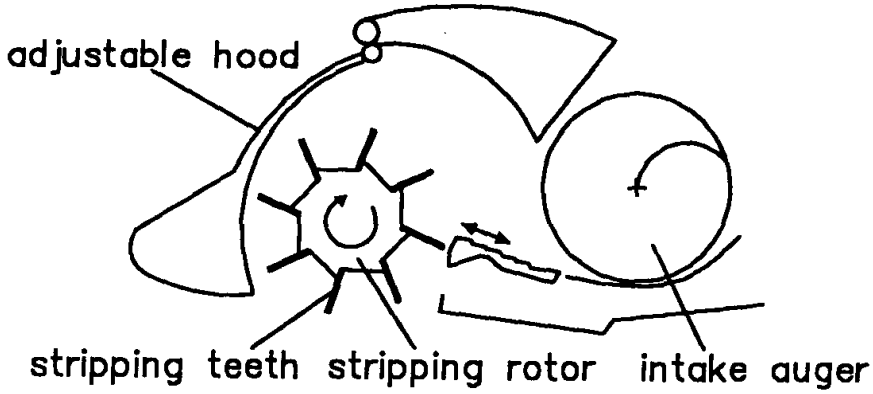


Fig. 23 - Self propelled forage mowing, super conditioning and matting machine [14]

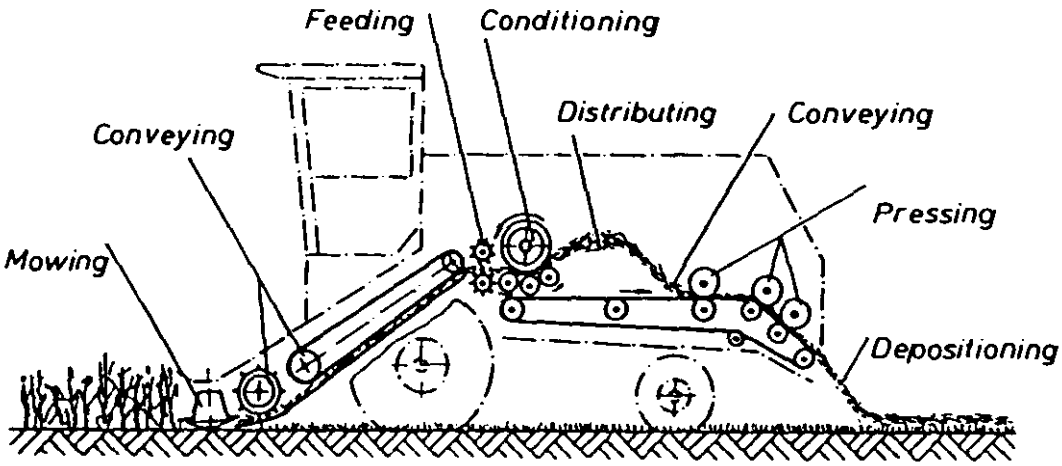


Fig. 24 - Interrelations of tillage intensity on soil-ecosystem [5]

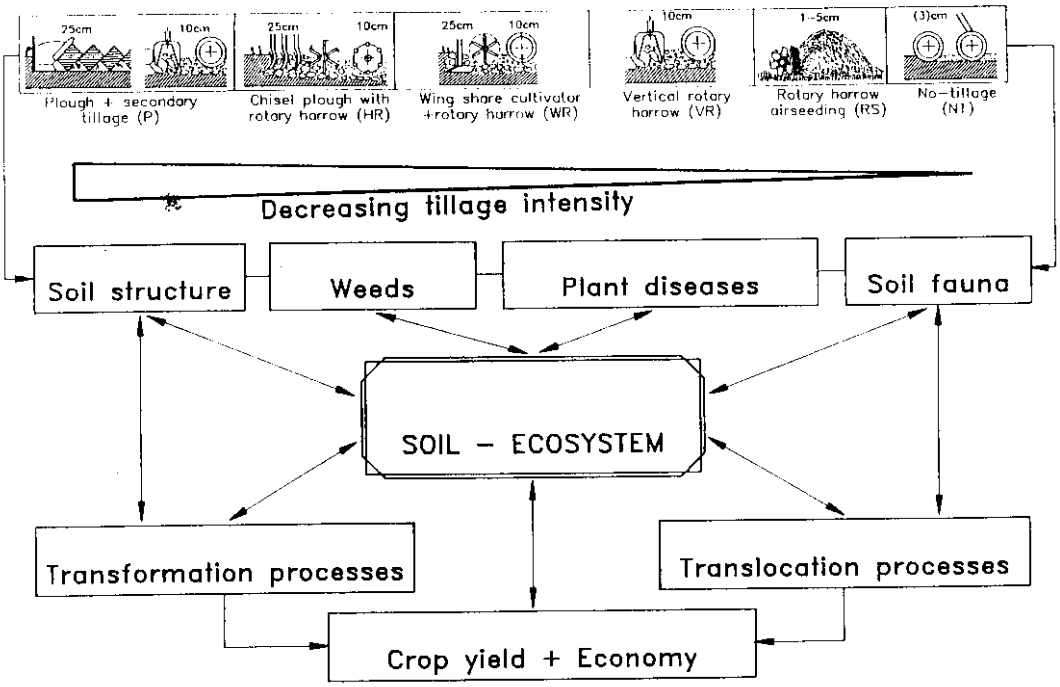


Fig. 25 - Automatìc steering for sugar beet harvester

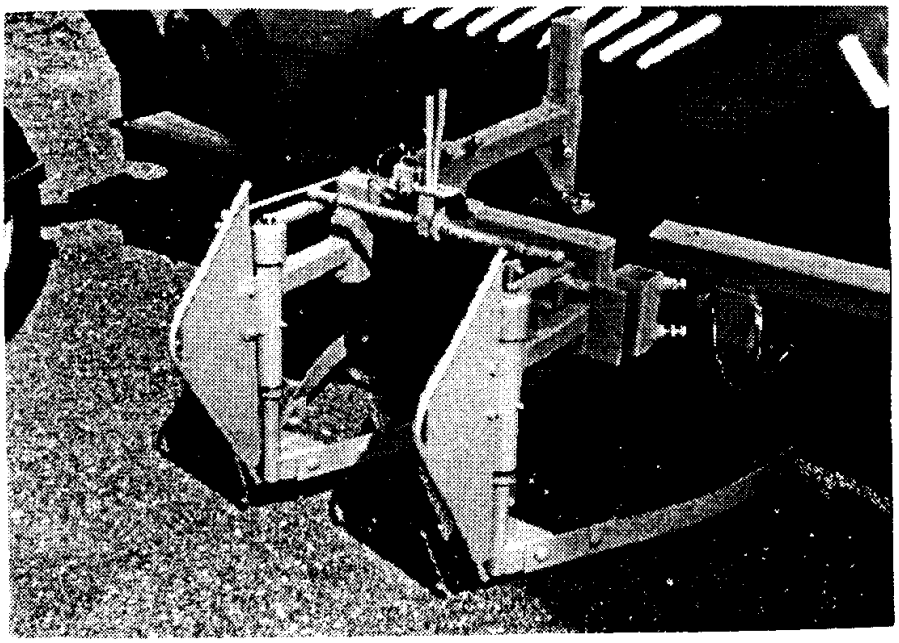


Fig. 26 - Method for yield prediction

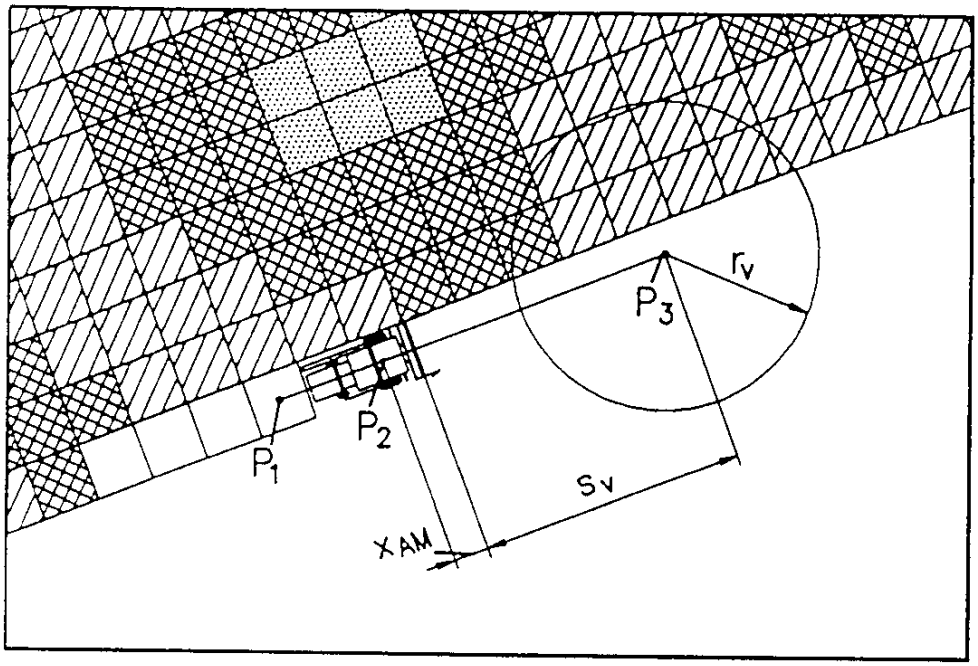
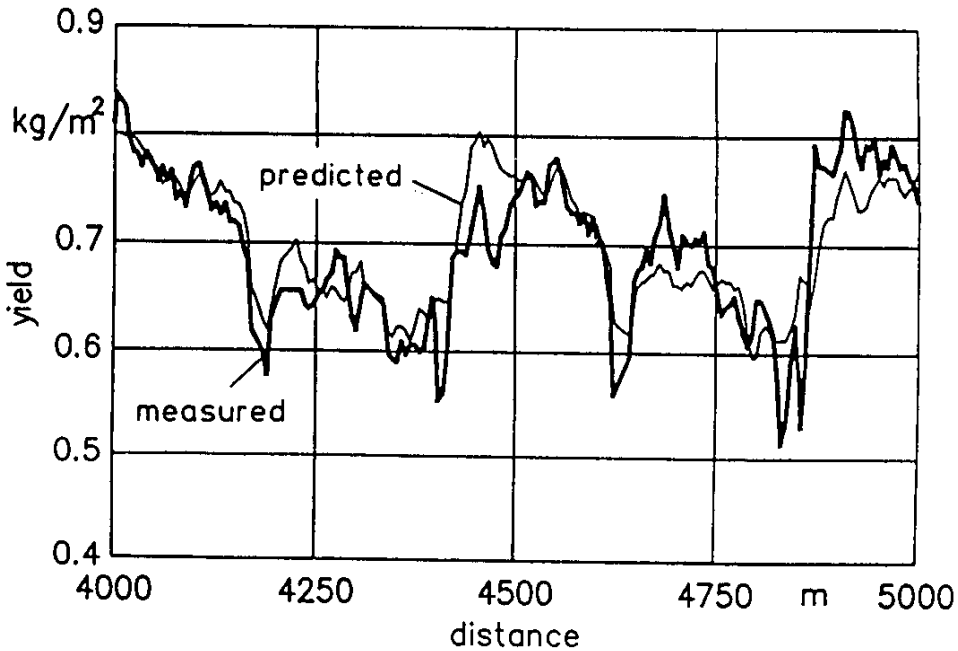


Fig. 27 - Comparison of predicted and measured yield



PRIVATISATION PROGRAMME AND ITS IMPACT ON FARM MECHANISATION MULTIFARM USE IN EGYPT

by Ali Mahmoud El Hossary
Egypt

1. Introduction

Over the past few years the word privatisation has been thrown around the world by economists and policy makers. And while various kinds of privatisation, such as the Mexican method of privatisation", the "British method" and the "Egyptian Method" have emerged to-date, there has been no real consensus on what the description of privatisation really is.

In fact, conflicting opinions on which policy is best, although the state-owned enterprises are major part of the economy in Egypt, the private sector also plays a significant role and there already exist a private capital market dealing directly with farm machinery custom service. It is estimated that 54% of farm machines are owned by small contractors and individual farmers.

Egypt's controversial agricultural privatisation programme, in particular, has served as a testing ground for a number of different privatisation methods. Although the government was successful in selling more than 2000 small agro-industrial projects owned by the various governorates and lo-cal authorities, this process witnessed a wide range of side effects in its execution.

To place the multi-farm use privatisation programme in perspective, a brief examination of the basic mechanisation issues is relevant. Recognizing these issues, and carefully scrutining their impact, can lead to a rational application of government policy towards mechanisation promotion. And where the issues are not clear, towards socio-economic and technical aspects of individual machine performance, then additional research is needed before a headlong plunge into full scale privatisation implementation is undertaken.

In this study we shall endeavour to present aspects of the Egyptian privatisation programme and its impact on the farm machinery multi-farm use.

2. Background

Egypt was described at the beginning of this century as the country with probably the highest rate of "disguised unemployment" in agriculture, where human labour was one of the cheapest things you could buy. The wretchedness of agricultural labourers, which made them (so attractive to their employers at the time), did not abate until deliberate efforts were made to ameliorate their conditions, mainly through the land reform laws from 1952 onwards, which started to make labour a little more scarce (Cheap labour and employment opinion, Al Ahram Weekly, page 9, Dec. 7996)

Wage rates tripled between late 1973 and mid 1978 after having remained virtually unchanged throughout most of the preceding decade. The demand for seasonal workers has pressed even harder upon available supplies. Principally responsible for the increasing scarcity of farm workers and the sharply escalating wage rates, the rapid rise since 1973 in the number of Egyptian agricultural workers who has moved to higher paying employment in construction work abroad, mainly in the Gulf states and Libya. The Arab Federation of the Agricultural workers, estimates that 1.5 million workers went abroad between 1973 and 1978. (Reforming the civil services in Egypt, money and business, Al Ahram Weekly, page 5, June 7993).

To solve the problem of agricultural seasonal labour shortage, the Egyptian govern-

ment adopted the National Programme for Mechanised Farming, which spread all over Egypt through 97 governmental renting units, five public sector earthmoving and construction companies, two agricultural engineering semi-private companies and five thousand village multi-purpose co-operatives offering farm machinery services, restricted to traditional ploughing, irrigation, pest control and threshing operations. The objectives of this programme were to extend farm machinery multi-farm use in Egypt. (Arab Republic of Egypt. Ministry of Agriculture Report 1985: agricultural mechanisation in Egypt, USAID Project, No. 263-0031).

In a nut shell there exist three types of farm machinery multi-farm use mechanisation technology in Egypt. Small scale technology to mechanise 57% of the holdings which are less than five acres; medium scale technology to mechanise about one million acres under the land reform programme and sophisticated technology to he used in the newly reclaimed lands in an area of more than one million acres belonging to several agricultural state owned companies. (El Hossary, 1982).

The spread and popularity of custom tractor services have enabled many migrated operators and small farmers to become tractor owners after their return from the Gulf states. As their own small acreage require only a fraction of tractor's time, custom work has almost became a separate occupation for many such small farmers, and in turn, a major source of family income. (Egyptian mechanisation; five-year development plan, 1983).

After the October 1973 war, President Sadat introduced a number of sweeping political and economic reforms that were designed to achieve rapid economic and social development. A greater role was to be given to the private sector. (Economic reform and privatisation in Egypt, AI Ahram strategic, paper No. 39, 1996).

After the second Gulf war, the Egyptian Gulf remittances in local currency increased which led to an accumulation of currency reserve of $ 18 billion. The majority of their savings were directed towards establishing land reclamation projects and buying assets of the government owned companies offered for sale. (Economic review, Vol. XXXV1, No. 3, 1995/96).

The government was successful in selling, mostly through public actions more than 50 farm machines custom service units, owned by various governorate and local authorities. The sale of these projects during 1992/93 was speedy and almost trouble free as many of these projects were sold to Egyptian Gulf workers, since their assets, land and machinery were in high demand. The implementation of soil improvement services became a demonstrational activity in an attempt to gauge its effectiveness and farmer reaction. In this manner, exposure would lead to adoption, if farmers viewed the programme as being beneficial. Moreover, this suggests a key role that the government can effectively assume: demonstration of new technologies and evaluation of their cost. Thus, this becomes the first step towards identifying a demand that the private sector can fill, since the government has not proven to be an effective provider of machinery services. (Agricultural mechanisation project, Final Report, Nov. 1995).

Small mechanisation custom service units were the first to be sold. Medium and large units followed. The machinery performance in quality and efficiency increased. Also machinery cost decreased. This result-ed in a corresponding increase in production. (**Table 1**).

The present paper examines the impact of the Egyptian privatisation process on farm machinery multi-farm use and its influence on the mechanisation adoption process.

3. Dimension of the constraints in public farm machinery custom service

A full discussion of the reform of the government administration and other authorities is beyond the scope of this paper. However, it is useful to briefly mention some of the salient features concerned with the public farm machinery hire service, for the sake of comparison.

In the last decade, Egyptian agriculture has been injected with large dozes of farm mechanisation activities. This acceleration in the speed of farm mechanisation hire service programme spurred a debate about the implications and sequences of this activity.

The International Agricultural Mechanisation Conference held in Cairo from 27-30 April 1986, rationalised that years of experience, show that the government tractor hire scheme has failed to he effective or economically viable over the long term.

Among other factors, low utilisation of farm machinery and uneconomic machinery hire charges contributed to the loss in many cooperatives and farm machinery hire service units (**Table 2**).

Due to technical, economic and administrative reasons, the renting operations, were not able to justify crop prices. The most serious symptoms of the administrative disfunction are: excessive regulations, surplus employment, poor pay and costs overruns. They are factors which inevitably lead to pervasive corruption and poor performance, yet with this turmoil of mechanisation activities being carried out as service rendered to the farmers, there is a more or less justified feeling that the public sector schemes concerned with farm machinery hire service are practiced without any declared philosophy or clear vision.

Unless the farm mechanisation system is financially profitable for the farmer and economically justified for the country, it cannot he sustained. This is probably the reason behind the fact that, specific reform measures are taken by the government to achieve the goal of keeping the size of renting service to the appropriate level. The most important measure taken recently by the government are based on economic privatisation programme, where priority has been given to agriculture.

The first farm machinery renting stations sold to private sector in the sugarcane growing area showed a reduction in labour time requirements and cost per ton. The private sector was able to invest more funds in mechanical sugarcane harvesting which resulted in dramatic reduction in labour requirements.

4. Efforts and issues of farm machinery custom service privatisation

4.1 *Size and domain of public farm machinery custom service*

The size of the public farm machinery custom service sector in Egypt is massive. The Public domain encompasses three farm machinery enterprises:

- an autonomous government hire service land amelioration organisation has been established in 1970 to practice deep ploughing, ditching and laser land-levelling;
- a huge network of 97 farm machinery renting stations, established since 1982;
- the land amelioration organisation along-with the farm machinery renting station network are injected in the state budget;

the public business holding company, which is a new name for a large number of public enterprises in all spheres of services including 7 land reclamation companies practicing earthmoving and farm machinery multi-farm use in the newly reclaimed lands, and sugarcane cultivation areas in upper Egypt. The book value of the public business holding company is estimated at 480 million

US$. Nevertheless the market value of these companies highly exceed their hook value, as their assets have been appreciated greatly. These companies are almost responsible for 60% of land reclamation and utilisation projects in Egypt. They also executed large land reclamation schemes in Iraq and Libya. The profitability structure of the public business holding company is mixed. In the last few years, and despite an improved performance, the average rate of return on assets averaged 2.6% per year in 1995. In mid 1980s the aggregate net profit of the public business companies was negative.

4.2 *Efforts to reform public farm machinery custom service*

The privatisation of public sector farm machinery hire service companies began in Egypt in 1993, when the Nubaria Agricultural Engineering Company was offered for sale. The company floated 300 thousand shares to the public while purchase orders exceeded 500 thousand, and the majority of the buyers were among the agriculture labour who migrated to the Gulf States, seeking for better pays. This first floatation served as an indicator of the potential of the Egyptian market, and it was not long before others starting offering shares to the public. The government network of farm machinery renting stations offered its shares shortly after the Nubaria Agricultural Engineering Company, and represented one of the most successful privatisation initiatives.

Encouraged by the success of these offerings, privatisation authority began offering whole farm machinery companies for sale to individual investors who were invited to bid for the shares.

In the summer of 1994, as the public sector and capital market laws issued in 1992 began to take effect, another privatisation method materialised. The government began offering a limited amount of farm machinery hire service units, roughly 20% of the total number of the farm machinery hire service units forming the network with strong financial position. This served to attract a large number of small and large investors who readily snapped up the shares. Most of the investors were among the agriculture labour working abroad, who came back to Egypt with a sizeable savings.

4.3 *Future of farm mechanisation reform policy*

Farm mechanisation reform policy achieved immediate and significant results. Their success has been supported by the Egyptian farmers intuitiveness and basic adherence to free market precepts. In view of the rigidity and unfairness of the direct control systems that farmers endured for more than two decades, they show clear preference for free market mechanisms.

Nevertheless, the continued success of the farm machinery privatisation policy requires agile response to new sets of challenges, where the development of the rural areas requires more than liberalisation policies. A more conscious national programme to alleviate rural poverty is needed to help compensate rural Egypt for years of neglect and discrimination.

The debate around the merits and viability of the privatisation programme still smoulders in Egypt. Some opinion leaders view it as a panacea for many of the financial and economic woes facing the public sector (liquidity problems, low productivity, backward production techniques, over-staffing, prevailing corruption). Others favoured privatisation as a vehicle for broadening the base of ownership, while yet a large segment of public opinion remains apprehensive and suspicious of the implications of the programme. In the following we will present some of the broader socio-economic values which resulted from the influence of farm machinery multi-farm use privatisation process. This paper will be

concerned with the significance of association between the socioeconomic conditions and the mechanisation incidence in the shadow of farm machinery hire service privatisation programme.

5. Impact of privatisation process on farm machinery multi-farm use

To place the privatisation process in perspective, a brief examination of the basic mechanisation issues before and after privatisation is relevant. Recognizing the issues, and carefully scrutinizing their impact, can lead to a rational application of government privatisation policy towards mechanisation.

Briefly, these issues centre around labour, increased productivity, social and financial costs and social structure.

5.1 *Initial farm machinery custom service conditions*

The initial custom service mechanisation conditions described here arc a result of a 1985 base line survey (El Hossary et al., 1986). The survey included 685 farmers, agricultural cooperatives (24 units) farm machinery Government enterprises, four government owned custom service units, a share holding company and ten family partnership hire service units, serving 10 villages in four governorates, Behera, Gharbia, Qaliobia and Minia. The survey topics were:

- machinery use;
- practices and preferences;
- changes in labour and custom service efficiency and reliability;
- custom service market;
- farmer access to machinery;
- machine owner/farmer and machine owner/service relationships;
- labour situation: within the-household and within community.

The survey intention was oriented rather to explore some of the more significant conditions that prevailed before privatisation programme took place. The survey revealed a number of discrete sectorial bottlenecks and constraints. While these constraints are many as the lack of efficient management, a poorly developed infrastructure etc. the survey concludes that not all of the farm machinery hire operations being carried in Egypt are effective. This is due to unmotivated and poorly trained staff, inadequate facilities and absence of sound management. The role of hire service farm machinery scheme owned by the government is vague and still far behind their actual capabilities. This governmental scheme has failed to be effective or economically viable.

Among other factors, low utilisation of farm machinery and uneconomic machinery hire charges contributed to the loss of many cooperatives and governmental farm machinery custom service units (**Table 2**). While the survey recognised that farm machinery multi-farm use have an extremely important part to play in the development of agricultural mechanisation, nevertheless this role should be clearly defined and future strategy should seek to reform mechanisation public sector hire services. The need to create a viable mechanisation hire service, requires more than a change in the ownership structure. Major institutional and market rules of behaviour that promote competition, fairly and transparency should be put in place.

5.2 *Privatisation and its influence on mechanisation adoption process*

Hereunder, the analysis of data collected, from records of privatised and non-privatised service activities, demonstrate some of the specific socio-economic and technical aspects of machine performance. This field research examines some of the broader socio-economic variables which influence the mechanisation adoption process.

A random survey of 281 farmers in Beheira, Gharbia, Qaliobia and Minia gov-

ernorates, tested the statistical association between the level of mechanisation services and socio-economic conditions prevailing at the village level. The survey revealed a number of positive merits resulted from government disengagement from the farm machinery custom service units, which are summarized as follows.

5.2.1 *Solve liquidity problems*

Villages with the highest emigration of agricultural labour have the needed capital, or can obtain credit facilities more easily. Groups of migrated farmers were able to buy the auctioned farm machinery custom service units and solved liquidity problems confronted the former Public Sector Owners. The new owners were able to improve service facilities and got the necessary spare parts in no time, moreover modern equipments were immediately procured.

5.2.2 S*olve low productivity problems*

The mechanisation incidence was highest in villages with private integrated farm machinery custom service units, it is provided with machinery repair facilities and well paid trained operators. Tractor productivity per year in terms of working hours increased from a total of 680 hours to an average of 1452 hours (**Table 1**). It is obvious that private management reinforce the tendency to mechanise, since, private sector is able to maintain its assets in a proper way. It would be expected that positive attitudes are generated by the ability of private sector to communicate and integrate with other needed facilities. This will tend to solve machines productivity problems.

5.2.3 *Modernize Production Techniques*

The study revealed that private sector especially migrated workers have viable social relations, and have viable contacts with the "outside world". During their migration in the Gulf states they dealt with the most up-to-date equipments, and communicated with foreign experts. They are now able to visit international exhibitions, and are in a position to contact reliable farm machinery dealers, and can establish strong relations with farm machinery extension officers to identify bottlenecks and constraints in the farming system (**Table 3**). This demonstrates the performance of a modern combined tillage system introduced by farm machinery custom unit new owners. The new combined tillage systems reduced power requirements by 42.86%, and fuel consumption by 57.94% and cost by 63.38%. The introduction of mechanical rice transplanters reduced cost by 64.1% and increased rice production by 34%. Using modern sugarcane mechanical production line introduced in farm machinery units at Minia governorate in upper Egypt, by private owners - increased sugar cane production by 54%.

5.2.4 *Rapid mechanisation expansion*

There appears to be a significant and positive linkage between the availability of farm mechanisation strong private sector with mechanisation incidence. This suggests that private sector is able to introduce successfully the most modern technology. This is considered an effective communication instrument to the extension effort. Attitudes towards mechanisation adoption by individual farmers increased by 68%. Sales of modern rice combine harvesters increased by 114%; at Gharbia governorate, sales of seeders jumped to an average of 1732 units the second semester of 1996 against an average of 43 units for the same period in 1992.

5.2.5 *Private ownership provide better management*

The importance of mechanisation economics to the adoption process, which has been justified by the machinery performance, was further supported by the sound management of the private owners. They have displayed a greater tendency to mechanise than the public sector burdened with bureaucratic disci-

discipline. They adopted simple records and machinery Log-Books to control fuel consumption and all kinds of repair and maintenance operations, they also fixed simple time recorders on the tractors to register the exact working time of each implement. They are using successfully the "Easy Hire Easy Fire theory" together with "Positive and Negative Incentive System" to offer the best service and better quality of work. Such system of management succeeded to correct the bath of the farm machinery units sold to the private sector and raised its profit rate after demonstrating painful losses under the public sector management. All the investigated units of farm machinery custom service sold to the private sector were able to settle all their debts in less than two years.

6. Conclusions

Privatisation enhance social integration, cosmopolitaness, and communication which reinforce the tendency to mechanise.

Holding of capital assets provide greater incentives and ability for further mechanisation, because of the availability of capital to finance further modern machinery acquisition. Private sectors have the needed capital, or can obtain credit facilities more easily. They have the means of capital-to-labour substitution.

The use of farm machinery multi-farm use increases with migration of adult males, reduced the effective labour supply and puts upward pressure on wages during peak demand. Villages with the highest emigration, and wage rates show the highest mechanisation incidents, villages with low peak season wages show the lowest use of farm machinery custom service.

Farmers with a greater number of plots showed a higher use of private farm machinery custom service units, than those with smaller number. Midget plot holders prefer to deal with farm mechanisation cooperatives for their subsidised hire rates, although their operation level is low in quality. Cooperatives mechanised operations are limited to shallow' ploughing, threshing and transportation.

Private farm machinery custom service units succeeded to arrange matters with farmers, so that they all have the same kind of work carried out at the same time and before the machines arc moved to another village or return to their base. Such way of management prevented machines being moved excessively long distance to serve small area. This way reduced hire cost and offered better quality work.

When privately owned farm machinery custom service units demonstrate successful management, individually owned machines as well as other types of farm machinery multi-farm use will soon appear in operation to a certain extent they can replace each other. This form of privately owned hire service facilities should continue in a larger scale.

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Table 1 - Mechanisation level before and after privatisation (Source: Data collected, from records of a 1985 base line survey compared with data collected from records of privatised hire service activities in the same governorates of Bheira, Gharbia. Oaliobia and Minia; El Hossary et al., 1996)

ITEM, (units)	BEFORE	AFTER
Average tractor annual use, (h)	680	1452
Average power used in 3 passes tillage, (kW)	129	83
Average machine time per acre, (h/acre)	2.55	0.8
Actual fuel consumption per acre, (l/acre)	20.70	10.6
Actual tractor hire cost per hour, (US$/h)	8.77	3.9

Table 2 - Cost of tractor work by different enterprises compared with actual hire service rates (Feb. 1993)

PARAMETERS, (units)	AG. COOP. **A**	GOV. ENTERPRISE **B**	F. PARTNERSHIP **C**	SH.H. COMPANY **D**
Tractor Power, (kW)	60	60	60	60
Annual Use Average, (h)	700	820	1400	1200
Tractor Average Life, (h)	5600	6560	11200	9600
Tractor Average Cost (LE)	35000	35000	35000	35000

COST/WORKING HOUR	LE			
Depreciation '	6.25	5.33	3.13	3.6
Interest	4.00	3.40	2.00	2.33
Fuel and Lubricants	4.32	4.32	4.32	4.32
Repair and Maintenance	6.87	5.82	4.88	3.46
Operator	0.90	0.95	1.20	1.50
Overheads	1.00	1.82	0.00	0.73
Total Cost	23.34	21.64	15.53	15.94
Actual Hire Rate	13.30	14.00	17.50	17.75
Amount of Subsidy or loss	10.04	7.64	00.00	00.00
Profit	00.00	00.00	1.97	1.81

Table 3 - Summary of comparative performance of conventional and improved, combined tillage introduced by farm machinery custom unit new owner

CROP: SUGAR-CANE	CONVENTIONAL	COMBINED	REDUCTION OR INCREASE	%
Horsepower, (kW)	158	90	- 68	43.03
Fuel consumption, (l/acre)	25.2	10.6	- 14.6	57.94
Cost, (US$)	10.65	3.9	- 6.75	63.38
Production, (t/acre)	35	54	+ 19	54.30

Table 4 - Reduction of tractor power and cost resulting from using modern combined sprayer/incorporation machine introduced by farm machinery custom unit

PARAMETERS, (units)	CONVENTIONAL OPERATION, SPRAYER, ROTARY TILLER	COMBINED SPRAYER INCORPORATION	REDUCTION	%
Horsepower, (kW)	75	30	45	60
Machine time, (h/acre)	1.06	0.4	0.66	62.3
Cost (US$/acre)	3.4	1.6	1.80	52.9

ANNEX 1

PRIVATISATION PROGRAMME AND ITS IMPACT ON FARM MACHINERY MULTIFARM USE IN EGYPT **(descriptive summary)**

1. Mechanisation management stages

1.1 *Free market period (1945 - 1953)*

- Cheap labour dominated
- Big land lords owned their farm machines
- No farm machinery custom service reported
- Sugar production companies offered farm machinery custom services to sugar cane producers.

1.2 *Limited intervention period (1953 - 1973)*

- Land reform lows transformed landless labour into small land holders
- Fragmentation of holding occurred (57% less than l ha)
- Government AG. Cooperatives established to provide farm machinery custom services
- Farm machinery services limited to ploughing, irrigation, threshing and pest control

1.3 *Open door policy period (1974 - 1988)*

- 1.5 million agricultural labour migrated to the Gulf States (yearly savings US$ 2 billion)
- Seasonal labour shortage
- State owned farm machinery custom service network established (97 units - Book value US$ 625 million)
- Co-existence of Private and Public sector
- Migrated labour raised private machines ownership to 54%, (Small contractors)

1.4 *Economic reform period (1989 - 1995)*

- Gulf war the second lead to back labour migration
- Gulf workers remittances US$ 18 billion
- Privatisation Programme Started
- 50 Farm Machinery Custom Service Units Privatised
- Migrated labour became Farm Machinery share Holders

2. Public custom service constraints

2.1 *Administrative*

- Excessive regulations and contradictory legislations

- Surplus Employment
- Poor Pay
- Lack of Organizational Stability
- Lack of Proper monitoring System

2.2 ***Technical***

- Lack of Appropriate Equipments
- Lack of Service Facilities
- Lack of Spare Parts
- Lack of Skilled Manpower
- Poor Operating Efficiency

2.3 Economic

- Low Utilization of Machines
- Uneconomic Hire Charges
- Financial Corruption
- Costs Overruns
- Excessive Fuel Consumption (Poor Fuel Handling)

3. Privatisation and its influence on mechanisation adoption process:

3.1 Solve liquidity problems

- Villages with highest emigration of labour have the needed capital
- Groups of migrated labour able to buy auctioned Farm Machinery Custom Service Units
- New Owner were able to improve Ma-chine Service facilities

3.2 Solve low productivity problems

- Mechanisation incidence was highest in villages with private integrated farm machinery service units
- Tractor Productivity per year in terms of working hours increased from 680 to 1452 hours

3.3 Modernize production techniques

- Migrated labour have viable contacts with outside world during their migration period
- Migrated labour dealt with modern agricultural equipment and communicated with appropriate dealers
- Migrated labour can establish strong relations with Extension officers (to identify bottlenecks and machine constraints) (See Table 3)

3.4 Rapid mechanisation expansion

- Private Sector was able to introduce successfully most modern technology
- Individual farmers attitude toward mechanisation adoption increased by 68%
- Sales of modern rice transplanters and combine harvesters increased by 114%
- Sales of seeders jumped to 1732 units the second semester of 1996

3.5 ***Private ownership provide better management***

- Private Owners Displayed great tendency to mechanize than public sector burdened with beaurocratic discipline
- Private Sector adopted simple records and Machinery Log-Books to control fuel consumption and repairs
- Private Sector adopted "Positive and Negative Incentive System"
- Farm Machinery Custom Service Units Sold to Private Sector nearly settled all their debts in less than two years

NEED FOR CONTRACTORS OF FIELD MACHINERY IN MEXICO

by ***Arturo Lara Lopez***
Mexico

1. Introduction

Mexico's land distribution, as in other developing countries, is characterized by a great number of small farms dedicated to grain production. Capital interest is high and labour relatively low priced. Under such circumstances ownership of commercially available field machinery is not economically feasible for a great percent of small farmers being the market of second hand machinery an alternative. An other alternative is to carry out field operations by con-tractors. In the past several state contracting companies existed located in strategic areas. Due to new government police such companies were sold. Farmers owning equipment normally contract field machinery services for neighbour farmers. This is the most commonly existing contractors system.

As the rural population decreases and the cost of labour grows it is necessary to look for economically feasible alternatives for field operations. In this paper an economic analysis from the point of view of contractors is presented along with some technical considerations for equipment specially designed for contracting services.

2. General aspects of mechanization

In the country exists 2.8 million farms with an average land size of 12.1 ha. Approximately 18 percent of the land is irrigated with possibility for double cropping. Corn, sorghum, beans and wheat are the main crops although the country production of vegetables is growing and forage crops are also important.

The number of tractors in the country was estimated in 134,205 in 1992 with an average power of 60 kW. Arable land is estimated in 23 millions of hectares giving a mechanization index of 0.3501 kW/ha (0.4668 HP/ha). This index is lower than the minimum cost power (0.75 kW/ha) previously reported [1], [2] and [3]. However, such index indicates the need for an increase of mechanical power in agriculture.

The number of combines was estimated in 8000 unites in 1992 which gives an average of 2875 hectares for each combine. The field efficiency of combines is highly reduced due to time spent in transport due to small size of fields.

Prices of forage production machinery such as choppers and balers are high for making such equipment profitable for small farmers. However, such situation represents an opportunity for contractors. The same situation exists for other type of equipment such as vegetable planters and harvesters.

Tillage represents the highest cost for the main crops of the country. However contractors must understand the minimum served area to have a positive income. A conceptual model has been chosen to analyze the economic aspect of tillage contractors [4] and [5]. From the pint of view of contractor the cost C, includes the prices of the tractor distributed annually, energy cost related to the work done by tractor and labour cost. The service price P will he assumed as the price of service for all the required tillage operations. Income 1 is the difference between the price of service and cost.

$$C_t = AKH + BLW + LWC/H \quad (1)$$
$$P_s = RL \quad (2)$$
$$I = P_s - C_t \quad (3)$$

Parameters for the model, specially related for the central region of the country, are given in **Table 1**.

Present value of tractors and tillage implements is proportional to the tractor rated power as shown in **Figures 1** and **2**. Considering the situation for conventional tillage. In the region two main crops are grown per year, allowing only 150 hours for such operation. For the case of direct planting the limiting time is the period for plantation, which may be of two months (approximately 320 h). **Figures 3**, **4** and **5** show the results of tractor models presently available in the market. Income in each case is attractive, specially considering that capital cost is taken in to account.

3. Contracting combines

Most of the grain harvesting is done by contractors. In irrigated land, two crops are harvested per year. In the central region **Table 2** shows some parameters for harvesting.

Special financing program make it possible to recover the investment with an harvested area of 173 ha per each crop. Figure 6 shows the economic performance of combines. In addition cost for repair is considerably high. Belt transmission is frequently broken. Combines specially designed for contracting need more reliable systems, such as hydrostatic circuits.

4. Contracting miscellaneous equipment

Regular forage harvesting equipment including rakes and balers are normally used. Owners normally work on neighbour farm in addition to their own one. The prices of a category II tractor and the minimum harvesting equipment is in the order of 30.769 US$. The charge for bale is in the order of $ 0.38 per piece. Yield of alfalfa has and average of 100 bales per ha. The point of equilibrium is in the order of 315 ha harvested per year. Although such situation is feasible, it will he necessary to have professional service for such type of equipment. In this case commercial interest was considered maintenance (30%).

Other type of equipment such as high clearance sprayers or special planters or harvesters exists in very low numbers. However there is a need for such type of equipmint trough contractors are scarce due to high price for such machines.

5. Conclusions

Contracting trlage according to capacity of tractors may have attractive income. However, good management is required to reduce the travelling time.

Special program for financing make contracting harvesting economically attractive.

Combines specially designed for contractors must be designed for high reliability, specially due to the short time available for harvesting.

Special equipment such as balers or sprayers are still scarce and offer attractive economic alternatives for contractors, assuming that enough land is contracted.

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Table 1 - Economic parameters of tractor operation for the central region of Mexico (Bajio)

PARAMETERS, (units)	
A - Annual fixed cost per unit of initial price, (-)	0.30
B - Energy cost, ($/kWh)	0.142
C - Operator wage, ($/h)	1.12
K - Initial cost per rated kW of tractor and implements, ($/kW)	525.46
R - Cost of tillage work, 1997, ($/ha)	336
W - Annual work per hectare, (kWh/ha)	170
H - Tractor power, (kW)	39-135

Table 2 -Average parameters for harvesting in the central region

PARAMETERS, (units)	SUMMER CROP	WINTER CROP
Field capacity, (ha/h)	1.2	2
Price of harvesting, (US$)	10.9	10.90
Fuel consumption, (l)	350	350
Price of fuel, ($/l)	0.318	0.318
Available number of days, (-)	60	15
Price of combines, (US$)	137,000	137,000
Capital interest, (%)	8	8
Harvested area in the neighborhood, (ha)	300	300

Fig. 1 - Price of tractor and implements for conventional tillage

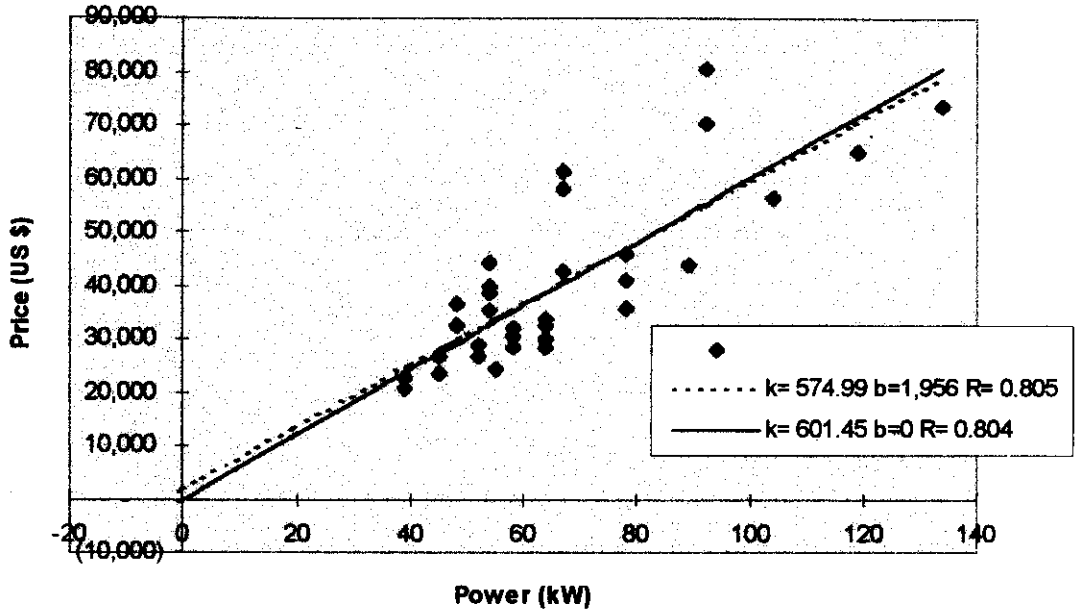


Fig. 2 - Price of tractor plus implements for no tillage practice

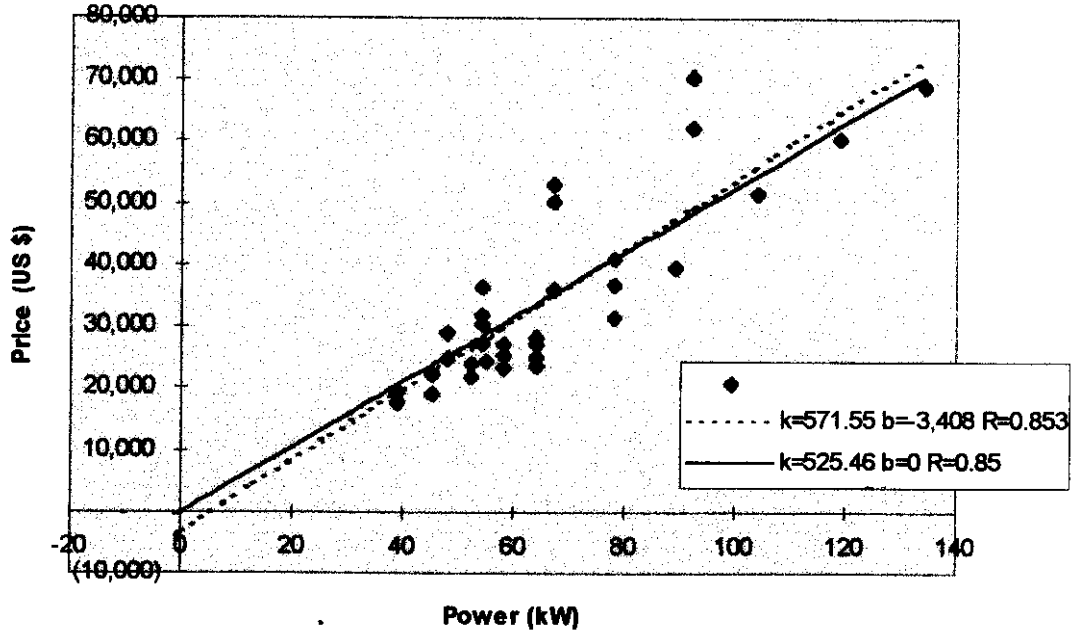


Fig. 3 - Economic analysis for a typical category II tractor

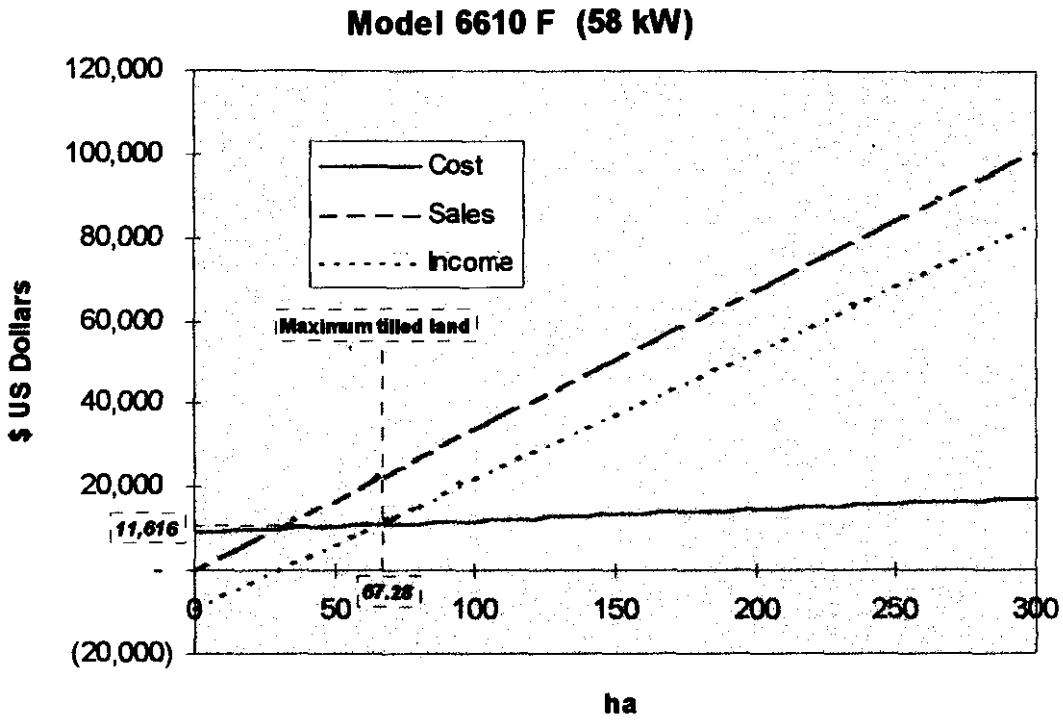


Fig. 4 - Economic analysis for a category III tractor and conventional tillage implements

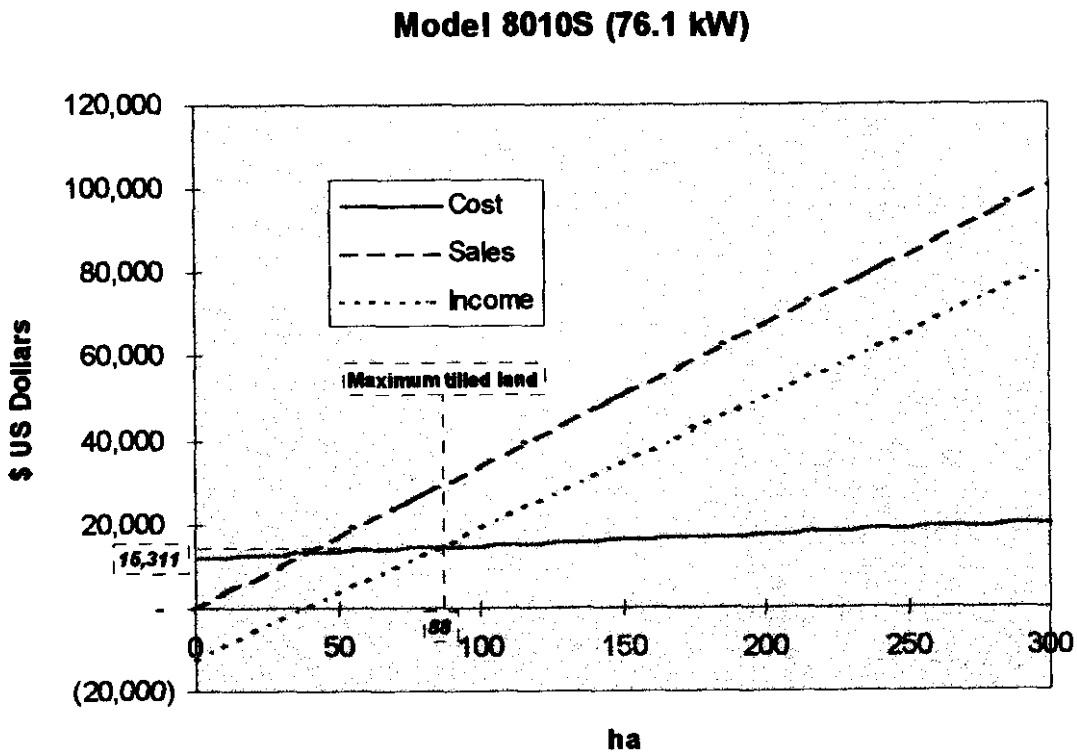


Fig. 5 - Economic analysis for a top category III tractor with conventional tillage

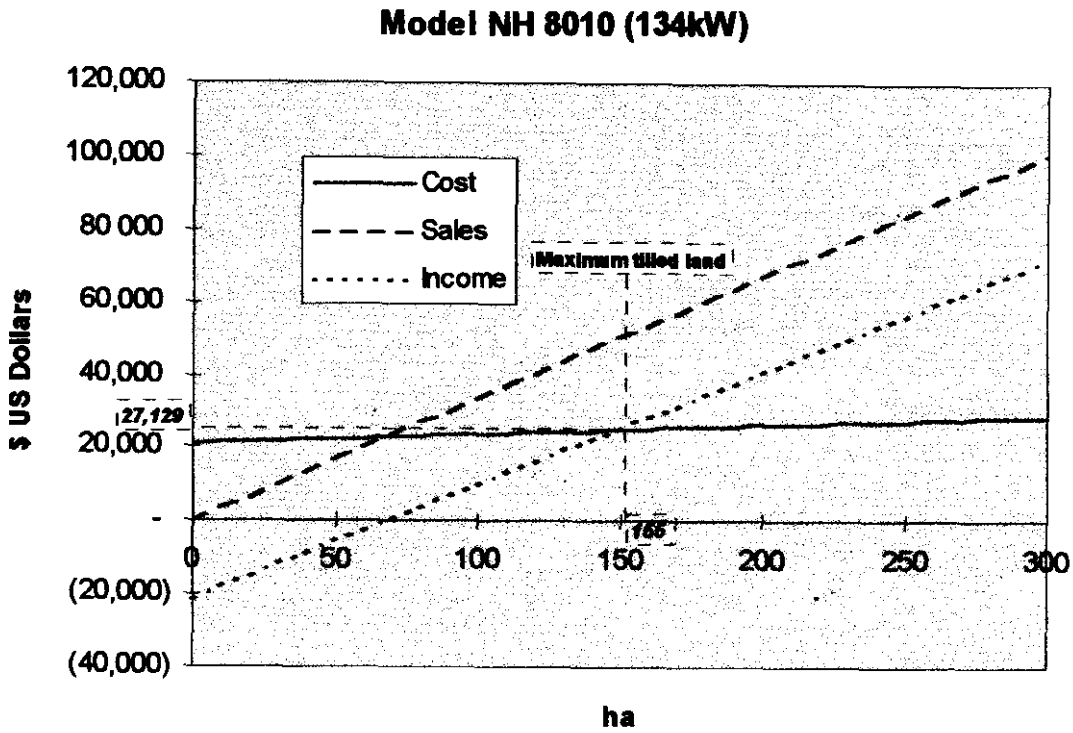
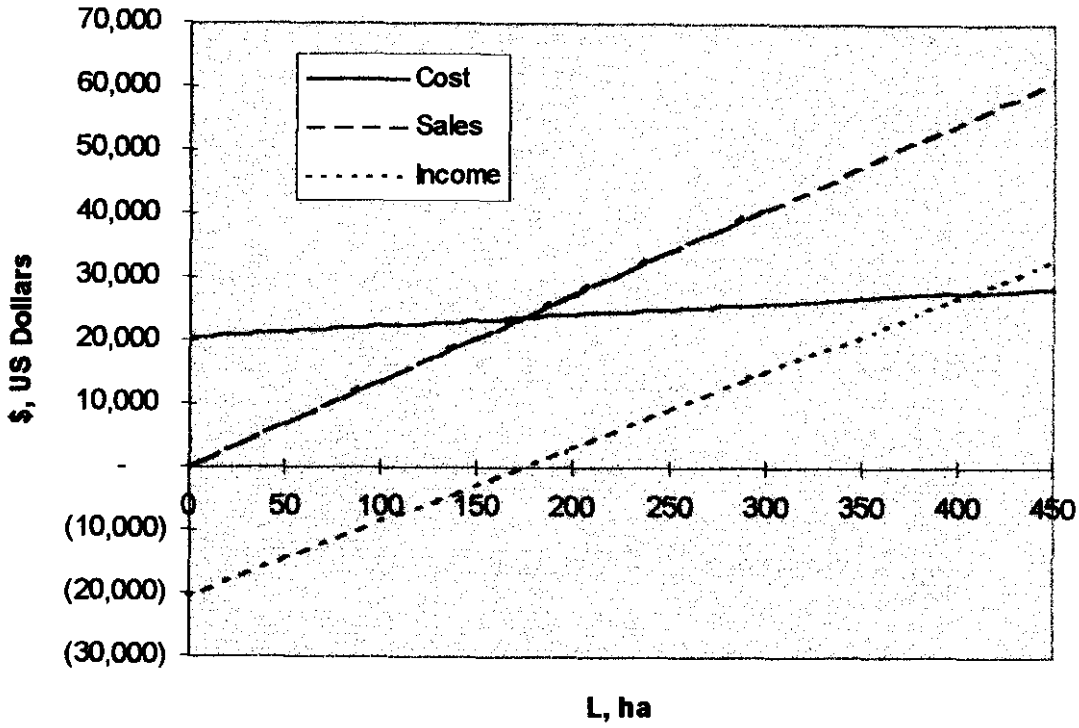


Fig. 6 - Economic analysis for combines in the central region



THE MACHINES OF WISHES

by **Roberto Guidotti**
Italy

What is the ideal machine for farm contractors? This simple question has a rather complicated answer, because we must consider the needs of agriculture, the market, the service and the work organisation.

Today, farmers expect contractors to provide specialised services, high technology equipment and low costs. Each of these requests reflects a specific need of the farmer, that is to say the optimisation of farm resources with outside ones, the production of good quality crops and the reduction of costs.

It must be kept in mind that, because Italian farms are very small in size, farmers are unable to match the standard of living obtainable in industry, commerce or other activities. There is consequently a need to focus on specialisation and high value-added production.

The concept of attention to quality has only recently started to make some headway in non-specialised farms. Whereas producers of milk, wine or fruit have long understood the relationship between quality and price, producers of wheat or corn have looked only at the quantitative yields.

However, the flattening of many crop prices — and of cereals in particular — brought about by the EU agricultural policy has convinced farmers that quality can provide higher profits without negatively affecting yields.

Another important requirement for farmers is timeliness: Italian soils generally have a high clay content and the useful days for their tilling are very few, especially when the ground is wet.

Furthermore, farmers usually harvest crops as early as possible to avoid the risk of precipitation, also because few farmers insure herbaceous crops.

We can therefore say that, in general, the most important characteristic for contractors is the working productivity of the machine: this makes it possible to meet farmer's needs and reduces the incidence of the cost of labour, safeguarding the profits of both farmers and contractors.

The ratio for increased engine power and working widths puts further restrictions on the operations calendar and can excessively reduce the annual machine workload, with negative consequence on the cost per hour: it is necessary to use the machine as much as possible, from ploughing to harvesting, all the year round.

Farm tractors must be suitable for many operations, but not for all uses: there are many types of tractors (vineyard, orchard, implement carriers etc.) which have a good chance of being amortised, because of the annual workload and daily utilisation.

In Italy, however, there is a dramatic drop in the use of crawler tractors among contractors: in the 120 to 200 kW power range, wheeled tractors are gaining favour due to their higher versatility, which allows them to perform a variety of operations such as hauling big balers and heavy trailers, or sod seeding.

Contractors now buy new tracklayers only for use on clayey soils or hilly areas, in the 50 to 120 kW power range. They are also penalised by the difficulty of moving from one farm to another.

The possibility of being used for different crops is an important characteristic for other self-propelled machines as well. This makes it possible to reduce the incidence of fixed costs, and amortisation in particular, but there is still a degree of resistance to interchangeable equipment, which can be attributed to two different reasons.

The first is the conviction that, although flexibility may be useful from the economic standpoint, it is not always compatible with technical soundness. The second reason stems from the difficulty of correctly planning the calendar of operations, due to the absolute lack of programming on behalf of farmers: often, for example, maize harvesting coincides with soy bean, sunflower or sugar beet harvesting.

The progress made by industry in the development of electronic and informatic systems and their application to farm equipment could solve the problem, for example, of adjusting the threshing unit in a combine harvester each time that the worker changes the harvesting head, by implementing an easy-to-use pre-programmed function.

Another obstacle to the application of new technologies in farm machinery is the lack of confidence in electronics on machines: contractors know and use computers in management, but they mistrust the operating reliability of electronic devices.

This fear is attributable to the poor reliability of the electronic components which have been used in farming equipment up to now: manufacturers have generally used components designed for the engine industry, which aren't suitable for the extreme environmental conditions encountered in agriculture.

If their costs aren't prohibitive, manufacturers should use electronic devices designed to military specifications, which are able to function under extreme temperatures, and in environments where there is moisture, dust or chemical aggression.

There is a need for manufacturers to design farm machinery with a view to reliability, because failures usually happen in the field, far from workshops, and during operations which must be completed within a specific and limited time window determined by bio-logical and climatic factors.

A few hours of downtime during the working season represent a major setback for a contractor: the farmer who sees the machine stopped in the field worries about completing the work on time, the next customer phones to know why the machine still hasn't arrived, and if the delay is above his limit of tolerance will call another contractor.

There is also the problem of materials: much equipment is currently constructed using low-quality steel, which is less expensive and easier to solder, straighten and repair. Many farmers appreciate these characteristics, but contractors prefer high-quality steel, because more durable equipment has lower maintenance costs.

Good materials make it possible to construct lighter equipment, which is an advantage when farm machines have to he combined with tractors: Italian law doesn't permit the combination of implements whose weight exceeds 30% of the tractor weight.

Many manufacturers don't use standardised parts on their machines: we believe this to be a mistake, because it's very difficult to construct every component, and it's easier to find on the market spare parts that are common to other machines.

Other branches of industry such as electronics have abandoned the practice, inherited from the handicraft tradition, of making everything in the same factory, and have thereby reduced their overheads and the cost of spare parts.

Contractors need timely and reliable certification of tractor and equipment performance. Industry produces a great many new models, but the only institute in Italy which certifies farm equipment isn't able to keep up with the hundreds of manufacturers.

This makes it very difficult to choose a new machine, because often dealers don't

know all of its characteristics or performance features, and the technical data supplied by the manufacturer is incomplete with regard to what the buyer needs to know.

There is a need for some kind of unified plan that would enable buyers to make a comparative search among different machines to identify his one: characteristics of engines (power supply, maximum torque and fuel consumption), PTO power, load capacity of rear and front hydraulic lifters, noise and vibration at the driving scat are all essential specifications for contractors.

Another problem that worries Italian contractors is the lack of transparency in the market: there is no review in general circulation that publishes price lists for each model and its various accessories: cab or roll bar, power shift or mechanical gearbox, reversible drive, front lifter, two-speed PTO, special tires etc.

These different accessories can significantly change the price of a machine, making it impossible to compare different models or versions.

In addition, commercial private discounts applied by Italian dealers make it difficult to know the sale price in advance: discounts can range from 10 to 40 percent, and are sometimes even higher.

Contractors know the final price only at the end of the negotiation, and therefore arc unable to plan for the value of investments in advance.

The enhancement of laws and decrees on worker safety has caught many manufacturers unawares, especially the smaller-sized companies. Although the CE mark has now entered the outlook of designers, noise reduction remains an unfamiliar concept.

One of these laws fixes the maximum noise exposure of the driver at 80 dB, but very few machines without a cab are able to meet this limit. If the noise level is higher, the contractor is obliged to fulfil a number of obligations ranging from medical supervision to the issuing of protective gear.

Noise reduction can be achieved only through good design: retrofitted modifications cannot solve the problem effectively. A contractor who modifies a machine is viewed, from a legal standpoint, as if he were a manufacturer (EC directive n. 91/392), and must take upon himself all civil and criminal responsibilities.

Many manufacturers believe that machines and equipment arc designed only for the field, but today few growers still have farms localised on a single plot of land: on the contrary, contractors cannot work with-out moving from one farm to another.

Road traffic is a serious problem faced by contractors: Italian regulations are much more restrictive than those of other European countries, especially those concerning the width of machines.

The 2.55-metre limit conflicts with the requirements of a modern agriculture, and the regulations applied to wider machines are very complex. However, only a few manufacturers design their machines bearing this issue in mind.

We do not think that the remarks expressed here are an impossible dream, nor would we want our proposals to be interpreted as a criticism of manufacturers, who are well aware that contractors are the best testers for new machines or equipment.

DISCUSSION

Prof. Jürgen HELLEBRAND
Germany
The presentations, and especially the last contribution, have given me certain ideas concerning contractors. I believe contractors would like to use machines with high efficiency: in many cases, that means we will have heavy tractors, heavy trailers, etc. But is this really in the interest of the farmers? Heavy machines can lead to increased soil compaction and so on, which might be in contradiction with the idea of sustainable agriculture. And do you think that contractors with huge, powerful machines will have a positive or a negative influence on the use of chemicals and so on? I am not sure whether the type of development promoted by contractors will be altogether desirable.

Prof. Bassam A. SNOBAR
Jordan
I have at least one question for the first three speakers. I'll start with Prof. Kutzbach, who spoke about the spread of contractors in Germany. This contrasts with the situation fifteen years ago, when to my knowledge there was no contracting in Germany and in most of Europe. I believe contracting came about when the size of machines, and consequently their price, started to increase. Now I know that when we increase the size of a machine we have a problem with field efficiency, and poor field efficiency implies more costs. l'rn afraid that we are seeing more and more machines with field efficiencies as low as 50%. That is to say, out of ten hours of work, only five hours are productive. I am suggesting that we should do something about increasing the field efficiency. I was also going to raise the issue of soil compaction, which has already been mentioned. My second question is for Prof Hossary who spoke about privatisation, and mainly the shift in ownership from small-sized to larger-sized holdings. A few months ago we heard about the new rental law in Egypt, which led to land being taken away from small farmers who had been tenants for a very long time, and there were demonstrations and protests about this. And now apparently we'll be seeing a project leading to larger farm sizes, and larger areas call for larger machinery or more intensive use of machinery. In this connection I would like to make one additional point, which is that large size machinery allows to catch up on timeliness. In some countries the time available for harvesting or planting a crop is very limited, we're talking in the order of days, and again this re-quires increased size of machines. Dr. Lopez mentioned the fact that efficiency of combine harvesting is very low This is due to the fact that, while the harvested material is being transported, the combine is standing still. I think we must come up with an idea that allows this machine to keep going while transportation is being done. In Jordan, for example, most of our work is done by contractors; in fact we started with contractors from the very beginning of machinery use in Jordan, because we have small sized plots, etc. So what we do ìs to use a combine that puts the harvested grain in a sack. This sack is immediately thrown on the field, and the combine keeps going. Later, a trailer cones back to collect the sacks and transports them to the storage area. Maybe a lot of things could be done to increase field efficiency, because this is the most important factor. This is a problem of work organization.

A.M. El HOSSARY
The previous speaker just touched on a very important point: the use of large machines on small plots. In Egypt we have got a policy which is based, as I said, on four main pillars. The first pillar is crop consolidation: that is to say we have to get larger areas in which to use the machines. And this is compulsory by law For example, we

have a big area that is devoted to cotton, and every small farmer has to cooperate with his neighbours in order to utilise the machine in the proper time. The second pillar is crop specialisation: we have so many different varieties of crop, and each one has its own start date for crop planting. Therefore, Egypt is divided into seven regions, where we start the operation at the same time. This enables as to implement the fourth pillar which is mechanisation. So the problem is not really the use of big machines. What I'm really concerned about is the high level of sophistication of the machines which are available today: in developing countries the efficiency of such sophisticated machines is very low, because they require a great deal of training and, at the same time, the fields are not prepared for them. I would therefore second your point that sophisticated technology needs to he introduced with precautions in developing countries.

H.D. KUTZBACH

In answer to Prof. Snohar's question, of course field efficiency is one of the main issues for both farmers and contractors. And therefore – for example – contractors do not just chop the corn but offer the entire chain for harvesting the silage: this means not only chopping but also transporting the chopped material to the silo, and preparing the silo. So they have found that it is better to offer the whole chain rather than just one part of the chain, because in the latter case field efficiency is lower. This-makes it necessary – as we have mentioned – to have trailers available to transport the materials; and there have been developments in this area, too: new trailers capable of loading "on the go". For example in the case of sugar beet, the harvested product is carried only as far as the edge of the field is concerned, where it is stored awaiting subsequent transport by truck to the sugar factory. As regards the 50% efficiency figure, I would hope this is not applicable to German contractors: I would expect their value to be closer to 80%, otherwise they could not make their business profitable. Of course big machines have the disadvantage of causing soil compaction problems, as Prof. Hellebrand mentioned. However, nowadays there are big tyres available, with special steering systems so that the tyres don't go into the same rut but use another one, in order to reduce soil compaction. On the positive side, a high capacity machine enables the farmer to wait for better weather conditions. I think that's an important aspect, not having to go on the field under any conditions, but being able to wait for more favourable conditions. This is backed up by a real trend, among many large farmers and contractors, to-wards replacing two large combines with one new combine having 50-60% higher capacity. So it seems easier for them to manage this one large combine than two smaller ones – though of course they don't have a total of just one, they have maybe 5, 6 or 7, and they exchange two of these old ones for a new one. So they are reducing the number of combines in their fleet. And its also a problem of skilled operators: its easier to operate one bigger combine with a skilled operator than two combines, one of which may be operated by a non-skilled operator.

A. LARA LOPEZ

Certainly the efficiency of combines is an issue that deserves our attention, it's a very important problem. I think that it is also essential to consider the cost to farmers. Increasing the efficiency of combines is a very complex problem, because the price of grain varies during the harvest season. In the case of the principal crops in Mexico such as corm, sorghum and wheat, prices can vary by as much as 10% between the beginning and the end of the harvest. Combines normally load trucks directly, which they are able to do very quickly, but the main losses in useful time occur during transfers from one field to another. So we need something like special trailers that can reduce these periods of non-productive time. Also, we have to consider that the

volume of grain being harvested is too large to be left on the field. Therefore, we need to find some innovation for moving the combine from one place to another more quickly.

Prof. John SCHUELLER
USA

Essentially, wherever we have productive industries – be it auto-making, paper manufacturing, and certainly agriculture – the heavy emphasis on the development of more productive machines has to some extent shifted the problem away from the actual manufacturing or production, and onto materials handling. In the United States (I have no general figures) there are essentially three different ways in which the materials handling in contract operations is performed. In one case, as Prof Kutzbach discussed, the materials handling – i.e. the transportation – is supplied by' the contractor. That works well, except where there are very different distances to be hauled, in that one farmer may just want it stored on his farm while another may want it to be transported a large distance. Also, in some cases the harvest operator does not want to deal with the transportation. In these cases, it's either provided by a separate haulage contactor which can be a normal trucking company or an owner-operator of a truck, or in some cases, since the farmer already has tractors available, the himself provides tine transportation and the contractor only provides the actual harvesting. It has already been mentioned the crops involved in contractor operations – the harvesting of corn silage, sugar beets and grain – are produced in very large quantities, in very large weights. My question to Prof. Kutzbach is: do any alternatives exist to the contractor providing all the services? And also, has there been sufficient analysis of the materials handling problem? There has been extensive analysis of the actual harvest operation, but I'm not so familiar with recent simulation analyses, under the current conditions, of materials handling in contracted operations.

H.D. KUTZBACH

The alternative possibilities mentioned by Prof. Schueller are available in Germany, too, although generally without the contractor and truck business, which is not as common in Germany as in the United States. Of course, the farmer will transport his material himself if possible, but it is more often a combination of farmer and contractor transportation, as well as neighbourhood collaboration. In fact, because transportation for these big forage harvesters is not normally available within a single farm, several neighbours get together to carry out the transportation. In Germany we are aware of this transportation issue, and several universities are dealing with these logistical aspects, particularly the universities of Berlin, Halle and Kiel. A special conference on this topic was held half a year ago.

Dr. Malcolm MC KAY
Australia

I want to come hack to the point raised by Prof. Hellebrand, and ask whether in other parts of the world there are activities similar to those we have in Australia. One of the major areas in which contracting is used in Australia is the production of sugar cane, particularly for the harvesting and transportation. There has been a lot of work done on transportation because there s a timeliness problem from harvest through to crushing, and therefore the whole transport system is integrated from in-field to the mill. More particularly than that, because – in Australia – sugar cane is grown as a returning crop, any adverse impact of the harvesting operation is immediately evident in the returning crop. There-fore there's a very close correlation between compaction and damage from the in-field operation on the (harvested crop. And, unlike other crops where you can actually ameliorate some of the damage by subsequent tillage operations, there is really no way of overcoming the damage that may have been caused to the sugar cane stool. So the farmers are now in fairly deep con-

versation with contractors to actually put into the contractual agreements incentives and penalties for the quality of tine job that is done at the harvesting stage. That's a new development, and one aspect they're struggling with is how do you quantify the quality of the job, and what the impact on the subsequent crop is. But it's being tackled with a great deal of enthusiasm at the moment, due to the recognition that the current harvest operations, and particularly the haul-out operations, have a significant economic impact on the subsequent crop. I'd like a comment, from the Italian contractor's point of view, as to whether this is an issue that is starting to arise. Are farmers wanting to put quality aspects into contracts, or is it still on a production basis?

Prof. Karl Th. RENIUS
Germany
I would like to come back to Prof El Hossary's. presentation. I would say that private activities are like a closed control loop, whereas non-private activities are like an open control system which needs many rules, and which even with these many rules does not work very well. Nonetheless, the non-private mute is very often attempted in developing countries. India and China, for example, tried to be successful with state-owned systems. Now let me give an example from India. I was travelling through India last week, and visited Indian farmers in connection with a tractor project. It is interesting know where the money to buy these tractors is coming from. The tractor in question is 45 HP and its price is US$ 8000. Many farmers in central India are making money by leasing tractor-implement combinations to other farmers. And this seems to be a very interesting business in spite of difficult conditions. One owner of the new tractor reported that the earnings over a six-month period, corresponding to about 1000 hours of operation with the new tractor paid back 40% of the initial cost So this really means becoming rich for their conditions, and others confirm that this is really possible, although it requires high-quality machinery and updated service. The final conclusion was that — even in India — this is only possible on a private basis. To achieve this — for example — we installed in the company, and for the first time in India, equipment for testing components in the lab. prior to the introduction of the tractor Another successful principle was to set up the dealership network before introducing the tractor There are no Indian colleagues here, but 1 think, for many countries, the way in which this operation was done is a very interesting example. Likewise for China, and my forecast is that the Chinese will have to shift to this principle, because even in China you can make money this way. And perhaps in the year 2005 they will, though not very much earlier

Prof. Giuseppe PELLIZZI
Italy — President of the Club
I have only two questions. The first one is: does it also happen in other countries, as it does in Italy, that contractors are engaged to carry out all the operations on the farm, from cultivation through to harvesting? Or are contractors used only for specific operations? My second question is: do you think that there is a need to regulate the activities of contractors within each country? For example by keeping a register of the different companies, in order to have a clearer situation from the legal standpoint.

Dr Derek SUTTON
UK
I'd like to follow up on the last two speakers. First of all Prof. Renius: I fully agree with his statement that there are problems when you compare the efficiency and effectiveness of contracting services provided by the public sector as opposed to the private sector. A number of years ago my group undertook a study for the World Bank, on the efficiency of government tractor hire services. We discovered, after a world-wide study of all the then-existing tractor hire services operated by governments, that

there was only one that operated in any way near efficiently And there is always a difficulty, which Prof. El Hossary mentioned, with corruption, subsidies, the near-impossibility of actually running an efficient operation. This leads me to my main point, which is that the viability of these operations, or of any enterprise, particularly a contracting enterprise, must obviously depend on how effectively you can utilise your capital investment in equipment. Therefore, Prof. Snohar's point about field efficiency and what 1 would also describe as equipment utilisation rates, is crucial to the success of these contracting enterprises. I'll just mention a couple of approaches that either have been or could be adopted to improve this: one is the practice in some parts of the United States and 1 think even Mexico of having mobile or roving contracting teams who move from the south of the country to the north of the country as the harvesting season advances, thereby permitting a very long utilisation period in the yew; making it a very profitable business. And therefore they can afford to use the most effective and the most efficient large-scale equipment. Secondly, a proposal that is being discussed with my colleagues in FAO and with my own department for international development in the UK: it addresses the developing country context where — particularly in the semi-arid areas — small farms and unimodal or at best bimodal rainfall patterns give a very short window of opportunity in which you can carry out operations, making it very difficult to get high utilisation rates unless you look at the possibility of using agricultural tractors in the wider rural context. i.e. you can use them for road maintenance, for civil construction and for other operations to spread the utilisation rate and thereby improve the efficiency.

Dr. Oleg S. MARCHENKO
Russia

I would like to come back to increasing the efficiency of harvesting machines. For example, we have designed and put into production adapters based on the 200 kW power unit. For example we have completed a sugar beet harvester, we are finishing the design for the grain harvester, and we have started potato harvester. For the same power unit. It means that the hourly cost of using this power unit is very low, and we use several adapters which can be utilised for a small number of hours per year. For contractors it seems to me the best way to decrease machinery costs and to increase the efficiency of field operations. We have so far put into production, for each harvester; and based on the 200kW power unit, the sugar beet harvester, the grain harvester is in final testing and we have started to design the potato harvester. It seems to me that this is one revolutionary way to increase the efficiency of field operations.

Dr. Yoshisuke KISHIDA
Japan

In the case of Japan, we have the additional problem of a sharply declining labour force, and contract operations are becoming increasingly popular. But one big problem is transportation of large machinery from field to field. Dr. Guidotti described the Italian situation, and ours is very similar. The size of fields is very small, and they are scattered. This means that, to carry out contract operations, the operator must transport the machine from field to field. In this connection, one problem is the public road regulations. In Japan the maximum permitted width for vehicles is usually 2 metres. There are some exceptions for which special approval can he obtained, but this is one of the problems. And the second problem, which has already been mentioned, is the soil compaction caused by large machines. To solve this, / would suggest to your engineers, for future research, the development of a very high speed machine. In the case of combine harvesters and tractors, for example, how can we increase the operational speed in the field? If this can be done, we can make smaller sized tractors and combine harvesters, with lower weight.

Dr. Uri M. PEIPER
Israel

Several speakers have mentioned the issue of soil compaction, which is a serious problem. In many fields, we see the result of what I would call a vicious circle: be-cause smaller machines are too expensive for one farmer to operate, the machines get a little hit larger and are operated by two or more farmers, ultimately leading to contractors and these very large machines for which we engineers – and this was al-so touched on by Prof Kutzbach – try to find the ways to reduce compaction with special tyres, etc. A problem which has not been mentioned here is the transportation of the produce in the field. These large combines, such as potato combines or whatever, travel side by side with some of the machines; we lake a great deal of care with the tyres of the agricultural machinery, but the truck which sometimes travels alongside the machine has road tyres, and we all know what road tyres do to the field. So I think we should take a more systems-oriented approach to the issue, rather than only looking at the agricultural machine itself. Another topic I would like to raise here, and which was also touched on by Mr. Mc Kay, is how you quantify or how you pay the contractor for the job he is doing: just by area, just by weight, or do you include the quality of the work which comprises both the quality of the product – i.e. the money the farmer gets from whoever he sells it to – as well as the quality of the job done in the field, taking into account the repercussions on the next crop. In our country we have at-tempted to gradually introduce paying for quality. And I think this is one of the approaches which is probably feasible. I hope its popularity will increase.

Dr. Lawrence J. CLARKE
FAO-Italy

I would like to contribute to the comments already made by Karl Renius and Derek Sutton, concerning the problem of farm power in many developing countries. FAO has a programme in what we call the LIFDCs, the low-income food-deficit countries, and we have a special programme for food security in a number of these countries. Now, not surprisingly – at least to us – the lack of farm power has been and is being identified as one of the major constraints to increased food production. We are trying to tackle that and, in many of these countries, particularly I would refer to sub-Saharan Africa, we have a situation where governments over the years have had many misplaced attempts at introducing tractorisation, such as the government hire schemes which Derek Sutton referred to. And there is a vacuum in these countries in the provision of farm power. We consider that multi-farm use of farm machinery, which includes contracting, is one of the methods which shows very good prospects of increasing access to farm power by small farmers. However, there are a number of fundamental problems involved with this. The first is the withdrawal of government intervention in the mechanisation sector: there is now a withdrawal of subsidies — although we wouldn't necessarily agree with the subsidisation of farm machinery. Another is the high cost of capital now: after structural adjustment interest rates are very high, it's a demand-led situation. And another problem is the low capital and asset base of the potential contractor: that is, most of these potential contractors lack assets that they can put up for security for borrowing money to buy machines. We do know as well that there is a great interest in this. In Tanzania, for example, there is a very great contractor base, operating with tractors which are twenty, sometimes thirty years old. But there is just a lack of possibility for them to finance purchases of new machinery to improve the farm power situation. So one of the approaches which we are now taking is, instead of supporting direct mechanisation projects – the traditional approach of training and demonstrating machines – we are looking at the whole of the input supply chain, as we call it, from the importation, local manufacture, distrib-

ution, dealers and retailers right down to the farm level, to identify where the problems lie in that chain of supply, and to formulate programmes which we hope will remove those constraints to the development of this, particularly the contracting sector. Derek Sutton has prepared for us a very innovative project in Tanzania, whereby we will be cooperating with New Holland, who in this particular instance will finance part of the project to assist us in looking at the whole of this input supply chain, and to try to remove die constraints to the development, as I said, particularly of the contractor business.

Prof. Hugo CETRANGOLO
Argentina
I'd like to give you a brief description of what the contractor situation is in Argentina. There are some activities, such as transportation from farms to stores, which in almost 100% of cases are done by contractors. Contractors handle about 80-90% of harvesting. These are highly specialised operators which move from the north to the south of the country over a 6 to 8 month period doing the harvesting; they have very good modern technology, and are highly efficient and profitable companies. For tillage and seeding, the tractors handle about 30-40%: these are specialised contractors, and not the same ones who do the harvesting. There are no specific regulations for contractors. In the past 5 or 6 years, the agricultural sector has seen the introduction of investment farms, which engage contractors to carry out all their operations. And for that reason, each year we are seeing contractors with increased operating capacity and more modern technology.

R. GUIDOTTI
I have heard that public regulations – the laws – very much affect the movement of agricultural machines. Especially for combine harvesters and sugar beet harvesters. In Italy, the weight of the machine is also a serious problem, because our legal limits are about 14 tons for a four-wheeled machine with two axles, and 20 tons for a three-axle machine. These limits are insufficient for the needs of modern agriculture. We have many difficulties in traveling from one farm to another: contractors must obtain a number of authorisations from public bodies – from the Province, from the State – and each of these authorisations has a very high cost. For example, for very heavy machines, we have to pay a tax that ranges from 170 US$ to 840 US$ a year to move our machines on the road. It's difficult for manufacturers to design larger machines and reduce costs if limits all over the world are too narrow for the machines.

Prof. Pierre ABEELS
Belgium
Of course, I agree totally with Yoshisuke Kishida. But now the use of agricultural forestry machines is increasingly being discussed outside the .sector, with regulatory restrictions – for example forest services telling us that that a particular make or manufacturer is forbidden in certain forests – which are unacceptable. My first suggestion is that agricultural engineers, such as those in the Club of Bologna, should become more active and involved with the legal aspects, particularly the process of establishing regulations at the national and even international level. My second suggestion is that we might hypothesise some sort of economic compensation for technical slowdown of machinery due to unfavourable environmental conditions, in other words a kind of financing for compliance with official restrictions dictated by environmental responsibilities. My final point – and this is a market issue – is that profitability is a major problem. How is it possible to reconcile the optimal area for profitability with agronomic requirements? I refer to imperatives such as the timeliness requirements for obtaining marketable products, which indirectly restrict the period of operation. It's a kind of conflict between supply and demand. How can this be resolved?

H.D. KUTZBACH

I would like to give my opinion on some of the points which have been raised. I'll start with paying the contractors according to the quality of work. I am not sure whet/her they are paid for quality but, as I showed in figure 4 of my paper, one of the reasons for hiring contractors is their extensive experience. And the contractor doesn't come just for one year – he will come back again the next yew: Therefore he has to deliver good quality, otherwise he loses his job. So I think that is one motivation for the contractor to do a good job and perform high-quality work. It was mentioned that transportation limits efficiency, and I would remark, from the technical standpoint, that there is equipment available that can reduce these preparation times. For example: the foldable head substantially reduces the travel time between the road and the field – down to the order of three minutes. 'There is even an automatic combine adjustment available now – which / believe will be discussed again tomorrow – which reduces the time which it takes to get the combine working in the field. At the push of a button, all the adjustments are made: threshing speed, concave clearance, air distribution, air amount, revolutions for the sieve openings, etc. Then, tillage – of course contractors are also doing tillage – but not on the same scale as / have shown for forage harvesters. As you can see in figure 6 – which 1 didn't show due to lack of time, although you can find it in the paper – you the amount of tillage work being done by contractors. Mr. Sutton mentioned mobile teams – these might he feasible in countries like Mexico, where there is a great distance between North and South. However, our experience in Germany, where the distance is not so great, is that the use of such teams is not opportune, because weather conditions might be such that the team is required to be at both locations simultaneously. And if the total capacity within this area is limited, they will run into severe problems for harvesting. We experienced such conditions last year, which was a very severe year So it turns out that, especially for Germany, it is better to have a slightly oversized capacity and harvest the product on time, without using mobile teams. But of course in countries which have great distances between north and .south, like the United States or Mexico, mobile teams can he a valid solution. In connection with increasing machine .speed, of course we can increase capacity through the use of lightweight, higher-speed machinery – and broader machines are of course heavier – but unfortunately a lot of agricultural operations require low speeds. Some decades ago, an attempt was made to introduce high-speed ploughing, and it emerged that the power efficiency and the fuel requirements were much higher than at lower speeds. But of course we shall aim for higher speeds, and especially for lighter machinery. I think that all de-signers of agricultural machinery are looking to this. Perhaps not successfully, but that is one of the requirements for machines: lightweight. Truck tyres are forbid-den in all cases – anyone who uses them is not working correctly on the field. Mechanisation in countries like Africa is a special problem, and I think the Indians started thirty years ago, so it takes thirty years and cannot be done in one or two years. We have to be patient, especially as concerns Africa. / think we have to go through all the stages again: trying to come out with animal traction, getting a little bit more money to the farmers and then starting with power tillers and finally coming to big machinery. We cannot just skip over all these thirty, forty or fifty years of farming experience. We have successfully introduced light weeding equipment in Niger, in which animal traction replaces manual labour And naturally, mechanisation is possible only if you know what to do with the workers – if you have another job for the workers. If that problem is solved, and there is a lack of labour with consequent increasing labour costs, then mechanisation will introduce it-self But if the cost of labour is low, and a lot of workers are available, mechanisation cannot be successfully introduced.

A.M. EL HOSSARY

I would like to second Prof Renius – confirming that there are some government-operated contract operations which are doing very well. I believe that the only merit of the governmental service stations we use in Egypt is as a vehicle for the introduction of new technology: in fact we use these units as demonstration stations to the farmers. This is because machinery users or contractors are hesitant to buy machines on their own and introduce them to the farmers. There-fore, we introduce the most up-to-date technology through the governmental stations and they are able to buy these machines. Then, once the farmer believes in this technology – and we always say that seeing is believing – the contractors will be willing to buy the machines. This is the only merit of the government-owned service stations.

K.Th. RENIUS

I agree completely with you on the educational problem. I think educational and informational activities should be supported by the government. This has been successful in all the countries in the world – and there is no doubt about it. To privatise 100% is, I believe, too dangerous. So I fully agree with your statement.

Prof. Pavel KIC
Czech Republic

I would like to say a few words about the contractor situation in our country. I can say that contract operations have gone through two distinct periods during the past fifteen years in the Czech Republic and in former Czechoslovakia. The first period started in the early fifties, during the so-called collectivisation process, when the first cooperatives and state farms were created. They were rather poor, didn't have enough skilled operators and lacked the investments to buy new equipment, so the state decided to help them through the establishment of "state machinery stations". These stations were equipped with new tractors – this was in the early fifties – and with new equipment such as combine harvesters, etc. The function of these machinery stations was to help the newly-formed cooperative farms and the new state farms. This period lasted for about ten years. And we can say that it was a big help from the state to the newly-established cooperative farms. But during the sixties, seventies and – of course – the eighties, new trends began to emerge. By then, the cooperative and state farms were bigger and had better financial situations, so they were able to buy new machinery. In fact, during the eighties the average size of our cooperative farms was about 3-4 thousand hectares, and State farms were even bigger – in the order of 5-6 thousand hectares. Due to these large sizes it was, of course, efficient to buy practically all the sophisticated machines on the market. But during the nineties, during the process of agricultural privatisation in our country, new cooperative farms were formed based on the private ownership of land The average size now is about 2 thou-sand hectares, which is still big enough. There are also newly formed private-ownership companies from the former state farms, which are about 1 thousand hectares. And now there are also big private family farms, of about 200 hectares or more. These three kinds of farmers are able to buy and utilise expensive machinery However the privatisation process also resulted in the creation of small farms, about 10 or 20 hectares in size, which are not able to buy such equipment. They are able to survive only by resorting to contractors. And the contractors are mostly from the newly-created cooperative farms. So I think that it's important to understand in what way sophisticated machines can be optimally utilised, and organise things so that conditions – in terms of land area and so on – permit the use of these machines. Contractors are the right way in those cases where we don't have the conditions for other alternatives.

Prof. Osamu KITANI
Japan

Japanese farming is a typical example of small-scale farming. As you know, the aver-

age farm size is just one hectare, and rice farming is still the main operation – accounting for about 40% of the total agricultural output. But on the other hand, some 85% of farmers are part-time farmers, and the field operations are mostly carried out on weekends. Under these conditions, the new systems are not so easy to establish. For example, machines for highly-trained professional operators are not very well-established It's probably a matter for investigation, and also a matter of the movement of the market in the future. We have here representatives from the two major farm machinery manufacturing companies from Japan — Kubota and Yamaha — and I'd like to invite Mr. Kobayashi to give a comment from the viewpoint of Japanese manufacturers.

Dr. T. KOBAYASHI
Japan
As Mr: Kitani has already said, the average acreage in Japan is about I ha, whereas in the northern part of the country — in Hokkaido — it is about 10 ha or so. Therefore, all farmers cannot buy new tractors and new combine harvesters. So what we are doing is focusing on the production of small tractors, which work very fast and accurately. And Yamaha is now promoting "ecotra" — an ecology tractor or economy tractor — which can cultivate twice as fast as conventional tractors, but its mainly rotary cultivation systems – not tillage. And so we don't go up to 100 HP tractors in Japan, but only 20, 30 or at the maximum 50 HP tractors which can be purchased by rich farmers on their own or by groups of neighbourhood farmers. Its our target to make small machines which work like big machines.

D. SUTTON
Just three points: going back to the question that our president raised before lunch. One concerned the need for regulation of contractors. I personally have some reservations about the involvement of government in regulation where it's not necessary. I think we should keep it out. But 1 do believe that there is a case for the contractor's associations being strengthened and encouraged. Mr. Guidotti – who gave the paper this morning – is in fact a representative of the Italian contractors association, and he told me that there is a meeting of the European associations of agricultural contractors in Brussels next month, and I think this is something we should encourage. The second point that Prof. Pellizzi raised was the question as to what extent full farm contracting was being undertaken, and I think Prof Kitani's point is an interesting one, that in the case of Japan – with a lot of small farm holdings – the contracting potential is apparently not yet being fully realised. I think in other countries to an extent it is: certainly in the UK, where there are part-time farmers who in many cases will subcontract all their operations with machinery to contractors. They are — as in the case of Japan — weekend farmers, and the only way of getting the work done is to have it done on contract. But I suppose one of the main advantages of contracting out is that you reduce your capital requirement, and if capital is a constraint, then it does mean you can he in operation more quickly and perhaps more profitably by using a contractor. But a disadvantage, of course, is the lack of direct control over the operation. So the success of your enterprise — your farm or whatever — is rather in the hands of outsiders. And if a contractor lets you down there isn't necessarily much that you can do about it, which does make you rather vulnerable as a small producer. The third thing I'd like to mention is a hit of information that 1 happened to read in the newspaper yesterday, which relates to the suggestion made by Mr. Kishida, of looking at smaller, faster, lighter weight machines, and to the problem of compaction which has also been mentioned by others. I noticed that John Deer company are embarking upon a new project to use modified soya beans as a source of material for pressings and for hollow sections to reduce the weight of machinery. And apparently the process has

been recently developed and is very exciting in that it reduces the weight very considerably, and uses a natural rather than a mineral resource. This is something we'll no doubt hear more about.

Prof. Bill. A. STOUT
USA
I wanted to follow up on a comment made by Prof Abeels this morning. I believe he said that we should participate more actively in aspects such as the legislation and regulations related to agriculture. I'd like to expand on that idea a little bit: I think sometimes we agricultural engineers are too good at what we do, and too many of its prefer to spend most of our time in our laboratories, sitting at our computers modelling things, or doing other technical work. Whereas too few of us are willing to take the time and put the effort into explaining to the general public why our work is important. As a result, we are often blamed for the problems of society. We are blamed for excessive production and for putting people out of work in developing countries. I think we know that the story is more complicated than that; we know that there are peak labour periods in every country where mechanisation is needed, and we know that we do other things than just increase production – we create a safer work environment for people. We do all these things, but we don't spend enough time explaining that to the public. Now, to come to the contractors, we know that contractors are necessary in certain places, and we know that contracting can he profitable, but instead of spending all our time talking about de-signs and tine mechanical side of it we need to spend more time on the human side. So 1 would just make the point that maybe the Club of Bologna ought to spend more time putting out press releases or putting a human twist on the work we do.

G. PELLIZZI
Its been underlined in the discussion that contractors are particularly important for small farms, because the big farms have their own machines. In this respect, the situation in Italy is completely different: in fact, almost 50% of large farms make extensive use of contractors, because farmers are interested in achieving greater flexibility in their production, without being tied down to the fact of owning a machine. Just to give you an example, 60 km from here there is a big 600 hectare rice farm, and the owner told me: "1 will never buy a combine harvester / prefer to hire a con-tractor for the harvesting, because in this way 1 am completely free. I don't have money to invest, and so on." I would like to know whether this attitude also exists in other countries.

H.D. KUTZBACH
I cannot answer Prof. Pellizzi's question –I think some big farmers are using contractors in Germany too. But I would remind you again that contractors are not only operating the machines, they are also doing extension work too. And I feel that that is another very important job for contractors, because they gain a lot of experience with their machines. And especially with chemical spreading or plant protection, for example – as I showed in my figure 1 – they do a job for sustainable agriculture and lowering environmental impact.

U.M. PEIPER
In answer to Prof. Pellizzi's question – one type of contractor operation in our country is when groups of large farmers – called kibbutz – join forces to purchase and handle large sophisticated machinery. So several kibbutzim (that's the plural of kibbutz in Hebrew) in one area have founded a kind of contractor service for different jobs: like cereal harvesting, potato harvesting if it's a potato area, or other crops which are popular in a certain area. And then they do it centrally for the whole region. In the smaller farms it is more what Prof. Kutzbach referred to as leasing or renting equipment by several people in the same settlement, with everybody operating it for himself on his own farm. On the other

side, in the large contractors 1 mentioned before, the machines are operated and maintained centrally; by the whole region.

J.SCHUELLER

The current edition of the farm magazine on New Holland's Web page in North America has an interesting article on a contracting case, which l want to mention in answer to Prof Pellizzi's question and in relation to this morning's discussion about quality. In Arizona there are large dairy farmers who do not have the specialisation to chop silage or maize, so they hire a contractor. And it is the operator of the silage harvester — the contractor — who decides when to harvest. But the dairy farmers are very sophisticated, and for example they might say "we want our silage harvested when it's 72% moisture". If it drops below 69%, the harvester hears about it. So there is a natural quality requirement there, which the contractor must comply with if he doesn't want to lose the business. Also, as Prof Auernhammer might want to discuss a little bit, they have a similar quality thing in Germany.

Prof. Hermann AUERNHAMMER
Germany

First of all, I would like to go back to Prof Pellizzi's question. I think we have the same situation in Germany. The very large farms in the eastern part of our country are now engaging contractors. And I think there are two reasons for that First of all they have no money to buy their own machinery. And secondly they have no experienced people capable of operating highly sophisticated machinery such as combine harvesters. So it's much simpler for them to engage a contractor — what I would call a "real" contractor And that means contractors are gaining importance in Germany, and particularly in Bavaria, as Prof. Kutzbach mentioned this morning. Con-tract operations in Bavaria started out be-cause there were a lot of small family farms which had overcapacity in machinery, and enough time to work with the machinery. Given this situation, we established a machinery exchange system, where the over-capacity in time and machinery was brought to the neighbouring farms. 1 believe that, in a situation where there are a lot of small family farms, this particular type of contract operation could he a good solution. On the other hand, with larger farm sizes we have to go to the "real" contractors — which is just what John Schueller mentioned — and this is in fact the situation now in the southern part of Germany, where we have a lot of dairy farms. When the size of these dairy farms increases beyond 40 or 50 cows, they no longer have enough time to operate their own field work. Consequently, contractors are coming in and taking over all the field work for them. The farmer himself thus becomes specialist only in dairying, and handles only the dairy operations on his farm. So I think we have to take into consideration the size of the farm, and the type of development in a certain country or region.

Prof. Jan PAWLAK
Poland

It's also my opinion that, for these small family farms, the exchange of services is the right type of contract operation.

P. ABEELS

In answer to Prof. Pellizzi's question, I think in Belgium we must make a distinction between farming and dairy farms. In farming, contractors are hired for heavy jobs, how-ever most small farmers do not trust con-tractors for soil preparation, because they generally work too fast and too roughly. So they try to strike a kind of compromise, by engaging a contractor to make a first pass, and then using small tractors themselves to prepare the soil according to their requirements and experience. As far as the harvest operation is concerned, the problem for the farms is the industry quotas: they have to deliver certain amounts within a given time. If they exceed the quota, they have to wait 8-10 days to bring those additional quantities to the industry. This is particularly true

in the sugar beet industry. Another operation that is contracted out is big baling – because those machines are too expensive and uneconomic for farmers to purchase. On dairy farms, the main concern is having the best harvesting technology in order to improve silage quality. The more up-to-date machines offer an improved cutting process and a faster work rate for making the silage at the farm, so daily farmers prefer to hire a contractor that has the latest new machines, rather than buy a machine for a ten or twelve year period. That's the situation.

Prof. Richard O. HEGG
USA

I would like to comment on two or three statements that have been made. One issue, which Prof Abeels and Dr Stout referred to, is the idea of contractors meeting some type of quality standard or certification. However, it has been my experience that policy-makers don't necessarily look at the scientific information: decisions are made on the basis of what's going to appeal to the most people at that time. A classic example, which I've been involved with recently in our state, is issue of animal waste management. We provided the relevant scientific information, however the decisions taken were not based on that information. I'd also like to respond to Prof Pellizzi's question about the use of contractors on large farms, with reference also to the examples raised by Derek Sutton. For many decades, large combine harvesting in the United States has been done by contractors who move from the southern states up through the northern states as the season progresses – as the grain matures. This system has been in place for a very long time, so for decades it has been the contractors who have been purchasing harvesters, rather than the farmers. And in my opinion, contracting in the United States has seen a continual evolution, with very little external regulation: it's been done on a farmer to farmer basis, on a community basis, ranging from leasing to contracting of certain types of equipment, to an almost cooperative basis, to these large combine operations. So there is a great deal of diversity with very little organisation about it, but that is what makes it an extremely flexible system. When an individual or a small company sees a need, which they believe could he profitably met, they will make the investment or see about getting the financing and stepping in to fill that gap. The driving force of course is the economics: if it's not economically beneficial either for the individual farmer or the contractor it doesn't take place. There's really no government intervention at all. Me third comment I was going to make is directed more specifically at Prof Kutzbach: when you talked about new equipment in your presentation this morning you referred to conservation tillage as not being very widely adopted in Europe. It wasn't clear to me what the reasons for this were. But if we have time maybe you can address that.

Dr. Syed Ghazanfar ABBAS
New Zealand

As a Pakistani immigrant to New Zealand, I am actually in a position to comment on this issue from two different standpoints. In 1990 I did a paper on custom hiring systems of combine harvesters in Pakistan. And the conclusion of that report was that even the farmers who could afford to buy combine harvesters did not buy one, because they were better off hiring or renting the combine harvester The other point, which we were discussing over lunch, is that I think a comprehensive study is needed to produce recommendations as to when contractors should dispose of their combine harvesters or other big machines and replace them with new ones, to save on repairs and maintenance costs whilst improving the efficiency of the farmer with the new machine. Such a study, especially in developing agricultural systems, would on the one hand be very beneficial to machinery manufacturers, because contractors will want to replace their machines as soon as they realise that the new ones are more cost-effective for their organisation.

K.Th. RENIUS

I think the minimum tillage problem is very important. And for this reason we have put it on the agenda for next year, so we should not go into this subject too much now I have to add some comments on the subject of contractors. If we consider quality and economics, and this has been stressed in several comments, we must also include the pilot function of contractors with respect to the development of new big machinery. Such machines are usually produced in very small quantities, and the manufacturers are interested in getting information and feedback on their practical use as quickly as possible. So these con-tractors are highly valued by the manufacturers of large machinery. Some people are worried about it, but I think this can be seen as a positive aspect for the economic system as a whole.

Prof. Axel MUNACK
Germany

I too would like to comment on the question raised by Prof. Pellizzi. I think most of it has been answered by Dr. Auernhammer already, but I would like to point out that there is a specifically German problem at the moment, because the country is experiencing a period of transition. In fact, German reunification brought quite a lot of large tracts of land from the eastern part of Germany, and this has extended to the western part. In northern Germany at least, the farm size has been increased substantially since reunification, in order to retain competitiveness. In the sugar beet and wheat country of northern Germany we now have farm sizes of about 800 hectares, which was unthinkable ten years before. And now that farm size is increasing, farmers are getting bigger equipment. With respect to the contractors, we see a situation where big farmers offer their surplus machinery and labour time to small farmers. So they are the first contractors now available to the smaller farmers. Maybe, if the capacity continues to increase, there might he a tendency towards spin-off activities, i.e. just outsourcing machinery and labour services and then renting it again. 1 think this is a very transitional stage in Germany right now, and might not be applicable to other countries, but it is still interesting to know about.

Dr. Henry JIMENEZ
Colombia

I want to share some comments in relation to Prof. Pellizzi's question. There are two very different agricultural regions in Colombia, which are characterised by many differences in the types of contractor operations. One of them is the sugar cane sector which is mainly situated in the flat areas of Colombia. In this kind of agriculture we have farms between 100 and 500 hectares, and all those farms share machinery. That means that the sugar mill gets all the machinery and serves all the farmers. The other situation is related to the production of coffee, which is grown in the mountainous regions of Colombia. In this area, the average farm size is about 5 hectares, and it's a less mechanised agricultural sector. But recently, because of quality regulations, in order to resolve the contamination problems we have with this process, the farmers have been joining into cooperatives in order to share mechanisation and process their coffee production. So there are different situations in the flat sugarcane areas and in the mountainous coffee-growing regions.

Dr. Chak CHAKKAPHAK
Thailand

The situation in Thailand, is very much in line with what has been discussed in this meeting. Private contractors are the major contributors to our farm operations, both in wetland conditions such as rice growing or with upland crops such as maize, etc. This is simply because all the parties involved benefit. Manufacturers can sell the machines, the contractors themselves make a profit – business goes well – and also farmers pay less for farm operations. So this private contracting system works very

well. The only problem, which / think has been mentioned also earlier, is the quality of the work. Our case is probably similar to that of other developing countries, in that the quality is not very good. We have heard many complaints from farmers about the quality of ploughing. Sometimes at harvesting time the material doesn't arrive on time. Farmers do not have much choice in these cases, and the contractors always like to work very quickly to move on to other farms, other jobs. So this is a situation where such problems exist in practice, and it would be good to discuss this issue of the quality of contract work.

H. AUERNHAMMER

I would like to make some comments concerning the no-till question in Germany. I think there are two main reasons why we are behind other countries, for example compared to the US. One of them is crop toration. If you have in your crop rotation, let's say sugar beet or potatoes, you have to have two machinery lines. So this is one reason I think. And the other reason is the climate conditions. In a lot of our country we have the heaviest rainfalls during the harvest time: that leads to very heavy soil compaction, and a very rough surface. Under these conditions you need to use a plough, or similar equipment. So those are the two reasons. And I think in Germany – especially in the dry eastern regions – no-till operations are more widespread, but it is very rarely attempted in the other regions. Another trend which I have observed in our country is that, at this time, if a family farm is still ploughing then they use a very heavy tractor only for ploughing – they hire a heavy tractor for this purpose. And certainly this is related to quality So the primary soil preparation should be, also in the future, done by the farmer himself so he can control what he does. If he hires a tractor specifically for this task, he can do all the other work with smaller tractors. Let's say 100, 130 or 150 HP, not more. I think that the last thing which a German farmer would give to the contractor is fertilising and spraying. I believe these jobs also will continue to be done, during the next ten or fifteen years, by the farmer himself.

Y. KISHIDA

I'd like to add some comments about the Japanese experience. After the war, the first custom operations came through small-scale mechanisation. At that time, all farmers used animal-drawn or manual equipment. We started to introduce a small power tiller, and many farmers started doing custom operations for neighbouring farmers, to pay the machinery costs. That was the first type of custom operation in farming. After this, the government did some research and started a project to promote mechanisation with bigger tractors. But the bigger tractors had very high costs, and the government recommended the organisation of cooperatives for sharing one big tractor However, many Japanese farmers are very busy, and never want to waste their time, and sometimes they have to find an-other job, outside of agriculture. All this makes scheduling a major headache for co-operatives. After that, individual ownership of farm machinery in Japan became very popular One example is the rice combine: the government bought these big rice combines from Europe and gave subsidies to the cooperatives to use the big combines for sharing. The result is that now 99% of combine is individual ownership. And this trend is still increasing. The next policy which the government tried was a project called the machine hark They set up such organisations in many places. But now, less than 20% of these machine banks still exist. One of the biggest reasons is a shortage of good operators. As I have already mentioned we are now experiencing a big farm labour crisis, because the average age of farm workers is already above 60 years. And the government has been trying to reduce machinery costs – they still want to promote projects such as machine banks, but the results have not been very good. Last year, machine banks did jobs only on about 5% of the total acreage. One of the

most popular custom operations is drying: special rice drying. However, this rice drying operation has a problem. In fact, many rice farmers now want to get more added value, and that means they want to do direct marketing to the consumer, and they try to put their own name on their rice. But in the rice drying facility, many rites are mixed (with others of the same variety). Of course the cooperative provides a seed to the farmer. In many cases they want to control the variety of the rice. But the result is that when the farmer brings the rice to the drying facility, they mix it. And afterwards they don't know which is their rice. For example, consumers want organically-grown rice. Some farmers do this, and in this case they cannot bring the rice to such a facility. Then, some of the slightly larger rice farmers now are going to have their own facilities. The government wants to promote couse of the facilities, but the private sector — very progressive farmers — want to have their own facilities. Even in such low-acreage operations as we have in Japan, there is a great deal of confusion. The economists criticise the excessive use of machinery in Japanese farming, and say that you should always reduce machinery costs. However; I did a study on how much cost is required for our farming. For the thirty years between 1955 and 1985, I studied how much farmers paid for their machinery: the result was that in those thirty years of individual ownership of mechanisation, farmers paid about 12 trillion yen for machinery. At the same they produced agricultural products for a value of about 170 trillion yen. That means machinery costs are not so excessive in percentage terms.

P. ABEELS

I would like to comment on what has been said about the quality and performance of contractors. The question for evaluating the work of contractor operations is that we must have correct knowledge about quality. Of course, for harvested products the buyer is there, and he will fix all the data: the length, the thickness, the characteristics of the products. But for soil preparation, who will give me the proper, ideal soil profile for growing sugar beet, or corn? There is no data. So who is able to say whether the contractor did a good job or not? The farmer has the experience and, even if you teach at the university or technical level, you will have to ask the local farmer what is a good profile for his area: warm or cold soil, humid or dry soil, and so on. What's the granulometry. There are a lot of factors, and we need to engineer the questions.

Dr. David WHITE
UK

Listening to this discussion, it seems to me that much of the information that we have on the extent to which contractors are employed in various countries is actually very anecdotal. Now in the United Kingdom we have all the scenarios that people have put forward during the discussion: we have farmers who own their own equipment, we have contractors who do work for farmers, and then we also have farmers who own machinery on a cooperative basis. I'm not really in any position to add to the figures which have been given around the table, to give proportions of what is done by whom. And this is why I found figure 3 in Prof. Kutzbach's paper to be particularly interesting, and I would actually like to ask him if the information in figure 3 is based on a comprehensive survey of activities, or whether it is based on intelligent guesses of how the different activities are divided. Because I think that this is rather important. The farmer has to make a very difficult decision, that is to say whether to own his own equipment, go in cooperatively with other farmers, or use a contractor. And of course his decision must be based on the amount of risk that he is prepared to bear. This is particularly important in those countries where weather plays a very important factor both in tillage and harvesting. And of course this is something which a number of people around the table have in fact mentioned. And this is one reason why

I think that we do need more information. Now if there is good competition from contractors, i.e. the farmer has no difficulty in getting a contractor, then it is less of a problem. And that's the second question I'd like to put to Prof. Kutzbach: is the situation in Germany very competitive? But if it isn't then the farmer has some difficult decisions to make. And I'd like to put in a plea here for the use of all these simulation programs that people have been producing over the years, and perhaps remind you that two or three years ago here — and I'm sure the president will remember — we had some presentations from the United Kingdom, from Italy and from France on simulation programs that are able to give very good guidance on the way in which farmer should go about arranging his operations. Some of these simulations are very, very sophisticated. They can take into account things such as transport distances, which was again a question that we raised earlier: it was pointed out that in different operations, in different circumstances, you have very different transport distances. Also, some of these simulation programs are sufficiently clever to take into account weather. And weather is a statistical thing, it varies over a period of years, it affects the soil condition and when and how we carry out operations. For the farmer, it may he wrong for him to make a decision on whether or not to use contractors in a single year. He should hedge his bets over a number of years. And again, this is where simulation programs have great power, because they can tell the farmer whether or not it's a good idea for him to decide that for the next twenty years he will use contractors, rather than own machinery himself. This, I think, is the contribution that academics can make to this practical problem.

H.D. KUTZBACH

Figure 3 of my presentation is based on a survey conducted by a contractor's journal in Germany. So 1 am not sure whether it is real or not, but it is the result of this particular survey. And it can be compared to a previous study in which more or less the same figures were obtained. As to whether it's applicable to other European countries — I cannot answer that question.

D. WHITE

Can I just remind you of the competition aspect, which I think is important? I asked if the contractor situation was such that there is great competition, so that the farmer is able to choose and get a good service, because there are many contractors wanting to do the job.

H.D. KUTZBACH

You saw the figure of about 3,500 contractors. And we have about 500,000 farmers, so.... the figures speak for themselves.