CLUB OF BOLOGNA

PROCEEDINGS
OF THE

1st LATIN-AMERICAN MEETING

Fortaleza (Brazil), July 4, 2000

The future of mechanisation: trends and requirements for the Latin-American countries

11th MEETING *(Part 1)*

Bologna (Italy), November 19 – 20, 2000

New technologies and methods for the evaluation of the quality of perishable agricultural products for the fresh market

11th MEETING *(Part 2)*

Tsukuba (Japan), November 26 - 27, 2000

Ethical aspects in manufacturing agricultural machines

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During the year 2000 the Club of Bologna has for the first time organised and carried out three distinct meetings in so many different countries.

On July 4th in Fortaleza (Brazil) took place the first Latin-American meeting on the occasion of the annual congress of the Brazilian Society of Agricultural Engineering (CONBEA), to debate on: *The future of mechanisation: trends and requirements for the Latin-American countries.*

On November 19th – 20th, during the usual framework of EIMA in Bologna (Italy), was debated the first part of the XI° meeting, discussing on: *New technologies and methods for the evaluation of the quality of perishable agricultural products for the fresh market*

Finally, on November 26th – 27th in Tsukuba (Japan), on the occasion of the XIV CIGR World Congress, the second part of the XI° Club meeting discussed on: *Ethical aspects in manufacturing agricultural machines.*

This volume of Proceedings includes, on sequence, the Conclusions and Recommendations, the introductory Reports and the Discussions of all the three meetings.

1st LATIN-AMERICAN MEETING

Fortaleza (Brazil), July 4, 2000

Conclusions and Recommendations
Conclusioni e Raccomandazioni

Session

The future of mechanisation: trends and requirements for the Latin-American countries

Leading person: ***Irenilza De Alencar Nääs, Brazil***

Annex

Guidelines for the technology transfer in the Developing Countries

CONCLUSIONS
AND RECOMMENDATIONS

29 experts from **4 American countries** convened at the 1st Latin-American Meeting of the Club of Bologna, organized under the aegis of **CIGR**, during the **CONBEA 2000** – the National Congress of the Agricultural Engineering Brazilian Society - in order to examine and discuss the following topic:

The future of mechanization: trends and requirements for the Latin-American countries

This important topic, which has a great relevance for the growth of the whole South-American machines market, was discussed on the basis of the key-note reports by: **E. Chartuni Mantovani**, **I. De Alencar Nääs** e **P.R Hermmann** (*Brazil*), **A. Lara Lopez** (*Mexico*) and **J. Hilbert** (*Argentina*).

The three speakers have basically presented a general overwiev of their national agricultural situation, giving interesting data about the main productions and their trends, the farming types, the situation of mechanisation and its trend of development, the present problems and the possible interventions to make progress on the sector, with particular reference to the implications linked to the transfer of technology done by the developed countries. Particulary:

E. Chartuni Mantovani has underlined how the Brazilian agriculture – strongly dominated by the presence of small farms – needs now a day a big effort targeted to the creations of plans, basically linked to the educational sector. It must assured technical assistance and farms training so to reach – through the use of new advanced technologies - an economic competitiveness to satisfy the global market. In this way, we have to take into account the changes on crop production processes due to the increasing diffusion of the no-tillage technique and - as regards to the big farms - of the Precision Agriculture. As a consequence, to boost Governamental agricultural subsidy plans to reach proper mechanizational levels into small farms, as well as international co-operation programmes on the educational and professional training have to be considered with high priority.

A. Lara Lopez, on his part, has pointed out how the Mexican agricultural system is based on small farms, on the most part addressed to the cereals production. The first step is to reduce the production costs, increasing, in the mean time, the present mechanization level, paying attention to the soil tillage operations, so to support the introduction of low cost solutions as, for example, the no-tillage technique. Of a great relevance is also the progressive growth of local high-profit crops (cactus pear, chili, etc), for which it is necessary to define machines and tools to aid harvesting and handlying practices.

Last, **J. Hilbert -** represented at the meetinng by **I. De Alencar Nääs –** has highlighted how the present situation in Argentina is characterized by the presence of small and medium farms specialized in cereals and industrial crops, the big part of which are managed by the contractors. Consequently, the agricultural mechanization is marked by the use of an old tractor fleet while the implements market is growing day by day, especially for fertlizers and sprayers. Recently, contractors and big farms have started using Precision Agriculture in a limited way, because of the high investement costs and the problems tied up to the management. For this reason, it is necessary to join up economic subsidies and technical assistance for small farms with the employment of new suitable technologies choosen on the basis of their performances and their technical and economic benefits. All the three speakers and the participants to the discussion had wished for the future a more dynamic transfer of technologies both inside the Latin American countries and from the developed countries.

After wide-ranging discussion, the participants unanimously reached the following:

Conclusions and Recommendations

- **Underline** that the transfer of technologies is a complex and articulated process, for which it is necessary to consider and link together educational, social, institutional and commercial aspects as important components of the whole industrial collaboration.
- **Acknowledge** the importance of supporting the transfer of proper technologies for developing countries so to allow: yield increasing and cost reduction, avoiding, at any rate, negative impacts on the environment. It is necessary then to take into consideration that this process involved problems, aspects and goals deeply different and depending on the agricultural sector recipient if mostly based on small-medium farms rather than big farms, or contractors.
- **Recommend** that every effort be made to rapidly develop the farmer training, the testing and certification of new models, helping the introduction of new technologies supported by educational actions. All this has to be included in the whole activity of the manufacturers implicated in the technology transfer and co-ordinated by local educational structures (Universities, Technical schools) with the purpose to promote the professional growth and the technical training of farmers.
- **Underline** the need to promote - with the primary intervention of manufacturers – international projects of co-operations – financed by International Agencies – to emphasize the real profits rising from the use of new solutions and techniques.

Finally, the participants confirm the need to define the different components necessary to a correct transfer of technolgy process based on its nature and pecularities and the mutual influence. They **conclude** establihing that the "Club of Bologna" can become the optimal tool to carry out the analysis of the stages which constitute the technolgy transfer process of the agricultural mechanization sector. Particulary, a deep analysis of the "*industrial co-operation"* from the simple step of selling, till the more complex "joint-venture", has to be developed by a restricted group of experts belonging to the Club.

CONCLUSIONI
E RACCOMANDAZIONI

29 esperti provenienti da **4 Paesi del continente americano** hanno partecipato al 1° Meeting Latino-Americano del "Club of Bologna", organizzato sotto gli auspici della **CIGR** nell'ambito di **CONBEA 2000**, convegno nazionale della Società Brasiliana di Ingegneria Agraria, per esaminare e discutere il seguente tema:

Il futuro della meccanizzazione: necessità e prospettive per i Paesi dell'America Latina

L'argomento, avente importanti riflessi sul potenziale mercato di macchine agricole nell'intero Sud-America, è stato discusso sulla base delle relazioni introduttive di: **E. Chartuni Mantovani**, **I. de Alencar Nääs** e **P.R. Hermmann** (*Brasile*), **A. Lara-López** (*Messico*) e **J. Hilbert** (*Argentina*).

I tre relatori – autori di rapporti relativi ai Paesi di appartenenza - hanno sostanzialmente presentato una panoramica generale della situazione agricola nazionale, fornendo interessanti dati sulle principali produzioni e sul loro andamento storico, sull'organizzazione produttiva delle aziende, sullo stato della meccanizzazione e sul suo trend di sviluppo, sulle attuali problematiche e sui possibili interventi per il miglioramento del settore, con particolare riferimento alle interazioni connesse al trasferimento di tecnologie in atto da parte dei paesi industrializzati. In particolare:

E. Chartuni Mantovani ha messo in luce come l'agricoltura brasiliana - largamente dominata dalla presenza di piccole aziende – pur avendo registrato in questi ultimi anni un forte sviluppo, richieda ancora un forte impegno finalizzato alla attivazione di iniziative – prevalentemente da indirizzare nel settore dell'educazione. Esse devono essere mirate al sostegno tecnico delle aziende agricole sì da consentire - mediante l'applicazione di nuove e appropriate tecnologie - il raggiungimento di una competitività economica che soddisfi le richieste del mercato globale. In tal senso, vanno attentamente considerate e valutate le implicazioni e i cambiamenti dei processi produttivi indotti dalla crescente diffusione del no-tillage e, limitatamente alla aziende di grandi dimensioni, dell'agricoltura di precisione. Di conseguenza, risulta auspicabile il potenziamento degli interventi di sostegno economico per il raggiungimento di adeguati livelli di meccanizzazione nelle piccole aziende nonché dei programmi di cooperazione internazionale nel settore dell'educazione e della formazione professionale.

A. Lara-López, dal canto suo, ha evidenziato come il sistema agricolo messicano sia basato sulle piccole aziende prevalentemente dedicate alla produzione di cereali. L'obiettivo immediato del settore è quindi quello di ridurre i costi di produzione aumentando l'attuale livello di meccanizzazione e ponendo l'attenzione sulle fasi connesse alla lavorazione del terreno, favorendo l'introduzione di soluzioni di basso costo, quali la semina diretta. Di grande interesse si dimostra anche la progressiva incentivazione di colture tipiche (fico d'india, chili), di elevato valore economico per le quali, tuttavia, vanno definite appropriate soluzioni meccaniche atte ad agevolare le fasi colturali e di raccolta.

Infine, **J. Hilbert** - rappresentato al meeting da **I. de Alencar Nääs** - ha sottolineato, per quanto attiene l'Argentina, la prevalente articolazione attuale in aziende di piccola e media dimensione per la produzione di cereali e di oleaginose e il forte ruolo giocato del contoterzismo. La meccanizzazione agricola argentina risulta, peraltro, caratterizzata da un parco trattoristico obsoleto e da un mercato delle operatrici in fase di potenziamento, con particolare riferimento a quelle destinate alle cure colturali. Recentemente presso i contoterzisti e nelle aziende di grandi dimensioni – che mostrano un trend di espansione – sta trovando crescente applicazione anche l'agricoltura di precisione; essa, tuttavia, risulta penalizzata sia dalla necessità di cospicui investimenti, sia dalle difficoltà operative e gestionali che le sono proprie. Ne deriva che, accanto alle iniziative di sostegno economico e di assistenza tecnica in favore delle

piccole aziende, va incrementata l'applicazione di nuove tecnologie appropriate e valutate in termini di prestazionali e di convenienza tecnica ed economica. Tutti e tre i relatori, infine, oltre che i partecipanti alla discussione, hanno auspicato lo sviluppo si un più attivo trasferimento tecnologico, sia all'interno dei Paesi dell'America Latina, sia da Paesi industrializzati.

Dopo un'ampia e approfondita discussione, i partecipanti hanno unanimemente raggiunto le seguenti:

Conclusioni e Raccomandazioni

- **Riconoscono** che il trasferimento di tecnologia è un processo assai complesso ed articolato, nel quale la "collaborazione industriale" costituisce solo uno dei componenti; è, pertanto, necessario considerare e integrare aspetti educativi, sociali, istituzionali e commerciali. La collaborazione industriale può assumere una varietà di forme, dalle più semplici alle più complesse e va analizzata ed applicata secondo modalità diverse per ciascun caso.
- **Evidenziano** l'importanza di favorire il trasferimento di tecnologie appropriate e rispondenti nei Paesi emergenti in modo da consentire l'aumento delle produzioni, la diminuzione dei costi evitando, tuttavia, impatti negativi sull'ambiente. Occorre, poi, considerare che tale processo interessa problematiche, aspetti e obiettivi anche profondamente diversi a seconda che il settore agricolo beneficiario sia prevalentemente strutturato in piccole-medie aziende piuttosto che in aziende agricole di grandi dimensioni ovvero sia organizzato sulla base di imprese agro-meccaniche.
- **Raccomandano** che venga compiuto ogni sforzo atto a sviluppare la formazione degli agricoltori e la certificazione delle nuove macchine, facilitando così l'introduzione di nuove tecnologie che vengano supportate da adeguate e parallele azioni educative - sostenute dagli stessi Costruttori coinvolti nel trasferimento tecnologico e coordinate dalle strutture educative locali (Università, scuole professionali) – finalizzate alla promozione della crescita professionale e della formazione tecnica degli agricoltori.
- **Sottolineano**, infine, l'esigenza di promuovere - con il diretto coinvolgimento dei Costruttori - progetti coordinati di ricerca internazionale – opportunamente finanziati da Agenzie sovranazionali - che evidenzino nelle diverse realtà operative i reali vantaggi derivanti dall'applicazione di nuove soluzioni e tecniche rispetto a quelle in uso.

I partecipanti, infine, nel riconoscere la necessità che vengano individuati tutti le diverse *componenti* che concorrono alla realizzazione di un corretto trasferimento di tecnologie, definendone la natura, le caratteristiche e l'influenza reciproca, **concludono** individuando nel "Club of Bologna" lo strumento ottimale per effettuare questa analisi dettagliata delle fasi che compongono il trasferimento tecnologico nel settore della meccanica e meccanizzazione agricola. Tale analisi, in particolare, dovrà tendere ad approfondire la componente "*collaborazione industriale*" in tutte le sue diverse forme di realizzazione, da quella della semplice "vendita", fino ad arrivare alla più complessa forma di vera e propria "joint-venture".

OPENING SESSION

WELCOME ADDRESSES

Renato S. DA FROTA RIBERIRO
President of CONBEA 2000 - BRAZIL
Ladies and Gentlemen, as a President of CONBEA 2000, I am pleased to welcome everybody, full members and invited people, to this first Club of Bologna Latin American meeting. Unfortunately Prof. Pellizzi - due to private problems - was not able to be here with us today. Now I want to ask to Prof. Irenilza de Alencar Nääs, who chairs this meeting, to make a short speech and to officially open the session.

Irenilza DE ALENCAR NÄÄS
Leading person - BRAZIL
Good morning dear Colleagues, I would like to welcome the Club of Bologna full members as well as the invited members for this first Latin-American meeting. As Prof. Ribeiro said before, Prof. Pellizzi due to health problems in his family was not able to be here at this time, and kindly pointed Dr. Pagani to represent him. By the way we have here at the table, Dr. Fiala at my right side, Executive Secretary of the Club of Bologna and Dr. Pagani a full member of the Club. So at this moment I invite Dr. Pagani to address the audience.

Antonio PAGANI
ITALY
Mrs. President, Ladies and Gentlemen, dear Colleagues, I am very pleased and honoured to present to each of you, on behalf of our President Prof. Pellizzi, my welcome to the 1st Latin-American meeting held in Fortaleza, in the occasion of the Congress of the Brazilian Association of Agricultural Engineers. With my welcome, let me express my deep thanks to the local organisers that have accepted to host the meeting and, particularly, to your President, Prof. Irenilza De Alencar Nääs, who has been very active in contributing to the organisation of this meeting in this lovely town of Fortaleza. This is an experience, organised for the first time that we have realised hoping to offer a better knowledge, and then a higher appraisal of the Club's activities. The Club, during its 11 first years, has been particularly improved and reinforced achieving the double goals: contribute to a rational development of mechanisation at world-wide level; establish a really international group of friends and colleagues open to grow together for discussing, in planetary terms, of the national developments of agricultural mechanisation in the view of the realisation of the global market involving agricultural machines and the agricultural engineering sciences as well. All this is merit of the UNACOMA's - the Union of Italian Manufacturers of Tractors and Agricultural Machines - far-sightedness. It has not saved any strength for the success of this initiative that counts nowadays more than 75 full members belonging to 40 countries of the 5 continents, in addition to the representatives of the main International Organisations as FAO, ADB - Asian Developing Bank -, AIT, CIGR, etc. Let me thank a lot UNACOMA, wishing that also in the future it will continue to support our efforts. The subject that we will debate in this day-session has been already considered last year. During the 10th meeting, in fact, we discussed the same topic with particular reference to the situation of three big Asian and Far East countries: China, India and South Korea, and we learnt a lot. I think that examining today the same problem as far as three Latin-American countries could complete the picture, offering us a detailed and articulated evaluation and giving us the possibility to draw some general conclusions to be submitted, for consideration, to the national firms interested in solving the transfer of technology problem around the world. This is the reason for which I should suggest to unit the reports presented in the two sessions, editing a unique volume able to offer appropriate guidelines for this broad topic. For the moment, I renewed thanks to Prof. De Alencar Nääs and to her staff: to you the best wishes of a fruitful day and of a pleasant stay in Fortaleza.

SESSION

The future of mechanisation: trends and requirements for the Latin-American countries

Leading person: ***Irenilza De Alencar Nääs, Brazil***

THE FUTURE OF MECHANIZATION: TRENDS AND REQUIREMENTS FOR THE LATIN-AMERICAN COUNTRIES: BRAZIL CASE.

by ***Evandro Chartuni Mantovani, Irenilza de Alencar Nääs*** *and* ***Paulo Renato Hermmann***
Brazil

1. Introduction

Brazil has a large territory of 8,511,965 km^2 representing 20.8% of the American Continent as well as 47.0% of Latin America. Around 93% of the Brazilian territory has altitude lower than 900 m. Over 41% is flat land, 58.5% are altiplans, being only less than 0.5% in mountains. Brazilian climate is mainly tropical, being partially equatorial, semi-arid and subtropical. The annual average temperature is 22 ^{o}C, and the average annual rain precipitation is of 1,300 mm.

The total population is 165,650,000 inhabitants, with a population density of 19 inhabitants per square kilometer, being around 76% in the urban areas. The population living in the Southern region of the country represents 45% of the total.

Brazil's economical activities has grown in the last ten years. In 1980 gross GNP represented US$ 173,153 millions and increased 3.5 times throughout the period in 1998 to 775.7 US$ million. Total South America gross domestic product represents the amount of 1,316.6 US$ million while Brazilian economy contributes with around 60% [4].

Dividing it by the sectors, the GNP in 1970 stated 11.55% for agriculture, 35.84% for industrial activities, and 52.61% for services. In 1980, the percentage of the GNP represented by the agricultural sector decreased to 10.2% while the percentage in the industrial activities increased to 40.58% and the services decreased to 49.22%, showing a slightly change in the country's economic profile.

In 1998 the final figures were state such as agriculture representing 6.84% of the GNP, industries 38.43% and services 54.80%, showing a small increase on the industrial business towards a large decrease in the agricultural activities, [7].

Brazil is divided in 5 large geopolitical regions, each one with different ecological, social economic and infrastructure characteristics and therefore, with different conditions for agricultural production and adoptions of technology **Figure 1** shows the Brazilian regions.

Each region has its specific agricultural production mainly related to soil, topographic and climatic characteristics. For instance Southern Brazilian agriculture is based upon a farm structure of medium to small size farms up to 10 ha, run by family member and dedicated to both agricultural and animal production.

In the Southern region the industrial production of both swine and poultry started twenty years ago and it was based on the use of intensive technology, as well as the partnership relation between large slaughter industry and producers. This partnership structure so called integration was a successful business investment that strongly reflected on the social development of this region. The need to supply grain for the animal industry led producers to increase yield not only in the region but investing in new frontier in the Center-West. **Figure 2** shows the relation between Brazilian new agriculture frontier named cerrados, and the European countries.

Southeastern region produces mainly coffee beans and sugarcane, and the dairy production is also important, representing around 50% of the total Brazilian production. The region characteristic is the intensive industrial processing of the agricultural production concentrating also labor employment at farm level.

In the Northern region is located most of the Amazon rain forest and the agricultural production is mainly of subsistent, even

though there are changes in some areas where beef cattle has been introduced as well as soybean, corn and bean crops.

With dry and hot climate, the Northeast of Brazil has been developing tropical fruits crops in areas where irrigation is available, such as melon, grape, pineapple and cashew. This area is know as an user of intensive familiar agriculture as well as in some sub regions, irrigated corn and soybean has been grown with success. With large cultivated area, the States of Pernambuco and Alagoas have a significant sugarcane production.

As shown above, many regions in Brazil are in process of agricultural development and expansion of agricultural lands, but one of the great concerns of Brazilian Government is the agricultural use of 127 million hectares of the land with agricultural potential in the so-called cerrados. These lands extends over part of Center-West, Northern, Northeastern and Southeastern regions of Brazil (**Figure 2**). That area relates to one of the fewest available land in the world for increasing food production by the increase in cultivated land. The current annual agricultural production of cerrados corresponds to 25% of the Brazilian production, which can be considered very important for the economy.

Mostly in the Southern and Southeastern regions, occupied by European immigrants still survive in hilly and stony soils. They farm corn, dry beans and other alternative crops and use mainly intensive human and animal labor. Farmers still maintain in their small communities cultural aspects brought by their ancestors. This is also reality in some places of Northeastern small farms.

With the exception of citrus crops and melon production, fruit production represent a large percentage of familiar agriculture all over the country. Peach, grape and apple are produced in the South, while mango and kiwi and other tropical fruits are produced in the other regions. The Northern is a large producer of cashew and the agricultural business of export of cashew nut plays an important role in absorbing rural labor.

2. Agricultural Production

Brazilian agriculture represented a large amount of the GNP throughout the years. In 1950, when the Brazilian industrialization started to take place, the total population was approximately 51 millions inhabitants, 65% living in rural areas. At that time it was known that 2,064,642 rural properties were legalized amounting around 232 millions of hectares, however only 19.1 millions hectares were cultivated. For that cultivated land there were 8,372 tractors, what gives a relation of approximately 2,280 hectares per tractor, [9].

In 1990 the total population was around 150 million inhabitants in urban areas while 35 million people living in farms. There were 6 million of rural enterprises of 380 million hectares, where 60 million farmed land have approximately 750,000 tractors relating around 80 hectares per tractor. In 1996, according to [3], the regions of Center West, Southeast and South of Brazil already had urbanization index equal to or higher in comparison to the US ones. Today over 77% of Brazilian population is living in the cities. Northern region had 12.5% of the total rural population while the Northeast had 45.7%. This region maintains 15.6 million people living in rural areas. The second larger rural population is located in the Southeast adding up to 7.3 million inhabitants. **Table 1** summarizes data on rural and urban population in Brazil by regions.

2.1. Brazilian crop and animal production

According to [10] total Brazilian production of grains reached 82.5 million tons in 1999, increasing 9.83% when comparing to 1998 production. The regions Southeast, South and Center West which participate with 90% of the total presented an increase of 7.18, while the regions North and Northeast, reflecting 10% of national production, increased around 44%. **Table 2** summarizes the total Brazilian grain production in 1999.

Table 3 as cited in [10] shows the evolution in the main production in 1999 and 2000, as well as the export values.

The estimate of the considered crop production is 28.33 million hectares, value

below 0.7% than the total crop area of 1999. Comparing with the harvested area (28.29 million ha) the planted crop area represents an increase of 0.15%, as seen in **Figure 3** and **4**, [10].

In 1990 Brazil exported US$ 3,744 million of sugar, US$ 10,996 million of raw coffee and around US$ 1,644 million of soybeans. Even though fluctuations on the external market involving the orange prices influences the national production, this is the sector that developed most in the past years. In 1990 the exports of orange juice was of US$ 6,180 million [9].

In other hand, Brazil imports some of the fertilizers consumed in the agricultural production. The last five years the percentage of production *versus* consumption increased, representing a deficit of 5.1% of nitrogen, 3.2% of phosphate and 8.8% of potassium, which was supplied by imports.

Agricultural land is widely distributed in unit area. Several factors like occupation policies, such as European immigration in the 19th and early 20th century, soil fertility, geographical location, major crops and market in each area, as well as labor cost dictates it. However the pressure today is more about ending the small agricultural business which lies compressed, at least in some transition areas, between the *modern* and *old fashion* agricultural trends.

The conflict between this trends is evident in some crops activities. A small farmer with up to 50 ha farming corn and dry beans, just feasible in a mechanized system, hardly survives in an economy that is in transition to the so called *developed world.* A crop like soybean is not competitive without mechanization, at least for harvesting operation. Few projects have been tried to adjust low scale mechanization system for small producers without success.

The animal production area increased significantly over the last ten years. Swine processed meat went from 980,000 tons in 1980 to 1.12 million in 1990. Beef cattle production increased from 2.115 million tons to 2.666 million in the same period. The poultry production had the highest increase, growing from a production of 1.306 million tons in 1980 up to 2.247 million tons in 1990. This sector developed significantly in terms of housing and equipments. Although the cow herd is large, milk production is low and the increase in production in the last ten years did not meet the country needs. In 1980 the production was 11,300 million tons, while in 1990 the total country production was 13,000 million tons [11].

Regarding the world's meat consumption which animal protein is the main source, according to [5] the summary: 44% are pork, 29% are beef, 23% are poultry and 4% are represented by others. In Brazil beef represents 52% of the total meat consumption, poultry 34% and the pork consumption is only 15%.

The success in Brazilian poultry and swine production is linked to variables such as economical feasibility, specialized labor force, productive and reproductive swine characteristics and adequate management [7]. Each one has its own importance and it needs to be evaluated in an interdisciplinary way. This labor intensive activity mainly in the South and Southeastern regions is in the hands of Europeans immigrants descendent families. They are efficient in growing swine and poultry associated to integration systems. With the grain production moving towards the Center-West region, this kind of farming activity is condemned to disappear soon.

The use of equipment for animal production is mainly divided into three segments: industry of animal feeding and processing; environmental and climatization and meat or dairy processing [11].

Brazilian dairy and meat industry is based up on three different segments: cooperatives, integration and independent producers. The integration is a production system where the producer is interactive with the industry demand. It involves two stages: first the main sector provides the animal or bird reproduction with the newly born production, and the second is related to the growing and finishing both pigs and broilers.

The evolution of mechanization of animal production operation, such as feeding, handling and environmental control is shown in **Figure 5**. It is clear that broiler production is the most mechanized activity while swine and dairy production still has room to apply some mechanized operations.

3. Overview of Brazilian agricultural mechanization

Brazilian population in average tripled in the last 40 years, becoming almost constant in the rural areas and increasing eight times in the cities, while the cultivated land also tripled. There was an increase in the Brazilian potential of mechanization in the agricultural land, specially based upon the migration of rural labor force to urban areas. In an overall view, Brazilian labor force in agriculture is very significant representing 60%, while animal traction is 31% and mechanized agriculture is only 14%. Southern and Southeastern of Brazil detains around 28% of the mechanized land. **Table 4** shows the evolution of the country land with agricultural potential, indicating the growth in the agricultural production indexes relating to the intensive use of mechanization, proportional to the labor force migration from rural areas, [8].

From 1970 to 1995 the land with agricultural potential increased in 47% while the total number of tractors increased eight times, in other words, the mechanized area in hectares by tractor decreased from 410 to 95 ha/tractor.

In animal production, specially in poultry production, most operation has been mechanized lately. Equipments for feeding preparation and distribution processes, as well as lot management control has been adopted. Around 10% of the milk production is also mechanized existing an enormous potential for the use of adequate equipments in this area.

3.1. Mechanization - Current Situation

Since the 50's overall industrial production of equipment in Brazil has increased. However in the last five years wheel tractor production decreased almost 30%. Annual growth in tractor use in rural land was significant in the 60's of around 60%, while in the 70's the real growth was 19%. From 1980 to 85 the increase was only 4%.

The cost of equipment allied to unstable economy problems in the country and the cut in subsidies in late years, made it very difficult for farmers to invest in purchasing of new products. In the other hand, the process of elimination of small farming units due to the lack of economical power for purchasing new technology is proportional to the industrial and urban expansion. The urban employment is a factor that may regulate this. However, the whole process is not properly managed by governmental policies leading to high unemployment rates and consequent crisis and social conflicts.

In other areas where crops like sugarcane dominates, the small farm units are already gone or rented. Without capital for investment in updated machinery is nearly impossible for small farmers to remain in business, and this has already caused a major process of land ownership concentration.

In crops such as coffee, mechanization has not been yet the interfering factor in the change in land distribution. However the harvesting technology for both coffee and sugarcane production is in a large expansion process. This means that a large amount of labor force that has being employed in fields will soon be dismissed, adding up to the already large rate of urban unemployment. In the other hand, due to environmental enforcement laws the burning of sugarcane prior to harvest has been restricted and, the only option is replacing the human labor force by machine harvesters.

Agricultural machinery in Brazil is mainly own by either the farmer or cooperatives so that the contractors do not have an important role in the agricultural business as in other countries.

The timing for plowing in the “cerrados” area is short for the conventional system. In order to plant in this large area within the right schedule the conventional system does not apply efficiently, leading to losses in quality

and soil management. This difficulties related to a lack of horsepower resulted in the preferential use of non-tillage technology by the farmers during the short rain period. In the last three years, more than 3 million of hectares of lands were added to this crop production system.

governmental actions during the last few years have significantly turned Brazilian economy more flexible and opened. The privatization of some sectors such as energy, communications, and transportation changed the overall picture of business ownership and brought foreign capital to the internal market. However, at the same time the international market was open and the agricultural industry has been affected by the new policies.

For years the locals agricultural machinery products did not show important technological changes and was represented by simple and inexpensive tractors. The imported technology is more sophisticated and high powered tractors have being introduced mainly in the large crop areas.

From 1970 to 1998 the total number of tractors available in the country showed a growth of almost 300%, and in 1998 the estimated total number of tractors being used in the rural areas were of 460 thousand. Brazilian industry has a capacity to produce for internal consumption as well as to export and Brazil's export of tractors and equipments in 1998 represented a total of US$ 740 million, while import added US$ 705 million. **Figure 6** shows the industrial activities evolution from 1960 to 1998.

Table 5 shows the mechanization in farming worldwide, giving an idea of the tractors and combines proportion amount spread all over the world and its contribution on the arable area and harvesting. Comparing the world to farming mechanization related to arable area per tractor and harvesting per combine among all continents, it can be seen that Africa and Oceania has, respectively, 5.8 and 2.5 times the arable area per tractor, and 12 and 2.6 times the area harvesting per combine, respectively. The South America index has a very close number to Oceania, with 2.45 times. Even though the South America number is apart from the ideal situation, when considering the most developed parts of the continent, such as Brazilian Southern and Center-Western regions and Argentina, the tendency is to bring the values very close to the ones shown from developed countries.

In Brazil towards the subject discussed above, the numbers for arable area/tractor and area harvesting/combine on **Table 5**, the mechanization farming are considerable high comparing to the others countries, and the country's potential is able to improve these coefficients, [7].

Table 6 shows Brazilian Agriculture Machinery Production for 1998 and 1999. These results indicates the country's actual agricultural machinery production. The data however don't reflect the potential capacity of the country to commercialize these equipments on the agricultural production area; but, instead, a recession problem due to the farmers economical difficulties (high interest rates) to purchase equipment. This can be seen on the **Figure 6**, where the production level during 6 years, from 1974 to 1979, was above 60,000 units, reaching a peak of 81 thousand equipments on the year 1976, being that only part of it commercialized in the internal market.

On chart 1 and 2 in **Figure 6** the production and domestic sales are almost the same, decreasing each following year the amount of machinery produced for agriculture use. As the domestic sales are low the exports numbers show a considerable contrast as the country's need and the amount of exceeding product been export, on chart 3.

This means that an urgent and stable economical plan to support agricultural production needs to be designed and implemented by the Government in order to give the farmers a chance to improve today's situation. The lack of such initiative will lead the country to maintain the same mechanization index, which is below the required index in a competitive agriculture.

In the last five years the Government has been reducing significantly subsidies for agricultural production which is nearly none

nowadays. The exception is still the sugarcane industry that supports the countries energy plan for the use as renewable source of fuel.

The increase and distribution of tractors by geographic regions from 1970 to 1999 is shown in **Table 7**. Despite the countries' economical problems the decades of 70 and 80 were mainly devoted for growing and land expansion, while the late social movements and increase in unemployment are the results of the globalization of economy as well as the impoverishment of small farmers.

From 1970 to 1975, the mechanization level of Brazil (ha/wheel tractors) improved 57%, and 35% from 1975 to 1980, as we can see on **Table 8**. The data also show a non-growth period from 1980 to 1990, and a 17% decrease up to now, with a mechanization level of 116 ha/wheel tractor, in 1998. Comparing these numbers it can be seen that even though improving the existing problems the country index are far away from the developed countries' results that have large production areas, such as Brazil.

Several investments were made in order to increase the use of tractors in Brazil, however the lack of real agricultural governmental subsidies make it very difficult for the small farmer to invest in infrastructure. The size of the country as well as the bad distribution of land with agricultural potential in some regions make the concentration of large farms in frontier lands where there are concentrated problems of storage and distribution for market.

The implement industry was also affected by the same crisis that merged the tractor market. Lately this industry has been involved in a direction change through no-tillage planters production, and that is strongly pushing the prices up mainly for industry that has a good no-tillage planter to offer the market. A well designed product has been associated with air seed meters and that has been possible by joint ventures with foreign companies that provide such technology.

Precision agriculture is also a technological change being introduced in the country leading to new ideas and opening a large area for consulting in the areas of knowledge related to: data acquisition, analysis and decision making based upon spatial variability of the land.

4. Technological support for agriculture: Universities, National Agricultural Research Centres and Private sector

One evidence of the globalization in agricultural production is that underdeveloped countries will be even more technologically dependent from developed ones. The so called modern agriculture has a strong technological background invested on it and the countries must purchase both equipment and technology to compete with those selling it. The direct result on farmers is the bias of producing at lower costs to compete in the international market or getting out of business.

The emergence of a global economy has resulted in new competitors and new opportunities for mainly developed countries companies and workers. Today, for instance, the industrialized nations, such as Germany and Japan, Italy and United States face fierce competition from both advanced, as well as from newly industrializing nations, such as China, South Korea, and Indonesia. At the same time, new markets are emerging as trade barriers fall and millions of people are lifted out of poverty. 1nternational accords, such as GATT and NAFTA, are fostering competition, opening new markets and expanding existing ones, and bringing consumers more choices and higher quality at lower costs.

As competitors new and old, seek to capture market-share in this new global economy, the pace of technological advance continues to accelerate as companies seek to gain a competitive advantage and to meet the increasingly high expectations of the world's consumers. Today technological leadership often means the differences between success and failure in the global marketplace-for companies and countries alike.

Nations around the world are planning to boost their national science and technology

investments, some astronomically [15], while the underdeveloped ones are barely living above poverty line.

The investments in R&D in Brazil for agricultural development are mainly distributed in the chain of educational system as well as in research institutes and the EMBRAPA Centers. In an overall figure the numbers barely average up to 0.2% of the total GNP. **Figure 7** summarizes the investments in R&D showing the resources available at the Ministry of Science and Technology as well as at the CNPq – National Council for Research and Development for all areas of knowledge [3].

Another source of funding R&D in Brazil are through the State Foundations. Those institutions linked to the Secretary of Science and Technology of the Federation states has a role of implementing actions towards funding projects at the researcher level or institutional. The state foundations are supported by a percentage of the taxes paid in each country' state and is legislated by state laws. The wealthier states certainly have more available funds for investment than the poor ones.

Unfortunately the scenario of Brazilian actual investment in R&D is very limited, considering the trained personnel available all over the country.

Even though the industrial sector in Brazil is established as multinational investment most of the agricultural machinery sold in the country is designed overseas. Up to the early 80's the machinery commercialized in Brazil was submitted to testing for efficiency following standards and normalization rules established by ABNT, Brazilian Association of Technical Norms and Standards. A Center for Agricultural Engineering was created during this time, under the administration of the Ministry of Agriculture with the mission for testing agricultural machinery

It is in the training at formal academic level, specially in graduate courses, that international cooperation mostly occurs. This tendency appears to be compatible to the nature of the educational activities where curriculum and courses are directed to themes where professional regulation is required. Motivation and personal relationships are still the main factor associated to cooperation rather than institutional initiatives. Even though the Ministry of Education had a cooperation program with few Land Grant Universities in the USA in the 70's, that particular action was the only one known in the field of agricultural formal training. It is also found that, although pointed as a main problem for cooperation for formal training abroad, the lack of interest in the subject leads to difficulties in establishing priorities in Governmental sectors. So, historically the tendency is that the government supports the training mainly at doctoral level, specially in areas of knowledge that the country either does not have formal courses or there is not competence in developing a research project.

The Southeastern region detains in average, nearly 80% of the graduates students, and 92% of the doctoral students at the Agricultural Sciences courses. The formal training abroad has also large number for students originated in this region.

Even though the main goal is to have only doctors teaching at graduate degree courses, still instructors with Master's degree are admitted. As it can be seen in **Table 10**, 96% of the instructors involved in graduate degree courses are doctors.

This data is related to research work in mechanized agriculture and its interaction with crop science, food science, food engineering, mechanical engineering and others course work related to the food chain production.

Institutions such as EMBRAPA - National Agency for Research in Agriculture, allied to Universities - and other Research Institutes work together towards the development of research projects and training of people in a national program of Agriculture Engineering that includes areas such as mechanization, storage and processing, energy and construction.

EMBRAPA is a governmental company, linked to the Ministry of Agriculture and

Food Supply, with private corporation characteristics [1]. It is involved with research in all agricultural products which is part of the Brazilian meals. EMBRAPA's goal is to provide feasible solutions for the sustainable development of the Brazilian agribusiness by generating, adapting and transferring knowledge and technology that benefits the Brazilian Society.

From 1973, EMBRAPA has generated and recommended more than nine thousand technologies for Brazilian sustainable agriculture, increasing food supply and reducing imports dependence on technologies, basic products and genetic materials.

Networking through 37 research units, two services and 15 central units, EMBRAPA is present in almost all the states of the country (**Figure 8**). There are 2063 researchers 52% with master's degree and 43% with doctoral degree. Embrapa coordinates the National Agricultural Research System in cooperation other national and international institutions. Projects in International cooperation are carried out in order to share knowledge and technology with other countries.

With a development approach, EMBRAPA's planning system process involves the generation of knowledge and technology and consequent products, processes and services characterized as innovations, and directly incorporated into the productive process. This approach has resulted in a model based upon actual customers demands, attending the identified agribusiness needs. The support chain for this system is mainly based on incentive to multidisciplinary projects, and on inter - institutional partnerships and funding [1].

In the field of R&D most well trained professionals in the research system in both EMBRAPA and the universities, formed groups that have reached a high level in the mainstream of their specific fields of knowledge, and prefer to cooperate with groups in developed countries in specific research networks, following up an international tendency of using the communication facilities to interact. However there is a need to identify the specific need of the country in technological cooperation, and both incentive and fund institutional initiatives.

The private sector has also an important role in transferring technology. Most multinational corporations have their design departments in their original countries with engineering concepts sometimes unadapted to Brazilian needs and demand. It is not uncommon to find that machinery work research are carried on at certain testing condition, both in research institution fields and in commercial crops, while management, maintenance and its overall use are adapted to some specific condition. This process usually takes time and investment and is mainly funded by the companies themselves [1].

5. Conclusions

Brazilian agricultural mechanization increased in the last years despite the fact that there were low investment rates. The expansion of the no-tillage area is dictating a big change in the machinery and implement Brazilian industry.

The country developed an infrastructure capable of supporting the agricultural machinery market demand. The level of research and technology development for different regions as well as the distinct environment was met for most cases. There is an installed chain of trained professionals able of responding to an emerging demand in agricultural products in both research and educational systems. However international cooperation is still needed in the areas of knowledge related to precision agriculture specially in data acquisition and decision making.

Brazil has a strong agricultural potential and it has been shown on the data regarding the land with agricultural potential increase in the last 10 years. This can also be seen in the percentage of agricultural products in the last GNP results. The country can also harvest 3 times in 2 agricultural years, due to climatic characteristics, advantage not found anywhere else in the world. Brazilian agriculture regarding products such as soybean, coffee,

corn, sugarcane, citrus, poultry, and swine are highly competitive on the international market. However the lack of an economical plan for supporting small farmers has led to farm and urban unemployment, and the consequent concentration of land ownership. Some investment in sustainable agricultural for small farmers needs to be implemented.

The trends lead to the new agricultural frontier; in the Cerrados area, in the Center West region, in terms of expansion of land with agricultural potential, and the use of precision farm in large cultivated land in order to reduce production costs. This is one of the fewest places in the world where it is shown increase in cultivated land associated to the increase of grain productivity. It is also an area of intensive use of no-tillage technology

Brazilian agricultural industry showed a significant capability of producing for internal consumption as well as to export. However the economical uncertainties, as well as the lack of governmental subsidies, lead the farmer to reduce investments or even to go out of farming business. It is necessary to apply in an economical and strategic plan in order to reduce the gap between development of the agricultural sector and its potential, without loosing the focus on the social problems brought up by the land concentration due to the occurring crush of small and subsistence farming.

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Figure 1 - Geographical regions of Brazil [2]

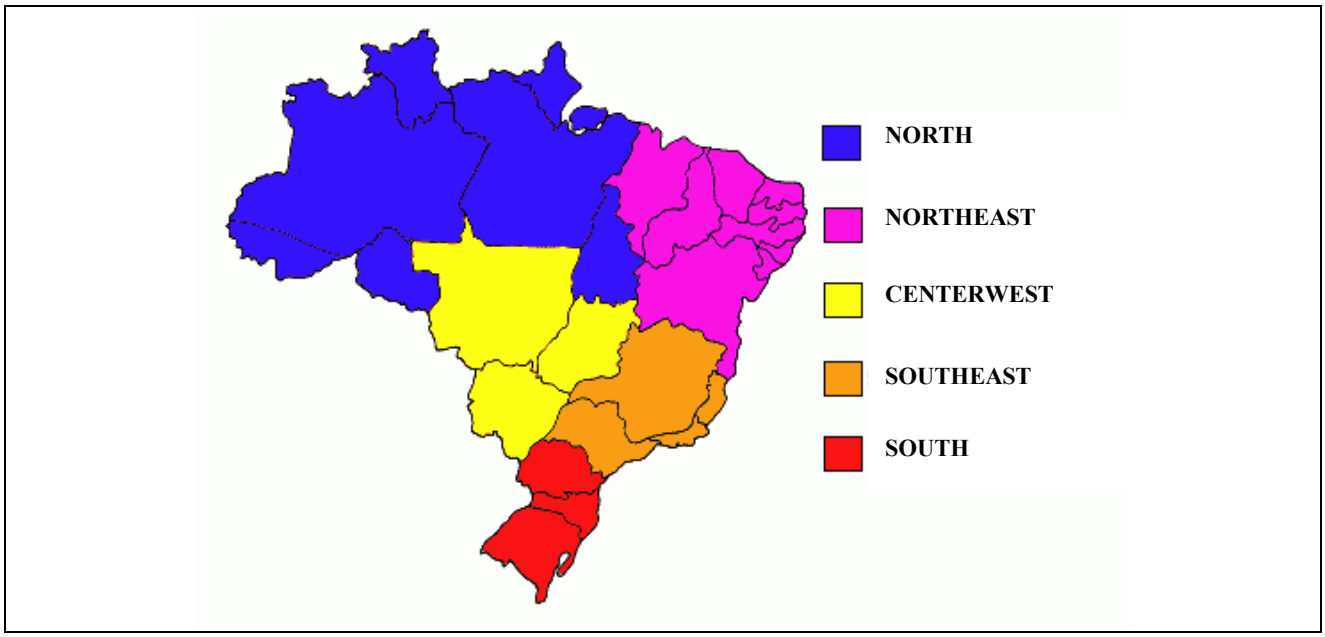


Figure 2 - Brazilian map containing the Western European countries inside the "cerrados" area

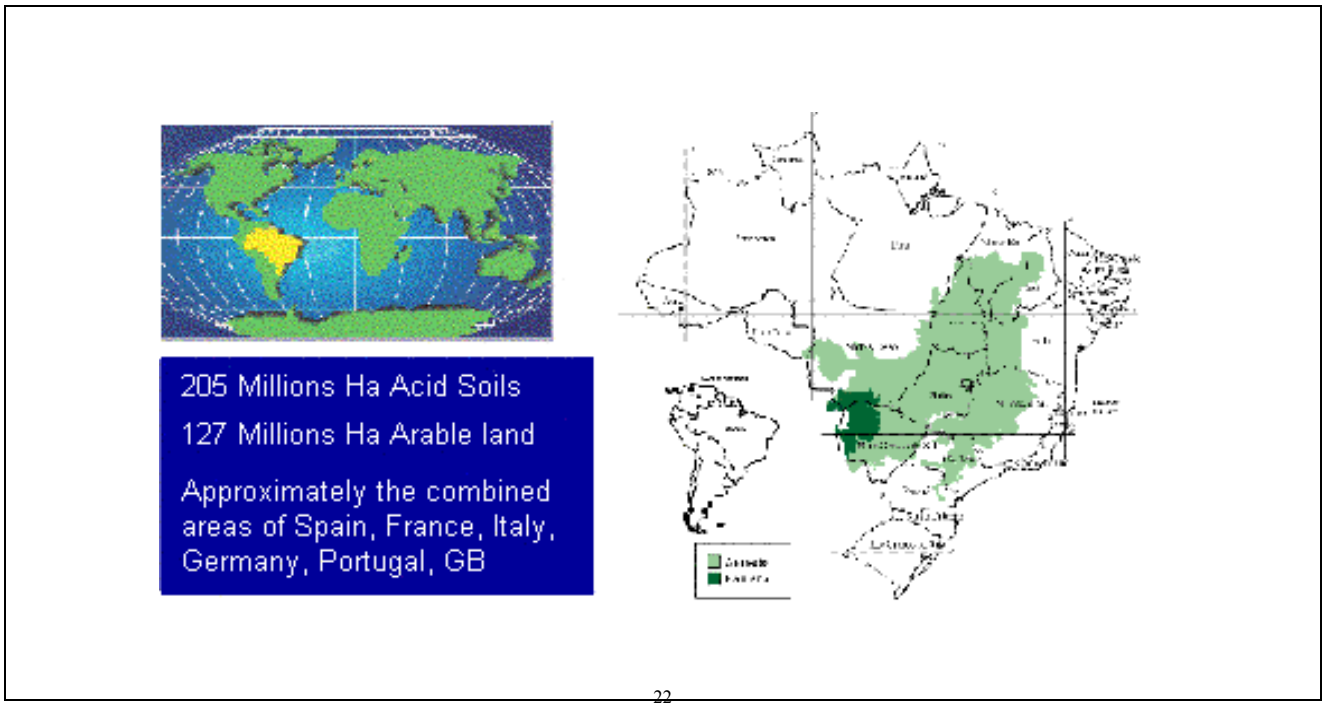


Figure 3 - Crop area and cereals production evolution in Brazil (1980-1999) [10]

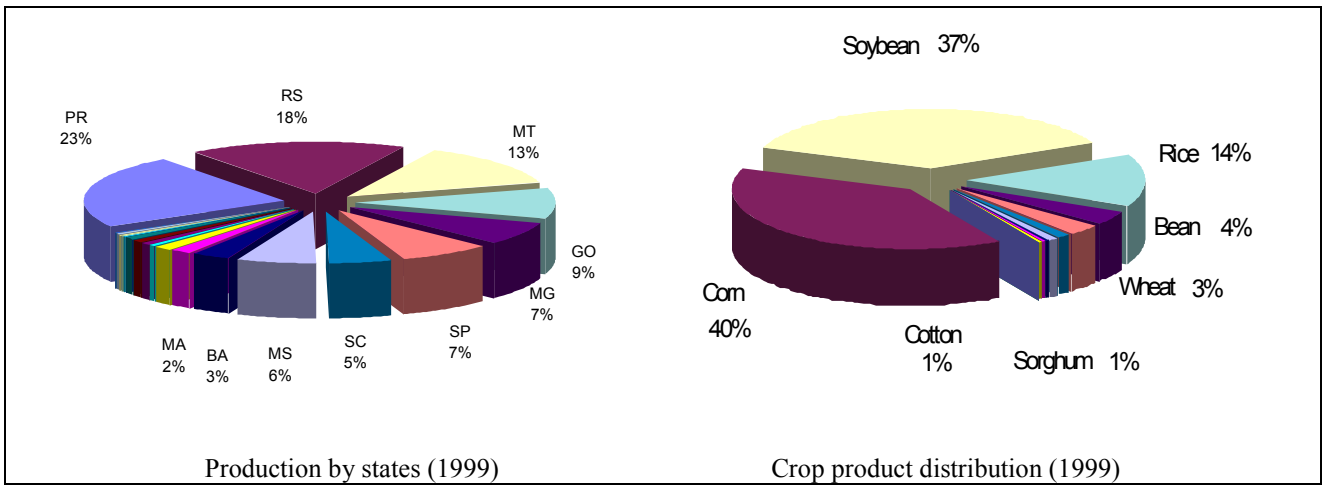


Figure 4 - Brazilian crop production evolution from 1980 to 1999 [10]

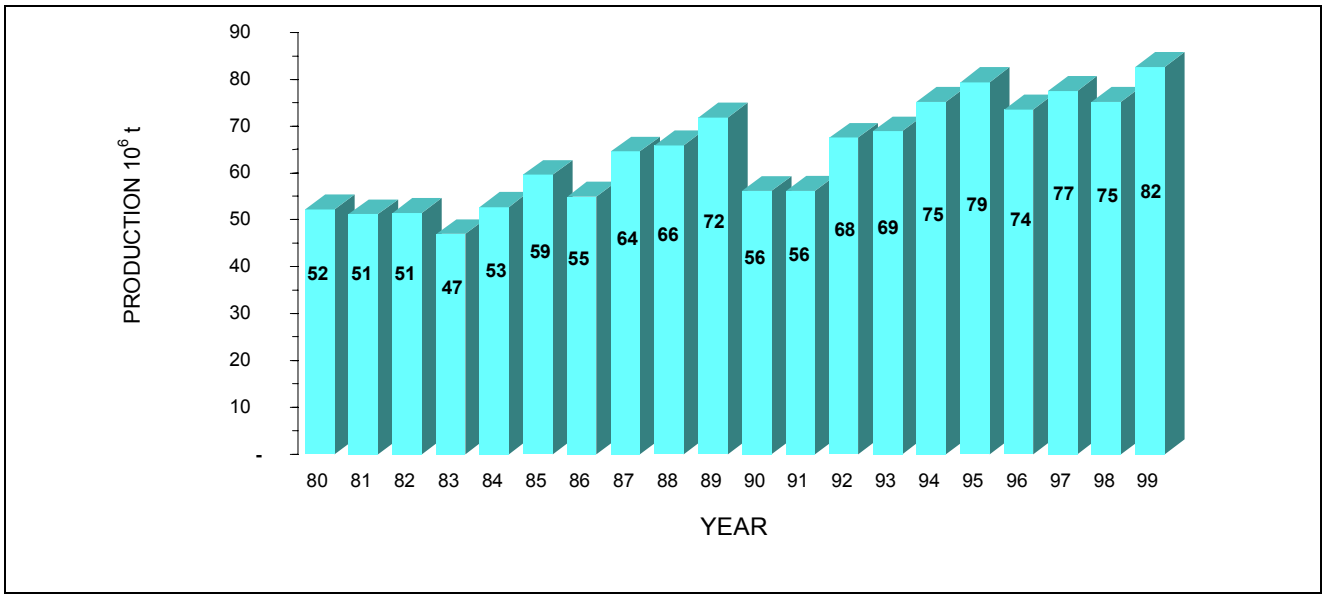


Figure 5 - Use of mechanization in the process of animal production [Adapted from 7 and 11]

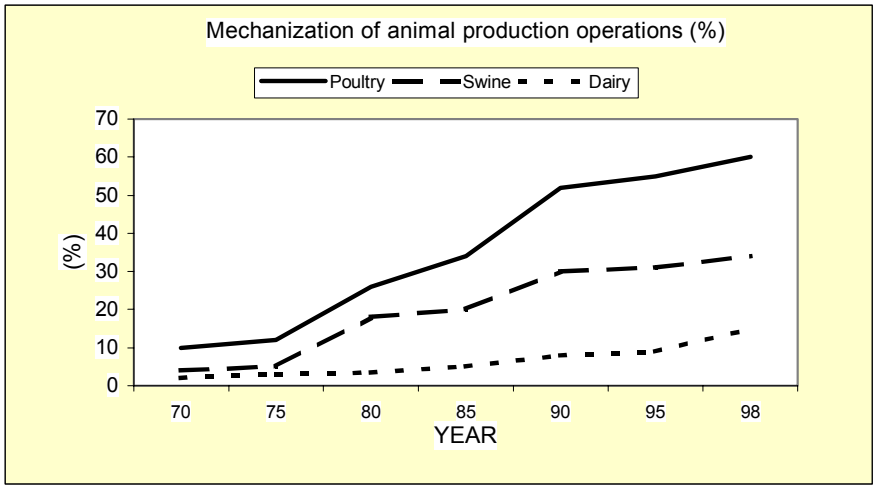
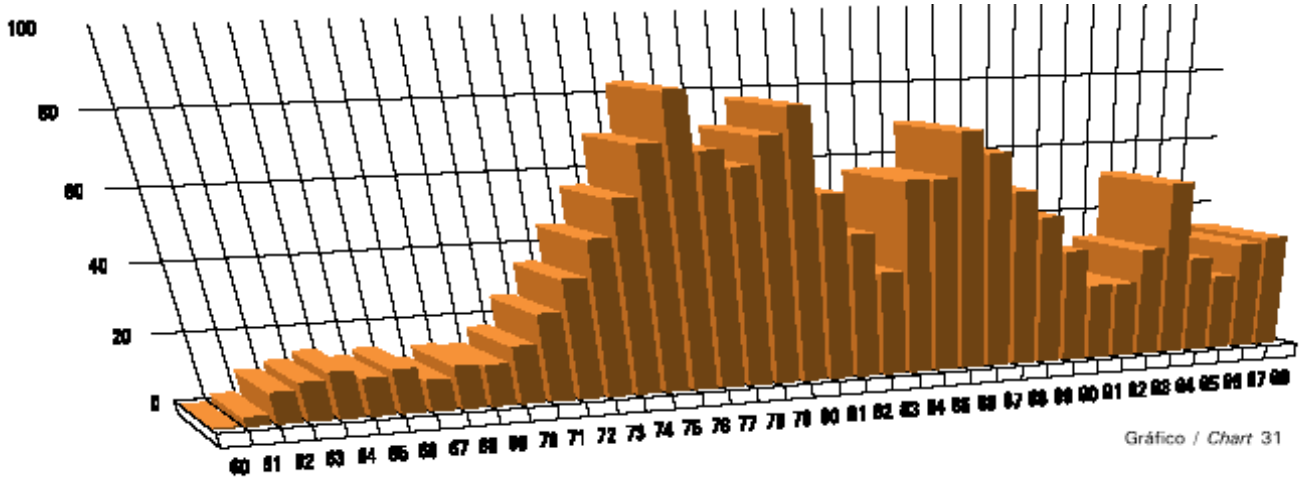


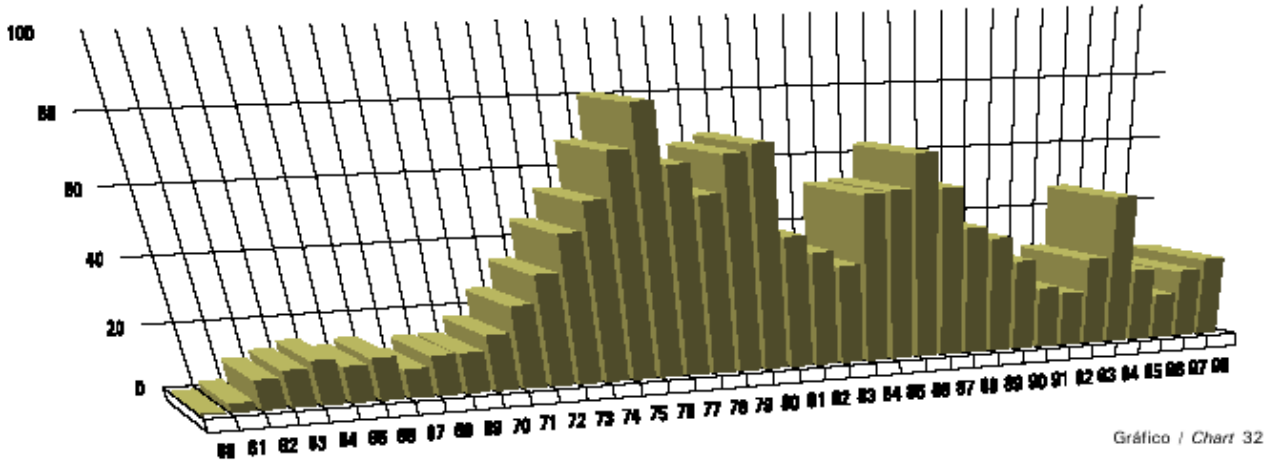
Figure 6 - Agricultural machinery production, domestic sales and exports [4]

Agricultural machinery production – 1960/1998



Domestic sales of agricultural machinery (nationally manufactured and imported) - 1960/1998

Mil unidades/*Thousand units*



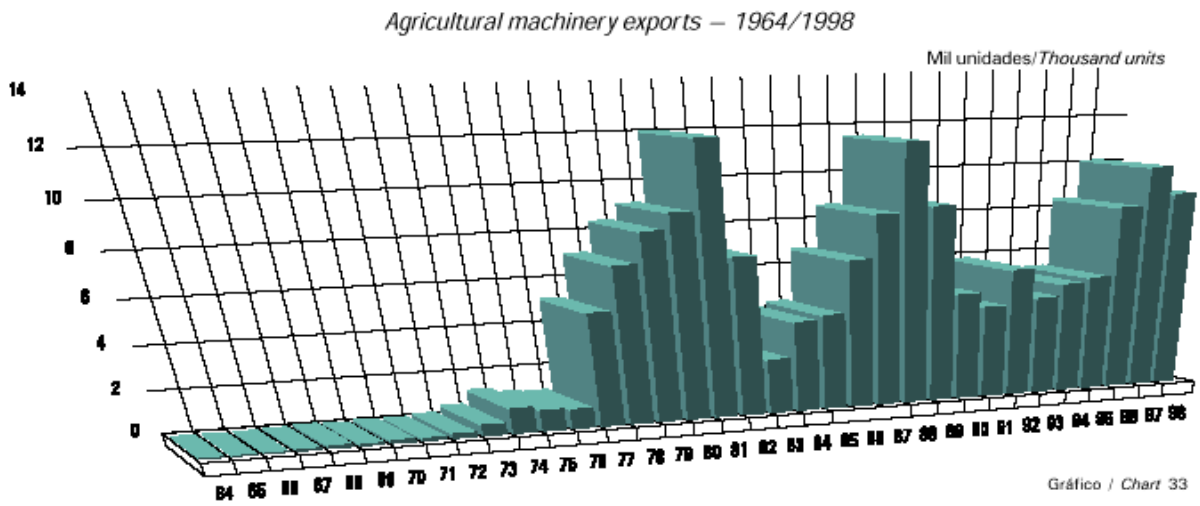


Figure 7 – Overall investment in research in Brazil from 1980 to 1999 [Adapted from IPEA 3]

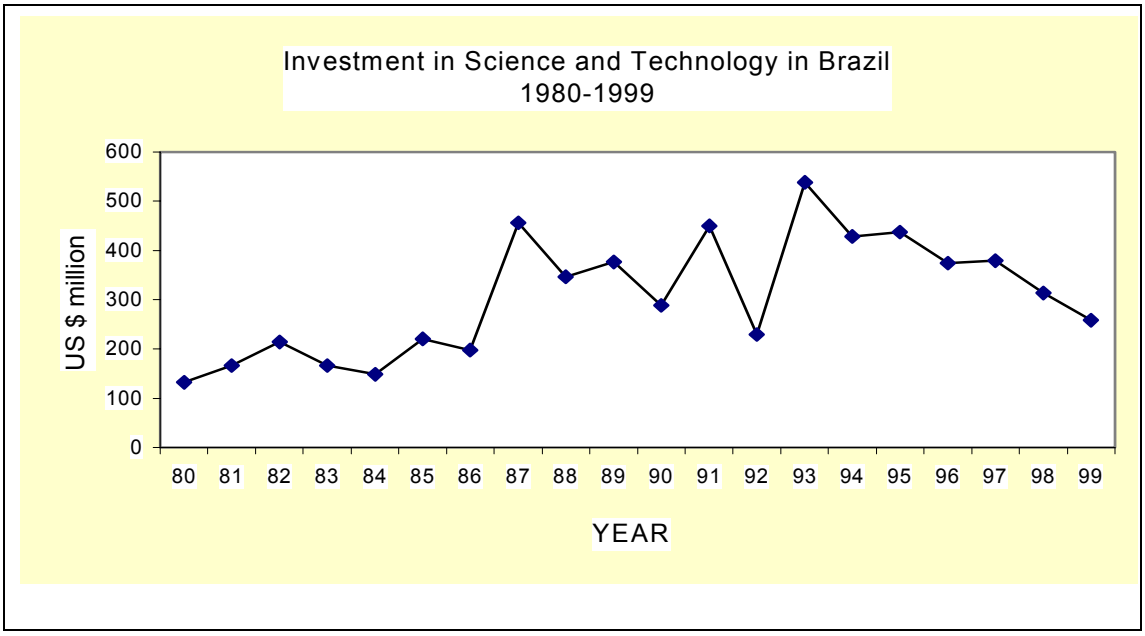


Figure 8 - EMBRAPA research network in Brazil [1]

1 - Embrapa Acre
2 - Embrapa Agrobiology
3 - Embrapa Agroindustrial Food Technology
4 - Embrapa Tropical Agroindustry
5 - Embrapa Agriculture West
6 - Embrapa Cotton
7 - Embrapa Amapá
8 - Embrapa Western Amazon
9 - Embrapa Eastern Amazon
10 - Embrapa Rice and Beans
11 - Embrapa Goats
12 - Embrapa Cerrados
13 - Embrapa Temperate Climate
14 - Embrapa Forests
15 - Embrapa Beef Cattle
16 - Embrapa Dairy Cattle
17 - Embrapa Horticulture
18 - Embrapa Agricultural Information
19 - Embrapa Agricultural Instrumentation
20 - Embrapa Cassava and Fruit Culture
21 - Embrapa Environment
22 - Embrapa Mid-North
23 - Embrapa Corn and Sorghum
24 - Embrapa Cattle Research of the Southeast
25 - Embrapa Pantanal
26 - Embrapa Satellite Monitoring
27 - Embrapa Cattle Research of the South
28 - Embrapa Information Production
29 - Embrapa Genetic Resources and Biotechnology
30 - Embrapa Rondônia
31 - Embrapa Roraima
32 - Embrapa Basic Seeds
33 - Embrapa Semi-Arid Tropics
34 - Embrapa Soybean
35 - Embrapa Soils
36 - Embrapa Swine and Poultry
37 - Embrapa Coastal Tablelands
38 - Embrapa Wheat
39 - Embrapa Grapes and Wine

Table 1 - Data on rural and urban population in Brazil by regions [5]

REGIONS	RURAL POPULATION (10^3 hab.)	(%)	TOTAL RURAL POPULATION (%)	URBAN POPULATION (10^3 hab.)	(%)	TOTAL URBAN POPULATION (%)
North	4249	37.6	12.5	7039	62.4	5.7
Northeast	15569	34.8	45.7	29198	65.2	23.7
Center West	1636	15.6	4.8	8865	84.4	7.2
Southeast	7292	10.9	21.3	59709	89.1	48.6
South	5357	22.8	15.7	18157	77.2	14.8
Brazil	*34102*	*100.0*	*100.0*	*122968*	*78.4*	*100.0*

Table 2 - Total Brazilian grain production in 1999 [10]

PRODUCTION	NORTH	NORTH EAST	CENTERWEST	SOUTHEAST	SOUTH	TOTAL
Tons (10^9)	2.37	5.8	24.1	12.5	37.75	82.52

Table 3 - Evolution in the main production in 1999 and 2000 [14]

	1999		2000	
PRODUCT	VOLUME (10^3 t)	TOTAL EXPORT (10^6 US$)	VOLUME (10^3 t)	TOTAL EXPORT (10^6 US$)
Cotton	1,502	517	1,785	676
Rice	11,582	1994	11,430	1905

Bean	2,915	1328	2,972	1354
Corn	32,417	3242	32,209	3579
Soybean	30,765	4785	31,497	5249
Wheat	2.403	280	2.403	294

Table 4 - Evolution of land with agricultural potential in use [8]

YEAR	1970	1980	1990	1995
Land with agricultural potential (%)	197.84	220.95	240.80	245.20

Table 5 - Mechanization in farming worldwide-(1996-98) [Source: data for Brazil refer to 1998, and for fleets the figures are estimates [7]

	CULTIVATED AREA (1000 ha)	WHEEL TRACTORS FLEET (units)	COMBINES (units)	ARABLE AREA PER TRACTOR (ha)	AREA HARVESTING PER COMBINE (ha)
World	1,381,917	26,345,272	4,232,536	52.5	326.5
Africa	174,202	567,397	39,809	307.0	4.375.9
North/ C. America	258,701	5,835,768	849,614	44.3	304.5
S. America	97,740	1,199,043	121,836	81.5	802.2
Asia	499,497	6,920,648	1,894,207	72.2	263.7
Europe	299,760	11,421,088	1,266,976	26.2	236.6
Oceania	52,017	401,328	60,095	129.6	865.6
Countries					
Brazil	53,500	460,000	49,600	116.3	1.078.6
Argentina	25,000	280,000	50,000	89.3	500.0
Canada	45,360	740,000	155,000	61.3	292.6
USA	175,000	4,800,000	626,000	36.5	264.4
France	18,288	1,312,000	154,000	13.9	118.8
UK	6,090	500,000	47,000	12.2	129.6

Table 6 - Brazilian agriculture machinery production, [6]

AGRICULTURE MACHINERY	1998	1999
Wheel tractors	24,092	20,889
Track-type tractors	2,072	1,248
Tillers	692	778
Combines	4,063	3,750
Loaders & Backhoes	2,493	1,526
TOTAL	*33,412*	*28,191*

Table 7 - Number of tractor by geographic regions, [6]

REGIONS/STATES	1970	1999
North	1,013	10,441
North-east	60,330	47,325
South-east	79,564	214,717
Center-west	9,449	70,011
South	50,933	199,649
TOTAL	*156,592*	*542,143*

Table 8 - Brazil – mechanization level [7]

YEAR	CULTIVATED AREA (1000 ha)	WHEEL TRACTORS FLEET (units)	MECHANIZATION LEVEL (ha /wheel tractors)
1960	25,671.7	62,684	410

1965	31,637.3	76,691	413
1970	34,811.1	97,160	359
1975	41,811.1	273,852	153
1980	47,640.6	480,340	99
1985	49,528.7	551,036	90
1990	47,666.4	515,815	92
1995	50,021.5	481,316	104
1998	53,500.0	542,143	116

Table 9 - Graduate students per area of knowledge [4]

	REGION						
	Level	North	Northeast	Southeast	South	Center West	*TOTAL*
	MSc	31	183	870	245	53	*1382*
Exact Sciences*							
	PhD	4	24	444	46	19	*537*
	MSc	34	110	699	184	72	*1099*
Biological Sciences*							
	PhD	15	12	402	36	7	*472*
	MSc	11	142	1297	369	53	*1872*
Engineering*							
	PhD	-	3	421	68	-	*492*
	MSc	23	165	819	337	51	*1395*
Agricultural Sciences							
	PhD	-	-	346	28	2	*376*
	MSc	138	1320	7693	2157	617	*11925*
BRAZIL							
	PhD	19	108	3149	285	43	*3604*

*Some research related to Agricultural Engineering basics are related to those areas

Table 10 - Instructors involved in graduate programs by region and area of knowledge (1997)[4]

REGION	EXACT SCIENCES*		BIOLOGICAL SCIENCES*		ENGINEERING*		AGRICULTURAL SCIENCES*		*TOTAL*	
	Total	Doct.	Total	Doct.	Total	Doct.	Total	Doct.	*Total*	*Doct.*
Brazil	2304	2276	1656	1637	1893	1837	1798	1701	*14060*	*13443*
North	19	18	63	63	15	14	36	36	*155*	*152*
Northeast	352	338	138	136	188	179	188	165	*1728*	*1592*
Southeast	1493	1483	1144	1136	1347	1309	1182	1145	*9534*	*9196*
South	356	347	222	215	301	293	339	305	*2091*	*1969*
Center west	84	84	89	87	42	42	53	50	*552*	*534*

* Some research related to Agricultural Engineering basics are related to those areas

TRENDS AND REQUIREMENTS OF MECHANIZATION: THE CASE OF MEXICO

by ***Arturo Lara-López***
Mexico

1. Introduction

Mexico's agricultural land, as in many developing countries, is composed by a majority of small farms dedicated to cereal production. A modern sector is growing with the production of more profitable crops which are highly mechanized and coexist with a traditional agricultural sector.

Small tractors could be recommended for small farming from an economical analysis. However, these are not commonly used, being second hand tractors and contracting services more accepted by small farmers. During recent years government mechanization programs have contributed to grow the number of tractors and agricultural implements perceptibly.

After a presentation of main characteristics for Mexico's agriculture, alternatives for small farms, local manufacturing of agricultural machines on going research and development projects are briefly discussed.

2. Main aspects of agriculture and mechanization

In Mexico the average land size is of 12.1 ha having a total of 2.8 million farms. Only 18% of the land is irrigated and with the possibility of double cropping. Main crops and corresponding yield are presented in **Table 1**. As it can be seen; corn, beans, sorghum and wheat are the main crops. Alternative crops are growing during recent years. Main and alternative crops require secondary cultivation and spraying. Those operations are difficult for standard small or two wheel tractors, requiring high clearance machines or at least category II tractors.

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. This index is lower than the minimum cost power (0.75 kW/ha), previously reported [1], [2] and [3]. Camarena-Aguilar [7] estimated 200,000 tractors in 1998 with an average power of 52.5 kW. This author assume an arable land of 16.9 Mha giving an index of 0.62 kW/ha. However, such index indicates the need for an increase of mechanical power in agriculture.

The number of combines was estimated in 8000 units 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.

Among the main needs of Mexico's agriculture is to implement an economical and quality alternative for tillage of small farms. Contractors of field machinery and local manufacturing of agricultural machines should be considered a comparison of both alternatives will be presented in this paper. High cost of production is one of the main problems to be addressed, looking for reduce and conservation tillage as one of the opportunity area to short the costs of grain production.

Especial crops during last years have been introduced in low raining areas such as cactus pear with relative success. Market, derivative products and production technology need to be developed for growing areas dedicated to such special crops.

3. Mechanization of Small Farms

Mechanization of small farms vary from one region to another. In the central and northern states, it is common to see that small farmers contract primary tillage and uses animal traction for secondary tillage, planting and cultivation. Due to new government mechanization program, medium size farmers and groups of small farmers are eligible to receive economic support for farm machinery.

Used tractors is also one alternative for small farmers. government program is subsidizing overhauled of tractors.

Contractor agencies is not extended in the country. Most contracting services is provided by farmers having available time. **Table 2** shows prices of tillage for the central region of the country. The cost for conventional tillage is of 391.89 US$/ha. For a typical category II tractor totally dedicated to contracting the point of equilibrium is on 31 ha as shown is **Figure 1**.

Optimal tractor sizes were calculated from an economical analysis and plotted in **Figure 2**. According to this analysis small tractors of 6 to 8 kW would be optimal for 15 ha. However, such tractors are not common in Mexico's market. For a tractor of 15 kW the cost of plowing was calculated in terms of worked areas, **Figure 3**. It can be seen that for areas larger than 7.5 ha this alternative is more economical than the contracting system.

Reduction of production costs is one of the main priorities for cereal production, specially for small farms. Direct planting is one of the main programs being promoted by the Government. Direct planters locally manufactured are partially subsided. **Figure 4** shows one pneumatic planter developed at the University of Guanajuato being produced by a local company.

Design of small tractors have being produced in reduced series by local industry **Figures 5 and 6**. Improved animal drown implements have been developed by research institutes and produced in reduced amounts by local industry. Tools for harvesting and processing prickly pears are also under development (**Figure 7**).

4. International co-operation for technological transfer is expected to find favorable government policy due to open market with Europe and US

4.1. International Cooperation

Several good examples of international cooperation have been relevants to promote agricultural mechanization, including research and teaching in Agricultural Engineering and transfer of technology for farm machinery manufacturing in Mexico.

During the last seventies a cooperation agreement between The National College of Agricultural Engineering at Silsoe in UK and The University of Guanajuato Mexico made it possible to star the B.S. program in Agricultural Engineering in this University. The program received significant support from the department of Overseas Development for laboratory equipment. This program during recent years has established academic cooperation with other academic institutions including Polytechnic University of Valencia and Texas A&M. Faculty in this program is active in research related to needs of the agriculture and industry of the center of the country.

During the seventies and eighties a mechanization program for small farms was conducted between the National Institute of Agricultural Engineering at Silsoe and The National Institute of Agricultural Research of Mexico. Emphasis of the program was on animal daft implements and local manufacturing.

The soviet agency Tractor-Export and the Mexican company SIDENA made and agreement for manufacturing in Mexico small model. Manufacturing of those tractors took place from 1974 to 1986 with a manufacture of 6,000 tractors per year.

Presently assembly and manufacturing of tractors is under license agreement. Due to the recently signed agreement between the European Union and Mexico, political situation is expected to be favorable for technology transfer between both continents.

5. Conclusions

Small scale farming is widely extended in the country, being important to promote systematic programs to grow mechanization including contracting companies. Recent financing program has significatively increase the number of new and repaired tractors.

Special crops require development of machines and tools to aid harvesting and handling.

Industry experimented a considerable growth and show more diversity of products. Direct planters manufacturing is one example according to the need for reducing the cost field operations.

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Figure 1 - Cost, income and profit for a tractor of 75 kW in the central region of the country

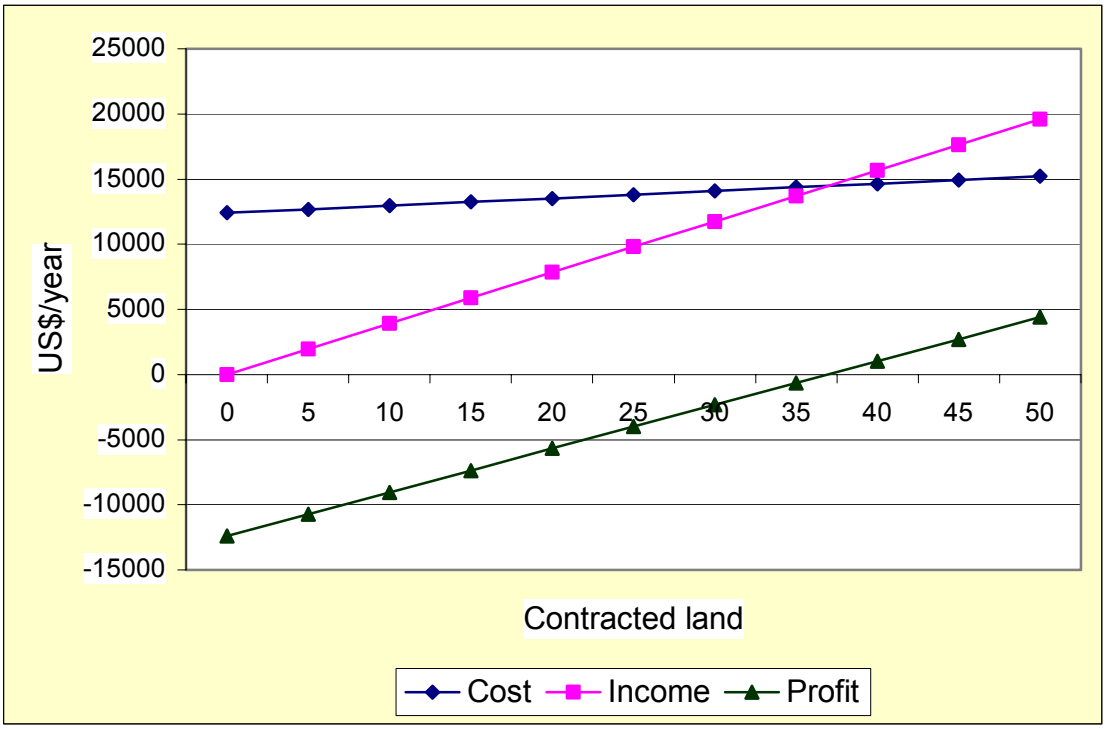

Figure 2 - Optimal power of tractor as function of farm area

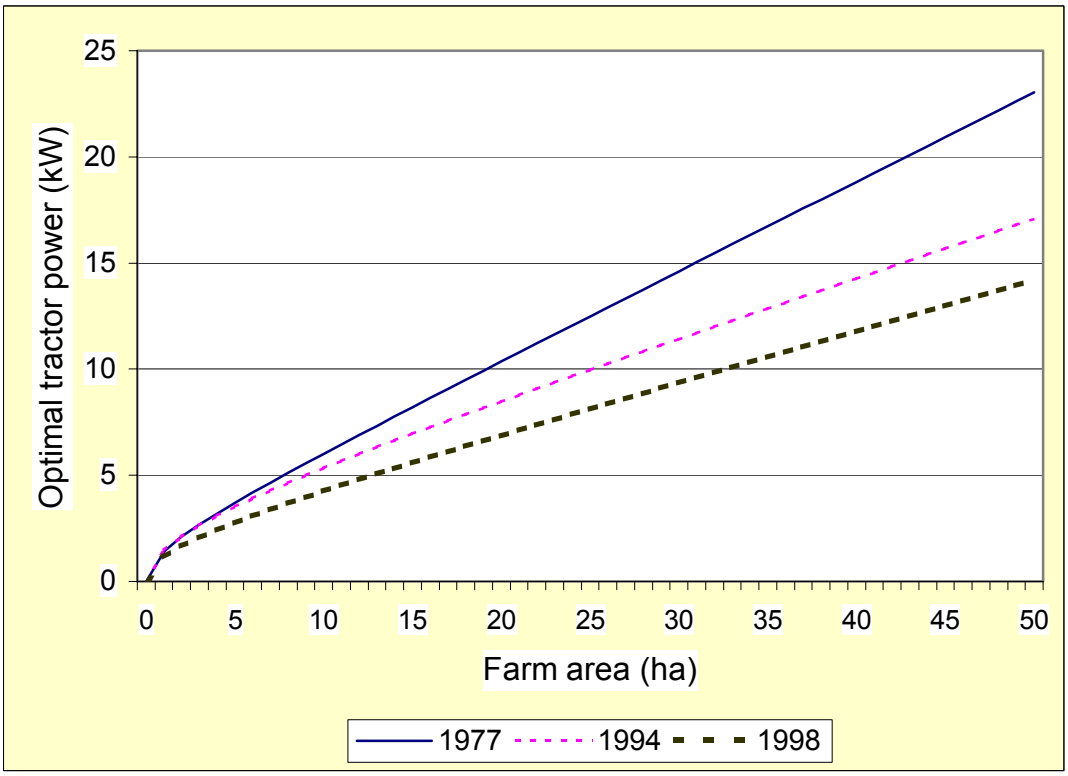

Figure 3 - Cost for a 15 kW tractor with traditional and zero tillage

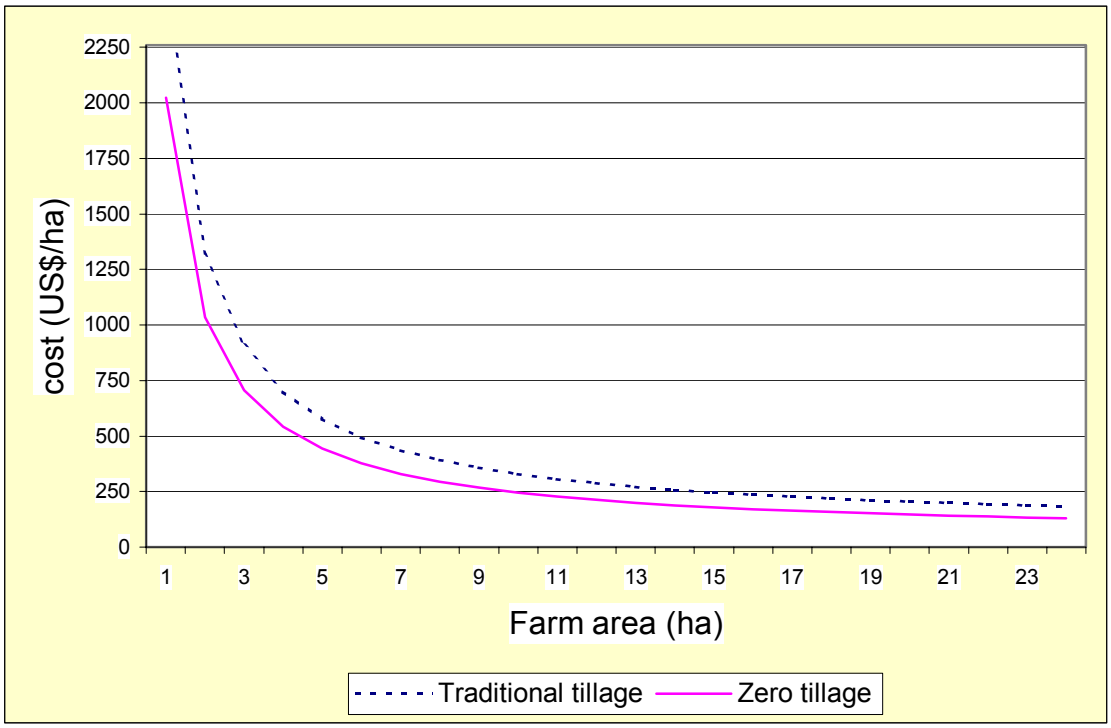

Figure 4 - Pneumatic planter locally manufactured

Figure 5 - High clearance two wheel tractor

Figure 6 - Riding option of a high clearance two wheel tractor

Figure 7 - Hand tool for harvesting prickly pears

Table 1 - Main crops of Mexico, 1998

CROP	HARVESTED LAND (ha)	YIELD (kg/ha)
Seasonal crops:		
Corn	7,876,819	2,343
Beans	2,146,498	587
Sorghum	1,953,073	3,315
Wheat	768,844	4,208
Barley	267,548	1,535
Cotton	245,278	2,876
Safflower	123,140	1,390
Soybean	94,065	1,598
Alternative crops:		
Chili	155,981	11,856
Tomato	78,785	28,583
Strawberry	6,539	18,169
Perennial crops	2,630,725	-
TOTAL	*16,506618*	

Table 2 - Cost for contracting tillage operations

OPERATION	COST (US$/ha)	TILLAGE COST (%)
Subsoiling	79.24	20.22
Plowing	66.05	16.85
Harrowing	88.02	22.46
Leveling	26.50	6.76
Planting	44.08	11.26
Cultivation	88.00	22.45
TOTAL	*391.89*	*100*

TRENDS AND REQUIREMENTS OF MECHANIZATION: THE CASE OF ARGENTINA

by ***Jorge Hilbert***
Argentina

1. General description of farm machinery trends

The mechanization process in Argentina has overcome different stages in its evolution reaching now days a stage were we have a delay in modernization of tractors and farm machinery in a great majority of medium and small farms.

The mechanization has permitted a great increase in farm production due to the innovations and increase in the productivity of farmers.

In the 70's and early 80's the contribution came through the increase in grain production per ha and the decrease in the costs per unit of surface.

The 90's were dominated by a great increment in the no tillage techniques. This brought an increase in the sales of new now tillage planters and sprayers. The Increasing grain production surpassing the 60 million tons per year would lead to a sustainable demand of farm machinery if international prices would recovery and subsidies and limitations to the free access to all markets is changed

There are still great challenges for the farm mechanization in Argentina. Recent studies show that there is a loss of more than US$ 500 million for harvesting losses, 200 million for soil degradation and erosion and more than 130 million for old tractors and bad techniques of operation and conservation of farm machinery.

The tractor and harvesting equipment is becoming older due to a lower rate of renewal (half as the value calculated as suitable according to life expectancy). This has become more important after the mid 80's. This phenomenon is caused by low production prices and very high interest rates.

The conservationist techniques are acquiring special interest in the last decade. This has caused a change in farm machinery sales increasing the amount of no tillage planters and sprayers.

There is also an increase in the concern for farm machinery safety measures due to the enforcement of a general safety insurance in argentine farms.

In the last decade there has also been an increase in the total sells of forage treatment machines due to an increase in its mechanization. This was caused by the increase in intensive production as dairy farms of high productivity and feed lots.

Argentina has suffered a great loss in its industrial potential. Only fifteen years all the principal tractor brands had complete plants that were able to produce entire tractors. Now day's only one plant under severe modifications conserves this capability. There was also a great concentration in the brands on fewer firms (Deutz + Massey Ferguson – AGCO) (Case + New Holland – CNH). A greater percentage of tractors are entirely constructed or assembled in the southern states of Brazil.

The National Institute of Agricultural Technology had run specific farm machinery programs related to grain harvesting losses (PROPECO) Forage process (PROPEFO) tractor efficiency (PROTRAC) and precision agriculture.

This programs contributed to significant changes in the adoption and improvement of mechanization in Argentina. The extension and research work that took place in different regions of the country had an important incidence in new farm machinery units sold and improvement in their correct use.

After this general broad view I am going to focus on certain subjects I consider more relevant in a modern agriculture

1.1. Tractors

Regarding tractors Argentina losses more than US$ 130 million per year caused by deficiencies in the utilization of this machines. This is caused by the high age of the equipment more than 17 years according to PROTRAC measurements (1999) **Table 1**. The estimated number of units according to the tractors chamber is between 180,000 and 200,000 units. The last general survey 1988 arouse a total number of 267,000 units according to the tractor chamber more than 20% of this total would be out of service.

According to the last survey carried over by INTA this reality is now day's worse with more than 40% of the tractors having more than 17 years.

In the provinces of Buenos Aires, Córdoba, Santa Fe, Entre Ríos y La Pampa, there are 188,000 tractores. This indicates that more than 85% of them are used in the pampeana region in extensive grain production.

According to different studies the total available power would range between a maximum of 13,500,000 to a minimum of 6,000,000 CV.

It is important to state that the mean power sold has been growing. In the seventies the mean power was 64 CV and it is now over than 115 CV.

This was influenced also by the new tractors were sold mainly to bigger farms and contractors that work very big surfaces.

Statistics depend on factories and importers declarations and differences arouse between numbers from different sources **Table 2**.

There is also an increasing trend towards FWA and double traction tractors covering in the year 1999 53.1% of the market.

1.2. No tillage farming

The production losses by soil erosion are very high. Estimated numbers reach values of US$ 160 and US$ 280 million per year Gallacher M.

INTA initiated in 1990 a national program of soil conservation. This work has been enlarged by a very big private private farmers no tillage association AAPRESID. This group works in all over the country with the support of the principal fertilizer and herbicide enterprises.

The evolution has been very rapid in 1990 only 7,000,000 hectares were under this system mainly soybean planted over wheat on the same year. In 1999 it has reached 32% of the agricultural surface 70 million hectares.
There has been a very great evolution in the national design and construction of specific farm machinery as planters and sprayers (see evolution of sales).

1.3. Harvesters

Argentina had a very long tradition on construction and design of this type of machines. Fifteen years ago there were more than a dozen factories distributed mainly in the province of Santa Fe. In the last decade the majority has closed concentrating the market in a small number of brands. As in the tractor case there is an increasing number of machines coming from Brazil and the United States. They are now covering nearly 50% of the market share **Tables 3, 4** and **5**.

1.4. Precision Farming

In relation to precision farming between 1 to 2% of Argentina's harvesters are equipped with yield monitors, half of them are equipped with global positioning systems. There are two differential correction beacon base stations covering a radius of 450 km each. This covers the whole of the Argentine grain belt provinces of Buenos Aires, Santa Fe, Cordoba La Pampa and Entre Rios. There is also an Omni star satellite correction signal. Prices of the service range for the first system US$ 1,300 per three years and US$ 2,000 per year. More than 100 DGPS guide systems are installed in sprayers (60% on planes).

Variable rate technology is just beginning since there are no more than 6 big fertilizers and sprayers equipped with this type of equipment. Only three private consultants are working on this subject and the National Institute of Agricultural Technology INTA

has a national program working with relatively very low funding.

Which is the future of this technology in Argentina. To answer this question it must first be seen whether the activities that make up the precision farming system can be adopted and/or used by farmers in Argentina. These activities include yield monitoring, global positioning systems, and intensive soil sampling and variable rate fertilizer applications.

Four differences can be detected comparing to the North American situation. Investment costs are higher, there are no governmental plans to support grain prices, there is less soil variability since agriculture compared to Europe is relatively new, interest rates for acquiring new equipment are fairly high 12 to 15% per year and finally there is low direct operation of the farms by the owners. This last point means that a good quality information gathering is difficult.

There are other points that point out that during the next decade portions of this technology will begin to be used by many producers.

Owners in Argentina are more interest in yields maps since they are not directly involved in the farm operation. The size of farms in Argentina is bigger than in the Corn Belt and costs could be reduced per unit. Farmers in Argentina have a tradition in sharing results between regional or local groups since the competition in hiring fields. Finally harvesters in Argentina cover very big surfaces per year (4,000 to 5,000 ha/year) permitting the reduction of the cost of a yield monitor per ha.

Variable rate technology will have a very slow evolution in Argentina since soil analysis is very high (40 to 70 US$) per sample. These prices are not compatible with grid sampling methods. Many farms in Argentina are still not using fertilizers even those that incorporate them are employing relatively low rates 30 to 60 kg/ha of Nitrogen per ha and 20 to 40 kg/ha of Phosphorus.

In general terms there a lot of farmers become interested in this technology, but are reluctant to accept it because of cost, the complexity of the equipment, and lack of first hand knowledge. Farmers who understand this technology will be better prepared to make intelligent decisions regarding its applications.

2. Recent Farm machinery statistics

In tractors the principal exporters were AGCO (61%) and Constructions Metallurgical Zanello (26%). Principal customers Brazil (40%) and Uruguay (21%).

In Sprayers it must be stated that of the total exports 12%, 2% belong to manual equipment. In this type of manual sprayers the enterprise Pesa is responsible for (88%).

In mounted and trailed sprayers the principal exporters were Industrias Pla (39%) and Metalfor (25%).

In headers and forage collectors Carlos Mainero (36%) leads the export ranking with Uruguay as the main customer.

Yomel was responsible for 99 % of fertilizers exports and 93 % went to Brazil.

In Drillers-Planters the share of the export market was divided between Giorgi (25%); Agropla (20%); Tanzi (17%); Schiarre (12%). The destiny were Uruguay (59%) and Brazil (24%).

Juan B. Bosio was responsible for 94% of the exports of dairy machines to Brazil.

3. Agricultural economy situation

At the date this report was being written the 1999-2000 growing season was approximately ending. In the case of cereals and oilseeds there is already a full panorama of the situation for all the crops in these groups, based on information provided by the Agriculture Secretariat. The total area sown will be 1.7% higher than in the 1998-99 season, although this increase is almost entirely explained by increased planting of corn, soybean and wheat.

According to official estimates, the area under cultivation is 5.8% larger than in the previous season, equivalent to some 700,000 hectares. The increase is due almost entirely to greater

sowings of wheat and corn, by 12.9% and 9.9% respectively. These crops account for over 73% of the area sown with cereals. Areas sown with all the remaining products have been cut by 7.5%. The most significant reductions having been recorded by rice and brewers barley, with cuts of 27.3% and 16.7% respectively **Table 6**.

As regards production totals, it has been estimated that the wheat harvest, which at present records a level of progress of 70% of the harvest area, will reach a volume of 14.2 million tons, 23.5% higher than in the previous harvest. As a result the export Table balance in 2000 will be 2.7 million tons greater than in 1999. According to Agriculture Secretariat estimates, it can be calculated that over 40% of the area cultivated with wheat will be assigned to second occupancy soybean sown on the stubble of the harvested wheat.

The larger area cultivated by corn has been at the expense of areas previously used for other cereals and oilseeds last season, in particular barley, peanuts and sunflower. Some 330 thousand additional hectares have been sown, which, added to an improvement in the overall productivity of the crop, would lead to additional production of some 2 million tons more than in the previous season. As in the case of wheat, this increase in production will lead to a large supply of corn available for export. On the other hand over 80 thousand hectares fewer have been sown with rice, a crop grown outside the pampas region, mainly along the Mesopotamian coastline. In this case production will fall, and so will the export table balance. A similar situation will be experienced by grain sorghum, for which the surface sown will be some 4.7% lower (slightly over 40 thousand hectares) compared to the previous harvest.

In the case of oilseeds, it is estimated that the total area sown will fall 2.4% or around 300 thousand hectares compared to the previous season. Soybean cultivation, which this harvest will account for 67.5% of the area sown with oilseeds, according to the Agriculture Secretariat, will achieve a historical record, with almost 8.3 million hectares sown. This total represents an increase of 3.4% compared to the previous season, and production could also reach record levels. Conversely, other leading oilseeds will suffer reductions in sowing areas: planting of sunflower, peanuts and flax will be down 10.5%, 35% and 33.3% respectively. In the case of the first of these, sowings were lower in both Buenos Aires and Chaco provinces, while in the case of the second the peanut-growing areas in the province of Cordoba were cut back considerably.

In short, according to current forecasts farmers have been specializing in just a few crops (85% of the area sown being used for corn, wheat, sunflower and soybean) and in spite of initial forecasts, there will be an increase in the total area sown. As a result, if no problems causing significant crop losses are experienced, grain production will increase in relation to the previous period, although without reaching the record achieved in the 1997/98 season.

There are no favourable signs in the evolution of depressed grain prices, in spite of certain optimistic forecasts. Unfortunately, in the latter part of the year these downward trends strengthened on market boards, particularly locally.

The market, on the basis of FOB prices, for January 2000 was quoted under US$ 80 per ton. This price means income to the farmer of barely over US$ 60 per ton, approximately half the level obtained from the 1997-98 harvest and one third of the price paid for the 1996-97 harvest. Fortunately the downward trend was reversed in later fixings, and towards the end of the year prices recovered to US$ 87 per ton. In the medium term the outlook appears better, as market prices for futures for May and July are set at US$ 98 and US$ 102 per ton, respectively.

However, many farmers will have no option but to sell as soon as they harvest, to cover their debts and finance the sowing of second-occupancy soybean. As a result, deals on the spot market in December ranged between 74 and 86 Pesos per ton, depending on the delivery terms, which means that values were lower than they were for corn, a grain that has

traditionally recorded a price that was 15% to 20% below that for wheat. According to the Agriculture Secretariat, at the end of December exporting companies had acquired close to 5 million tons of wheat from the new harvest, of which barely over one quarter had been shipped. If the buying rate is maintained during January, companies will have fulfilled most of their current and future commitments for the shipping of export surpluses, paying the prices in force at those moments.

The making available of loans to farmers through Banco de la Nación Argentina, with a partial subsidy of interest rates so that they are able to either totally or partially withhold wheat harvests, is intended to help farmers obtain better prices. This will occur as long as rising prices on futures markets are realized at the time the loans are to be repaid. As mentioned, in view of the current rate of new harvest sales, only a small percentage of farmers will be able to resort to this financial assistance.

Brazil, took 80% of Argentina wheat exports during the commercial year ended in November 1999. According to foreign sale reports notified to the Agriculture Secretariat which at the end of December covered approximately 40% of the export table balance of the harvest, there is currently a greater diversity in export destinations than during the previous harvest. Brazil still continues to be by far the most significant destination for export sales, although currently accounting for almost 44% of committed sales. No doubt this proportion will increase in coming months, given the need to meet demand on its domestic market, but it will not reach the market share recorded in the previous year, although volumes will be similar.

Forage grains were also unable to escape the downward trend on international markets, especially in the context of growing supply world-wide. FOB corn and grain sorghum prices were respectively 8% and 11% lower than last year.

FOB prices for soybeans and sunflower have also performed negatively after a brief recovery in August and September, a behaviour that was matched by domestic prices. In the first eleven months of the year, comparison with the same period in 1998 shows that FOB soybean prices have fallen 21.7%, oil prices were down 33.5% and flour was 12.4% lower. Sunflower seed, oil and flour prices suffered falls of 30.2%, 33.4% and 18.3% respectively. Although world demand for oilseed, oil and by-products shows firmness for the coming year, world-wide supply will also be high, in spite of lower US soybean production.

Available information on the evolution of crops grown outside the pampas region is much more limited. It has been confirmed that the area planted with cotton was 33.8% smaller than in the previous season and the harvest in the period has been 37.4% lower. The 1999-2000 harvest began in the third quarter in the context of an extended drought in the cotton-growing dry-lands of the north-east, in particular Chaco, Formosa and the north of Santa Fe. These conditions, added to the bad economic results from the previous season, low prices anticipated for cotton and the lack of credit for farmers have led to a further significant cut in the area planted, which has been 37.2% lower than in the previous season, although private sector analysts estimate an even greater fall. According to official estimates, the cotton-growing area is currently one third of that which existed only three years ago.

This year the sugar harvest was affected by low sugar prices, although production fell by only 5%. The unfavourable result from the previous year's harvest - with a sharp fall in yields and the impact on prices of the devaluation of the real - led to a drop of 30.4% in the area sown with dry bean this season. In the case of the wine grape segment, it is still too early to estimate the results of the coming harvest, although there has been some bad weather that has affected certain wine-growing areas.

Livestock sector indicators for the 1998-99 cattle year ended June 30 last show that the slaughter of cattle controlled by the SENASA, which covers around 80% of total slaughter, recorded a drop of 1.4% compared to the 1997/98 cattle year. Total slaughter estimated

by the DNCN fell by 6.2% in the same period, equivalent to some 850,000 head.

Prices for cattle on the hoof continued to decline in the third quarter. Actual steer prices at the Liniers market - the basic indicator for cattle prices - were down 28.3% compared to the same period of the previous year and 3.9% compared to the second quarter. The increase in supply mentioned previously has been the main cause of declines in the short term. Current price levels continue to favour competitiveness in the exporting sector, which has gained in strength this year, although still limited by problems inherent to this manufacturing segment. Domestic consumption has remained firm in recent months as the declines in the price of cattle on the hoof have been passed on the to the retail sector.

Stock levels at June 30, 1999 calculated on the basis of the 1999 National Agricultural Survey carried out by the INDEC between August and October have still to be announced.

Having successfully eradicated foot-and-mouth disease and having ceased to require mass vaccination in April this year, it is hoped that progress will be made in 2000 towards obtaining the status of "free of foot-and-mouth disease without vaccination" from the International Epizootic Organization. As indicated in the previous Economic Report, this rating will allow Argentina to participate actively in all segments of the international beef market, although it will still have to overcome barriers of other kinds.

Pig and poultry slaughter supervised by the SENASA in the third quarter recorded rises of 19.1% and 3.8% respectively in relation to the same period of the previous year. In both cases consumption is firm, in particular in the case of chicken, as prices are competitive in comparison to other meats. This trend continues to be favoured by lower prices for grain and animal feed and pressure from imports which has obliged local firms to set competitive consumer prices.

Milk production was 7% higher than in the same period of the previous year. The rate of growth was lower than in the second quarter because of the problems in the sector caused by the level of prices received by farmers. These prices have fallen sharply, leading to a fall in production that will be noted in coming months.

4. Final conclusions

4.1. Role of contractors

The role of contractors in Argentina is very important and is growing every year in new areas. 30% of the crops are carried over by contractors and this figure increases to more than 50% in the corn belt area Buenos Aires – Santa Fe - Cordoba.

This type of contract were an independent firm offers the complete service of planting, spraying or/and harvesting has a very long history in this country.

In the recent years the growth of the traditional harvesting system has been accompanied by the introduction of new complex services. Between them one of the more interesting one is the provision of soil analysis, agronomic advice and field application using very big American machines.

According to the present trends the following future panorama is expected:

- increase in the mean power of tractors since there is a need to increase productivity and reduce time;
- tractors with more efficient engines, transmissions etc to reduce the energy losses in older tractors. There is a specific national program carried over by INTA and all the firms present in the market to improve the use of older machines and replace them;
- increase in the mean size and power of harvesters. The actual surface worked by machine is more than 430 ha/year;
- modernization of harvesters in order to reduce harvesting losses;
- increase in the utilization of transport devices due to the extremely high distances that harvesters travel on roads moving along different regions in north-

south direction. This will also be supported by the increase of enforcement of travel legislations and limitations;

- development of integrated companies introducing complex services as soil sampling and analysis, fertilizers and sprayers, GIS and GPS assistance.

4.2. Need for improved machines

The need for improved machines must be considered taking into account the different realities that coexist in the country.

There is an increasing number of big farms, investment groups and contractors that manage surfaces that range from 3,000 to 12,000 hectares. This sector is interested in introducing new technology that could reduce labor costs, increase productivity and reduce the risk of machinery failures.

The limitations to a higher degree of purchasing of new machinery is directly related to the low international prices of the commodities, the limitations to introduce our products to certain markets and the extremely high loan interest rates. When in certain years as 1997-1998 international prices were high a great explosion of tractors and farm machinery sales occurred.

The rate of new technology in this sector is one of the highest in the world surpassing the conservatory behaviour of American and European farmers.

In the other end we have small farms and subsistence surfaces that need to be address in a specific way. The Government has some special programs as Cambio Rural. This program was designed in order to organize small and medium farmers in groups of 10 to 15 members in order to share experiences, technology and organizational knowledge. At the present there are 2,000 groups with 21,125 farmers working. Each group has a professional advisor covered by the Government in the first three years.

The results are very positive with a medium increase in profits of 6.8%. The limitations found to increase this type of programs has been mainly the lack of founds. There are not technological gaps and the need of technology in tractor and farm machinery can be covered out by the national industry and scientific and technology institutes and universities.

For the last range of farmers that could be classified as subsistence group are attended by specific programs that focus mainly in diffusing basic technology to enable this sector of the population to produce their own food increasing their very low nutrition level. These programs depend entirely on national and state founds and they don't present technological deficiencies.

4.3. Situation and interest in the technology transfer from developed countries to developing ones

There is a great need in technological transfer from different parts of the world. Nowadays-big companies have the entire liberty to introduce this knowledge to the country. At the present days there is a deficiency in the local capabilities to test and evaluate the convenience and effects of the different technological innovations that are introduced daily. This problem could be rapidly corrected by means of an increase in the funds dedicated to these aspects and also a drastic improvement in the national organization and coordination between different governmental and private actors.

4.4. Industrial development of tractor and agricultural machinery

4.4.1. Positives and negatives results achieved

Looking back at the history of industrialization of the country Argentina developed an intensive and familiar farm machinery industry concentrated in the agricultural area. This companies initiated mainly by Italian and Spanish immigrants had a very impressive development until the 1980 tees. From this decade onward there was a slow adaptation to the new world reality.

There has been very little integration between the local factories and there are towns were more than five different families were constructing the same type of farm machinery

with differences in their parts and components.

There has been also very little progress in standardization and machinery testing.

This reality has changed dramatically in the last five years with fierce competition of machinery coming from abroad. There are some plans of training in the fields of standardization, factory organization etc.

The National standards organization IRAM working together with INTA and the factories has made good progress in the development of new standards together with the translation and adoption of ISO documents. There is still very little interest in this type of work by the medium and small factories. The majority of them have.

There are no cooperation barriers between the country and the rest of the world. In the last 8 years the stable currency fixed with the dollar made possible the periodic trips to fairs, universities, factories and training centres of different parts of the world.

There has been some progress in joint ventures between Brazilian and Argentinean partners and this phenomenon will grow in the near future.

Figure 1 - Plows: 1998 imports origin

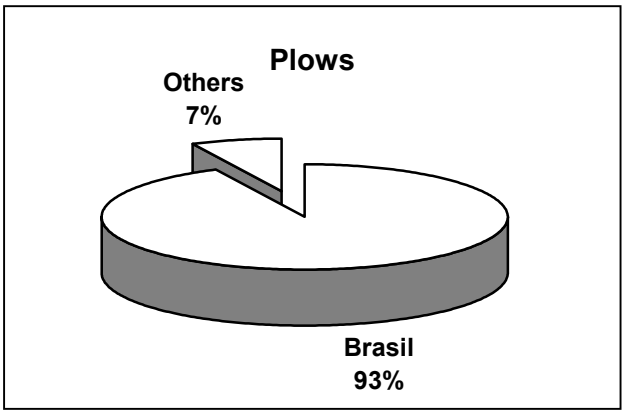

Figure 2 – Planters: 1998 imports origin

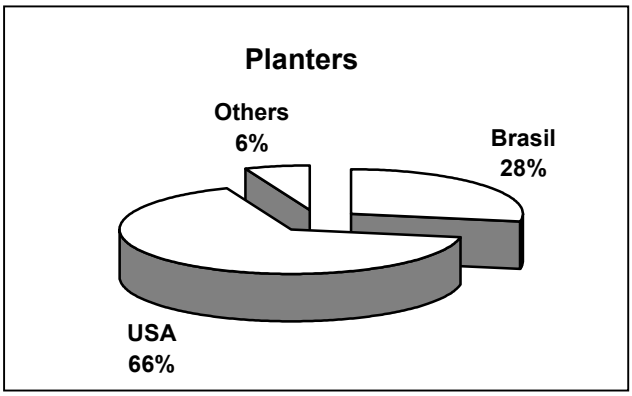

Figure 3 – Rotary balers: 1998 imports origin

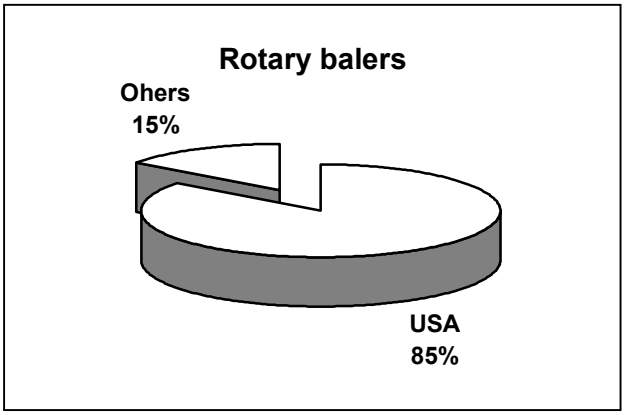

Figure 4 – Tractors: 1998 imports origin

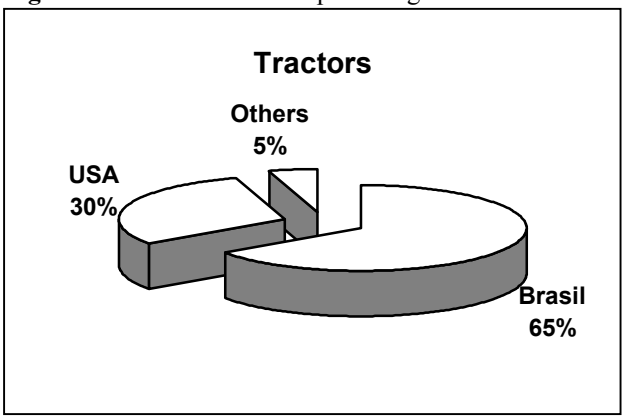

Figure 5 - Farm machinery exports. During 1998 farm machinery exports totalized a total FOB value of 16 million [Source: Administracion Nacional de Aduanas]

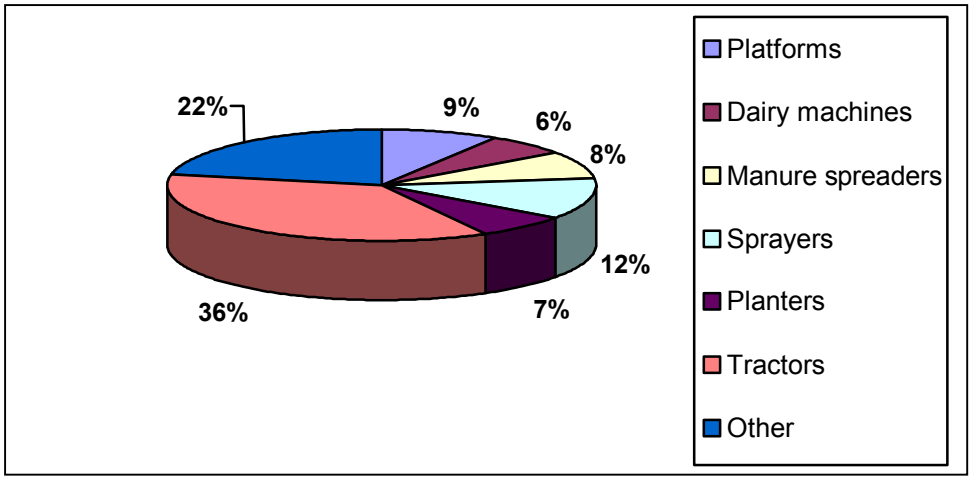

Table 1 - Number of tractors in the different provinces by age

PROVINCE	TOTAL	< 5 YEARS	5 TO 9 YEARS	10 TO 14 YEARS	> 15 YEARS
Buenos Aires	71,173	7,722	9,030	16,518	37,903
Santa Fé	44,265	5,252	4,165	11,033	23,815
Córdoba	49,484	6,182	4,393	10,504	28,405
Entre Ríos	15,526	1,127	806	2,989	10,604
La Pampa	7,838	1,164	860	1,584	4,230
Corrientes	4,297	414	500	1,335	2,048
Misiones	8,574	838	911	2,501	4,324
Chaco	10,057	482	533	3,219	5,823
Formosa	2,139	194	262	702	981
Catamarca	924	129	83	264	448
La Rioja	638	70	114	189	265
Salta	5,776	737	922	1,855	2,262
Jujuy	3,173	452	453	1,093	1,175
Tucumán	8,976	680	970	3,031	4,295
S del Estero	3,829	381	394	1,042	2,012
Mendoza	15,597	640	1,295	4,638	9,024
San Juan	3,746	155	461	1,363	1,767
San Luis	2,568	260	239	510	1,559
Río Negro	6,174 [3]	432	460	1,680	3,602
Neuquén	1,256	123	140	340	653
Chubut	1,317	47	81	275	914
S,Cruz	322	15	25	70	212
T. del Fuego	79	5	12	29	33
TOTAL	*267,728*	*27,501*	*27,109*	*66,764*	*146,354*
%	*100.0*	*10.3*	*10.1*	*25.0*	*54.6*

Table 2 - Tractor units sold

YEAR	TOTAL SOLD	AVERAGE POWER (CV)
1971	n.a.	63.8
1981	2806	90.8
1982	1507	91.0
1983	9064	102.8
1984	12781	106.4
1985	5597	104.1
1986	6461	95.4
1987	3198	98.2
1988	5017	100.0
1989	4655	103.5
1990	4614	102.8
1991	7978	109.9
1992	9515	103.9
1993	10305	108.3
1994	11293	102.3
1995	4800	112.1
1996	6433	113.4
1997	6841	117.2
1998	5740	100.9
1999	3430	110

Table 3 - Production of harvesters [Source: Cafma and Afat]

YEAR	UNITS
1983	1120
1984	1222
1985	660
1986	530
1987	260
1988	765
1989	950
1990	1120
1991	760
1992	1030
1993	557
1994	1011
1995	662
1996	1550
1997	1511
1998	1067
1999	551

Table 4 - Total number of harvesters by age and province [Source: INDEC, Censo Nacional Agropecuario, 1988]

PROVINCE	TOTAL AGE	< 5 YEARS	5 TO 9 YEARS	10 TO 14 YEARS	>15 YEARS
Buenos Aires	11,618	986	1,584	2,486	6,562
Santa Fe	5,059	905	856	1,518	1,780
Córdoba	5,149	711	737	1,208	2,493
Entre Ríos	2,356	84	98	386	1,788
La Pampa	1,333	95	149	263	826
Misiones	1,200	412	315	244	229
Corrientes	425	31	74	201	119
Chaco	472	39	68	138	227
Formosa	91	4	48	10	29
Catamarca	37	13	8	3	13
La Rioja	5	2	1	-	2
Salta	287	80	54	96	57
Jujuy	-	-	-	-	-
Tucumán	355	72	105	97	81
S,del Estero	-	-	-	-	-
Mendoza	-	-	-	-	-
San Juan	-	-	-	-	-
San Luis	118	11	15	22	70
Río Negro	-	-	-	-	-
Neuquén	9	2	-	2	5
Chubut	34	-	1	2	31
Santa Cruz	1	-	-	-	1
T,del Fuego	-	-	-	-	-
TOTAL	*28,549*	*3,447*	*4,113*	*6,676*	*14,313*
%	*100.0*	*12.1*	*14.4*	*23.4*	*50.1*

Table 5 - Harvesting area

CROP	AREA (ha)
Corn	2,530,000
Sorghum	800,000
Sunflower	2,650,000
Soybean	4,900,000
Wheat	4,800,000
Linum	700,000
Rice	1,50000
Others	3,470,000
TOTAL	*20,000,000*

Table 6 – Indicators for the agricultural and animals sectors

Table 1.7

Indicators for the Agricultural and Fishery Sectors (*)

1. Agricultural production (in tons)

Products	Harvests		Var.
	1997/98	1998/99	%
Cereals			
. Corn	19,360,000	13,198,000	-31.8
. Sorghum	3,762,000	3,222,000	-14.4
. Wheat	15,000,000	11,500,000	-23.3
Oilseed			
. Sunflower	5,600,000	6,817,000	21.7
. Flax	75,000	84,800	13.1
. Peanut	627,000	340,000	-45.8
. Soybean	18,732,000	18,500,000	-1.2
Industrial crops			
. Cotton	987,000	618,000	-37.4
. Sugar cane	16,692,000	15,857,400	-5.0
. Tobacco	116,510	113,700	-2.4
. Tea 1/	232,794	245,798	5.6
. Wine grapes	2,001,673	2,417,151	20.8
. Yerba mate 1/	281,573	286,770	1.8
Vegetables and Legumes			
. Garlic 1/	116,248	148,032	27.3
. Onion 1/	625,873	797,782	27.5
. Potato 1/	3,011,325	3,412,395	13.3
. Dry bean	303,000	340,000	12.2
2. Livestock production			
	1998 (III qtr)	1999 (III qtr)	%
. Cattle 2/	2,262,442	2,583,338	14.2
. Pigs 2/	434,628	517,433	19.1
. Poultry 3/	83,094	86,247	3.8
. Milk 4/	2,497,215	2,673,034	7.0
3. Fisheries			
. Ocean catches 5/	281,894	157,016	-44.3

4. Area sown with cereals, oilseeds, cotton and beans (in hectares)

Crops	Harvests		Var.
	1998/99	1999/00	%
Cereals			
. Canary seed	27,000	24,000	-11.1
. Rice	291,000	211,600	-27.3
. Oats	1,822,000	1,716,000	-5.8
. Brewers barley	218,000	173,500	-20.4
. Forage barley	24,000	20,000	-16.7
. Rye	372,000	380,000	2.2
. Corn	3,268,000	3,591,000	9.9
. Millet	89,000	80,000	-10.1
. Grain sorghum	880,000	838,700	-4.7
. Wheat	5,193,000	5,861,000	12.9
Total I	12,184,000	12,895,800	5.8
Oilseed			
. Safflower	15,000	26,000	73.3
. Colza	2,000	2,000	0.0
. Sunflower	4,097,000	3,665,000	-10.5
. Flax	102,000	68,000	-33.3
. Peanuts	337,000	219,050	-35.0
. Soybean	8,009,000	8,285,000	3.4
Total II	12,562,000	12,265,050	-2.4
Total I+II	24,746,000	25,160,850	1.7
Others			
. Cotton	751,000	471,800	-37.2
. Beans	431,000	300,000	-30.4
Total III	1,182,000	771,800	-34.7
Total I+II+III	25,928,000	25,932,650	0.0

* Provisional estimates. Information at December 23, 1999.

1/ Data corresponding to 1996/97 and 1997/98 harvests

2/ Slaughter controlled by SENASA, in head. 3/ Slaughter controlled by SENASA, in thousands of birds.

4/ In thousands of liters. 5/ In tons

Source: National Bureau of National Accounts, with data from SAGPyA, SENASA and INV

Table 7 - Evolution of the Argentine farm machinery market in the last four years

TYPE OF MACHINE	1995	1996	1997	1998
Grain harvesters				
Local production	210	574	680	510
Imports	365	599	767	798
TOTAL	*575*	*1173*	*1447*	*1308*
Plows				
Local production	1700	1890	1505	1215
Imports	145	116	99	186
TOTAL	*1845*	*2006*	*1604*	*1401*
Harrow				
Local production	3400	4420	4050	3330
Imports	144	308	333	566
TOTAL	*3544*	*4728*	*4383*	*3896*
Cultivators				
Local production	1200	1560	1700	1020
Imports	642	462	195	184
TOTAL	*1842*	*2022*	*1895*	*1204*
Drillers-planters				
Local production	3400	6080	4740	3900
Imports	301	391	382	374
TOTAL	*3701*	*6471*	*5122*	*4274*
Sprayers not manual				
Local production	2040	2420	2920	2420
Imports	374	557	909	1018
TOTAL	*2414*	*2977*	*3829*	*3438*
Forage machines				
Local production	820	660	510	380
Imports	283	337	333	511
TOTAL	*1103*	*997*	*843*	*891*

Table 8 - Growth of farm machinery imports

TYPE OF MACHINE	1997	1998	INCREASE (%)
Plows	99	186	87,87
Harvesters	767	798	4,04
Press for forage	333	511	53,45
Sprayers	909	1018	11,99
Harrow	333	566	69,96
Tractors > 45 HP	1775	2640	48,73

Table 9 - Iported tractors classified by power and type of traction [Source: Administración Nacional de Aduanas]

POWER RANGES	TRACTION	UNITS
< 45 HP	4x4	490
	Simple	9070
45< HP ≤ 65	4x4	143
	Simple	227
65 < HP ≤ 100	4x4	315
	Simple	331
100 < HP ≤ 150	4x4	655
	Simple	243
150 < HP ≤ 200	4x4	517
	Simple	30
200 < HP ≤ 300	4x4	75
> 300 HP	4x4	42
TOTAL		*12200*

Table 10 - Argentina crop area (ha)

CROP	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99
Cotton	553100	638800	614900	377747	503610	761500	1011000	956000	1134000	751000
Canary seed	58200	40200	35100	30235	22380	20975	20000	25000	25000	27000
Rice	132180	98000	147950	144100	148200	188520	211000	227000	248000	291000
Oats	2100000	1815000	2180000	2006100	1971400	1971835	1848000	1870000	1789000	1822000
Cart am	s/d	s/d	s/d	24200	19050	21000	14000	22000	27000	15000
Beer Barley	180000	147300	233400	239300	202050	147450	230750	278100	324000	218000
Forage Barley	94800	66200	54000	45500	40300	41387	31000	29000	19000	24000
Rye	595000	507000	451800	462900	460400	473000	390300	380200	353000	372000
Colza	s/d	s/d	45550	19870	7935	15900	10000	4000	2000	2000
Sun flower	2800000	2372350	2724375	2187100	2205800	3010440	3410000	3120000	3511400	4097000
Lignum	600000	589500	431300	215400	148360	156090	195580	94000	116000	102000
Corn	2070000	2160100	2686000	2962820	2781380	2957700	3415000	4153000	3752000	3268000
Peanut	170400	198000	153300	110000	133700	155210	239000	329000	407000	337000
Millet	105300	148000	122000	57700	69200	86700	89000	121000	107000	89000
Beans	213400	189630	188150	155700	193800	239600	265000	260000	293000	431000
Soybean	5100000	4966600	5004000	5319660	5817490	6011240	6002000	6670000	7176000	8009000
Sorghum	800000	751900	823200	809900	670380	621910	671000	804500	920000	880000
Wheat	5500000	6178400	4750850	4547700	4910000	5308000	5088000	7367000	5919000	5193000
TOTAL	*21072380*	*20866980*	*20645875*	*19715932*	*20305435*	*22188457*	*23140630*	*26709800*	*26122400*	*25928000*

DISCUSSION

Antonio PAGANI
After these exhaustive presentations I think we have enough material to exchange some points of view on these broad topics of technology transfer and international co-operation. As I pointed out this morning, we prepared a preliminary picture, just to offer an opportunity to better understand each other on the meaning of the words. Now the session is open and I ask to Prof. De Alencar Nääs to lead this session inviting you to make your comments freely.

Irenilza DE ALENCAR NÄÄS
In the morning we had three reports linked to the future of mechanization trends and requirements for the Latin American countries. But I would like to raise other few points to be discussed. The first: I want you think about is how to meet those trends in long, medium and short term. The second point is the standardisation. As far as I could understand from the three papers it still remains something vague; which strategy are we going to use to reach the standardisation? The third point is: even if all we want to do is the transfer of technology we have to ask our-selves: which kind of transfer would we like to have? Are we able to transfer to our neighbouring? Are we enough educated to supply to some of the neighbouring countries' needs?

Helvecio SATURNINO
BRAZIL
I appreciated very much the three papers. I understood that the mechanization work is very interesting, because you can have one approach and work for the future. It is clear that in this decade we have a lot of things to do as far as co-operation are concerned. We stared on 1972 and we took two decades to arrive to 1 million hectares in field crops. In the 90's we changed from 1 million to 12 million hectares; we are moving very fast and for this reason it is very important to better understand what mechanisation is.

Irenilza DE ALENCAR NÄÄS
I would like to ask a thing to Dr. Lara Lopez about educational guidelines. How do you see the points that I have raised here?

Arturo LARA LOPEZ
Regarding curriculum, there is a great variety of Agricultural Engineering curricula in Latin America. There are some schools where the engineering bases are quite strong and other where the mechanization or the contact with machinery is mainly view as an administration of machinery. I think it's important to move towards the training and education for engineers, to be able, in the near future, to develop machines appropriate to the peculiar conditions and problems we have in our particular regions or crops. For instance, some crops need adjustments that can be done only by engineers. We have to consider the technology transfer in total. The scheme presented this morning is excellent, but we have the educational part to consider too, not only as a way to end-up, but as a way to improve that received technology and to up date it with local talent.

Antonio PAGANI
You are perfectly right in both cases. When we talk about technology transfer we should consider that the industrial co-operation is just one part, and by it-self is not enough. I fully agree that technology transfer should take into account several aspects, where education is fundamental to build something for the future. I can tell you that in some specific undertaking we are involved in, we are now approaching the problem of technology transfer in a more global way. Our approach now is lightly different from that used in the past; now we are planning to send young engineers or agronomists into the country for few months to leave and work there. These men have to understand what the problem is in that specific area, what the situation is like and to report it to our manufacturers; then we can start talking about possible industrial co-operation. This is a big difference as compared to the past, when in most cases industrialised countries were approaching other countries by saying "Have you an irrigation problem? This is the solution". For me education is in both directions: we expect our experts to go there for few months to be first educated on the situation, in order to understand and explain later to our manufacturers which part of the technology could be suitable, or adopted there.

Irenilza DE ALENCAR NÄÄS
I would like to ask to Dr. Molin and Dr. Mantovani to make an intervention about what we said this morning and now during the discussion.

José Paulo MOLIN
BRAZIL
For me we have to consider two different worlds when we talk about mechanisation in Latin America. In Brazil we have the small family farm and the competitive enterprise. So when we talk about technology transfer we have lots of different experiences on that. For example people from developed European countries export small machines, or animal tools machines to Africa. We tried to do the same, but these machines never worked here. When we tried to work on some specific programme for small tractors using one imported, it didn't work. So that is the major aspect from the agricultural machinery point of view; we have to clearly separate the worlds and separately work for them. A family farm with 10 hectares of corn - which is quite the maximum for a small farm - will reach US$ 1,000 per year. Coming back to the precision farming my consideration is: it is

a technology for improving the production, but when the farmer first has a minimum of technology, because it comes from companies which develop the first step and then offer it to the farmers. The problem is that no one of these companies are based in Latin America, they all come from abroad.

Evandro CHARTUNI MANTOVANI
Let me try to make a comment about the technology transfer. In US they are using precision agriculture in addition to the conventional combines, GPS monitor, sensors and it's about US$ 7,000. In case of Brazil it will be necessary US$ 10-15,000. Can we pay this technology with the crop production? 25 years ago when I was working for my PhD in US this technology just started over there, now this technology comes here by industry. There will be no solution if we will not think on the educational process; we have to create an agreement between people from university, industry and research.

Antonio PAGANI
I would just like to mention that once more we have to consider technology transfer as something very complex, that incorporates several aspects and last but not least to consider the transfer as a way of managing enterprises and industry as well. Even a big company that undertakes big joint ventures it is not vertically integrated as many of the big enterprises in countries like yours. Transfer here the design of a machine from Europe may be done. Things change when you talk about the manufacture unless following the same managerial approach. In that way you are going to reach some negative economic results and that's for it becomes impractical.

Irenilza DE ALENCAR NÄÄS
I just want to make a comment on Molin's approach. I agree with him that specifically in Brazil we have two different worlds where the needs are completely different. But I still think that we can't stop developing high technology, as well as we can't stop helping the smaller farmers. You pointed the problem; do you have any answers for it? Do you suggest any particular way to solve this situation?

José Paulo MOLIN
1996 has been an important year for Brazil: AGCO bought Massey Ferguson; in the same year John Deere started making tractors in Brazil. Concurrently the small farmers are still here with no solutions for major problems. If we have to make programme for the future, I have no idea if those families will reached solutions for their surviving. As far as co-operation between and among farmers is concerned, I have to add that we are speaking about areas where the co-operatives are stronger, where the European culture is stronger than in the rest of the country. When I visited these small groups they have old machines, no money for replace them, no financial supports and this concerns the cultivation of corn even if now they are changing on beans, that are easier to sell.

Manuel CABRERA SIXTO
MEXICO
All the three papers we saw this morning presented similar situations. There are at least two kinds of farms: the small and the big, with a large variety of specific crops, linked to specific regional conditions. Somebody spoke also about the irrigation problem, the no-tillage and the use of precision farming. Prof. De Alencar Nääs asked about the educational aspect inside these particular realities. I hope that for the future the Latin American countries will include the teaching of these new technologies in the classrooms, because we have to work harder in the research area, the most part of the work on precision farming has been done on field. Concerning the transfer of technologies, it is very important for me to increase the exchanges of experiences between the Latin American countries, because unfortunately there are few examples of them, in spite of the number of machines and methods that we could exchange.

Luiz Carlos PAVANI
BRAZIL
I try to focus the educational aspect, because it is important to increase the training also of that people having to manage and plan inside an agricultural system. In the university planning we have about 30-40 mechanisation training courses, but they are only linked to the functioning, they don't point out the managerial aspect. This is for me a very important point to be developed inside the Latin American universities. There are 3-4 universities that are going to create post-graduated courses of 2-3 years, in order to allow students to go directly inside the farms to see the real problems and to solve them. These students are helped by professors to find the best solutions and to train also the farmer in finding solutions by him-self. Concerning the problem of technologies transfer, I agree with the other people when they say that in this globalisation era, the Latin American countries are still considered as poor countries, they haven't enough financial supports by the Governments. So they must be careful with the investments; a good idea could be to work together - 3-5 countries - to develop a topic, working hard in a specific direction.

Irenilza DE ALENCAR NÄÄS
Dr. Herrmann how do you see the technology transfer especially from an industrial point of view?

Paulo R. HERRMANN
BRAZIL
A company has to make money in order to survive; I work in a company that invest every day 1 million dollar. We are able to develop equipments for small farmers and small activities, but the problem is that they are not able to pay for them, or to take some credits. Some years ago when the car industry in Brazil launched a new model called "popular car", the Government invited us to make the same, developing a

kind of "popular tractor". Our answer was " We are ready to offer a popular tractor for US$ 10,000; which is the credit line to finance these farmers?" At least this is the point. Under this view we have not just to consider the specific farm size, because I believe that the size doesn't matter, the real question is "Is this farmer profitable or not?" We have a lot of cases of small farmers who have good income, they invest in new equipment and technology, because they are integrated inside the market, their production goes directly to some companies that pay the right price. So my point of view as industrial man is that I don't see the difference between small and big as everyone said before, the point is profitable and not profitable farmers. We are not against small farmers, we are producers and we are looking for buyers all the time, but for people who can pay us.

José Paulo MOLIN
I fully agree with Dr. Herrmann. The limit is not the farm size, but the profitability. Coming back to the educational point of view, I say that this is an aspect we must develop inside universities and even in the industry. In Brazil we have agricultural engineers and agronomists that are different in preparing a professional for the market. The agronomists have to cover the whole production aspects, not just the vegetable but also the animal ones. It is hard to come inside the market as a professional who knows a little bit of everything. To prepare professionals for agricultural machinery we have to consider how big is the market, where they will go to work: industries, universities with research institutes and private consulting services. The market is very small and for this reason we have to better prepare the people, to be sure to go directly inside the system. At this time we are not enough organised to know exactly what we need and what we have to prepare in terms of professionals. In the public education, speaking about operators, the farmer basically doesn't work in the farm, we have operators and people to operate with machines.

Manuel CABRERA SIXTO
I agree on the separation between profitable and non-profitable farmers, but I believe that we will find the challenges to make these people all profitable. This is a challenge for universities and researchers to provide technologies for them to be applied, creating a better way of life. For example precision farming is a way to do things and it doesn't necessary require high technologies. You can apply the principles of precision farming also for small things. We have big farmers with high buy power and small ones with minor buy power, we should help these last to have a better living.

Paulo R. HERRMANN
I want to add two comments. First is that the research institutions aim will be to convert these small farmers into profitable farmers, because is a governmental responsibility. When we see people with 10 hectares growing corn, it is clear that this is the case to convert the production in something with higher value; it is impossible to compete with the people growing corn in the centre-west part of the country with 5,000 hectares per farm. Second point is that: the machinery products developed in certain countries as US or Europe and that we introduce are not ready to well work in our conditions. We have to make hard work to adapt these machineries to our needs.

Arturo LARA LOPEZ
Regarding the small farmers, I don't think that small is the same as unprofitable. There are in Mexico very small farmers located in places where water is abundant, so that they are able to grow profitable crops that they export. Unfortunately this is not a general situation, you can find it in a small portion of the country. Other positive situations are linked to the fact that Universities have worked closed with some farmers groups, solving specific problems and creating good conditions to operate. Regarding curricula, I think it is very important to understand that the education is not only learning engineering sciences, because in addition to that we need to teach, to develop the innovative attitudes of engineers, to see how our students are able to face to a real problem and to find a solution; otherwise we will be far from educating people.

Paulo R. HERRMANN
I would like to know if there is the possibility to make co-operations within, for example, Universities and the Club of Bologna.

Antonio PAGANI
I try to summarise what I understood up to now and please correct me if I am wrong. The discussion at certain point turn out to distinguish between small and big farms and then between profitable and non-profitable situations. I completely agree on the fact that small doesn't necessary mean less profitable, I personally saw a small grower in Mexico producing roses for California and he was the richest man in his town, with just a small piece of land. I was very interested by the point of view of manufacturer, because it was very clear: we work for some return, who produces machinery is glad to sell his machines to whoever is in the position to pay for them. At a certain point it was mentioned that it is not our work to grate the non-profitable farmers, but it is a governmental duty. It is true, but at the end if the action of the Governments, or of the universities, or research institutions succeeds, small farmers become a fantastic potential for the manufacturers. Are the manufacturers standing by, waiting for the institutions to up-grate the small farmers or to convert the non profitable into profitable standards, saying "Now you have the money and me I have the product for you".

Paulo R. HERRMANN
We have different responsibilities. If you look there are some examples of industries integrated even without governmental decisions, but by decisions made by private companies in order to reduce their costs and to be more competitive to sell locally and to export

products worldwide. Related to the taxes problem I can say that now during the congress we want to review taxes, in order to reduce them, becoming more competitive.

Arturo LARA LOPEZ
I think that something that should be explored deeply is the possibility for small farmers to work with more innovative schemes. If a small farmer is growing corn using traditional tillage operations, he will loose money; but with a new scheme created by professionals there may be some alternatives.

Paulo R. HERRMANN
I was thinking about the theme, transfer of technology, in terms of solution. If we can discuss about technologies available for a specific region, can we discuss with universities, research centres and industries to have a clear and precise link to continue in the process? Discussion should turn practically in terms of what should be done, what kind of equipment should be produced, its price etc.

Irenilza DE ALENCAR NÄÄS
I want to come back repeating two considerations. First I want to insist in education: are we looking for a special curriculum to all solve these problems, are we going to search for this curriculum, or the target for us is only a burocratic amendment? Are we trying to create a professional that is flexible enough to solve his problem in different ways, or are we creating a professional for specific things? All these questions must remain in our minds because are very important. Are we training our students in the right way? I would like really to bring up the subject, because I think that the way we are dealing with our curricula today is obsolete. The other point is to work in a multidisciplinary team, we might not be able to get professionals complete, but we would be able to have groups walking towards the idea of mechanisation as a whole, not only tractors or agricultural machinery, but also processing and storing the products. All this is a potential investment, not only for training people, but from business point of view as well.

Paulo R. HERRMANN
This is the key-point in the discussion and it is not easy to answer. From one side we have the basis that means university studies and, from the other side, we have to follow the development. My question is: how can we help people when we are far from them and we don't know what happens there? We have to look more outside, being closed to the development.

José Paulo MOLIN
I agree on this; the point is that it doesn't matter where you are, the difference is the type of programme you are working on.

Claudio BIANOR SVERZUT
BRAZIL
My first comment is that I completely agree on what Prof. De Alencar Nääs said about education; also I think that the students should be closed to where the problem really is, as it was said: a student before starting in developing something should go to the producers, see and learn what the problems are. Just after that we can start in developing machineries appropriate to that specific case. Is there a university with a programme, which is able to give to the students the tools? Is there a company that finances the developing of specific equipments?

Irenilza DE ALENCAR NÄÄS
The point is that industry needs good students and good professionals, university wants to create good professionals and the professional him-self wants to be well trained, but timing for each segment is so different that we can not just run at the same time. I think it will still remain the major question for the whole world.

Claudio BIANOR SVERZUT
In my experience as university professor I can tell that there is another thing to point out: mainly our students come from urban areas and not from the countryside, they need to learn what the farmer is before they start to work.

Irenilza DE ALENCAR NÄÄS
I think the problem is that a student spends too much time for courses and not enough outside. I would like to know the situation in Mexico.

Manuel CABRERA SIXTO
In general, we have 5 years programmes with lots of courses and not much practice. Few years ago we included in the programme the idea that every student has to work in a farm, or a company for the summer period to have practice. At least during the 5 years he/she can spend about 10 months working in different places. The difference between urban students and non-urban students I think is just political. The people from rural areas haven't enough education, or they don't have good programmes in primary schools, they are not able to reach university. For this reason the most part entering in the university is coming from urban areas.

Arturo LARA LOPEZ
In addition, I can tell that probably the agrarian universities in Mexico may have more students coming form rural areas because they give scholarship to everyone and this is a good opportunity to be educated. The situation mentioned by Dr. Cabrera is more present in schools where the agricultural engineering is little stronger.

Irenilza DE ALENCAR NÄÄS
I just want to add a comment because this morning I spoke about the Argentinean case. I don't know the specific details, but in general they don't have special curricula for agricultural engineers. What they have is a basic curriculum, just as the same of the

agronomists, with some specialisations. As far as I know there is the same situation in Peru, Colombia etc. Why Latin American countries don't have similar curricula at least?

Arturo LARA LOPEZ
I think that the only point in common we need is to be more creative and innovative.

Marco FIALA
ITALY
Concerning the curricula problem, I can tell you the example we had in Europe. A CIGR work group, leaded by Prof. Pellizzi, made a research among the European countries to establish the different types of curricula required. The purpose, reached by this group, was to know the various countries situation and to create a homogeneous number of elements composing each curriculum.

Antonio PAGANI
Now at the end of our discussion we can make some comments and we can collect the ideas. First of all we have to come back to our primary position, without forget that we are here as Club of Bologna and so we have to answer to a question: "What has the Club to do now within this topic of technology transfer?" In order to answer that question I will try to put down in a sequence a sort of logical framework. If I understood correctly the starting point for discussing the topic of technology transfer is to know local conditions and take them into account in your operations. Study local conditions in terms of physical, social, technical, economic, educational conditions. A region, a country, an area have peculiar characteristics. Once these aspects have been identified and we know the conditions we are operating into, then we are in a position to identify the needs in terms of technology transfer: know-how, hardware, equipments, software education. So to be able to point out the various pieces that concur to compose the technology transfer. Then each topic needs to be studied more in depth and we - as Club of Bologna - have to identify the people who can do this. In order to clearly know what we want eventually to come up with, we have to define the terms of reference, knowing that a certain topic will be studied by a team going trough this term of reference. So we have to do an exercise that we can summarise in two sentences: to find out what to do and who is doing what. We should not forget that - since the Club of Bologna is dealing mostly with agricultural machinery mechanisation - in the end when we talk about technology transfer our contribution should be of facilitating the relationships and the exchange of information between and among utilisers and producers of agricultural machinery. My suggestion is that Club of Bologna should study more in depth these aspects taking into account all of your suggestions and perhaps really identify areas to be studied more and see among the members who can do something.

Marco FIALA
I invite you to give suggestions in order to prepare almost preliminary Conclusions and Recommendations. Then when we will come back we will deeply analyse the discussion and your comments in order to improve and put them into the final version. Next step will be to send to all of you a copy, to put it into the web site of the Club and on the proceedings.

Irenilza DE ALENCAR NÄÄS
I want to thank all of you for your participation; the discussion has been very fruitful for me and on behalf of SBEA I thank the Club of Bologna for the opportunity it gives us to have this first Latin American meeting.

Antonio PAGANI
Thank you Mrs. President for your words and your invitation and to our Colleagues for the contribution they gave to the discussion. I will refer to President Prof. Pellizzi your comments and I am sure that he will be very interested. Let me now draw your attention to the short guidelines prepared on the "Technology transfer in Developing Countries". Please, have a look of them and send to the Technical Secretariat your comments and suggestions. Thank you very much.

Annex

GUIDELINES FOR THE TECHNOLOGY TRANSFER IN THE DEVELOPING COUNTRIES

by ***Antonio Pagani****,* ***Marco Fiala*** *and* ***Giuseppe Pellizzi***
Italy

1. Introduction

Many and different are the patterns of collaboration (**Fig.1**) between industrialised countries (I.C.) and developing ones (D.C.), based on the technology transfer within the agricultural sector, there included tractors and equipment. The choice of one of these patterns much depends on the evaluation of the countries concerned and the companies involved which have to select the transfer modality most appropriate for the particular condition of the D.C. at issue.

As an indication, 8 to 10 different possible solutions (**Fig.1**) are available: from simple technical collaboration, aimed at meeting the country internal market, to increasing levels of technical assistance required, there included growing quantity of locally manufactured parts, up to a full-fledged joint-venture. This means a permanent (or long lasting) technical and financial involvement of the supplying enterprises.

Broadly speaking, the simpler types of co-operation mentioned particularly concern small-medium size enterprises and the simple technologies should only match, in most cases, the needs of the local market. On the contrary a *joint venture*: (often a technical and financial permanent or long lasting association between large, well established firms from I.C., and serious firms from D.C.) implies a comprehensive transfer of technological know-how – including high level, sophisticated equipment - from the I.C., with its financial participation and a rigid, technical control of the local D.C. production, capable to meet the requirements of internal and/or international markets.

2. Key factors for success

The success of these different co-operation forms much depends on:

a) the establishment of good relationship between the concerned parties and their reliability;

b) the mindful appraisal of all external factors in both industrialised and developing countries.

From a broad view-point, even the simplest forms of co-operation would necessarily call for:

- a careful evaluation of the seriousness of both counterparts, as well as the soundness of each productive structure and its marketing prospects;
- a detailed analysis of the local situation as far as materials to be utilised, the spare parts required, the assurance of their continuous supply and availability are concerned beside a clear identification of parts and components that could really be manufactured locally;
- an evaluation of locally available human resources, in both technical and commercial domains.

All this requires the use of locally trained people possibly supported in methods from I.C. In addition a responsibility feeling person (or a group) within the D.C. with a long vision and some resources, is required too.

Dealing with more articulated financial participation patterns and joint-ventures, requires an accurate evaluation of the external conditions, with particular reference to:

a) institutional and economic aspects such as political stability, industrial development policies and investment promotion initiatives in place, intellectual property protection measures, available credit facilities, financial terms applied;

b) social aspects including level of education of management and production staff, after-sale service technicians, final users and farmers;

c) organisational aspects such as the presence of: MIRDC (Metalworking Industry R&D Centres), extension and after-sale services, repair and maintenance facilities and their distribution over the territory, testing and certification centres - AMRTC – for agricultural machinery.

It is necessary to carry out previously an in-depth analysis of these external conditions, mostly linked to the establishment of joint-ventures, but also of interest to firms involved in simpler technical co-operation forms.

3. Institutional and economic constraints

In view of the fact that joint-ventures have long duration, it is indispensable, for the I.C., to look at the legislative framework in place, particularly as it concerns:

a) existing forms of financial support in the D.C. (granting of tax relief, their duration, maximum amount, guarantees insisted);

b) financial support, as well as insurance guarantees against political risks in the D.C.;

c) existing legislation on the intellectual properties and patents.

In various instances, however, the situation may differ, as an I.C. could have more or less interest about credit supports opening and insurance guarantee against political risks in a certain D.C., in association to the general political interest for that specific country, or that defined area.

Similarly, a Developing Country might adopt a different approach, depending on its political situation, economic and social conjunctures, development plans applied, as well as the government willingness to support the transfer at issue.

4. Educational constraints

The achievement of the agreement main economic goal also depends on the educational level of the staff, particularly as it refers to: production, after-sale technical assistance in place and characteristics of the buyers.

In fact, the success of our enterprise much depends on the compatibility and seriousness of the staff directly involved. At manufacturing level the problem concerns technical, administrative, commercial and financial staff as well as labourers, both skilled and unskilled.

The same applies to the personnel in charge of after-sale and technical assistance services. The lack of well trained people at various levels may cause unexpected and insurmountable difficulties that, consequently, may lead to a failure. In any case, also as it refers to the final users, the farmers, it is necessary to offer assistance for improving their technical capability of utilising and maintaining machinery and equipment, beside promoting tailor-made training courses aimed at increasing their knowledge.

5. Organisational constraints

These possible constraints mostly concern the assessment of allied facilities in place, both down and up-stream of production, but tightly linked to it. It means to ensure the presence and the effectiveness of Research and Development Centres in the Metallurgical and Mechanical sector (MIRDC), able to provide technical consulting services to enterprises, as it refers to the utilisation of locally available material, design and manufacturing of machines and relevant components. Such centres frequently exist in the various countries, but sometimes their impact, being little related to real productive needs, is unsatisfactory. Should adequate centres be unavailable, the input of the I.C. needs to be characterised by the highest possible degree of assistance.

The same applies to the Agricultural Machinery Research and Testing Centres (AMRTC) that are entrusted with the identification of the technology most appropriate for the needs of the country and, once implemented, with the assessment of its suitability from both the technical-managerial and the economic view-points.

The results shall be utilised to establish, in co-operation with the local manufacturer, extensive demonstration events and field trials.

Also in this case, the lack of such institutions (usually, but not always, state-owned, and often linked to existing technical high schools or universities) represents a considerable drawback. In fact, as there is no quality assurance for the marketable products, farmers may not have access to easy-terms credits and loans. In addition without an extension services network there's no vulgarisation.

Consequently, the I.C. firm has to provide for these lacks with higher costs and a more articulated organisational pattern even if a company from I.C. is mostly not able to send its best experts for long time to D.C. For that reason, top consulting personalities are often required for selected areas. In these cases a special financial support from I.C. Governments could help the success of the initiative.

6. After-sale services

Last but not least, it is necessary to verify the presence, over the considered territory, of after-sale services and, in particular, a machinery repair and maintenance network. The level of mechanisation, typical of a D.C., calls for the presence of such structures as a key for the success of the enterprise. To this end, not only it is necessary to foster an agreement between the local industry concerned and small local workshops, but also to train their staff, providing the right equipment for the job.

The equipment should possibly include one or more mobile workshops, to enable the technicians to provide assistance on the spot in case of urgent needs. The number of these stationary workshops and their location is closely related to the number of farms in a specific area , but, in general it has proved necessary to have one of them every 40-50 km^2.

Obviously, the production success much depends on this type of organisation, which is a burden for the new enterprises and has to be carefully assessed ahead of any sort of commitment.

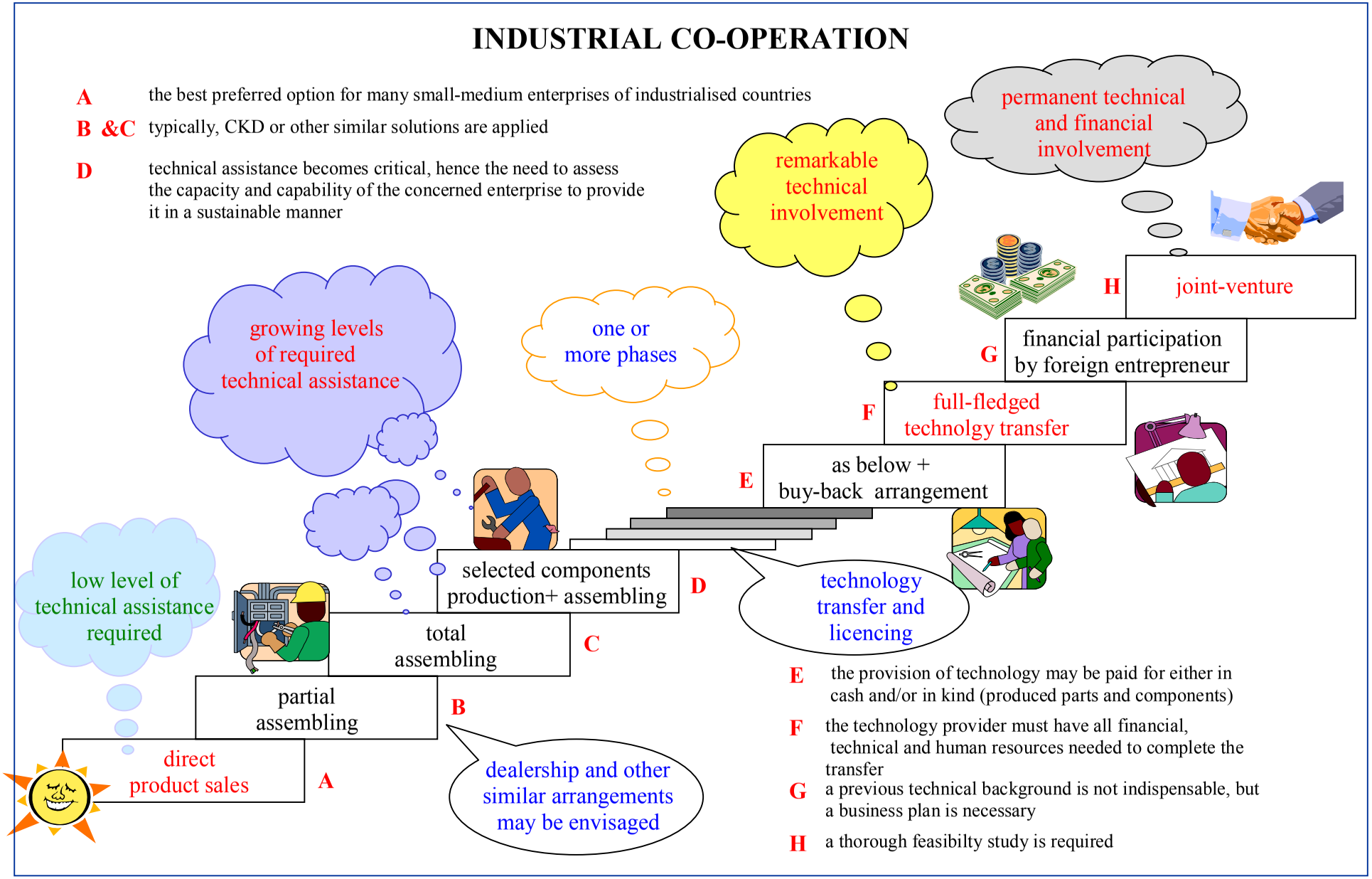

Figure 1 – Different forms of industrial co-operation

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