1.1 Agricultural Mechanization: its role in the development of civilization

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The long journey of human civilization began 10.000 years ago when humans, until then hunter-gatherers, thanks to the advent of agriculture had access to a food surplus that led to the formation of permanent human settlements.

From then until three centuries ago the development of human society was based on technical development of tools and facilities dedicated to primary economic sector and therefore it can be said that the “agricultural engineering” - in its earliest and simplest forms - was the first of technological innovation so it may be considered the mother of all future innovations.

A second major step took place in Middle Age with significant improvements in the agricultural techniques and technologies. The development of handcrafts and processing of iron improved the production of agricultural implements such plough and hand tools as well as animal traction techniques with horse shoes and harnesses.

Then with the advent of the Age of Enlightenment in 1700 which extends the application of the analytical methods and mark the beginning of modern science, agriculture undergoes a major transformation of both the farming system and the technical means that from “tools” evolve into “machines” in the modern sense.

Thus began the dramatic development of mechanization of the last three centuries that led to increase by more than a thousand times the productivity of human labor thus reducing employees in agriculture to 1-2% of active population in more industrialized countries.

Nowadays agricultural mechanization is facing two major challenges: from one side to produce food supplies for a growing population that is expected to rise to 10 billion in a few decades and on the other hand protect and preserve the environment.

An additional global strategic role of mechanization is its key role in the improvement of economic conditions of the less developed countries: a low level in agricultural engineering in generally associate to a high level of poverty while agricultural mechanization can reduce the number of people working in agriculture and increase the GDP of the country.

The exceptional development of agricultural machinery industry of the last decades is based on a growing globalization and on a worldwide networking and cooperation in order to reduce the production costs and to increase the quality.

Driving forces of modern farm machinery are automation and electronics with enormous progress in diffusion of IT technologies that have led to tremendous improvement in both efficiency and productivity of machinery and environmental protection during operations as has often been discussed in the Club of Bologna.

The contribution of mechanization to the goal of feeding the planet in the near future must also focused on the development of simple and cheap machines for developing countries in order to improve efficiency of the agricultural systems, reduce malnutrition and improve the economic conditions of those countries.
1.2 Sustainability. The industry approach for improving competitiveness and future viability

by Norbert Alt, VDMA – Germany (norbert.alt@vdma.org)

Today sustainability is not only a social requirement with respect to finite resources and climate change but primarily due to its holistic approach it also offers the opportunity to increase the competitiveness and future viability of a company. The VDMA Task Force 'Sustainability' was installed to provide specific recommendations concerning the development and application of sustainability criteria in order to assist VDMA member companies when implementing the principle of sustainability. The Task Force concentrates on the following items

- to develop a concept for the implementation,
- to develop a tool for assessing the status of the company's sustainability,
- to provide recommendations for presenting sustainability reports,
- to support the development of the international standard for sustainability.

The report will present the actual status of the discussion, provide detailed information about the available results and show the need for future actions.
2.1 Ongoing improvement on automatic milking, forage harvesting and sustainable energy production

by Evert J. Niemeijer, Lely Industries, The Nederlands (ejniemeijer@lely.com)

Due to the change of the agriculture world the agriculture industry has to change as well. The politics and the public opinion demand in the favor of human welfare, animal welfare and environment for changes. These changes are forces by agreements and laws created by the local governments, EU and UN.

Therefore the industry has to come up with solutions to solve this issues but of course to stay in business as well and to survive. The changes and the solutions can only be made by a company when the mentality of the employees of such companies changes as well. Only when they recognize the problems they are able to work on the solutions.

2.2 Intensive farming systems: efficiency and innovation for sustainability

by John K. Schueller - University of Florida, USA (schuejk@ufl.edu)

As the world’s population has passed seven billion and increasing standards of living have increased the demands for food, feed, fiber, and fuel, intensive farming systems in North America have risen to challenge of producing these items in a manner which is economically, environmentally, and socially sustainable. The very high level of productivity and efficiency, while maintaining sustainability, allows the North American farmer to produce enough food for over 140 people in North America and abroad.

Economic sustainability in North American agriculture is challenging due to the high costs of labor, land, and other inputs. In addition, the general high standard of living in North America demands that those involved in agriculture be sufficiently economically rewarded. The development of integrated systems of powerful equipment allows each agricultural worker to produce many tons of food or other agricultural materials. The complex systems of equipment reliably perform their tasks, thereby reducing economic risk.

Environmental sustainability is also promoted by contemporary intensive farming systems. Precision agriculture technologies insure that the needed inputs are supplied to maximize production while minimizing environmental impacts. For example, the right amounts of water and fertilizers are applied to growing plants at the right place and right time. Other aspects of agricultural mechanization systems are also designed, manufactured, and managed to efficiently perform their needed tasks.

Further developments in these systems will bring new technologies to performing the tasks of sustainable agriculture and overcoming the many current challenges, including climate change, decreasing arable land, and disparities of access to nutritious food. With proper support, further advances in such areas as precision agriculture, robotics, and information technologies will help produce enough food, feed, fiber,
and fuel to meet the needs of nine billion people in 2050.

2.3 Robot farming system in Japan

by Noboru Noguchi - Hokkaido University, Japan (noguchi@bpe.agr.hokudai.ac.jp)

Agriculture in developed countries after the Industrial Revolution has tended to favor increases in energy input through the use of larger tractors and increased chemical and fertilizer application. Although this agricultural technology has negative societal and environmental implications, it has supported food for rapidly increasing human population. In western countries, “sustainable agriculture” was developed to reduce the environmental impact of production agriculture. At the same time, the global agricultural workforce continues to shrink; each worker is responsible for greater areas of land. Simply continuing the current trend toward larger and heavier equipment is not the solution. A new mode of thought, a new agricultural technology is required for the future. Intelligent robotic tractors are one potential solution.

In Japan, the number of farmers is decreasing and aside from the fact the problem in aging farmers. In the near future, Japan farmers will decrease rapidly that will result to shortage in food production. That is why researchers in Japan are doing a research about robot farming system which is one of the possible solutions to solve the food shortage production.

This presentation will give the application of robot vehicles in agriculture using new technologies. The robot farming system will fully automate the farming from planting to harvesting until to the end user of the products. A robot tractor and a planting robot will be used to plant and seed the crops using navigation sensors. It includes a robot management system, a real-time monitoring system, a navigation system, and a safety system. In the robot farming system, the robot vehicles receive a command from the control center and send information data through a wireless LAN or packet communication. The robot vehicles such as a robot tractor and a robot combine harvester can perform its designated tasks and can work simultaneously with each other. The operator at the control center can analyze the data sent by the robot vehicles in a real-time basis and can immediately send the necessary information to the farmers, retailers, and producer’s cooperation, etc. Also, the operator can see the real-time status of the robot vehicles using a GIS while their performing its task.
3.1a Agricultural mechanization strategies for sustainable production intensification: concepts and cases from Africa

by Josef Kienzle - FAO/UN (josef.kienzle@fao.org)

The production of food in developing countries and especially Africa is generally very labour intensive particularly in smallholder agriculture. The manual work carried out by farmers and their families is arduous and time consuming and in many countries this is a major constraint to increasing agricultural production. Also, the day to day drudgery of farming is a major contributory factor in the migration of people, particularly young people, from the rural countryside to the prospect of a better life in towns and cities.

Agricultural mechanization is a crucial input to agricultural crop production, processing and transport. It is frequently very capital intensive, compared to other (usually annual) inputs and it has repercussions on the efficiency of input use – including seeds, fertilizer, water, and time/labour. It is also much more complex in its application, requiring not only correct use, but also a service infrastructure for maintenance and repair. For this reason it is essential for FAO, and especially its Plant Production and Protection Division (AGP), to embrace the agricultural mechanization sector and raise its efficiency in the context of Sustainable Crop Production Intensification.

Whilst agricultural mechanization is indispensable for agricultural production, it can also have very detrimental effects on the environmental sustainability of farming (soil compaction and erosion, tillage, chemical pollution). However if the correct technologies are applied, for example: climate smart practices such as conservation agriculture; safe and efficient application of pesticides; precision application of fertilizers; soil compaction management; efficient harvesting; and natural resource conservation, then sustainable intensification can ensue.

One of the major mandates of FAO is to assist member states to make their input supply and food production chains more effective and efficient and at the same time provide farmers with improved livelihoods. The effective and sustainable use of increased levels of mechanization is one of the most important means of achieving this.

FAO has, over the past decades, assisted a number of African countries to develop strategies for mechanization in order to achieve the goal of increasing levels of agricultural production and improving the livelihoods of farmers. This paper provides some lessons learnt from this experience. It highlights how crucial it is to clearly define and divide the roles for the public sector, as well as for the commercial private sector, from financing and operational arrangements for the use of agricultural mechanization, to training in the use of machines, their maintenance and the related private sector supply infrastructure for sales, and after sales services.
As for the way forward it is clear from the past experiences, especially for Africa, that mechanization cannot be an end in itself but must be part and parcel of an integrated and sustainable approach to rural development as it will have to contribute to face the challenges ahead for food production and sustained livelihoods in a scenario of increasing population, rural-urban drift and natural resource degradation.

3.1b Agricultural development and mechanization in 2013. A comparative survey at a global level
by Namal Samarakoon - UNIDO (n.samarakoon@unido.org)
This paper examines several rather broad questions: What are the world trend and evolution of agricultural mechanization? What are the factors driving the future demand for agricultural mechanization at global level? What would be the changes in the structure of domestic demand, imports and exports of agricultural machinery over the next 10 years? And what would be the future market penetration of selected high-tech innovative agricultural machinery? The findings of this paper are based upon a review of available industry data for agricultural mechanization and a survey targeting major Associations of Agricultural Machinery Manufacturers. The survey investigated questions related to: (i) General development tendencies likely to affect the future demand of agricultural mechanization; (ii) main field operations for the production of staple crops; (iii) Trade related to agricultural machinery – including implements, tractors and combines; (iv) the impact that selected issues (irrigation, organic production, and growth in the bio-fuel/bio-products markets) will have on the demand for agricultural mechanization; and (v) the technological trends for the sector over the next 10-20 years.

3.1c Advancing agricultural mechanization in Africa. What kind of public-private strategies are needed?
by Ulrich Adam – CEMA, Belgium (sp@cema-agri.org)
Agricultural mechanization levels differ dramatically across the globe. Africa remains the most challenging region for mechanization. In Sub-Saharan Africa (SSA), land productivity is among the lowest in the world, and Agricultural Mechanization has either stagnated or retrogressed in recent years. In order to untap the potential of mechanization in Africa in a sustainable and inclusive manner the public and the private sector will need to work together to nurture an adequate enabling environment that will allow the largely self-sustaining private sector to develop and operate effectively. The report will discuss which kind of cooperation mechanisms and strategies between public and private actors could be envisaged to ensure that agricultural mechanization efforts in Africa will succeed.

3.2 Low input production systems: innovation in mechanization for food security
by Gajendra Singh - Doon University, India (prof.gsingh@gmail.com)
With growing population food security remains a major challenge in many countries in Asia. As poverty is quite prevalent more than half the malnourished and under nourished people live in Asia. The share of agricultural labor is decreasing and urbanization is increasing. The share of agricultural sector in GDP is decreasing faster than decrease in agricultural labor force. In most countries power availability per hectare is increasing rapidly and this varies from region to region in the same country. The level of mechanization varies from crop to crop within same country. The labor productivity has increased with increased level of mechanization.
Main challenges for mechanization include, 1) small land holdings (average size is only about 1 ha) and majority of the farmers have low investment capacity; and 2) the use of sub-standard manufacturing technology producing poor quality products performing poor quality work, giving poor fuel economy and resulting in injuries and fatal accidents. Present low level of mechanization in many countries provides opportunities for growth by improved efficiency of utilization of machines available with farmers through custom hiring to neighbor farmers and or through larger operational holdings. There should be greater regional cooperation in information sharing, collaborative R&D, harmonization of standards, capacity building and trade and investment facilitation. There is a need for favorable government policies and manufacturing processes need improvements to produce quality machines with improved safety standards. There is need to develop and / or adopt low energy consumption machines and practices like no-till drills / planters and conservation agriculture.

3.3 South American Case: Brazilian tropical agriculture for food production

by Daniel M. Queiroz – Universidade Federal de Vicosa, Brazil (queiroz@ufv.br)
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Brazil has experienced a significant growth of the agricultural production in the last 40 years. Today Brazil is one of the most important producers and exporters of many agricultural products. To reach this position, Brazil, with the support of the national research, has developed many techniques for farm management in tropical areas. The innovative spirit of Brazilian farmers, associated to private sector contributions, has allowed the intensive use of technologies developed by the agricultural research, reaching high productivity of grains, fibers, livestock and energy.
4.1 Good agricultural practices, product traceability and food quality

by Josse De Baerdemaeker, KU Leuven, (Josse.DeBaerdemaeker@biw.kuleuven.be)

There have been major developments in the world related to food safety and traceability. Some of the initiatives come from governments to protect the health of the citizens, the other are private initiatives by growers and retailers in order to meet the expectations of their customers with respect to food safety. It appears that the origin and destination of animal feed, materials and food in all stages of production and distribution must be known and as information available to the qualified authorities or to food safety departments at manufacturers or retailers. For these reasons Good Agricultural Practices (GAP) standards have been developed for primary agricultural production. These standards are either government requirements or are developed in a partnership between retailers, food traders and growers. Global standards, accepted world-wide, can help to ensure integrity, transparency and food safety since sourcing of food, either fresh produce or processed farm products, has become a global activity.

In precision agriculture and automation a lot of measurements are carried out at different spatial scales (from single plants to entire fields) and at different moments during crop production. Precision Farming and the use of Global Positioning Systems (GPS) on agricultural machinery, provide location and time information of all treatments. It started with yield sensors, but at this moment tools are available for on the go measurement of the type and dose of treatments, for identification of the crop condition and possible infection with pests or diseases. Wireless communication can be used to transfer field data to record keeping software. One can see that Control Points and Compliance Criteria of a GAP scheme can to a large part be automatically addressed using precision agriculture technology for the automatic record keeping of fields activities.

Traditional traceability systems are mainly identification systems. The generated information is of a static nature and does not contain dynamic information especially in the post-harvest chain. Process conditions are relatively easy to measure but continuously measuring product quality is often not feasible. However, quality change models can be used to predict product quality based on the initial quality and the measured conditions. Quality change models can be integrated with traceability systems to lift these administrative tools to the level of decision support systems accounting for quality of the product going through the chain.

5.1 Farm of the future.

by Giuseppe Gavioli - CNH (giuseppe.gavioli@cnhind.com)

The evolution of the farms in the next 30 years will be impressive. There are several external drivers that will have a very strong influence on the farm of the future such as: the increase of food demand for growing world population and for growing individual food consumption, the need to increase productivity and efficiency of production on current crop land and to cultivate new land, the availability of new technologies for farm tools, the pervasive presence of information and data. The farming activities will also
have to be increasingly sustainable for the environment.

Farmers will interact more and more with global crop and food markets, which will increasingly drive farm medium to long term strategy, while they will be strengthening links and connections with local farm communities and groups, leveraging on local and regional networks for energy production and sharing, logistic optimization, information and services.