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Milestones in the development of agronomic management practices in crop production

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Summary

From the dawn of the history of the human race, agriculture has always been a profound activity of mankind producing food and feed as well as various plant originated materials for further processing.

Agronomy, like any other human activity, depends on the perpetual development of knowledge and technical skills, - in a modern context – science and innovation. This paper is intended to provide the reader with information regarding the main phases of the development of agricultural production from the Neolithic societies through the early Mesopotamian and Egyptian empires to the inventions of first organised learned society of Rome. The major research findings of the past two millennia including agro-chemistry, genetics and technical development are presented.

Such a review should not lead to any scientific conclusions, but rather a philosophical postulate similar to that of Jonathan Swift written some centuries ago: "And he gave it for his opinion, that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground, where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together".

Keywords: agronomic development, crop production, management practices

The roots of agronomic development

Any live matter upon the Earth is generated by solar energy in a direct or indirect way. Organic materials are produced by live systems which are all based on photosynthesis. Consequently almost all organic materials within live organisms are originated from autotrophic physiological processes based on plant's photosynthesis.

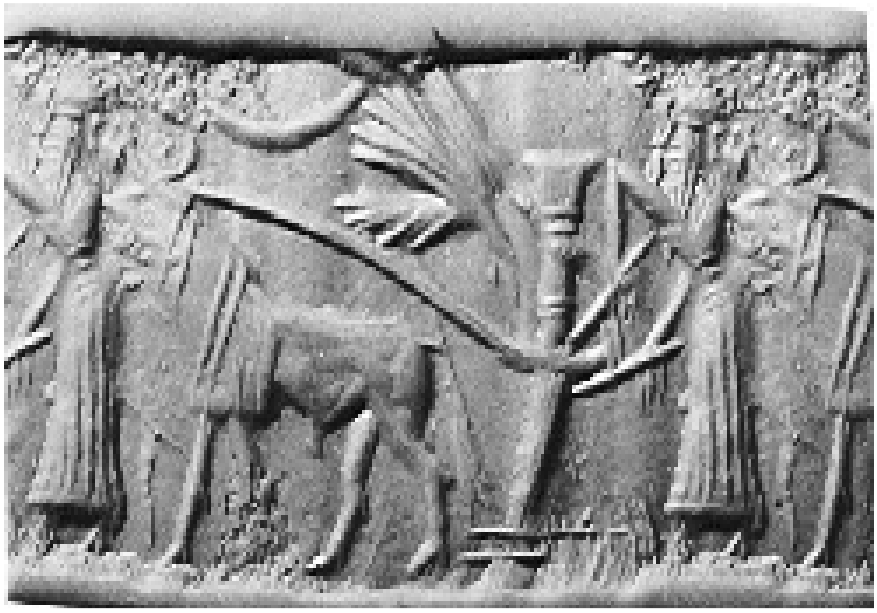
Agronomy is the science and technology of producing and using plants for food, feed, fuel, fibre, and land reclamation. Agronomy encompasses work in the areas of plant genetics, plant physiology, meteorology, and soil science. Agronomy is the application of a combination of sciences like biology, chemistry, economics, ecology, earth science and genetics.

The Paleolithic age is a prehistoric period that extends from the first appearance of humans, some 5 million years to the development of agriculture. These people were hunters, gatherers. They have taken away whatever nature has produced. Then mankind arrived to the phase called Neolithic Revolution. It happened some 10,000 years ago, when people first discovered how to cultivate crops and to domesticate animals. This is the most significant single development in human history.

Agronomy in the ancient ages

Mesopotamia was the first ancient empire, where soil tillage was applied in favour of increasing the productivity of land in the 6th to the 3rd millennia BC. It was the time from which period we have documented evidence of using animals to provide traction power for soil tillage implements. Also, Mesopotamia was the land where irrigation has been introduced (*Figure 1*).

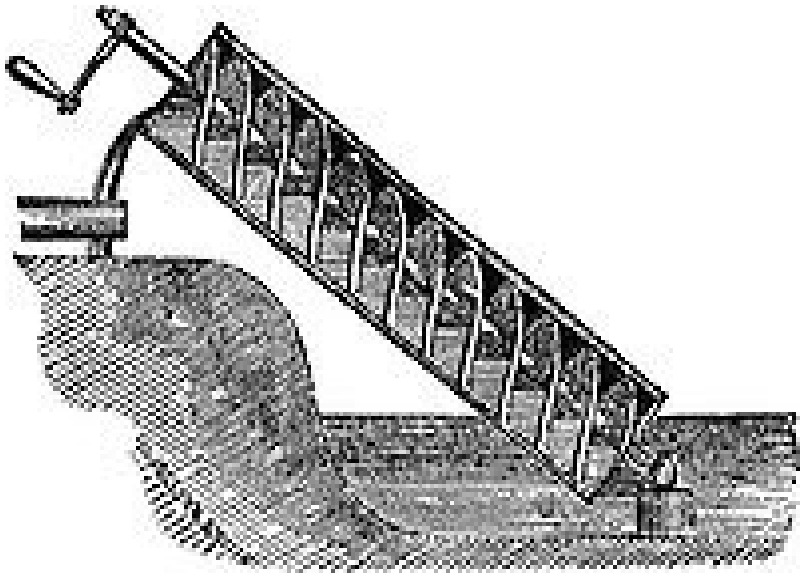
Figure 1. *Mesopotamian soil tillage implement (Pergamon Museum, Berlin)*



Egyptian agriculture from the 3rd millennium BC to AD used all the technical inventions of the earlier societies, and added some further knowledge to increase productivity. The traction power has been doubled using two oxen instead of one, threshing has been introduced

serving the purposes of more developed milling techniques. But the most ingenious invention of that age was the introduction of water elevation systems that could contribute to a more efficient use of water. The Archimedes screw was a real innovation of engineering however no one knows the origin of that (*Figure 2*).

Figure 2. *The Archimedes screw*



The most crucial period in the development of agriculture was without any doubt the age of the Roman Empire. The first implement still in use up to now was the invention of the mouldboard plough. Since the First Century AD the threefold action of the implement; turning, mixing and disintegrating serves as a technical basis of all soil tillage operations.

Rome as a learned society was the first to set up exact crop production technologies. Many Roman writers, like Varro, Cato or Columella have compiled useful handbooks to broadcast knowledge in an organised way to people involved in agriculture of their age. Some of the information proved to be very durable. Columella's handbook titled „De Re Rustica", written in the 1st Century was translated to most languages and used as a basic textbook in agricultural education for almost two millennia until the end of the Nineteenth Century. Most of the statements and technical hints regarding land use, soil tillage, crop production, animal husbandry, forages and food are still valid in our age.

Development in the recent centuries

After the fall of the Roman Empire for more than a millennium there was no considerable development in agriculture. Some early shy attempts in the field of natural sciences during the 17th and 18th Century were leading to a real scientific revolution again. The development of chemistry and almost two centuries were needed afterwards to the basic inventions of physiological processes by von Liebig, Lawes and Boussingault. Justus von Liebig a German scholar has described the level of development with the help of a barrel, where staves are uneven in size. According to his thesis, plant growth is determined by the minimum level of a certain plant nutrient. His theses were clear and widespread, however they were immediately doubled by Sir John Bennet Lawes an English nobleman who tried the theses in his replicated exact field experiment and could not verify them. Who was right and who failed? Both of them were right, however the discrepancies were induced by the system of approach.

Liebig as a chemist has followed a static model, and Lawes as a practicing landlord made a dynamic assessment. A third scientist and a new invention were needed to formulate the physiological process. Jean Baptiste Boussingault a Frenchman described first the Nitrogen cycle and so gave an explanation to diverse situation. Also, it was the time when urgent need appeared in establishing exact field trials to provide in vivo conditions for research in plant physiology. Chemistry has contributed to the success of plant nutrition and plant protection.

Another key field of development was the introduction of genetic measures in breeding. The fact that living things inherit traits from their parents has been used since prehistoric times to improve crop plants and animals through selective breeding. The first scientific assessment, a real breakthrough was experienced in the 19th Century, only. Johann Gregor Mendel, a Roman Catholic priest, abbot of the Augustin order in Brno, botanist was the founder of the modern scientific genetics. He set up the principles of inheritance. He is often labelled as the „Father of genetics", however the word "gene" has never been written by him. Breeding tasks are as follows: improve yielding ability, resistance to pests and diseases, quality improvement (protein, sugar, oil content, milling- baking properties etc), technical features (resistance to lodge, fiber length, uniformity etc), physiological characteristics (ripening, proterandria, tillering, male sterility etc), subjective characteristics (colour, odour, taste etc).

Today the most controversial innovation agronomy has ever experienced is the use of GMOs (genetically modified organisms). In case of sexual reproduction transmitting genetic information is done by creating a diploid formation of haploid cells by fertilization – the union of male and female gamets. In case of GMO, genetic information is

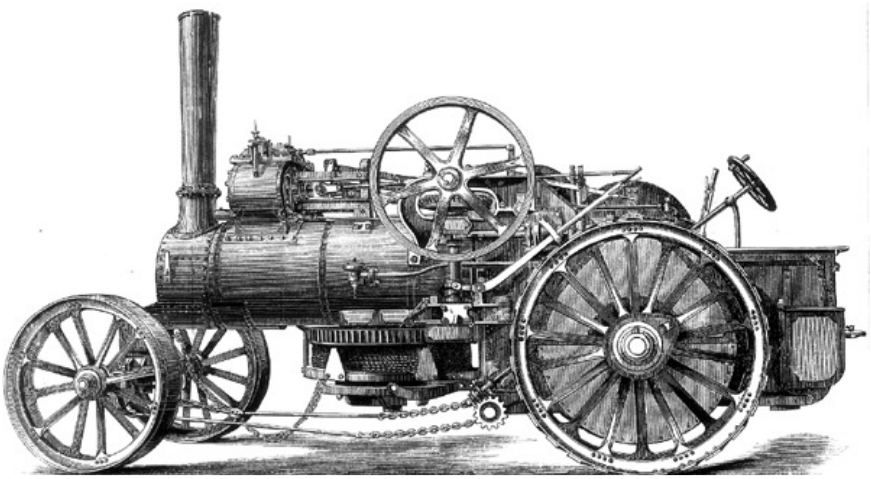
transmitted by genetic engineering, when the molecules that carry information are partly or fully modified in their chemical structure. GMOs are no wonder solutions but reliable tools in breeding. They may contribute to the improvement of biological bases in a quicker, more target oriented and efficient way. However there is a public concern about the opposition of that. Instead of useless prosecution of GMO applications, a new emphasis should be given to the field of its research, better understanding, and moreover to successful agronomic uses of that.

On the other hand there is an urgent need to establish safe and efficient regulation systems for controlling its uses.

A further milestone in the development of management techniques is the role of mechanical engineering. Technical development has always been important in solving agronomic tasks, like to those happened in the prehistoric and ancient ages.

Modern times yielded novel technical solutions as well. The industrial revolution of the 18th and 19th Centuries resulted in a wide range of technical innovations. Without any ranking there are some examples to highlight them. The first should be the engineering inventions that have improved mechanization is general and almost unlimited traction power in particular. These were the application of steam engines (*Figure 3*), Otto, Diesel and electric motors to vehicles and to stable devices. The development of material sciences, especially metallurgy and the invention of various plastics have resulted in unforeseen technical solutions in the milling industry, in soil tillage quality implements, in transport and storage.

Figure 3. *Steam locomotive (Pallas Nagy Lexikona, 1896)*



The birth of informatics or IT in general has opened a new phase for all sort of agronomic applications. The use of site specific precision techniques based on GPS (global positioning systems) and GIS (geographic information systems) applications led us to a brave new world. IT technologies provide new chances for more efficient and environmentally sound agricultural applications however the high theoretical expectations are not always reliable.

Complex measures are needed for a more thorough improvement involving physical, chemical, biological knowledge as well as the development of system approaches.

Really, in the row of milestones there is one more, that cannot be specified neither by time, nor by space. It is the complex application of the management techniques. During the history of agriculture there were many innovations in the system approaches that were not new in their elements, but provided a sort of a compilation that was more efficient in use. Such were for example the Norfolk four course rotation of Arthur Young, or the dry farming system of Campbell, A. (*Figure 4*) wide range of Hungarian scientists contributed to the implementation of certain specific crop technologies like János Nagyváthy, Emil Grabner, Adolf G. Manninger, János Surányi, Károly Kolbai, Béla Győrffy, József Antal and Ernő Bocz.

Figure 4. *Campbell's Soil Culture Almanac*

Agronomists today are involved with many issues including producing food, creating healthier food, managing environmental impact of agriculture and extracting energy from plants. Agronomists often specialise in areas such, as crop science, irrigation and drainage, plant

breeding, plant physiology, soil classification, soil fertility, and weed, insect and pest control. Our task is to supply 7–8–9 billion people.

Upon this overview no scientific conclusions can be drawn. May be a statement of Jonathan Swift written some centuries ago can give some hints to the reader: "*And he gave it for his opinion, that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground, where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together*".

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