THE GENESIS AND FUTURE OF AGRICULTURAL ENGINEERING

Assoc. Prof. PULS Karol Durczak
Department of Biosystems Engineering
Faculty of Environmental and Mechanical Engineering
Poznań University of Life Sciences
Wojska Polskiego 50, 60-627 Poznań, Poland
karol.durczak@up.poznan.pl

Abstract: The significance of agriculture and agricultural engineering is usually appreciated only during a crisis, because a well-organised society has a surplus of agricultural products, which prevents panic. Now that the world is facing a pandemic, it is time for historical and philosophical reflection. The history of the world shows a strong correlation with agricultural engineering. There are only a few scientific disciplines which can boast a biblical origin, e.g. culture and religion sciences, theology, and canon law. St Joseph of Nazareth was the first known craftsman to produce agricultural equipment such as ploughs and yokes for oxen. For this reason, all sympathisers of modern agricultural engineering can be considered 'chosen people', marked by 'divine calling'. This article also explains how St. Joseph is related to workshop metrology, standardisation, as well as publishing houses, associations and organisations established by supporters of agricultural engineering.

Keywords: agricultural engineering, genesis, Joseph of Nazareth, metrology

1. Introduction

The development of civilisation is closely related with progress in agriculture. This also applies to agricultural engineering, whose historical domain can be presented in the following way: mechanisation of plant production, mechanisation of animal production, mechanisation of horticultural production, food industry engineering, organisation and management in agricultural engineering, agricultural power engineering, electrification and automation in agriculture, agrophysics, transport in agriculture, agricultural building engineering, drying of agricultural produce, mechanisation of agriculture in mountain areas, modelling of production processes in agriculture and technical infrastructure of agriculture and its surroundings [1].

This list can be further expanded by other historical stages of the development of modern engineering: agricultural machinery design and technology – mechanised agriculture – agricultural technology and finally – agricultural engineering [2].

According to the CIGR (*Commission International du Génie Rural*, since 2008 – International Commission of Agricultural and Biosystems Engineering), agricultural engineering is a much broader concept. Agricultural engineering has been applying scientific principles for the optimal conversion of natural resources into agricultural land, machinery, structure, processes and systems for the benefit of man [3].

Challenges of agricultural engineering technologies in 2020 are included in the document Agricultural Engineering and technologies – Vision 2020 and Strategic Research Agenda [4]. This paper contains the Vision 2020 and the AET Strategic. Research Agenda (SRA). European manufacturers of agricultural engineering technologies are the number one players. They have the highest rate of world exports of agricultural technology and they lead the world in the development of future-oriented new technologies.

Modern agricultural engineering is focused on the following socially important problems:

- economical water management as a limiting factor in the production and processing of biological raw materials,
- a new approach to economics and organisation of work in agriculture, especially in the context of its subsidisation,
- organic farming, genetically modified plants,
- bio-materials for the production of biofuels,
- multipurpose, including non-agricultural use of mountain and foothill areas,
- the use of electronics in agriculture,
- production of biofuels [5-7].

Without the development of agricultural engineering there would be no surplus of food for humanity, because crops could only be grown along rivers, which periodically flood and fertilise fields. Agriculture would still be the same as it was in the heyday of Mesopotamia – the cradle of modern agriculture. Wheat and barley seeds would be sown individually and harvested manually – one ear at a time.

Until 2019 agricultural engineering was a discipline of agricultural sciences. However, due to changes in Polish legislation concerning higher education, mechanical engineering, which has been present in

technological sciences for decades, was arbitrarily transformed into the current discipline. It is a pity, because agricultural engineering is one of the few sciences (apart from theology, philosophy, algebra, metrology, astronomy) that dates as far back as about 2,000 years ago to ancient Mesopotamia. The aim of this study is to specify the role of agricultural engineering in modern science and practice by presenting its origins in early Christianity.

2. Discussion

Thanks to St Joseph of Nazareth, the earthly father of Jesus, husband of Mary and patron of the Church, those who practise agricultural engineering could be regarded as chosen people.

However, this is not the case. Thanks to St Justin, who lived a short time after the times of the Apostles (around 100-160 AD), we know that St Joseph was a carpenter. According to St Matthew, Jesus was '*the carpenter's son*' [Mt 13, 55]. St Mark described Jesus as '*the carpenter, the son of Mary*' [Mk 6, 3]. The actual word was *faber* (Hebrew, *charash*), i.e. a builder, labourer – craftsman repairing agricultural tools and wooden objects. Thus, he was the first known ecologist, although probably unaware of this fact.

In a small village he was the only craftsman who worked in wood under modest conditions. Therefore, he is often referred to as 'the man with a saw' (Fig. 1).

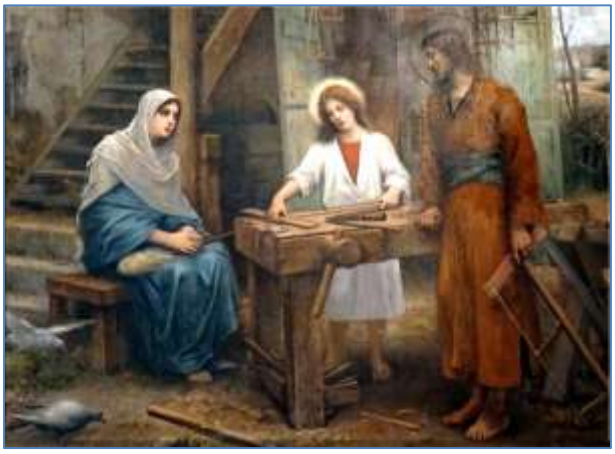

Fig. 1. 'The man with a saw' with his family; the original painting titled '*Jesus helping St Joseph in his workshop*' is in St Joseph's Church, Nazareth. Public domain

St Joseph was a carpenter, who made beam scaffoldings on the walls of houses and flat roofs of brushwood, straw and clay as well as stone and iron, which had been known for 1,000 years. Saint Joseph made simple agricultural tools like ploughs, which resembled Polish medieval ploughs (Fig. 2), significantly different from modern constructions [8, 9].

Figure 2. A wooden swing plough, Agricultural Museum, Szreniawa, Poland

This corresponded to the agricultural nature of Nazareth, as was proved by archaeological excavations. Unfortunately, no artefacts have been preserved. This may have been caused either by ignorance or wear and tear. The durability of modern ploughs, which are made of good steel, is estimated at 15-25 years in Poland, whereas in Switzerland (the method developed by FAT Tänikon, currently Agroscope Reckenholz-Tänikon) it is only 12 years [10].

When Jesus lived in Nazareth (He lived there for 29 years), it was an ordinary Galilean village where plants were grown and animals were bred. As early as then, the work of a carpenter, who was a qualified craftsman,

was valued and well paid. It ensured fair living conditions for his family of three. This allowed St Joseph's only child to acquire good and costly education because when Jesus was 12 years old, He was able to have disputes with priests at the temple in Jerusalem. Jesus worked as a journeyman for his father.

Thus, St Joseph of Nazareth was the first known plough-maker. He operated as a family business, without a brand name. So far no one has used such strong connections for marketing purposes, which means that contemporary manufacturers of machinery for basic soil cultivation are not much aware of this fact. St Joseph's activity was specific to the discipline of agricultural engineering.

He was described as a pure, righteous, hard-working, pious, prudent, faithful, courageous, trusting and caring man. Due to these traits of his personality he was included in the liturgy of the Catholic Church. 19 March is the feast day of St Joseph, who was the husband of Mary and patron saint of the Catholic Church. He is also the patron saint of working people, educators, poor people, refugees, and even the Internet. As St Joseph made agricultural machinery, he might also be revered as a patron saint of agricultural engineering.

The development of agricultural engineering is a denial of wars and the pursuit of peace. The vision of Isaiah, son of Amos, regarding Judah and Jerusalem [Is 2: 1-5] gives us the answer what to do to be given the peace of God's kingdom '*And He shall judge among the nations, and shall rebuke many people: and they shall beat their swords into ploughshares, and their spears into pruning hooks.*' This message is obvious but not practised and not widely known. Increasing amounts of money are spent on armaments also in Poland. It is impossible to stop this global trend even with the word of God.

It is significant that artists, especially painters, depicted St Joseph holding an angle bar in his hand (Fig. 3).

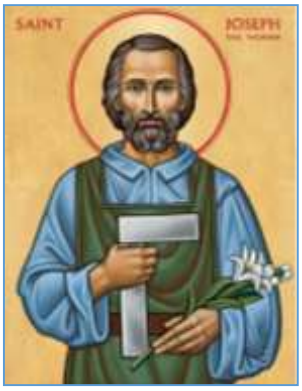

Fig. 3. St Joseph – a metrologist. Public domain

The application of technical metrology as a science about measurements is necessary not only at the stage of design and production, but also the operation (repair) of all technical facilities, including agricultural machinery. The angle bar is a basic tool in each repair workshop because it enables workers to check the right angle quickly. However, it is more likely that the 90° angle pattern was used for stonework. As a craftsman, St Joseph probably also used other metrological instruments such as graduated rulers to measure length.

It is interesting that the Bible provides a wide range of examples of metrology, specifically the standardisation of measures, weights and money in order to bring order to social and economic chaos. Saint John the Evangelist, who described Jesus' first miracle in Cana of Galilee [Jn 2: 1-11], mentioned waterpots of stone, containing two or three firkins apiece (Hebrew measure *bat* ≈ 40 l).

The standardisation of measures is an endless and constantly improved process, which favours globalisation. It was forced by trade development and navigation. The beginnings of standardisation were turbulent. Fair trade required reliable weight units. People were inspired by nature, so about 3,000 years BC the first weights were created in Mesopotamia. Powers developed through trade. However, the grain-based system was not perfect. England used pounds – the unit developed in the Roman Empire. Originally, the pound was equal to 12 ounces, whereas one ounce was equal to 437 barley grains (Fig. 4).

Fig. 4. It is hard to believe that barley kernels could be reliable weights

The smallest weight unit in the Imperial system is grain (gr). It is based on one barley grain (Latin *granum*), whose weight is unfortunately variable. Experiments showed that the average barley grain weighed only 65 mg. An inch is a unit of length, which originally was equal to a triple length of an average barley grain.

Since 1991 the supporters of agricultural engineering in Poland have been associated in the Polish Society of Agricultural Engineering (PTIR). It integrates the national agricultural engineering environments, organises scientific conferences and schools and publishes scientific and technical documents. The Society has its statute, which specifies its goals and means of action, its members' rights and duties, its structure and authorities. It also provides information about its 8 local branches.

The statutory goals of the Polish Society of Agricultural Engineering are as follows:

- inspire and support technical thought and thus contribute to the development of the food economy complex in Poland,
- initiate and support scientific research, development and experimental works as well as other agricultural engineering studies,
- participate in the implementation of technical progress innovations in the food economy complex,
- support and participate in the education and training of agricultural engineering specialists at all levels.

Agricultural Engineering is a journal published the Polish Society of Agricultural Engineering (PTIR). It has no impact factor (IF). According to the list of the Ministry of Science and Higher Education of 18 December 2019, its current value is only 20 points. Since July 2019 *Agricultural Engineering* (ISSN 2083-1587, e-ISSN 2449-5999) has been assigned to the discipline of mechanical engineering (UIC 200186).

The publishing house in Cracow publishes articles in English, which encompass 5 broad thematic areas, i.e. agricultural engineering, production engineering, food processing engineering, machine construction and operation, and renewable energy. In reviewers' opinion, the articles published in the journal are of high value and they significantly broaden the knowledge of agricultural engineering.

3. Conclusions

Agricultural engineering has the most outstanding creators, founding fathers, and prophets in the literal sense of this word. The word *creator* has not been abused here, because we mean St Joseph of Nazareth and his son Jesus, who established the first officially known agricultural machinery business. The most famous son of Nazareth often talked about sowing grain and harvest, shepherds (the present-day agricultural producers) and vineyards, but His words were allegoric. Although He was not a farmer but 'harvested crops' and today He has the most followers of all religions in the world (33 %).

Does this mean that agricultural engineering should disappear? It has already disappeared from the Polish Academy of Sciences. The only remaining organisation is the Polish Society of Agricultural Engineering with its 'faithful' supporters. Indeed, the ones who practise this discipline are chosen people, but not much perceived or respected.

Nowadays agricultural engineering is transforming into bioengineering to meet the requirements of contemporary times. For example, in the last 50 years the Institute in Poznań has changed its name from the Institute of Agricultural Mechanisation, through the Institute of Agricultural Engineering to the Institute of Biosystems Engineering (from September 1, 2020 Department of Biosystem Engineering). This is the future. In addition, due to the requirement to adapt Polish higher education to the EU standards our discipline was arbitrarily transformed into existing mechanical engineering. This meant that Polish scientists who have achievements and diplomas in agricultural engineering since October 2019 have been operating in a new different reality. Not only the discipline has changed. In consequence, the research area has also changed from agricultural sciences to engineering and technical sciences. It will take long years to strengthen the former agricultural engineering among engineering and technical sciences.

All we can do is work at the grassroots and use solid knowledge. Like St Joseph, who was a craftsman, an entrepreneur should speak with actions. Just as he was able to work in a foreign environment, agricultural engineering is so well known that it will find its place outside the group of agricultural sciences.

Biosystems engineering seems to be the science of the future due to contemporary biodiversity. It guards the normal function of each state. In hard times, e.g. in an epidemic emergency (e.g. SARS-CoV-2 virus causing COVID-19 disease), agriculture still provides agri-food products in an uninterrupted manner. It prevents panic and other unpredictable adverse socioeconomic activities. Agricultural production based on modern equipment is part of the normal function of each country on all continents. According to the National Veterinary Chamber, coronavirus is not transmitted through food or animals. According to the World Health Organisation and the World Organisation for Animal Health, currently there is no evidence that humans can be infected with coronavirus by domestic animals. Only a global pandemic lets us notice the areas of life and

science that are really relevant to society. Although microbiology was underestimated, at present it is a science of utmost significance. It is followed by necessities such as food and hygiene products. An efficacious vaccine against coronavirus is the most important issue at the moment, whereas culture, sport, tourism, cars and politics are of much lesser importance. Agricultural engineering is an essential element of a secure food supply chain. If this chain is broken, various sectors in the economy of each country will collapse. Agricultural producers' awareness will help us to get out of the current chaos unscathed.

Finally, there are two more specific examples showing the role of agriculture (including agricultural engineering) in crisis. Rectified spirit, which is made by processing agricultural produce, is an essential and basic component of hand sanitizers. SARS-CoV-2 can be killed with alcohol with an ABV of at least 70 %.

This publication does not have many references, because it does not repeat well-known facts. Individual chapters are the result of the author's considerations, where the discipline he has been practising for 30 years is confronted with brutal and unpredictable reality. In addition, the issue of the coronovirus epidemic is so new that it is difficult to make analyses and polemics. Agricultural engineering, which for centuries has been functioning continuously in the background, like the quiet worker – St Joseph of Nazareth, deserves more recognition from society, because it is an element in the food supply chain. Farmers are still strong [11].

'*Beloved father, father of tenderness, obedient and hospitable; the father of creative courage, a worker, always in the shadow'* – Pope Francis used these words to describe St Joseph in the Apostolic Letter "Patris corde" ("With a Paternal Heart"), published on the 150th anniversary of the proclamation of the Spouse of Mary the patron of the Catholic Church. It was Blessed Pius IX who bestowed this title on St Joseph by the *Quemadmodum Deus* Decree of 8 December 1870. To celebrate this anniversary Pope Francis announced a special "Year" dedicated to the Guardian of Jesus until December 2021. Therefore, St Joseph's merits for modern agriculture deserve a mention.

References

[1] R. Michałek and M. Kuboń, The future of agricultural engineering". Agricultural Engineering, **18(3)** (2014) 247-252.

[2] T. Juliszewski, Agricultural Engineering from the CIGR's perspective. Agricultural Engineering, **18(3)** (2014) 237-245.

[3] *CIGR Handbook of Agricultural Engineering. Vol. I - VI, Edited by CIGR – The International Commission of Agricultural Engineering*. Published by the American Society of Agricultural Engineers USA, 1999.

[4] R. Frerichs, *Agricultural Engineering and technologies – Vision 2020 and Strategic Research Agenda of the European Agricultural Machinery Industry*. Brussels, 2006, http://www.manufuture.org/wp-content/uploads/AET-Vision-and-SRA1.pdf

[5] D. Abhinav, M. Pankaj and S. Atish, *Recent Trends in Agricultural Engineering (1st Edition 2020)*. Sharma Publishers & Distributer's, 2020.

[6] A. Fehr, S. Fleischlin, J. Friese-Tapmeyer, R. Friske, H. Ganzmann, G. Huber, A. van Huet, W. Keil, R. Lohuis, J. Mann, M. Petersen and A. Wimmer, Fachkunde Land- und Baumaschinentechnik. Verlag Europa-Lehrmittel, 2019.

[7] A.K. Srivastava, C.E. Goering, R.P. Rohrbach and D.R. Buckmaster Soil tillage. Chapter 8, Engineering Principles of Agricultural Machines, Monography, 2nd ed., St. Joseph, Michigan: ASABE. Copyright American Society of Agricultural and Biological Engineers, 2016. 169-230, Michigan / USA.

[8] C. Nite, D. Irimia, C. Persu and A. Cociu, Testing the multifunctional aggregate for soil tillage works – MATINA. INMATEH - Agricultural Engineering, **36** (2012) 5-12.

[9] B. Xuanbin, Z. Xiangyu, H. Jin, L. Hongwen, W. Qingjie, L. Wenzheng, Design and performance test of plowing and rotary tillage combined machine. INMATEH Agricultural Engineering, **58(2)** (2019) 213-222, Bucharest / Romania. doi.org/10.35633/inmateh-58-23.

[10] C. Gazzarin, Ökonomie. Maschinenkosten 2019. Agroscope Transfer, **291** (2019) 1-27. Gültig bis September 2020, ISSN Online: 2296-7230. http://link.ira.agroscope.ch/de-CH/publication/41838.

[11] J. L. Anderson, You're a Bigger Man: Technology and Agrarian Masculinity in Postwar America. Agricultural History, **94(1)** (2020) 1-23. doi:10.3098/ah.2020.094.1.004.