IMPACT OF LONG TERM TRIALS ON CROP PRODUCTION RESEARCH AND EDUCATION

M. JOLÁNKAI, F.H. NYÁRAI, K. KASSAI

SIU CROP PRODUCTION INSTITUTE, GÖDÖLLŐ

Long term trials have a twofold role in life sciences; they are live laboratories as well as public collections. Long term trials are not only scientific curios or honoured relics of a museum, but high value live ecological models that can never be replaced or restarted whenever ceased or suspended. These trials provide valuable and dynamic databases in solving scientific problems. The present paper is intended to give a brief summary of crop production aspects regarding long term trials.

Key words: Long term trials, crop production, research, education

Introduction

Two committees of the Hungarian Academy of Sciences, namely the Crop Production Committee and the Soil Science and Agricultural Chemistry Committee got the task to operate the „long term trial register" of Hungary. This work covers a broad field of activities. The committees monitor and record permanently the state of crop production long term trials regarding aim, applications, design, size, implementation, as well as data of responsible scientists and the institution where the experiment is located (*Kismányoky-Jolánkai* 2009). Long term trials are within a wide range regarding temporal and spatial characteristics as well as the means of institutional implementation and the legal structure of land tenure of the latter. Financial sources of these trials are rather diverse. Even in the case of some economically viable host institutions, long term trials are operated on the basis of temporary or occasional sources, like research projects, fundings, or even supports and subsidies not fully entitled to use for these purposes. Actually there are two major problems long term trial operations have to face: one is the uncertainity in long term planning and the other is the lack of responsibility of the host institution. According to the report of the committees it can be stated, that maintenance and operation of long term trials depend mostly on the goodwill and enthusiasm of individual scientists rather than host institutions. There are several examples, that in case of personal changes (retirement, new position or even unemployment) of such key scientists, long term trials are often exposed to operational problems, or may be terminated even.

Long term trials have a twofold role in life sciences; they are live laboratories as well as public collections. In most countries agricultural governments provide and guarantee framework for their operation. It is worth to overview briefly the history of long term trials as well as to get acquainted with present international experiences in this field.

Historical precursors

Plant nutrition is one of the most ancient human activities in the world. According to early empirical experiences human beings have realized that some sort of organic materials, like human or animal excreta applied to a crop field may improve its organic matter, and at the same time increase its yielding ability (*Kellogg* 1957). The words like manure and plant nutrition have been mentioned first in the 11th Century BC by the Greek poet Homer in his immortal work – the Odyssey. Odysseus the far-wanderer returning to his home island Ithaca was recognized first by his old dog Argos "...lying on a heap of dung with which the thralls were wont to manure the land." This was the first written evidence of plant nutrition and manuring. The ancient Greek language had both words in its vocabulary.

The Romans had several good manuals for farmers, prepared by keen observers who shifted out the best from experience they saw around them. Lucius Junius Moderatus Columella's Husbandry – "De re rustica", written in the 1st Century AC was a practical handbook for almost two millenniums. He discussed amounts of material to be used, timing of operations, and application of combinations of practices to various kinds of soil. Knowledge of this book in the field of soil tillage, cropping, plant nutrition, plant protection, storage proved to be highly durable. This book was translated to most European languages. In Hungary it used to be a farmers' handbook. It was edited last time in 1819 in Pest, translated by József Fábián.

Jan Baptista van Helmont, a Flemish chemist was the first scientist who made experimental attempts to identify the role of chemical elements and compounds in the life of plants. His famous willow tree experiment in 1635 was not successful, however this trial was one of the first steps towards understanding principles in plant physiology.

Justus von Liebig a German, and Sir John Bennet Lawes an English scientist had long scientific discussions about the "minimum law" of plant nutrition. Liebig made careful analyses of soils and plants and stated the balance sheet of plant nutrition: "The crops on a field diminish or increase in exact proportion to the diminution or increase of the mineral substances conveyed to it in manure". He has identified the level of plant development with the help of describing 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. The seemingly simple reasonableness of his views, his prestige as a scientist, and his skill in debate swept away all other theories of plant growth. There was only one problem with this theory. Since it was based on the assumption that soils were static, the principles could never be proven. Lawes started to examine cropping systems in his long term trials at the Rothamsted Experimental Station. According to his observations plant and soil form a synergistic system that may enable plants to overcome plant nutrition deficiencies. Also, he obtained results that suggested tillage operations to be beneficial in lessening harmful effects of nutritional failures. The scientific discussion of the two respected scholars was ended by new findings of a research in biochemistry. Jean Baptiste Boussingault, a French scientist discovered and described the nitrogen cycle. He stated, that Liebig and Lawes both were right, except they did not realize that plants' nutrient uptake is manifested in a permanently changing dynamic system.

Long term trials and scientific research

The first long term trials were not founded by agriculturists, but botanists. The basic task of these trials was to provide „ceteris paribus" (equal measures) conditions for scientific observations. It was known for long, that to study behaviour, growth and development of any living creatures, identical conditions and replicated methods are needed (*Cserháti* 1901). According to this phylosophy the University of Padova has founded Orto Botanico in 1545, a live instrument that serves as a useful tool for plant science research up to recent days. Karl Linné created his Uppsala experimental garden in 1728. This latter is no more involved in research activities. Today it is more of a museum attracting tourists. A most well-known long term trial in the world is the Broadbalk of

Rothamsted, designed by Lawes himself in 1843. This long term experiment, especially with its chronological plant and soil sample collections is a most valuable scientific instrument in plant nutrition research.

What are the long term trials of Hungary like? Our national long term trials have been founded in favour of to explore various scientific hypotheses and to observe agronomic techniques (*Várallyay* 2006). There is only one common characteristics of them. Each long term trial has been designed in a way, that they should yield exact data in the field of physics, chemistry, biology, or in combination of these in ecology to identify principles of their processes temporally over a long term. Long term trials are not only scientific curios or honoured relics of a museum, but high value live ecological models that can never be replaced or restarted whenever ceased or suspended. These trials provide valuable and dynamic databases in solving scientific problems.

Long term trials are therefore „major instruments" in basic research of crop science, agrochemistry, soil science, and agro-ecology. Their role is similar to any of the man-made tools, instruments or implements, like that of a phytotron, a lysimeter or a reactor.

Long term trials and education

Apart from their scientific value and utility, long term trials have a profound role in education. Various branches of education, like regular higher education, PhD courses, vacational training and extension services may benefit from research results obtained from long term trials. Some of today's long term trials have been designed originally for educational purposes. Such is the Westsik trial at Nyíregyháza founded in 1929 for demonstrating sand-soil tillage methods for farmers. Other long terms trials have been designed for solving certain scientific problems, however most of them can be used for educational purposes. All Hungarian long term trials let them be owned and operated by research institutions or universities are involved in one or more accredited educational programmes. Also, any of them can be visited, studied and examined within the framework of regular scientific and extension programmes.

Economic aspects

Long term trials may have a role in the implementation of certain economic processes, as well as in prevention or handling of hazards and disasters. Without long term trials most of crop production technologies and plant protection applications would be less efficient. Even in the case of adaptation of international research results, materials, instruments and technologies, long term trials may help us in a more accurate, succesful and plausible application regarding the local conditions. Also, long term trials often contribute to the success of avoiding and managing the consequences of natural hazards, catastrophes, climatic extremes, anomalies, epidemics, gradations (eg. flood, water logging, drought, eutrophication, cyanid pollution etc), just to mention some of these from recent years. Environmental protection and nature conservation should rely on long term trials. Over 80 % of the territory of Hungary is covered by terrestrial ecosystems from what area – as a unique in Europe – agro-ecosystems represent the majority of that.

International cooperation

Hungarian long term trials should not be considered as scientific tools possessed by respective institutions in the field of research or education only. They represent a virtual network and most of them have a role in national programmes. Also they provide basis for regional cooperations as well. Within the Carpathian basin many of the transfrontier cooperations are based on research activities of long term trials. Research results contribute to solve problems in the field of natural and social sciences. Some examples to highlight the latter: Keszhely (Hungary)-Nitra (Slovakia), Látókép-Nyíregyháza (Hungary)-Livada (Romania), or Nagyhörcsök (Hungary)-Eszék (Croatia) joint research programmes, or the utilization of the OMTK (National Fertilization Long Term Trials) results and data in EU climate change research projects are essential for scientific cooperation (*Jolánkai* 2008).

Alps-Adria scientific cooperation provides a scientific forum for presenting and discussing research results of long term trials of the region. During the conferences of the past decade more than one thousand scientific papers have been presented, and about 200 of them were based on long term trial research results (*Jolánkai* 2009). International

cooperations in this field are of high value. Also they may contribute to present and future tasks in plant and soil research.

References

Cserháti S. (1901): Általános és különleges növénytermelés. (General and specific crop production *in Hungarian*)Czéh Sándor Könyvnyomdája, Magyaróvár.

Jolánkai M. (2008): Ember által befolyásolt ökoszisztémák (Növénytermesztési körülmények, Szántóföldi növénytermesztés, Kártevők, kórokozók, gyomok, Alkalmazkodási lehetőségek, javaslatok). /Ecosystems influenced by humans (Crop production conditions, Field crop production, Pests, diseases and weeds, Adaptation chances and suggestions) *in Hungarian/* In: Klímaváltozásról mindenkinek Eds: Harnos Zs. – Gaál M. – Hufnagel L. Budapesti Corvinus Egyetem. Budapest. 89-129 pp.

Jolánkai M. (2009): Az Alpok-Adria tudományos együttműködés – a térség agrárkutatásának fóruma. (Alps-Adria Scientific Cooperation – a regional forum for agricultural research) *Magyar Tudomány*. **170**. 4. 485-489 pp. *in Hungarian*

Kellogg C.E. (1957): We seek, we learn. In: Soil. The yearbook of agriculture 1957. Ed: Stefferud A., USDA, Washington DC.

Kismányoky T. – Jolánkai M. (2009): A magyarországi tartamkísérletek. (Hungarian long term trials *in Hungarian*) In: Az Országos Műtrágyázási Tartamkísérletek (OMTK) kutatási eredményei (1967-2001). Eds Debreczeni B-né – Németh T. Akadémiai Kiadó, Budapest. 25-34 pp.

Várallyay, G. (2006): Soil degradation processes and extreme soil moisture regime as environmental problems in the Carpathian Basin. *Agrokémia és Talajtan*. **55**. (1-2) 9-18 pp.