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Recent trends in public and private agricultural research expenditure in Hungary[1]

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This paper is based on a case study conducted in the frame of the European Union (EU) Framework 7 project IMPRESA which aimed to evaluate the impact of EU research on agriculture. Official data sets were used to show trends in agricultural research expenditure in Hungary from 2008 onwards, focusing on public and private research efforts, research strategy and priority areas, research staff and evaluation of research, and dissemination of research results. The factors behind these trends were explored through semi-structured, face-to-face interviews with key experts. Total R&D expenditure (not adjusted for inflation) in the field of science 'agricultural sciences' increased from HUF 19.7 billion in 2008 to HUF 22.1 billion in 2016. There was a marked decline in expenditure at public-sector R&D institutes and (until 2015) broadly constant R&D activity at universities, while that of the business sector increased. Public-sector R&D institutes have been reorganised in an attempt to improve their efficiency and effectiveness, but several further actions are needed. These include the development of a national agricultural research strategy, the recruitment of younger, innovative staff coupled with the provision of motivating conditions of work, and a greater emphasis on applied research together with more effective evaluation of research impact.

Keywords: agricultural research, field of science, socio-economic objective, sector of performance, R&D institutes, HE institutes, business enterprises.

JEL code: Q16.

Introduction

Agriculture continues to be an important part of the Hungarian economy. In 2012 it accounted for 5.2 per cent of employment and 3.2 per cent of GDP, while the equivalent figures for the food industry were 3.3 and (in 2011) 2.3 per cent. There were around 5000 food companies in Hungary in 2011, of which 3600 had up to nine employees (Szczepaniak et al. 2014). Agricultural products accounted for 10.1 per cent of exports in 2012 and there was a positive trade balance of HUF 1043.5 billion (approximately EUR 3.4 billion). The largest product groups in terms of export value were cereals, meat and oilseeds/fodder (19, 12 and 10 per

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cent respectively) and in terms of import value meat, animal fodder and other consumable products (11, 10 and 8 per cent respectively) (VM 2013).

Of the 5 338 000 ha of agricultural area in 2012, 4 324 600 ha was arable land and 758 900 ha was grassland (VM 2013). In 2010, 8800 enterprises and 567 thousand private farms were engaged in agriculture (Andrási–Bóday 2012), accounting for 58.5 and 41.5 per cent of the agricultural area respectively (Tóth 2012). The number of farms has fallen by 41 per cent since 2000. Hungary has a bi-polar farm structure in terms of land area: in 2010, 92.3 per cent of individual farms occupied less than 10 ha of land while corporate farms larger than 300 ha amounted to 85.3 per cent of the whole agricultural area (Tóth 2012). Around 61 per cent of individual farms produced only for their own consumption and 20 per cent produced mainly for the market.

Mindful of the need for food security, growth and job creation in rural territories, and environmental management and climate change mitigation, the European Union (EU) attaches great importance to promoting the sustainable agricultural productivity growth (EC 2016). Investment in agricultural research, both public and private, is one of the factors that influences the level of agricultural total factor productivity (Midmore 2017), and globally the impacts of research on agricultural productivity growth have been studied extensively. Mogues et al. (2012) found that, for the second half of the 20th century, estimates of internal rates of return to investments in agricultural research frequently exceeded 60 per cent. On the other hand, lags between expenditure and their effects on productivity tend to be lengthy, for example estimated by Alston et al. (2010) in the USA to be a minimum of 35 years rising to 50 years. These lags can dampen political enthusiasm for funding agricultural research, notwithstanding the eventual potentially high rates of return.

The European policy context is the ‘Innovation Union’, one of the EU’s seven ‘Flagship Initiatives’ for implementing its Europe 2020 Strategy of smart, sustainable and inclusive growth. Research and innovation have a critical role to play in the creation of economic prosperity and the resolution of major societal challenges (EC 2010). The aim of the Innovation Union is to enhance the effectiveness of research and development activities by building a solid research and innovation ‘system’ in Europe to ensure that new knowledge-intensive products and services contribute substantially to growth and jobs. The Innovation Union approach is just as relevant to agriculture as to any other sector of the economy.

There have been few attempts to measure the impact of European agricultural research on productivity and no analysis has yet been undertaken for the EU as a whole (Midmore 2017). To at least partly compensate for this, during the period 2013-2016 the EU Framework 7 research project IMPRESA[3] sought to measure, assess and comprehend the impact of all forms of European agricultural research on key agricultural policy goals, including farm-level productivity but also environmental enhancement and the efficiency of agri-food supply chains (Ruane 2014). Such studies require reliable data series that extend over several decades. Thus, the project began by preparing country-level analyses of the agricultural research expenditures and an assessment of the availabilities of data regarding public and private investments in agricultural research in 20 Member States across Europe, including Hungary (Fieldsend 2014). IMPRESA defined 'agricultural research' as covering all research on the promotion of agriculture, forestry, fisheries and foodstuff production. It includes research on chemical fertilisers, biocides, biological pest control and the mechanisation of agriculture; research on the impact of agricultural and forestry activities on the environment; and research in the field of developing food productivity and technology.

This paper presents an assessment of recent agricultural investment trends in Hungary using a mixed-methods approach involving data analysis and semi-structured interviews. The research focuses on public and private research efforts, research strategy and priority areas, research staff and evaluation of research, and dissemination of research results. It identifies positive developments and areas where further actions are needed. The paper presents an abridged set of results (i.e. those that are of general interest beyond the project) from the IMPRESA country case study, but updated to 2016, together with some additional data not considered in the IMPRESA project.

Methodology

A common methodology was used for all IMPRESA country case studies. The first objective of each case study was to investigate the general availability of data related to public and private investments in agricultural research at national level. In Hungary, this was done primarily through consultation with the Hungarian Central Statistical Office (KSH), which has the primary responsibility for data

[3] Impact of Research on EU Agriculture, http://www.impresa-project.eu/.

collection in Hungary in the frame of the National Statistical Data Collection Programme. The KSH has a designated expert for research, development and innovation statistics. For Hungary, it can be concluded that there is no shortage of quantitative data on agricultural R&D and that the KSH undertakes its data collection and distribution tasks in a professional and customer-focused way. The data can be assumed with confidence to be reliable.

The second objective was to review trends in agricultural research expenditure in Hungary in the period 2008-2012, i.e. following the onset of the global financial and economic crises, using KSH data sets. Monetary values are quoted at current prices, i.e. not corrected for inflation. The data are dependent on several definitions, many of which can be found in KSH (2012); some of the most notable ones are described below.

Three 'sectors of performance' are defined in line with the internationally-recognised Frascati Manual (OECD 2015):

- *Government sector*: all organisations performing research and development activities and financed by the government except higher education;
- *Higher education sector*: all universities, colleges and other institutes of post-secondary education which, besides their education tasks, perform research and experimental development activities;
- *Business enterprise sector*: all firms, organisations and institutions whose primary activity is the market production of goods or services for sale to the general public at an economically significant price and which perform research and experimental development activities as well.

Research and development can be classified according to the following criteria:

- *Socio-economic objective*: an R&D programme or project is classified according to its primary objective, i.e. its intended purpose or outcome. In 2007 there were 14 objectives, one of which was 'agriculture' (Eurostat 2008a);
- *Field of science*: nomenclature used to categorise research expenditures of the four 'sectors of performance' according to the research itself, rather than the main activity of the performing unit. One of the six categories is 'agricultural sciences'.

The factors behind these trends were explored through 30-45 minute, semi-structured, face-to-face interviews with experts from national statistical authorities (including the Ministry of Agriculture), agencies in charge of research, public and private research organisations, and farmers' and food industry associations. The interviews were conducted in July and August 2014. The anonymity of all interviewees is respected and no remarks reproduced in this paper should be attributed to any individual or organisation.

For this present paper, the data sets were updated to 2016, which means that the interview results can now be compared to statistical trends occurring both at the time and in the subsequent 18 months.

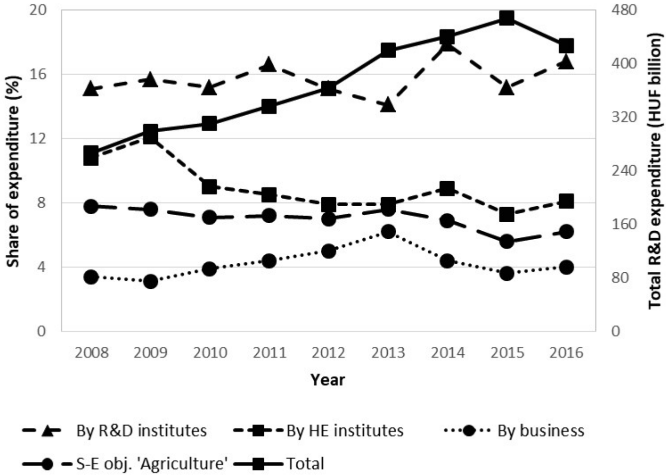
Results

Public-sector research effort

In nominal terms (i.e. not adjusted for inflation), total R&D expenditure in Hungary increased steadily from HUF 266 388 million in 2008 to HUF 468 390 million in 2015, followed by a slight decline in 2016 (Figure 1). The proportion of total R&D expenditure spent on agriculture as a socio-economic objective fell over this period from 7.8 to 7.0 per cent, but still showed a substantial increase. The share of total R&D expenditure allocated to agriculture differed by sector of performance. The share spent by R&D institutes (constant at around 16 per cent) was by far the highest of the three sectors, while that of the HE sector notably declined (from 10.8 to 7.9 per cent). The figure for the business enterprise sector increased slightly, from 3.4 to 4.4 per cent.

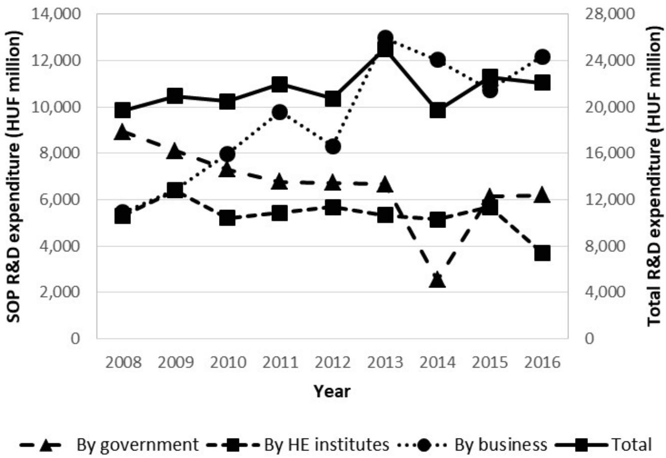
Total R&D expenditure in the field of science 'agricultural sciences' increased during the period 2008-2016, from HUF 19.7 to HUF 22.1 billion (Figure 2). Data disaggregated by sector of performance (SOP) show that, owing to a marked fall in government R&D expenditure, public-sector R&D expenditure declined from HUF 8939 million in 2008 to HUF 6207 million in 2016. It should be recalled that, as a percentage, the real-terms decline (i.e. after inflation is taken into account) would be even higher. This decline was compensated for by an overall increase in business enterprise R&D expenditure in nominal terms, although this remained constant or even declined since a peak in 2013. The figure for HE institutes remained almost constant at around HUF 5500 million in the period 2008-2015, but experienced a notable decline, to HUF 3703 million, in 2016.

The interviewees had conflicting views on the funding situation of public-sector research institutes and, to a lesser degree, universities, and this issue was interlinked with that of organisational restructuring, discussed below.



Sources: KSH (2012) Tables 2 and 20, KSH (2017) Tables 2 and 25, and other KSH annual publications on R&D

Figure 1. R&D expenditure in Hungary, 2008-2016 (in nominal terms)



Sources: KSH (2012) Table 44 and KSH (2017) Table 46

Figure 2. **R&D expenditure in the field of science 'agricultural sciences' in Hungary, 2008-2016 (in nominal terms)**

Public-sector research institutes are funded by state money, plus private and EU money. An interviewee who should be well placed to give correct information on funding stated that the institutes that are now part of the National Agricultural Research and Innovation Centre (NAIK)[4] depend primarily on government funding with "less than 10 per cent" of funds coming from the private sector. The priority of the current Hungarian government is no longer to save money on research but to spend money on research. The interviewee stated that this does not automatically imply an increase in public-sector funding, but rather to produce institutional changes that will result in real coordination of research. This has previously been lacking; previously individuals have been "trying to do their best", but there has been "no clear strategy and working plan" for individuals and institutions. Agricultural R&D is by nature a long-term activity that requires stability and this was the political rationale for setting up the NAIK.

While it is generally accepted by the interviewees, in line with the published data, that expenditure in public-sector agricultural R&D has declined in recent years, they analysed this trend in different ways. Some stated that, before the establishment of NAIK, most if not all the constituent institutes had financing problems. Insufficient money was available from national funds, but the institutes (and universities) were quite successful at obtaining funds from other sources such as the EU and the private sector. The tax arrangements in force encouraged the private sector to fund research at government institutes, providing "quite a huge" income. Recently the tax system has been restructured, reducing the income of the institutes from that source. Also, with the advent of NAIK, the individual institutes have less opportunity to apply for EU and national funds as they are not so independent and the administrative challenges are much bigger. Others say that private sector and EU funding of government sector institutes is currently increasing.

In terms of political priorities for agricultural R&D, an interviewee suggested that the biggest change in recent years has been "at the political level", with agricultural research now being considered as a "kind of investment". The result of this new approach is a stable political background and, through NAIK, better coordination of research.

[4] On 1 January 2014, many of the research institutes that formerly reported to the (then) Ministry of Rural Development, together with some other state-owned research institutes, were reorganised as thirteen agri-food and farming research institutes under the umbrella of NAIK. This now represents the main public sector funded research activity outside the universities. Four commercial spin-off companies are connected to it.

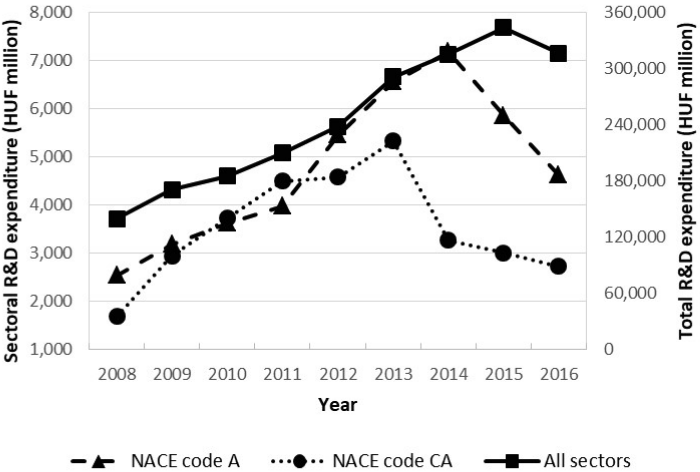
Other interviewees believe that the reason for the setting up of NAIK is centralisation and the elimination of separate ‘kingdoms’. It is suggested that as the institutes were receiving relatively little funding from the Ministry of Agriculture they felt little obligation to respond to the needs of the Ministry. NAIK is perceived to be still ‘under construction’ in the sense that institutes are working together at the technical level, as a support service sector has been created for finance, infrastructure etc., but not scientifically. This is to be expected, of course, and, when the interviews were conducted, was still true for the National Food Chain Safety Office (NÉBIH), a ‘background institute’ of the Ministry of Agriculture that was formed in 2012 from several institutes, and was not yet operating in a fully integrated way.

The Ministry of Agriculture is liaising closely with the universities, as these are also seen as being “fragmented”, with too many such institutions currently involved in agricultural education. The government wants a more concentrated university system that focuses more on education, with a different approach to research, and the intention is to define which tasks should be carried out in universities and which should be undertaken in research institutes. More university research units are likely to be transferred to NAIK (reversing the trend that can be traced back to 2000 when a major restructuring of the university sector took place), but it would still be possible for researchers to present lectures at the universities. This would be the future form of long-term collaboration.

Private-sector research effort

Total R&D expenditure in the Hungarian business enterprise sector increased from around HUF 140 billion in 2008 to around HUF 344 billion in 2015, but declined slightly in 2016 (Figure 3). Between 2008 and 2013, the rate of increase in R&D expenditure for NACE[5] codes A (agriculture, forestry and fishing) and CA (manufacture of food products, beverages and tobacco products) was higher than for total expenditure, and spending levels in the two sectors were similar. However, R&D expenditure for NACE code A fell from HUF 7189 million in 2014 to HUF 4633 million in 2016, while for NACE code CA it declined from HUF 5337 million in 2013 to HUF 2730 million in 2016.

[5] European Classification of Economic Activities (Eurostat 2008b).

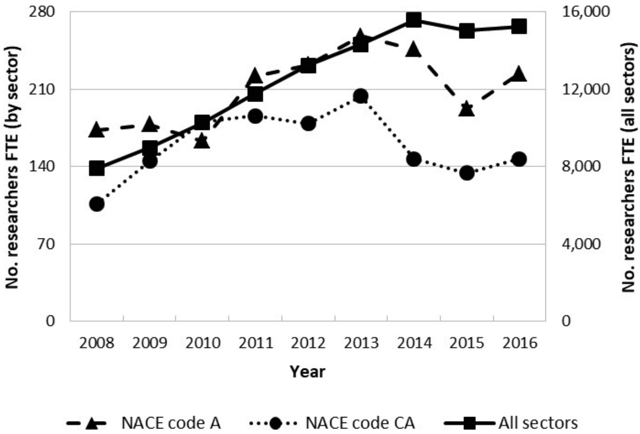


Sources: KSH (2012) Table 50 and KSH (2017) Table 50

Figure 3. R&D expenditure in the business enterprise sector in Hungary by NACE category, 2008-2016 (in nominal terms)

Trends in the numbers of researchers in the business enterprise sector reflected those for R&D expenditure. Total employees increased from 7912 in 2008 to a peak of 15 577 in 2014 (Figure 4). Numbers of researchers in both NACE code A and CA increased until 2013, but at a lower rate, and then declined substantially. In all years except 2010 the number of researchers in the former sector (agriculture) exceeded that in the latter (food manufacturing).

There was a strong conflict in opinions between interviewees on the level of business sector R&D activity in agriculture and the food industry in Hungary. Some interviewees suggest that the level of private-sector agricultural research activity has declined now that the tax system has changed but the KSH believed (as of 2014) that private-sector R&D in Hungary has grown even since the onset of the financial and economic crisis in 2008 and that, in general, private-sector R&D has been increasing while the public-sector R&D has been shrinking. This assessment was echoed by an interviewee from the private sector. It may be a question of how 'R&D' is defined. One view is that business sector 'investment' projects, that at best could be interpreted as 'process innovation', are described as 'research' projects as this allows the company to claim tax breaks. The KSH says that it has cross-checked their general business sector data against tax data and found that, if anything, the business sector claimed less tax against R&D than it was entitled to. On the other hand, the KSH notes that, of around 300 000 businesses in Hungary, fewer than 2000 carry out R&D.



Sources: KSH (2012) Table 49 and KSH (2017) Table 49

Figure 4. **Number of researchers (FTE) in the business enterprise sector in Hungary by NACE category, 2008-2016**

One interviewee stated that for several reasons Hungary has been a good place to locate commercial agricultural R&D. In the past it was the most easterly country in which that interviewee's company operated. Hungary is in the middle of Europe and as (in the 1980s) a western-focused member of the Eastern bloc it was "part of Europe but not". As Hungary is in the continental climate zone it is possible to select crop varieties that are adapted for the region. It is a 'gateway' for eastern Europe including ex-Soviet Union countries including Russia and to some extent Asia. Furthermore, the country already had the necessary infrastructure: good quality roads, utilities, and good water availability. The standard of agricultural education in Hungary is "unique" and the skills of the educated persons are high. Hungarian people are prepared to work.

Several large international agribusiness companies have well established, if relatively small, R&D operations in Hungary. Furthermore, one interviewee pointed out that, among relatively recent developments, the PannonPharma

Group took over the Research Institute for Medicinal Plants from government ownership in 2008, while the Bunge Europe Research and Development Centre was established in Budapest, working on sunflower and canola oils. There is a suggestion that investment in large R&D projects (e.g. buildings) is low but that the level of actual R&D activity is relatively high. The interviewee observed that the private sector is doing well-targeted research pursuant to their own interests and "doesn't make a lot of noise" about the results.

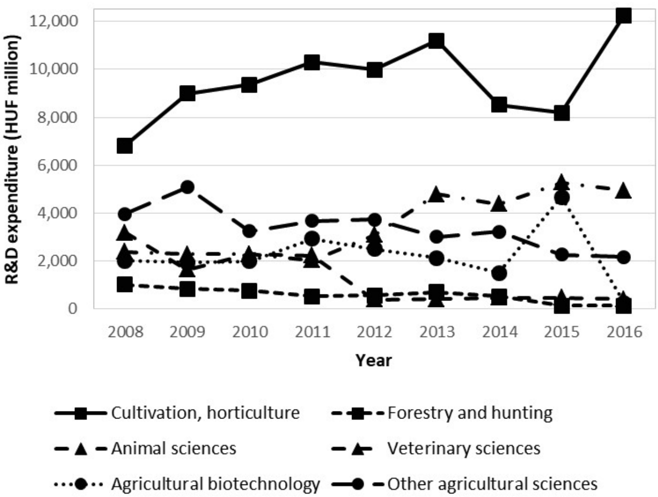
By contrast, another interviewee described Hungarian food industry research as being "fragmented" with a "far from satisfactory" level of private-sector activity. The difference in the level of activities between Hungary and, for example, the UK is "enormous". The latter has used innovation to address the effects of the financial and economic crisis but this has not been the case in Hungary. Research and innovation are seen as areas where money can be saved. Many companies do not have a strategy of continuous innovation.

In fact, the private-sector food industry has its own story. In order to promote practical research and innovation, the Hungarian National Technology Platform of the ETP 'Food for Life' was established in 2006. This was in reaction to the then government's "hostile" policy towards food research: from 2006 to 2010-11 it is said that there was no government funding for food industry research as this was seen as a 'mature' sector that was no longer developing. The Platform produced and circulated the first food innovation strategy in 2006, and this strategy and implementation plan was revised in 2009 in the aftermath of the economic and financial crises. This was submitted to the government at the beginning of 2010 and following the change of government a few months later some ideas started to be included in government documents. So, even if government funding is "still limited" (in terms of funding, most public funds in the Hungarian food industry in fact come from the EU), the food industry is starting to be seen as a government priority.

Further private-sector development could be discouraged by the government's new Land Act which, after the post EU accession transitional sale moratorium that expired on 30 April 2014, introduced strict restrictions on leasehold and ownership title transfer of agricultural land and forestry. This will make it "impossible" for a company to start agricultural R&D in Hungary. It is unlikely to affect existing activities, however, as private companies now have a lot of investments in agricultural R&D fixed assets (offices, greenhouses etc.) in Hungary.

Research strategy and priority areas

In the period 2008-2016, total R&D expenditure in the field of sciences 'agricultural sciences' consisted of ca. 90 per cent current costs and 10 per cent capital expenditure. The data can also be disaggregated by sub-category (Figure 5).

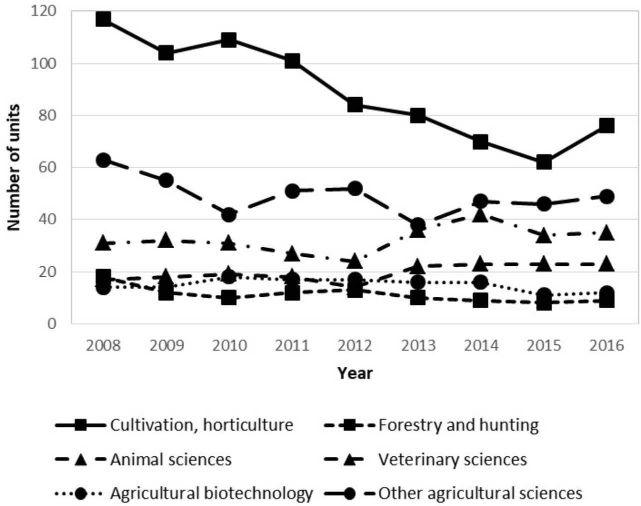


Sources: KSH (2012) Table 56, KSH (2017) Table 55 and other KSH annual publications on R&D

Figure 5. R&D expenditure of R&D units in the field of science 'agricultural sciences' in Hungary, 2008-2016 (in nominal terms)

The highest R&D expenditure occurred on cultivation and horticulture, and this accounted for an increasing share of overall expenditure, from 34.6 per cent in 2008 to 55.5 per cent in 2016. Actual expenditure almost doubled from HUF 6819 million to HUF 12 253 million over this period. Animal sciences expenditure more than doubled (from HUF 2382 million to HUF 4957 million) but was offset by a fall in veterinary sciences expenditure from HUF 3196 million to just HUF 421 million. R&D expenditure on agricultural biotechnology remained broadly constant at around HUF 2000 million apart from major fluctuations in 2015 and 2016.

The total number of R&D units in Hungary fluctuated from 2821 in 2008 to 3159 in 2013, but declined to 2727 in 2016. The number in the field of sciences 'agricultural sciences' fell from 266 in 2013 to around 220 in 2012, since when it has remained fairly constant. The decline can be almost entirely accounted for by the reduction in the number of units in cultivation and horticulture (Figure 6), although this group remains the biggest. The numbers of animal and veterinary units fell slightly and that of biotechnology units increased. Within the 'other agricultural sciences' category, the number of food product sciences institutes fluctuated around 20 in this period.



Sources: KSH (2012) Table 54, KSH (2017) Table 53 and other KSH annual publications on R&D

Figure 6. **Number of R&D units in the field of science 'agricultural sciences' in Hungary, 2008-2016**

Historically, government sector research institutions were very fragmented and there was no clear strategy on how agricultural research should be organised. Around 2006/7 it was proposed within the (then) Ministry of Agriculture and Rural Development that a national institute like INRA in France should be created, but there was a very strong resistance as the institutes wanted to keep their autonomy. Later, as the Ministry did not have enough money, universities absorbed (and therefore also part-finance from Ministry of Education funds) the agricultural research institutes nearest to them. For example, the Agricultural College in Gyöngyös (near Budapest) absorbed the wine institute in Eger and the University of Pécs took over the nearby grape research institute.

This 'dance', as one interviewee described it, was not part of a wider political research strategy, and was seen as a big loss for Hungarian agriculture. The institutes wanted to remain independent but did not have enough funding to do so and felt that it would be better to merge with the nearest educational institute. The problem was that the people in the university framework had no research strategy. There was still a strict separation between the research institutes and the teaching activities. There were also plans at that time to merge some institutes, such as the small animal institute in Gödöllő with the large animal institute in Herceghalom. This happened, but the constituent parts were later separated, and recently again merged, but in a different way.

The government currently does not yet have an agricultural research strategy as it is concentrating on the restructuring described above. Several interviewees felt that having a strategy is an important priority, as are identifying who is responsible for what in Hungary, linking up with the strategies of other EU Member States and at EU level, and stability. It is suggested that the research priorities of some other EU Member States (e.g. biomass use in cities) are not priorities in Hungary. Hungary is described as being an outsider in development of international strategies as it is focusing on reorganisation. However, the Ministry of Agriculture states that it would like to see more international research collaboration as it perceives agricultural research as an international activity, the results of which tend to have public rather than commercial benefits.

One interviewee suggested that future research strategy should be much more selective and much more focused on the needs of the country. At present, less than 10 per cent of maize seed sold in Hungary is of cultivars bred by the Hungarian Academy of Sciences' Agricultural Institute at Martonvásár while 90 per cent come from various international companies. Martonvásár commands a 70-80 per cent share of the Hungarian wheat market but there is increasing competition from German and Austrian cultivars.

Among interviewees, climate change was mentioned as one area that could be a priority for agricultural R&D, as could plant genetics and production of local varieties adapted to local conditions (and climate change). In line with the total ban on growing GM crops in Hungary, it seems that researchers are not proposing new GM-related research projects. For food, resource efficiency along the food chain, and transdisciplinary research that combines manufacturing, ICT and energy management solutions in the food chain were mentioned as possible priorities. At a practical level the main challenges for the future include closer cooperation between institutions (such as through NAIK) and improved English language skills to enhance participation in EU and other international research activities.

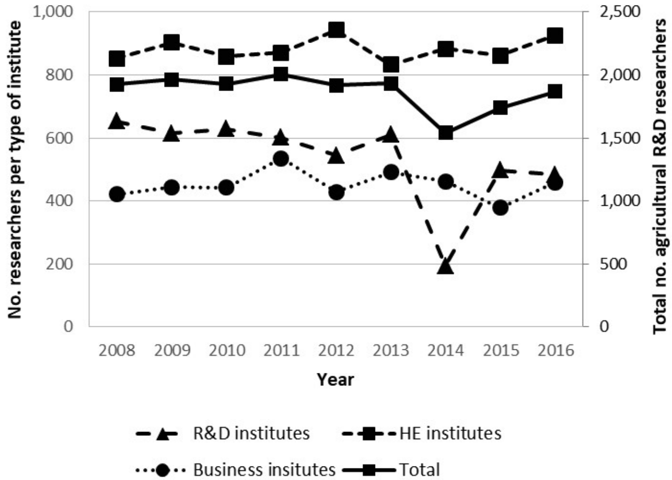
A future strength of NAIK should be the ability to conduct multidisciplinary research. Some interviewees felt that public- and private-sector agricultural research could also be better aligned, with the latter focusing on market-driven research. There are said to be very few examples in Hungary of strong research cooperation between private companies and research institutes. One approach recently promoted by the government is the establishment of 'clusters' centred on universities. The latter tend to provide services rather than real innovation but the companies are starting to develop new products and technologies. A feeling in the private sector, by contrast, is that government research policy is "not relevant" as the private sector is focused on the demands of the market.

Duplication of research efforts by the Ministry of Agriculture and the research units of the Hungarian Academy of Sciences is also recognised but it is not so clear how this can be solved because the latter organisation is an independent (and powerful) entity similar to a Ministry. Such Academies of Sciences seem to be a legacy of former Soviet influence with no clear equivalent in western Europe.

Similarly, an interviewee felt that there could be more research collaboration between Hungarian food industry companies at the pre-competitive phase, possibly through the National Technology Platform. The view of this interviewee is that the public sector carries out little if any research on food-related issues.

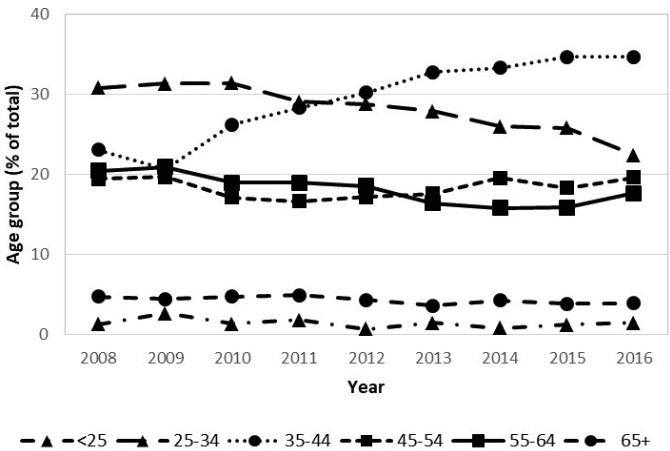
Research staff and evaluation of research

The total number of agricultural researchers remained fairly constant at around 1900 in the period 2008-2014, although lower figures were recorded for 2014 and 2015 (Figure 7). The dominant group, which increased from 853 persons in 2008 to 926 persons in 2016, has been researchers in HE institutes, even although the HE sector accounts for the smallest share of recorded agricultural R&D expenditure. By contrast, the number of researchers in R&D institutes declined from 653 to 484 over the same period, while the number employed in business enterprise institutes fluctuated around 450. Gender-disaggregated KSH data show that, in 2016, 41.1 per cent of all agricultural sciences researchers were women.



Sources: KSH (2012) Tables 38-40, KSH (2017) Tables 40-42 and other KSH annual publications on R&D

Figure 7. Number of researchers in the field of science 'agricultural sciences' in Hungary, 2008-2016



Sources: KSH (2012) Tables 38-40, KSH (2017) Tables 40-42 and other KSH annual publications on R&D

Figure 8. Age profile of researchers in the field of science 'agricultural sciences' in Hungary, 2008-2016

There is evidence that the average age of agricultural R&D staff is increasing: the percentage of researchers aged 25-34 declined from around 31 per cent in 2008 to 22.5 per cent in 2016, while those aged 35-44 increased from a little over 20 per cent to 34.7 per cent (Figure 8). The data do, however, suggest declines in the percentages of older age groups: from 20.5 to 17.7 for those aged 55-64 and 4.8 to 4.0 for those aged 65+.

In the minds of interviewees, perceptions of trends in human resources, particularly in the government sector research institutes, are linked to their interpretation of the way in which the institutes are funded. In the understandings of some interviewees, since most of these institutes "did not receive any" government funding they were not so exposed to staff cutbacks arising from reductions in government budgets. They say that since the formation of NAIK there have been cutbacks in administrative staff (but not (yet) in R&D staff) resulting in around HUF 1 billion of savings annually.

Another view is that staff numbers in the government sector research institutes have continuously declined in recent years as funding has been cut and leavers have not been replaced, and at the same time the average age of the staff has increased. There has been no real human resource development strategy. Young people do not want to go into research because there is no clear future for them and government sector research staff are not well paid and not well motivated. The Ministry of Agriculture recognises that there is need to renew the research staff in research institutes and universities as there are a large number of staff over 60 or even 70 years of age.

Most interviewees had strong views about the evaluation of agricultural R&D activities, at the level of both institutes and individuals. There is a need to measure the quality of research personnel, in terms of their ability and motivation to do R&D. Personal motivation is "not always money". Money clearly has a positive influence, and one interviewee noted that in at least one public-sector research institute in Poland staff who publish high impact-factor research papers receive a financial bonus. Furthermore, some researchers are not involved in international research because it involves extra work but in parallel they conduct private research to earn more money.

It is widely accepted that the evaluation of the work of government sector agricultural research institutes has been inadequate in the past. It is suggested that over many years much research has simply been repeated in a different way.

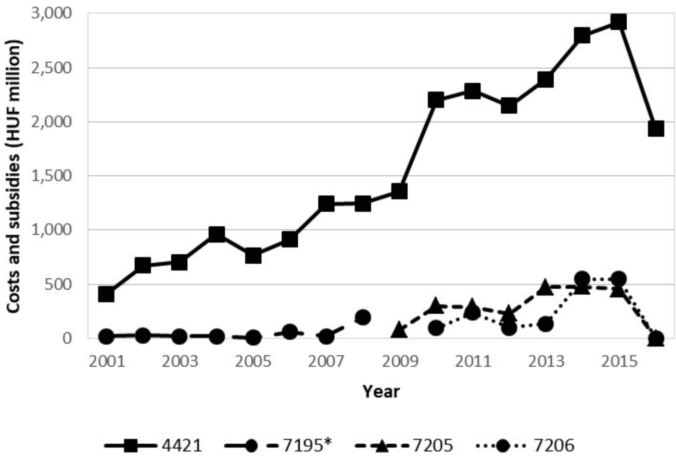
In 2004-2005, evaluation consisted of an institute making an annual report and someone in the Ministry of Agriculture and Rural Development (as it was then) providing an opinion on it. This was obligatory to get the budget for the next year. There was a proposal within the Ministry for an annual performance contract to be signed between the government and each research institute but this was not accepted because the research institutes did not want such a transparent procedure. After six months there would have been an interim report and a final report coupled with an independent evaluation process. However, demand for better performance should be linked with the provision of acceptable working conditions.

There is still no proper evaluation plan or indicator plan for evaluation of public-sector agricultural R&D, although a strategy for evaluation of food chain safety research is under development. Evaluation procedures in NAIK have apparently been strengthened but are still quite basic and do not distinguish between outputs, outcomes and impacts: the focus at present is on financial issues.

Dissemination of research results

The classical channel for the flow of academic knowledge from academics to farmers is via advisors and advisory services. This is the clearest route by which the results of research can be translated into increased agricultural productivity. Hungary does not have a state-run service of specialist farm advisors, but rather the national Chamber of Agriculture manages the provision of advice to farmers through a very strongly regulated system that involves around 1100 contracted but self-employed advisors. The service is dominated by the provision of subsidised advice within the frame of the EU's Farm Advisory System (EC 2013).

Farmers' expenditure on training and consultancy, and the amount of state subsidies for these activities, can be estimated from Hungarian Farm Accountancy Data Network (FADN) data. The FADN consists of 1599 individual and 388 corporate sample farms as representatives of ca. 106 000 commercial farms. The variables of the Hungarian FADN are described and coded in the Farm Return document. Costs of education (including vocational training and farm advice) incurred by farmers (variable 4421) increased steadily from around HUF 409 million in 2001 to around HUF 2923 million in 2013 (Figure 9). Subsidies for extension services (variable 7205) increased from HUF 75 million in 2009 to around HUF 475 million in 2013 and for vocational training (variable 7206) reached almost 550 million in 2014. Non-payment of subsidies in 2016 can be attributed to administrative delays in the implementation of the 2014-2020 Rural Development Programme and is reflected in a substantial decline (to around HUF 1936 million) in farmers' expenditure on vocational training and farm advice in 2016.

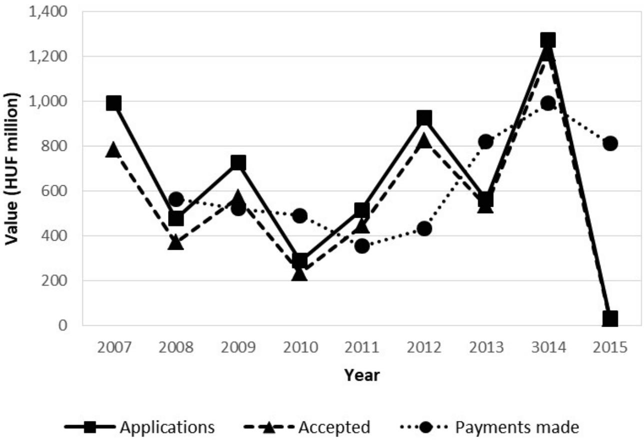


*Until 2008, all consulting services related grants (i.e. 7205 and 7206) were reported together as 7195

Source: Hungarian FADN database via AKI

Figure 9. Costs of training and further training, consultancy (4421), and state subsidies paid to farmers for agricultural extension (consultancy) services (7205) and vocational training (7206,) in Hungary, 2001-2016 (in nominal terms)

The Agricultural and Rural Development Agency, the Hungarian 'paying agency' and another 'background institute' of (at that time) the Ministry of Agriculture, publishes annual data on numbers of persons and financial value of payment applications; accepted payments; and payments actually made via the Rural Development Programme of the Common Agricultural Policy for Measure 114: Farm advisory system, (FADN variable 7205). Initial enthusiasm (around HUF 1 billion of payment applications) was followed by a slump (to less than HUF 300 000 in 2010) caused, to a great extent, by lengthy delays in making payments to the farmers to subsidise the cost of paying an advisor (Székely–Halász 2010), and a subsequent recovery to a peak of HUF 1.275 billion at the end of the funding period in 2014 (Figure 10).



Source: MVH (2018)

Figure 10. Value of payment applications, accepted applications and payments made for farm advisory services paid out via the Rural Development Programme in Hungary, 2007-2015 (in nominal terms)

The Hungarian government is trying to put more emphasis on applied research with clear end uses. Despite the setting up of NAIK, adjusting the mentality of its research staff from one that is science-driven to being practice-driven is accepted by the interviewees as being a much slower process than building new buildings and buying new equipment. Renewal of the personnel via the appointment of younger researchers is needed. Some interviewees believe that state research institutes sometimes do not know who is going to use their results; they are doing the research for its own sake.

The Hungarian government has not yet been able to create a situation where all of the actors in the agricultural knowledge chain communicate with each other. The advisory services are not well developed for disseminating the results of the research and there is said to be no vision on whether the research should be targeted at large or small farmers.

The Ministry of Agriculture recognises that it is not sufficient to rely on websites and publications, and is trying to strengthen communication by encouraging personal contacts between researchers and farmers. To raise awareness of good practices in agriculture it has set up experimental farms where people can see technologies in operation through demonstration activities. It sees the need to strengthen the farm advisory system by finding young advisors and helping them with their technical progress via training, conferences, and involving them in scientific programmes e.g. via on-farm experiments. However, the most difficult challenge is to make farmers believe that it is a good decision to adopt new solutions. Very few small farmers will change their practices even with great effort. It is very difficult even to engage with mid-size farmers; it is necessary to do so through the education of their children and grandchildren.

Discussion

In the frame of the IMPRESA project, Chartier et al. (2014) surveyed the availability of official data sets on investment in agricultural research and, from these, the structure of, recent levels of, and trends in agricultural research expenditures in 19 EU Member States plus Switzerland which between them account for just over 95 per cent of European agricultural research. A small number of countries (Germany, Spain, the United Kingdom, Italy and France) accounted for over 70 per cent of public agricultural science budget allocations, and a substantial minority accounted for less than 5 per cent. The survey included seven Eastern EU Member States, namely Bulgaria, the Czech Republic, Hungary, Latvia, Poland, Romania and Slovenia. According to 2018 United Nations data, these seven countries account for around 16 per cent of the population of the EU-28 (and 86 per cent of the population of the 11 post-socialist Member States), so clearly their per capita expenditure on agricultural research is very low by European standards.

While it is the case that the Gross Domestic Product per capita of the EU-11 is also lower than that of the EU-28, agriculture plays a relatively more important role in the economies of these countries. Midmore (2017) argued that it is in the EU-11 that the impact of agricultural research is most needed, owing to difficult climatic conditions for agriculture, the rapid transition to family farming and the legacy of central planning. He notes with concern, however, that here as elsewhere in the EU, trends in expenditure are declining. In Hungary, total R&D expenditure in the field of agricultural sciences increased during the period 2008-2016, from HUF 19.7 to HUF 22.1 billion (Figure 2), but these figures are not adjusted for inflation. Public-sector R&D expenditure declined markedly over this period, and the proportion of total R&D expenditure spent on agriculture as a socio-economic objective also fell over this period (Figure 1). These trends are supported by the views of most of the interviewees. The stated intention of the Hungarian Ministry of Agriculture is to maintain the levels of public-sector expenditure on agricultural R&D but, notwithstanding the points that follow, this approach is insufficient: the level of expenditure should be increased.

It is evident from the results of this study that an increase in public-sector spending will, in isolation, have only a limited effect on agricultural productivity growth, even in the long term. The Hungarian Government's focus on what it sees as much-needed organisational reforms can be taken as a genuine attempt to improve the efficiency and effectiveness of public-sector agricultural research by developing the 'critical mass' of research institutes through greater cooperation. This in turn could lead to more interdisciplinary research and participation in EU-level research activities. Its desire to enhance the career prospects of younger researchers is another positive message. Prerequisites for this include improved salaries, more pleasant working environments and adequate resourcing of research activities (FAO 2014). Any action must be supported by well-designed personal development programmes including learning and using English, and the results cannot be measured by quantitative data alone. Several interviewees noted that more qualitative data are required to measure 'human' aspects such as the level of motivation of agricultural researchers. It is not entirely clear how to collect such data although the suggestion of using interviews (for example of researchers or of users of the farm advisory services) surely has a place. The Hungarian Ministry of Agriculture stated that it "would be ready to use any feasible and reliable method".

The absence of an official research strategy for agriculture is another serious concern and the identification of priority research topics, and aligning these where possible with the EU and other EU Member States, must begin very soon. There are two associated issues. Firstly, the potential for alignment of public- and private-sector research. This is easier said than done because private-sector agricultural research priorities are market-driven and broadly independent of government policy. Secondly, the need for a greater emphasis on applied research. It would be unreasonable in the extreme to suggest that the disconnect between research and practice is exclusive to Hungary. SCAR (2012) discussed this issue at length and advocated the distinction between science-driven research and innovation-driven research. There is a conflict between the publication of research papers and papers for implementation: the former tend to be included (and viewed favourably) in staff evaluation systems while the latter are considered to be of lesser value.

Chartier et al. (2015) reported that coverage of agricultural research expenditure data by fields of science varies across countries from full availability to complete absence, and that coverage of expenditure data by socio-economic objectives is even poorer. In this respect, the excellent performance of the KSH sets the standard to which data agencies in other countries should aspire. It is essential that complete data sets be collected and Hungary shows that it is feasible to do so. Even so, there were some questions that could not be adequately answered. One was whether the KSH data relating to business enterprise agricultural R&D activity were truly accurate. Some interviewees expressed doubts, and the dramatic reversals in trends shown in Figures 3 and 4 are difficult to explain. The KSH was specifically asked for their interpretation of these reversals. Their opinion was that a high proportion of projects are financed from government funds and that the timing of the payments influences the levels of expenditure. Also, it was not at all clear, either from the data or the interviews, which sector (if any) has driven the increase in business sector agricultural R&D. Some KSH data indicate that between 2007 and 2011 manufacture of food products as a percentage of total business enterprise expenditure on R&D has increased, while agriculture and fishing has declined, but the two years use different NACE code sets.

Even with complete data sets, measuring the impact of agricultural research on productivity in the post-socialist EU Member States is difficult because, as Midmore (2017) observed, of the structural break involved in the transition from centrally-planned to market economies that began early in the 1990s. Midmore (2017) believes that the report of Ratinger and Kristkova (2015), which estimates national internal rates of return in the Czech Republic to be between 14 and 32 per cent, is the sole national study from the Eastern EU.

The interviewees in this study noted the distinction between data that measure *outputs* and those that measure (shorter-term) *impacts*, with the availability of the latter being inadequate. This matches the findings of Fieldsend and Székely (2013) who reported that, for farm advisory services, there are no data on the level of use of private-sector advisory services, on the quality of advice provided by public sector advisors or on the impact of this advice on the performance of the farming sector. These weaknesses in contemporary practices related to the ex-post evaluation of Hungarian agricultural research are widely recognised and were stressed by several of the interviewees. They are deep-seated problems that can be traced back over many years and there is broad agreement that "something must be done". Again, though, Hungary is not unique and the author is not aware of any good practice elsewhere in Europe. The most effective approach may be to focus on improving the quality and relevance of the research *output*, in the expectation that this will enhance its *uptake*. The political will to address the issue does seem to exist and it remains to be seen whether this will actually happen after the present round of 'top level' reorganisations has been completed.

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