The Impact of Research on EU Agriculture

impresa

Study on Investment in Agricultural Research: Review for Germany

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Content

List of abbreviations

The list of all acronyms used within this report as well as their meaning in English and German is provided in Annex II.

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FOREWORD

This report forms part of the deliverables from a project called 'IMPRESA' which has been awarded financial support by the European Commission under the 7th Framework Programme.

The project aims to evaluate the impact of EU research on agriculture, collecting data on recent trends in investment in agricultural research, and developing a framework combining case studies, econometric analysis and modelling for assessing its impact. A first task is to prepare country-level analysis of the agricultural research expenditures and an assessment of the availabilities of data regarding public and private investments in agricultural research.

Agricultural research covers 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; research in the field of developing food productivity and technology[1].

More information on the project can be found at http://www.impresa-project.eu.

[1] http://www.impresa-project.eu/glossary.html

1. INTRODUCTION

Macroeconomic context of Germany

The GDP in Germany increased by 2.7% in 2013 compared to 2012. The GDP per capita amounted to € 34,219 in 2013 and has witnessed an increase since the last four years; also the export earnings have been increasing as well (cf. Table 1).

Table 1 GDP and expenditures in Germany

	2008	2009	2010	2011	2012	2013
Gross value added (billion EUR)	2217	2117.05	2235.16	2334.89	2386.79	2453.85
GDP (billion EUR)	2558.02	2456.66	2576.22	2699.10	2749.90	2809.48
GDP (change in percent)	1.9	-4	5.1	4.6	2.2	2.7
GDP per capita (EUR)	31150	30005	31511	33005	33569	34219
Export (billion EUR)	984.14	803.31	951.96	1061.23	1095.77	1093.82
Import (billion EUR)	805.84	664.61	797.10	902.52	905.93	896.16

Source: (DESTATIS 2014a)

The private consumption expenditure in 2012 came to average € 2,310 per month and household, slightly higher than the expenditures of the preceding years (DESTATIS 2014e). The number of unemployed persons has gone down continuously over the last decade. While in 2005 4,860,909 inhabitants were without work, in 2013 Germany had only 2,950,250 unemployed persons (cf. Figure 11 in Annex III) (DESTATIS 2013).

The agri-food sector in Germany

The average cultivated area of holdings in all over Germany 2013 was 58.6 ha. The situation of the agricultural sector in Germany is characterized by very low economic importance and a heterogeneous agricultural structure. A particularly strong distinction is observed with regard to farm size between the former Eastern and Western German states (Länder). There is a noticeable reduction in intensification of land use from the north to the south of Germany. When considering the Länder (federal states) separately the largest holdings are located in the eastern states. The average farm size in 2013 in Mecklenburg-Western Pomerania was 285.3ha followed by Saxony-Anhalt with 279.2ha and Brandenburg with 243.3ha. In contrast to these large farming areas in the so-called 'new' federal states, the average cultivated area of holdings in the Western Länder especially the Southern part of Germany are relatively small. For example in the Northern state Lower Saxony the average farm size is 65.6ha while in Bavaria as well as Baden-Württemberg it is approximately 34ha. Consequently, the total number of holdings of these three states represents 60% of Germany. Therefore in the new federal states the agricultural businesses are fewer but larger whereas relatively small holdings are mostly located in the western and southern states (cf. Table 10) (DESTATIS 2014b).

In 2013, Germany had a total of 285,000 agricultural holdings with a total utilized agricultural area of 16.7m ha, including 11.8 million ha arable land, 4.6million ha grassland and 0.2 million ha permanent crops. Table 6 in Annex III provides details about farm types and agricultural production. Around 6% of the German agricultural holdings are specialized on organic farming, which corresponds to 6.3% of the total utilized agricultural area. The federal government continues to support conversions to organic farming with the objective to reach a share of 20% UAA of organic farms (DESTATIS 2014b).

Table 2 Gross value added and employment of the German agricultural and food industry 1995 to 2010.

	1995	2000	2005	2007	2009	2010
Gross value added (EUR billion)						
Agriculture, Forestry and Fisheries	18.30	20.45	16.09	18.96	16.23	18.67
Manufacture of food and beverages and of tobacco products	34.54	36.43	37.32	37.98	37.77	
Share in national total (percent)						
Agriculture, Forestry and Fisheries	1.10	1.10	0.80	0.90	0.80	0.80
Manufacture of food and beverages and of tobacco products	2.10	2.00	1.90	1.70	1.80	

Source: DESTATIS online : https://www.destatis.de/EN/Publications/STATmagazin/Prices/2012_06/Tables/2012_06Table2.html [21.10.2014].

Table 3 Employment in agriculture and food industry in Germany 2009 to 2012.

	2009	2010	2011	2012
Employees (1000 units)				
Agriculture, Forestry and Fisheries	648	637	649	622
Manufacture of food and beverages and of tobacco products	546	551	559	564
Share in national total (percent)				
Agriculture, Forestry and Fisheries	1.68	1.64	1.63	1.55
Manufacture of food and beverages and of tobacco products	11.41	1.41	1.40	1.40

Source: DESTATIS 2014a

In 1991, 1,167,000 persons were employed in agriculture which was 3% of the national total. However the numbers of employees as well as the gross value added of this sector were decreasing permanently during the last 20 years (cf. Table 2 and Table 3). Also the share of agriculture (agriculture, forestry and fisheries) in the gross value added is falling. In 2000, agriculture made up 1.10% and in 2010 0.80% of total gross value added (DESTATIS 2014a, 2014d). The food sector in Germany has remained on a rather steady level during the last five years: numbers of holdings have increased slightly from 5,848 (2009) to 5,902 (2013), same as numbers of employees with 545,967 persons in 2009 and 564,350 in 2013. In the last two decades, the gross value added of manufacture of food and beverages and of tobacco products has increased in absolute numbers from € 34.5 billion (1995) to € 37.7 billion (2009), relatively the share decreased from 2.1 (1995) to 1.8 (2009).

Content of the report

This report provides a review of recent trends on investment in agricultural research. It provides a brief introduction to the national Agricultural Knowledge and Innovation System (AKIS) in chapter 2, an assessment on the availability of data (chapter 3), an analysis of recent investment trends (chapter 4) and a discussion (chapter 5). The conclusion provides expert opinions on future perspectives and recommendations for better monitoring of agricultural research investment. The report has been prepared between May and September 2014 by Simone Schiller, Kerstin Hülemeyer and support from Charlotte Behrmann. It is mainly based on a review of existing literature and on a consultation of key actors involved in agricultural research (cf. ANNEX I: List of consulted Persons).

2. OVERVIEW OF THE AGRICULTURAL KNOWLEDGE AND INNOVATION SYSTEM

2.1 Overview of the AKIS

The German agricultural knowledge and innovation system is composed of a large variety of organisations and differs considerably between regions and sub-sectors. This is a consequence of different political history in Eastern and Western Germany, different farming structures and the federal governance system shaping institutions and administrative procedures. In the Federal Republic, the Federal Ministry of Food and Agriculture (BMEL) is responsible for all superior matters in the agricultural sector. In particular it is in charge of policies such as the Pillar 1 of European Common Agricultural Policy (CAP) and the Joint Task on Agricultural Structures and Coastal Protection (GAK). The 16 states (Länder) on the other hand are in charge of implementation of Pillar 2 of the CAP, of agricultural education and professional training, of extension and advisory services, as well as of state level departmental research. In particular, the advisory services are institutionally very different and multiple structures prevail even within one state (Paul et al.).

Due to the differences between the AKIS in the different states, Figure 1 can only provide a generalised overview of the four different types of AKIS actors in Germany. Moreover, the attribution of certain actors to the categories is sometimes fluent and can differ from state to state. The centrality of certain actors, however, becomes evident; such as the state ministries of agriculture, the regional chambers of agriculture – where they exist, or the state research institutions. The importance of the latter in 'bridging research and practice' was confirmed in surveys conducted within the PROAKIS project (Paul et al.).

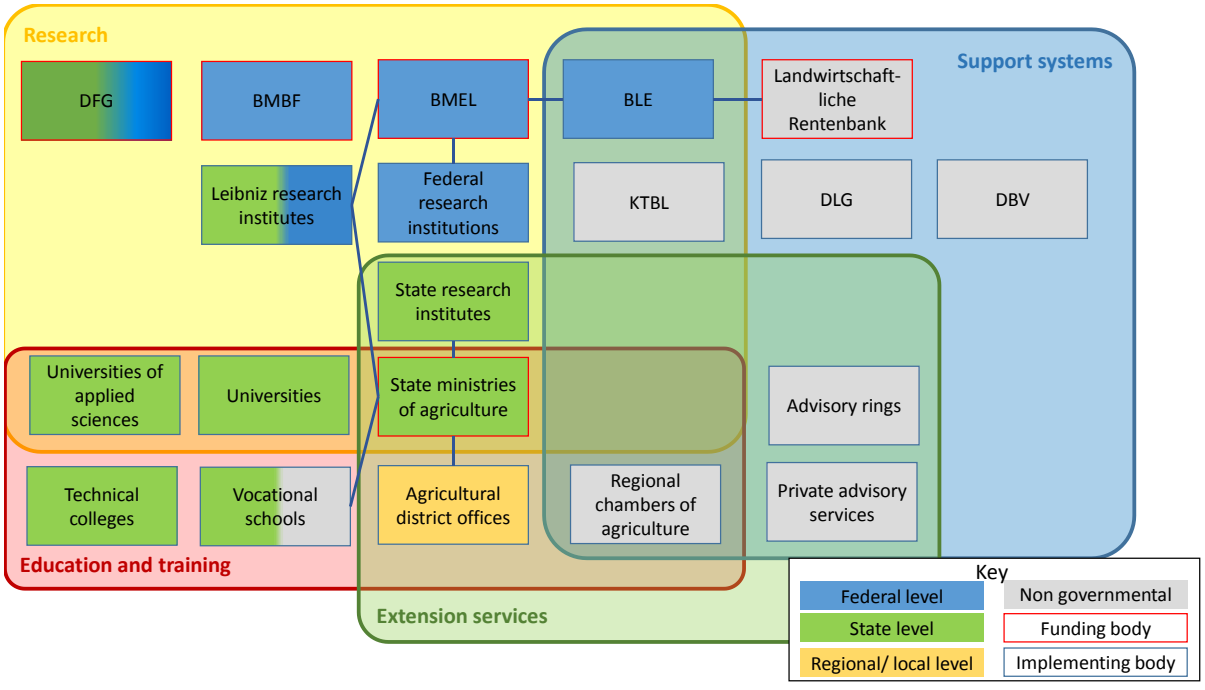

Figure 1 German Agricultural Knowledge and Innovation System Actors
Source: own illustration based on the SCAR AKIS categorization (EU SCAR)

2.2 Main actors

It is impossible here to provide a full list of relevant German AKIS actors; however, Table 4 illustrates the types, numbers and roles of some of the most important organisations. Also the boundaries between private organisations and farmer associations are often fluent which makes it hard to separate one from another (Paul et al.).

Table 4 Agricultural knowledge and innovation system actors in Germany

Type	Name	Description / Primary role
Public decision-making system		
Federal and State Ministries	- Federal Ministry of Food and Agriculture (BMEL) - Federal Ministry for Education and Research (BMBF) - Also relevant: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU); Federal Ministry for Economic Affairs and Energy (BMWi) - 13 state ministries of agriculture/rural areas, 3 representatives of city states.	Policy and regulation, departmental research institutions, innovation funds Research funding, (university) education R&D programmes, innovation funds Vocational training, CAP rural development programmes, State departmental research, partly public advisory services,
Public agencies	- Federal Agency for Agriculture and Food (BLE); - Federal Agency for Nature Conservation (BfN).	Implementation of R&D programmes, innovation measures (DVS, BÖLN)
Research associations and councils	- German Agricultural Research Alliance (DAFA) - Umbrella association of scientific societies of agricultural, forestry, nutrition, veterinary and environmental research (DAF); - German Research Foundation (DFG); - Senate of Federal Research Institutes *(Senat der Bundesforschungsinstitute);* - German Council of Science and Humanities; - Bio-Economy Council (*Bioökonomierat*).	Coordination between research bodies, strategic orientation of (public funded) research Funding basic research
Information and knowledge system		
Public research institutions	- 4+1 Federal (departmental) Research Institutes; - 6 Leibniz institutes; - 31 state (departmental) research institutes.	Departmental research, policy advice Applied research and extension
Universities	- 10 universities offering agricultural studies; - 5 universities offering veterinary studies.	Education and research
Universities of Applied Sciences	- 12 universities of applied sciences	Higher professional education
Private research organisations	- Association for Technology and Structures in Agriculture (KTBL); - Deutscher Wetterdienst, Zentrum für agrarmeteorologische Forschung (ZAMF)	
Training and education institutions	- Vocational schools (163 agricultural schools, 143 horticulture, 9 viticulture); - Technical colleges, (122 agriculture, horticulture 38, viticulture 8); - Independent training institutions e.g. DEULA e.V. (13 institutions); Andreas-Hermes-Academy (AHA); - Federal Association of Agricultural Vocational Training (VLF).	Secondary education (vocational training) Tertiary education (continued vocational training) technical training courses, Further education Support and training for farmers offering vocational training
Chambers of agriculture	- 7 regional chambers of agriculture in northern and middle west Germany; - The Federation of Agricultural Chambers (VLK).	Extension, vocational training

Farmers/ producers associations	-	German Farmers´ Association (DBV) with 18 regional branches, and associates like Young farmers associations;	Advisory services, analysis, professional representation
	-	Other farmers associations like Federal Association of Dairy Farmers (BDM), Syndicate of Traditional Agriculture (AbL);	
	-	Federal Association of Machinery Rings (BMR);	
	-	Organic farming associations like Bioland, Naturland, Demeter;	
	-	German Raiffeisen Association (DRV).	
Non-governmental organisations	-	Information service for food, agriculture, consumer protection (aid)	Public funded non-profit information service
Private advisory services	-	Numerous from individual freelancer to companies	Advisory services
Socio-economic system			
Professional associations	-	German Agricultural Society (DLG)	Information provision for members
	-	Professional Association Agricultural, Nutrition, Environment (VDL)	
	-	Federation of Rural Advisors (IALB)	Knowledge network, training of advisors
	-	Association of German Agricultural Analytic and Research Institutes (VDLUFA)	
	-	German agrochemical industrial association (IVA)	

Source: own processing

Farmers constitute another important group of the socio-economic system. 285,000 agricultural holdings existed in 2013; with a labour force of about 1 million. Around 90% of those farms are family-run, and 132,100 holdings are part time farms. Farm numbers declined by 5% since the last agricultural census in 2010. Around 68% of the farm owners/managers have completed some level of vocational training; 7.3% have completed a university or university of applied sciences degree. Around one third do only have practical agricultural experiences without formal training (DESTATIS 2014c).

The public education system

Within the federal organization of the German government, education is the responsibility of the individual states. Agricultural education and training is split between a multitude of organisations. The dual vocational training system in Germany combines farm-based training with regular attendance of vocational schools (*Berufsschulen*). Fourteen different agriculture-related training courses are offered in Germany with 34,764 attendants (11% female) in 2012. Within the last 15 years the number of agricultural trainees (only) has been fluctuating between around 7,800 (in 2001) and 9,700 (in 2007). In the following 5 years numbers have been decreasing again to 8,500 agriculture trainees in 2012. Advanced (continued) training is offered in form of 1 or 2-year courses by technical colleges (*Fachschulen*) leading either to a certificate as *Meister* (translates 'master' but not in the sense of scientific qualification) or as technician (*Techniker*). The number of students at agricultural technical colleges is more or less stagnant with 7,783 attendants in 2012 (agricultural training in particular 4,709).

Tertiary agricultural education is also offered by universities (*Universitäten*) and universities of applied sciences (*Fachhochschulen*). Within the field of agriculture, forestry

and nutrition sciences[2] 275 study courses are offered at 20 universities and at 32 universities of applied science in Germany. Agricultural studies in particular are offered at ten universities and 12 universities of applied science[3]. In the winter semester 2012/13 47,766 students of agricultural, forestry and food sciences were enrolled at German universities, of which 26,673 studied agricultural sciences, food and beverages technology. Recent developments in the education sector are the realization of the 1999 academic reform (Bologna reform). Almost all (95%) faculties and institutes offering agriculture, forestry or nutrition science in Germany are now offering Bachelor and Master degrees. Although universities are under the responsibility of the *Länder*, they have a certain degree of autonomy in strategic orientation of the education and research.

A specific form of education is the dual study system, which combines vocational training with university studies and offers graduates both certificates with a time advantage of about one year. A growing number of dual agricultural studies courses are offered at currently 13 universities of applied sciences or universities of cooperative education (*Berufsakademien*).

Besides the above described formal education system, there are several private institutions offering advanced professional training some of which lead to certificates. Leading actor to be mentioned here is the Andreas Hermes Academy (AHA), the central further education institution of the German agriculture and food industry.

The public research system

The governance, funding and implementation of public agricultural research is split between the federal and the state (Länder) level. Leading actor is the Federal Ministry for Food and Agriculture (BMEL) being responsible for federal (departmental) research institutions and funding of particular research programmes such as the 'Federal Framework Programme Ecologic Farming and other Forms of Sustainable Agriculture' (BÖLN). The 2013 budget for research of the BMEL was € 178.8m. The second important federal level actor funding agricultural research is the Federal Ministry for Education and Research (BMBF) with a 2013 budget for 'bioeconomy' of € 139.4m (BMF).

A third actor, the German Research Foundation (DFG) is the self-governing organization of science and research in Germany, financed by federal level and states. It therefore 'funds knowledge-oriented research without stipulation of topics and utilises competition to select the best projects in terms of scientific quality'. It had a 2013 budget of € 41.4 million for agriculture, forestry, horticulture and veterinary medicine out of its' total € 2 billion annual research funding (DFG 2014).

The BMEL funds departmental research by 4 federal research institutions and supports furthermore six institutions of the Leibniz association, the Federal Institute for Risk Assessment (BfR) and the German Biomass Research Centre (DBFZ). The overall structure of departmental (agricultural) research in Germany is illustrated in Figure 2.

The state ministries of agriculture have a dual role as they are in charge of state departmental research institutions but also have responsibility for education and in some states for the extension services. The private sector plays a considerable role in agricultural research, with almost 400 private sector organisations being involved in agricultural and food research according to the FISAonline data base . Unfortunately this can hardly be substantiated by data on private research expenditure levels (cf. 3.1).

[2] including the follow disciplines: agricultural science, horticulture science, forestry, timber industry, land use planning and environmental protection, home economics and nutrition science, and food technology

[3] Bildungsserver Agrar [online], URL: http://www.bildungsserveragrar.de/index.php. [accessed 09.09.2014]

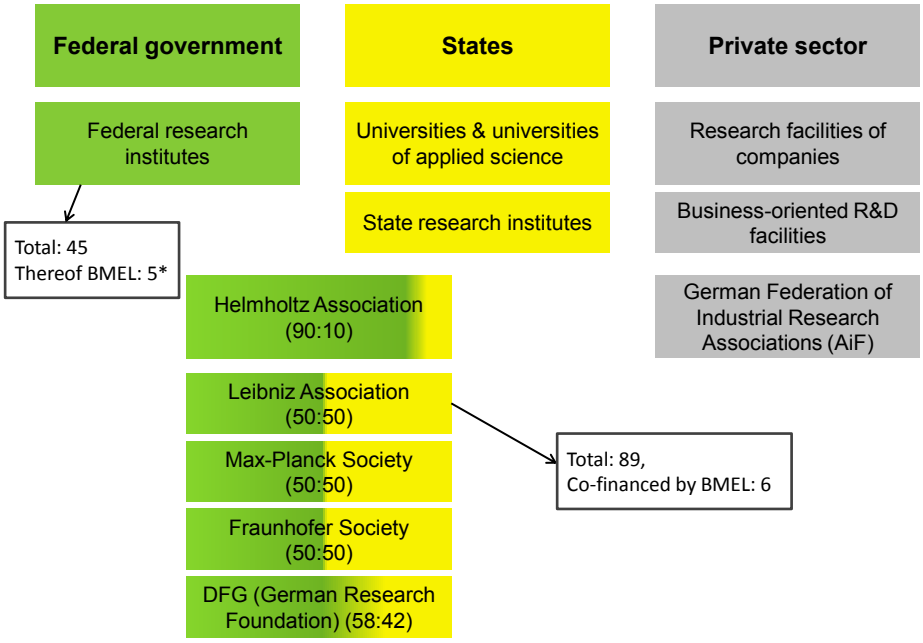

Figure 2 The German Research landscape
Source: adapted from Senat Bundesforschung .

Federal and state (public) research funds are either channelled through short-term project support or medium and long term institutional support. Project support is granted within the frame of larger framework programmes (e.g. the BÖLN programme of the BMEL, or the FONA programme of the BMBF) and administered by Project Management Agencies. Institutional support is granted to departmental and other public research institutions (such as the Leibniz Association) for – among others – infrastructure and direct costs (Paul et al.).

The Agricultural Extension System

Several reports have highlighted the fact that the German advisory system differs considerably between different regions in the institutional setup as well as in the actors involved (Bokelmann et al. 2012; Paul et al.; Thomas 2007; Hoffmann 2002). Thomas (2007) differentiates between (1) official public advisory services, (2) advice through chambers of agriculture, (3) advisory rings (organised as associations), and (4) private advisory services. In the southern states public advisory services dominate, in north-western and middle Germany advisory services are offered by the chambers of agriculture, and in most eastern federal states the advisory services are offered by private companies or banks. Figure 13 provides a map illustrating the distribution of advisory systems in the Länder. Recently private advisory service providers become increasingly important as funding for public extension services is decreasing. Of course all farmers can consult private (and commercial) services (Bokelmann et al. 2012). Paul et al. concludes that this 'creates considerable obstacles for the horizontal knowledge flows. According to literature and experts, the linkages within the AKIS therefore cannot be classified as well-functioning, especially from the national perspective.' Advisory services are funded through different public and private sources. EU funding is offered through measures 114 of the Rural Development Programmes 2007-2013 (appeared only by six out of 14 programmes); co-funding is possible through federal GAK funds.

Innovation programmes

Innovation and research support for the agricultural sector is offered by a number of institutions, with the Federal Ministry of Food and Agriculture (BMEL) with its implementing agency, the Federal Agency for Agriculture and Nutrition (BLE), being the central actors. Other federal ministries such as the Federal Ministry for Education and Research (BMBF), the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU) are also offering suitable support. Three innovation programmes in the area of agriculture, food and consumer protection are administered by the BLE: (1) the programme for innovation support (Programm zur Innovationsförderung) of the BMEL, with an annual budget of € 37 million; (2) support through the Federal Government's special-purpose fund held with the Landwirtschaftliche Rentenbank; (3) the German Innovation Partnership (Deutsche Innovationspartnershaft Agrar – DIP). The BMEL furthermore awards prices for innovative organic farming concepts as part of the annual Federal Competition for Organic Agriculture.

All German *Länder* (states) have offered innovation measures as part of the rural development programmes in the previous funding period (2007-2013), as axis 1 measure and under the Leader programme. Part of the new RD programmes (2014-2021) are measures under the European Innovation Partnerships (EIP). Many *Länder* also offer programmes funded under ERDF, some also under ESF. In addition, some *Länder* offer other measures to support innovation more generally. The sector study on innovation in German agriculture provides an overview of the recent *Länder* initiatives (Bokelmann et al. 2012).

In addition, there are (smaller and regional) private initiatives – mainly competitions and awards to highlight successful agricultural innovations. To mention a few:

- Agricultural Award for business innovations (Landwirtschaftspreis für Unternehmerische Innovationen, L.U.I.) through ZG Raiffeisen;
- Biogas innovation award of German Agriculture (Biogas-Innovationspreis der Deutschen Landwirtschaft);
- Innovation award of Vogtland Agriculture (Innovationspreis Vogtländische Landwirtschaft);
- Innovation award of 'New Agriculture' (Innovationspreises der NL Neue Landwirtschaft) through the German Agricultural Publishing House (DLV).

2.3 Governance

It has been introduced in section 2.1, that the distribution of responsibilities for education, research & development, extension and innovation support is split between the Federal Government and the *Länder* governments, as well as between the departmental ministries (education & research, agriculture, economic affairs). To add to the complexity the AKIS-related governance system is constantly evolving as a result of institutional reforms. A two-step reform of the German federal system in 2006 and 2009 had the aim to decrease bureaucracy and ensure better strategic coordination between Federal and *Länder* level and affected agricultural and education administration. Other reforms such as the Bologna-reform or the introduction of the 'Freedom of Science Act' (*Wissenschaftsfreiheitsgesetz*) in 2012 have affected the education and research institutions. In early 2008 the federal agricultural departmental research institutes were reorganized on the basis of a concept for a sustainable departmental research (BMELV 2008). The aim was to technically and organizationally align the organisations to optimally support decision needs of the federal ministry (BMELV 2008). This reform is a result of a number of studies and evaluations of the German agricultural science and research system (Isermeyer 2003; Ober 2004).

Overall governance of the agricultural sector is determined by a number of policies; mainly the GAK (Joint task 'improvement of the agrarian structures and coastal protection') and the Common Agricultural Policy (CAP). The planning commission for the agrarian structure

and coast protection (PLANAK) determines annual framework plans for the GAK, while a 'national framework regulation' provides the coordinating mechanism between the GAK and the CAP. Another important coordinating instrument is the thematic working panels which are initiated by federal ministry on different topics such as the working panels of the agricultural extension speakers. The German Networking Agency for rural areas (DVS), hosted at the BLE, 'acts as a networking platform on a national and, partly, EU-level' (Paul et al.). Its main purpose is to 'support cooperation and exchange between administrative, scientific and practitioners in agriculture and rural areas, e.g. via thematic networking events, a topical newsletter as well as a regular journal' (Paul et al.). The BLE also plays a significant role in coordinating research, as it is the executing agency for BMEL-funded research programmes, and also hosts the German Innovation Partnership (DIP).

The mechanisms in place to administer and coordinate research are further described in section 4.2.3. The strategic orientation of different level research organisations is fostered through a number of institutions such as the:

- German Agricultural Research Alliance (DAFA),
- Senate of Federal Research Institutes (*Senat der Bundesforschungsinstitute*),
- German Council of Science and Humanities (*Wissenschaftsrat der Bundesrepublik*),
- the Joint Science Conference (*Gemeinsame Wissenschaftskonferenz* GWK[4]) ,
- Bio-Economy Council (*Bioökonomierat*).

The web-based platform 'FISA online' was initiated to support coordination between the different *Länder.* It provides an overview of public (federal, state level), private and non-governmental research institutions in the field of agriculture and food. The information on previous and current research projects and programmes, however, is rather incomplete (cf. 4.2.3).

[4] The GWK is an initiative of the federal BMBF and the *Länder* ministries in charge of research and science, dealing with questions of research funding, science and research policy strategies and the science system which jointly affect the Federal Government and the Länder.

3. AVAILABILITY OF DATA ON AGRICULTURAL RESEARCH EXPENDITURES

3.1 Overview of data availability

Time series of any statistical data for Germany have considerable restrictions in comparability. First of all, the German reunification in 1990 led to substantial territorial changes, thus data prior to 1990 usually only covers the territory of the 'old' Federal Republic. In addition, the German classification of economic activities of the year 1979 has been revised considerable in 1993. Later revisions (1993, 2003 and 2008) are of minor relevance. Data for 1993 and 1995 are still based on the older classification.

GERD – Gross domestic expenditure on R&D *(Bruttoinlandsausgaben für Forschung und Entwicklung):* Total federal level GERD expenditure and personnel data is available differentiated by sectors from 1981 onwards. Furthermore, a breakdown of total GERD expenditure by *Länder* (states) is also available for recent years.

Consecutive GERD by FOS 4 Agricultural sciences data are available for the government sector (GOVERD) and for the higher education sector (HERD) from the year 1993. These are comparable with some minor limitation. E.g. since the reporting year 2011 only internal expenditure for R&D are included, not counting funds which are only passed on, in order to avoid double counting. In addition biannual HERD data is also available for the period between 1981 and 1991. Only singular years are available for the private non-profit sector (1983, 85, 87, 89). Very few values are available for GERD by NABS for the government sector. The German Federal Statistical Office (DESTATIS) is in charge of collecting GERD data.

GOVERD data is based on compulsory surveys of public and publicly financed research and development organisations. Likewise is the HERD data based in compulsory University and Personnel statistics, which are differentiated into research and teaching using estimation techniques to get isolated contributions for the research statistics.

GBAORD – Government budget appropriations or outlays for R&D *(Staatliche Mittelzuweisungen oder Ausgaben für F&E):* Total GBAORD appropriations are available for the period 1980 to 2007 (NABS 1992), and for the years 2008 to 2013 (NABS 2007). Likewise, GBAORD appropriations for NBS06 - Agricultural productivity and technology (NABS 1992) are available for 1981 to 2007, followed by NABS08 - Agriculture (NABS 2007) for the period 2008 – 2013. Very few values are available for NBS1107 - Agricultural sciences for this period (NABS 1992). Responsibilities for GBAORD collection is shared between Federal Ministry for Research and Development (BMBF) for federal level expenditure and the Federal Statistical Office for state budgets. For gathering GBAORD data, experts are searching public budgets for titles with research relevance.

The R&D expenditure of the federal state and the *Länder* by NABS for the research objective 'agricultural productivity and technology', published by the Deutscher Bundestag until 1998 and by the BMBF since 2002, is mostly congruent with the GBAORD by NABS data for the period 2002 to 2012[5]. Some deviations occur for the values before 2002, however overall dynamics are very similar to the GBAORD by NABS NBS06 - Agricultural productivity and technology data.

BERD – Business enterprise R&D expenditure (*F&E-Ausgaben im Wirtschaftssektor / der Unternehmen*): Private research expenditure data is collected on a voluntary base by the Donors' Association for German Science (*Stifterverband für die deutsche Wissenschaft*) – a business community initiative advocating long-term improvement of the German

[5] The value for 2009 is slightly different

education and research landscape. Data is collected by industry, and in our case one sum is published for agriculture, forestry and fishery.

BERD data can be obtained for national level as well as for the level of the *Länder* – and at aggregated level even down to the level of administrative district. The Stifterverband, however, anonymizes data in case there are less than 3 enterprises or if one enterprise dominates agricultural research funding (spends more than 70% of total sum). Due to theses anonymisation rules data at *Länder* level for the agricultural sector are of no relevance for the IMPRESA project.

In comparison to other sectors, agriculture and forestry as well as for food industry have a relatively small amount of R&D expenditure by enterprises. The responsible of the Stifterverband claimed several reasons: The number of enterprises in the sector is low and the existing enterprises invest little in R&D ('It is not a sector at the cutting edge of innovation', Stifterverband, personal communication, 07.08.14). In addition the enterprises are not obliged to report the amount of spending to the Stifterverband (for a further assessment of BERD data cf. section 4.1.2). Due to the above mentioned restrictions in comparability, the earliest BERD data of interest are for the years 1997 to 2007. These can be obtained for free. Data for 2009 and 2011 had to be purchased due to low expenditure rates (were categorized as 'others' in the public report, thus a special evaluation was required).

The Federal Ministry of Research and Education (BMBF) publishes actual expenditure data broken down by **funding areas and funding priorities**, which are based on the Federal Government's R&D planning system (*Leistungsplansystematik*)[6]. This system has been revised since the reporting year 2011. Agricultural research is now reported under category D: food, agriculture and consumer protection and divided into (DA) food sector; (DB) sustainable agriculture and rural areas; and (DC) health and economic consumer protection. Previous to the revision R&D expenditure was summarised for agriculture, forestry and fisheries (in category R), and the food sector (Q). Data is available from the year 1981 on with a gap in 1984. For each funding area and funding priority, total expenditure and therein R&D expenditure are provided. Expenditure is assigned to the categories at project level; and for other ministries mainly according to budget headings. The funds for institutional support, including the expenditure of the federal government-owned scientific institutions, are - based on their specific tasks – also classified by research themes to one or more funding areas or priorities. There are some deviations from this for some federal funded departmental research organizations and the DFG. The data reported in this format is not consistent with the GERD data.

Agricultural research expenditure data disaggregated by the level of federal states (*Länder*) is not available for GERD and GBAORD. However, the annually published report on research expenditure by the Federal Statistical Office (Fachserie 14 / 3 / 6 *Ausgaben, Einnahmen und Personal der öffentlichen und öffentlich geförderten Einrichtungen für Wissenschaft, Forschung und Entwicklung*[7]*)* contains information on R&D expenditure by FOS agricultural sciences for public and publicly funded research institutions broken down by the states[8].

[6] http://www.datenportal.bmbf.de/portal/en/bufi.html

[7] All available documents from 2002 on are available at https://www.destatis.de/GPStatistik/receive/DESerie_serie_00000137

[8] Expenditure on R&D and their Share in GDP by States 2006 to 2008 available at https://www.destatis.de/EN/FactsFigures/SocietyState/EducationResearchCulture/ResearchDevelopment/Tables/RDExpenditureANDGDPStates.html

Table 5 Data availability for the main indicators

Indicator	Time series available
GERD	
All areas	1981-2012
By FOS (Agricultural sciences)	
All sectors *Government sector* *Higher education sector* *Private non-profit sector*	Not available 1993-2012 1981-1991 (biannual), 1993-2011 1983-1989 (biannual)
By NABS 1992	
Chapter 6 - Agricultural production and technology *All sectors* *Government sector*	 Not available 1996; 2000
By NABS 2007	
Chapter 8 – Agriculture *All sectors* *Government sector*	 Not available 2008;2012
BERD	
By NACE rev. 1.1 2 (DE and *Länder*)	
All areas *A B - Agriculture, forestry and fishing* *DA15 - Manufacture of food products and beverages*	1981-2010 1997; 1999; 2001-2008 1997; 1999; 2001, 2003; 2005; 2007
By NACE rev. 2 (DE and *Länder*)	
All areas *A - Agriculture, forestry and fishing* *C10 C11 – Manufacture of food products and beverages* *C10-C12 food and fodder industry, brewery and tobacco*	2005-2012 2007-2012 Not available 2009; 2011
By NACE 79 (DE and *Länder*)	
All areas *28/29 Food products, tobacco processing*	1993; 1995 1993; 1995
GBAORD	
By NABS 1992	
All areas *NBS06 - Agricultural production and technology* *NBS1107 - Agricultural sciences*	1980-2007 1981-2007 1987; 1994-2001; 2004-2006
By NABS 2007	
All areas *NABS08 - Agriculture*	1980-2013 2004-2013
Federal expenditure for science, research and development by funding areas and funding	
All areas *Q: R&D for food sector* *R: R&D for agriculture, forestry and fisheries* *D: food, agriculture and consumer protection*	1981-1983; 1985-2012 1981-1983; 1985-2010 1981-1983; 1985-2010 2011-2012
R&D expenditure of federal and state level by research objectives (NABS) (in million EUR)	
Total all NABS *Agricultural productivity and technology*	1993; 1995; 1997-2013 1981-1983; 1985-1995; 1997-2001; 2003-2013
Expenditures for R&D of the public sector scientific institutions	
For Agriculture By Länder	2002-2012

In black: data available in EUROSTAT database
In red: national data not available in EUROSTAT database

3.2 National expenditure on research and agriculture relative share

The **Gross domestic expenditure on R&D** in Germany has steadily increased since the 1980s from € 15 billion in 1981 to € 79 billion in 2012. The largest share of this expenditure comes from the business enterprise sector (67.7% in 2012). The higher education sector only accounts for 17.9%, the government sector only 14.3% of the total GERD expenditure in 2012.

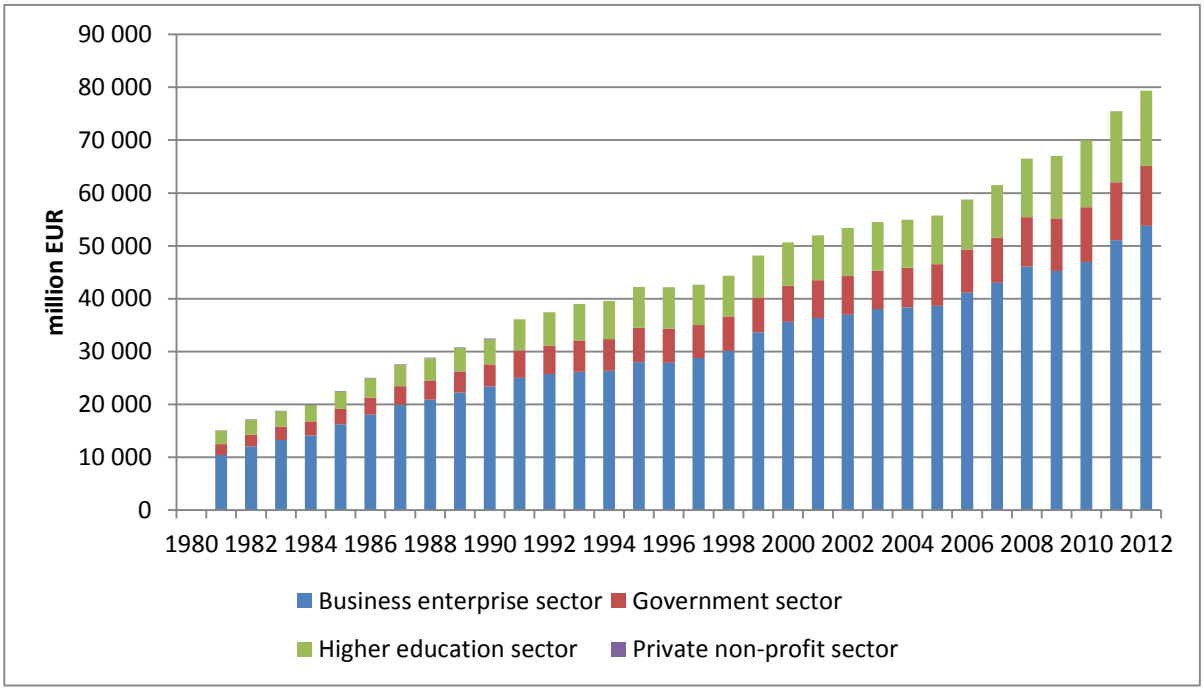

Figure 3 Gross domestic expenditure on R&D by sector 1981 to 2012
Source: EUROSTAT

Due to the limited availability of data on GERD by FOS (agricultural sciences) it is not possible to provide an analysis of the share of agricultural expenditure in total GERD expenditure. Comments on the share of agriculture within the government and higher education sectors are provided in section 3.3.1.

3.3 Investment in agricultural research

3.3.1 Public and private effort

Similar to the general trend of research expenditure in Germany, the available GERD data for the FOS 4 Agricultural sciences shows that the absolute government sector and higher education sector expenditure have been steadily increasing (cf. ANNEX III: Additional information Table 9). However, the share of expenditure for FOS 4 of total expenditure particularly for the higher education sector have been decreasing from just below 5% in 1993 to just above 3% in 2011 (cf. Figure 4). Similarly, the GOVERD share of FOS 4 in total GOVERD shows a decreasing trend, with alterations between 5 and 6% in the period between 1993 and 2012.

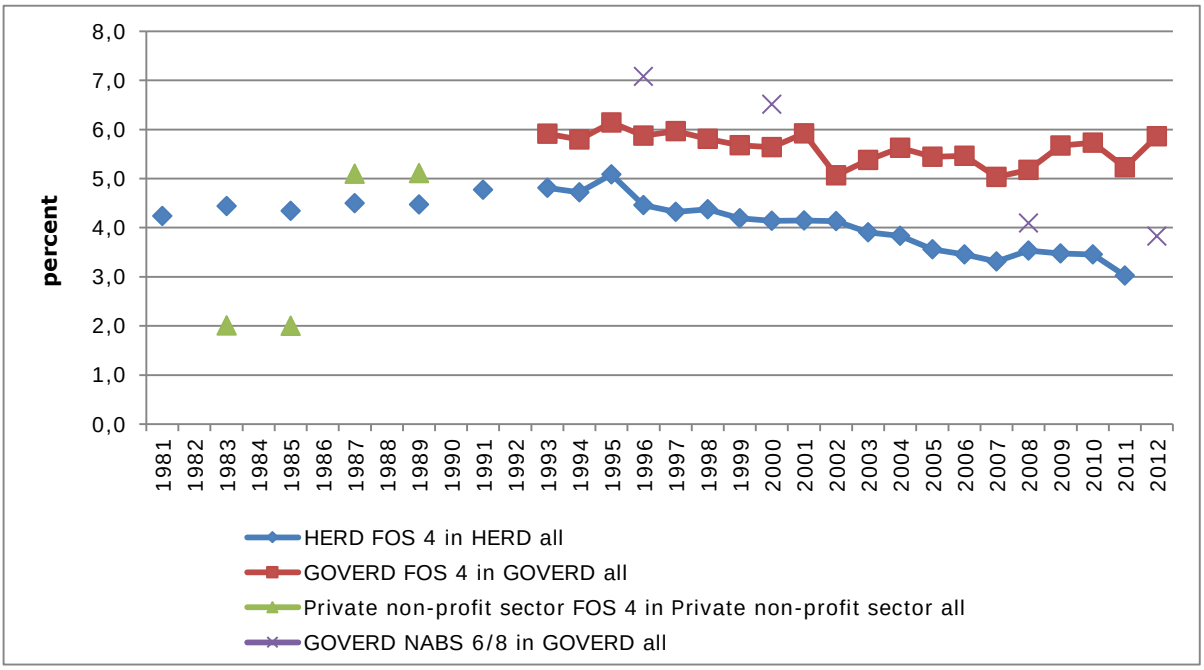

Figure 4 Share of agriculture in total gross domestic expenditure on R&D (GERD) by sectors 1981 to 2012
Source: EUROSTAT

The analysis of actual government R&D expenditure data broken down in the German systematic by **funding areas and funding priorities** shows a slightly different picture than the GERD data analysis (cf. Figure 5). Although in both sources total government expenditure has constantly increased since 1981; the total GERD (GOVERD+HERD) rate of increase is much higher than the one of government expenditure according to the German *Leistungsplansystematik*. The expenditure for agricultural research reported by the German funding priorities has always been much lower than the GOVERD+HERD FOS 4 expenditure, but both timelines show increasing expenditure levels.

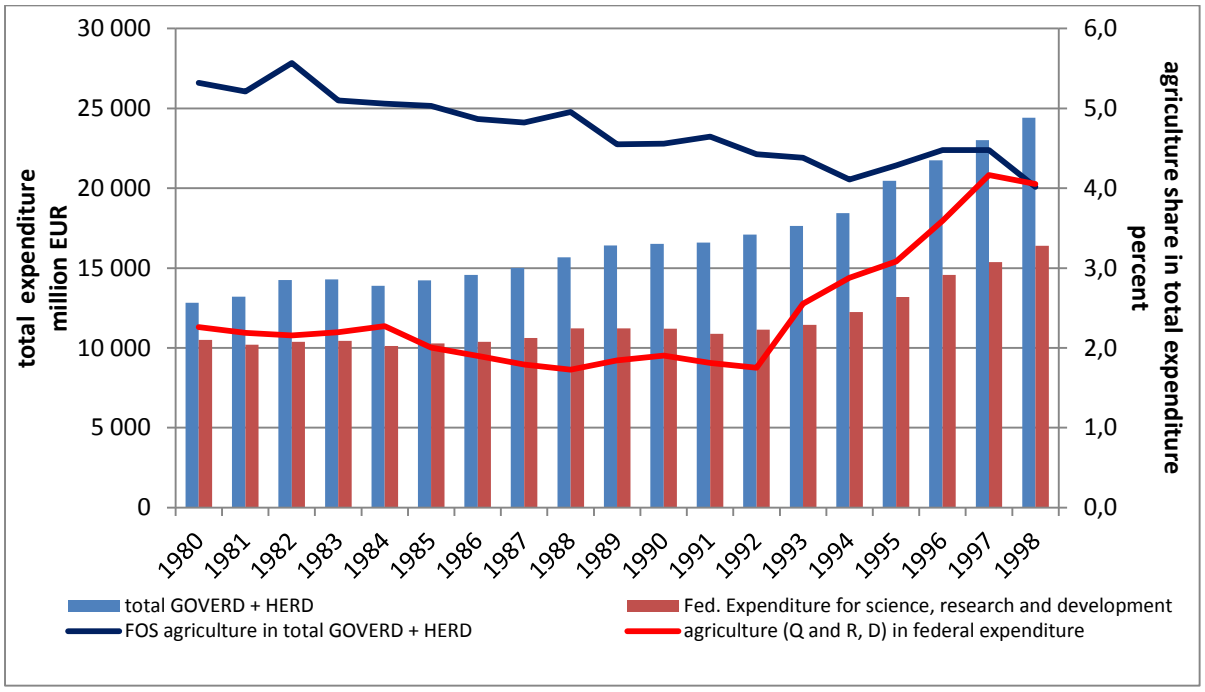

Figure 5 Total GOVERD+HERD and expenditure by funding area (Leistungsplansystematik) and agricultural share therein 1993 to 2011
Source: (Deutscher Bundestag 1990, 1996, 1998; BMBF 2006; BMBF 2010, EUROSTAT)

Particularly since 2005, the share of agricultural research in total expenditure (by the German funding priorities) has been constantly increasing from 1.75% to 4.2% of total expenditure in 2012. Opposed to that, the share of governmental agricultural expenditure (GOVERD+HERD) in total governmental GERD data decreased from over 5% in the early 1990s to 2.6% in 2012.

The reason for this divergence of data on actual (agricultural) research expenditure has been explained (communication with BMBF 2014) by the application of different categorization of expenditure.

GBAORD data since the 1980's show an upward trend of government expenditure Opposed to the decreasing share of agriculture in GERD explained above; GBAORD share for agriculture (NABS 92: NBS06 - Agricultural production and technology and NBS1107 - Agricultural sciences; NABS 07: NABS08 – Agriculture) has been steadily increasing from around 2% in the early 1980s to just below 3% in 2012 (cf. Figure 6).

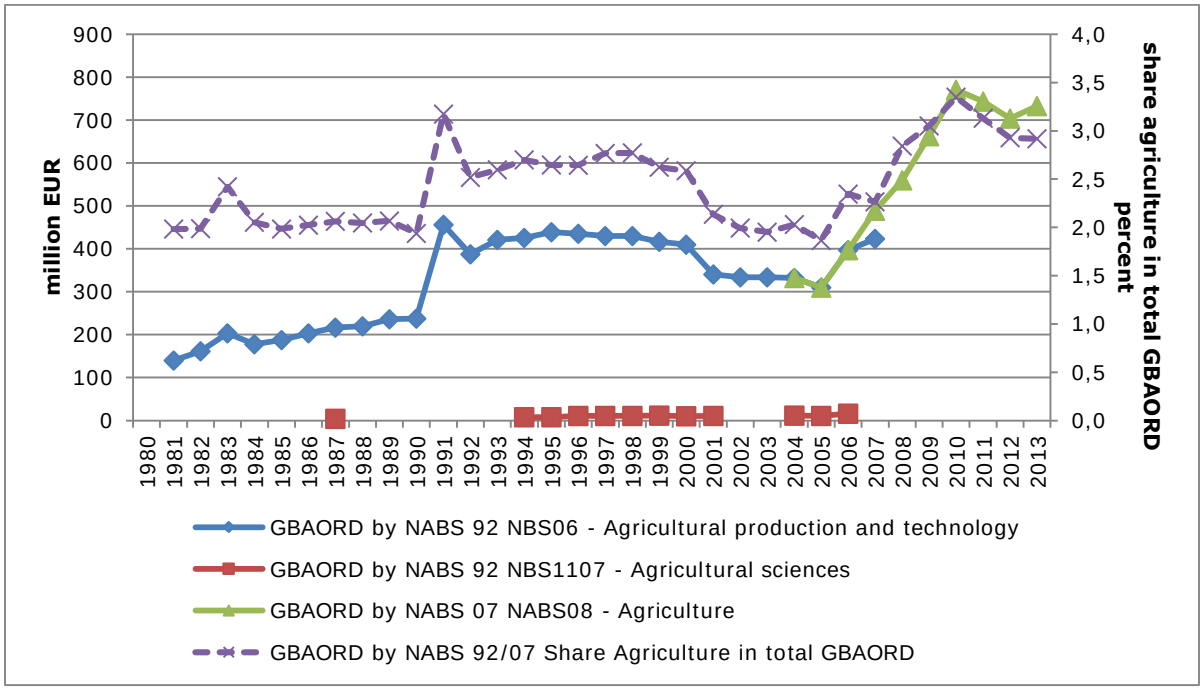

Figure 6 Government budget appropriations (GBAORD) for agriculture (NBS06+1107; NABS08) and share of total GBAORD from 1981 to 2013
Source: EUROSTAT

The limitations of data of private agricultural research efforts have already been described in section 3.1. The analysis of the BERD data shows constantly increasing private efforts for the total of all NACE activities. The data available for the agricultural sector show also increasing efforts for the period 2001 to 2009. However, single values of earlier years indicate that expenditure has been higher. Overall, expenditure for agriculture (NACE 11: A B, and NACE 2: A) make up only between 0.2% and 0.3% of total BERD expenditure, but it is estimated that actual research efforts of the private sector is considerably higher than the BERD data indicates (cf. Figure 7).

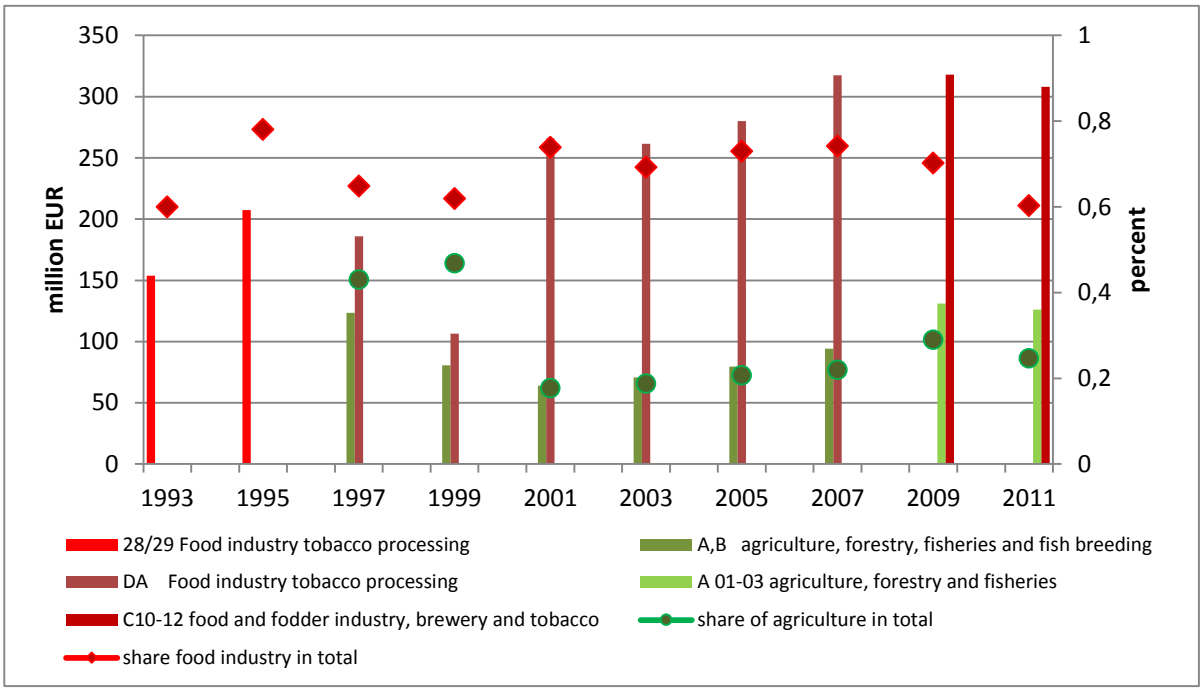

Figure 7 Business Expenditure on R&D (BERD) total, agriculture and food industry 1981 to 2012
Source: (Kladroba 2013)

The comparison of the available expenditure on R&D for the government (GOVERD) the higher education (HERD) and the business (BERD) for agriculture leads to the conclusion that business expenditures for agricultural research are only a minor share of total expenditure. However, it is assumed that the BERD data contain only a fragment of the real total business R&D for agriculture.

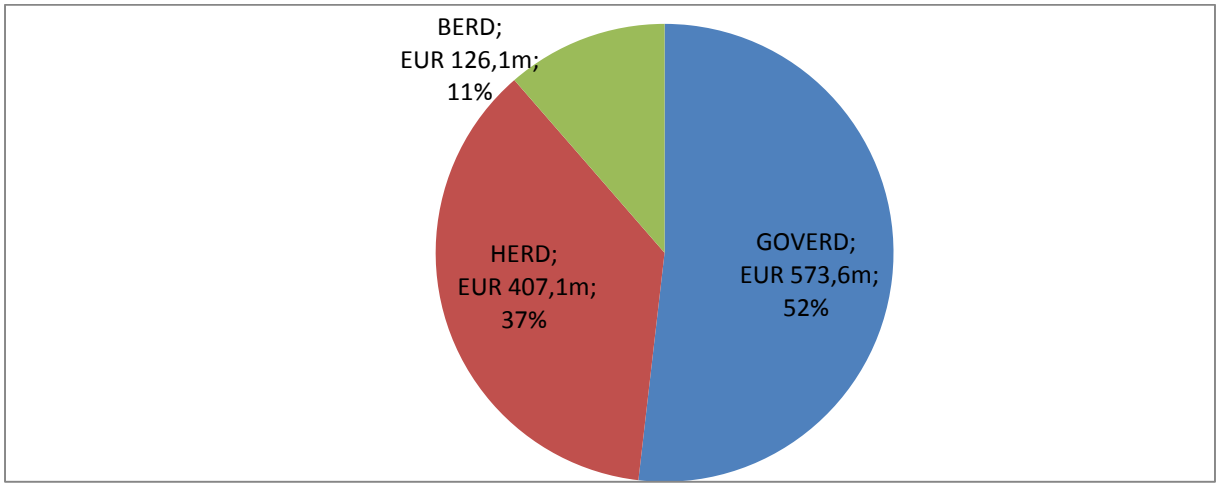

Figure 8 Public and private agricultural research expenditure in million EUR of the year 2011.
Source: (Kladroba 2013, EUROSTAT)

3.3.2 Research and extension effort

The complex German advisory system makes it difficult to provide any total figures for extension efforts. As an approximation, *Länder* budgets have been analysed for positions indicating public expenditure for advisory services for the years 2010 to 2014. Total sums, and calculated values per farm holding or UAA differ massively so that no conclusion can be drawn on the available data. As an example the state government in Schleswig-Holstein have in 2012 allocated about € 8.4m of their budget to the Chamber of Agriculture for their advisory services to the states' 13,600 farms, which divides to a nominal rate of € 635 per farm. In contrast, Rhineland-Palatinate state government has accounted in 2012 for public advisory services support for a total expenditure of € 651,747, which divides into € 34 per

farm (for their 19,200 farmers). Mecklenburg-Western Pomerania paid a support of almost € 1.5m to the LMS Agrarberatung GmbH – the privatized advisory service in the state – for services to the 4,700 farmers (€ 311 per farm). Table 10 in the Annex III provides details on the available figures for each state. With these difficulties of assembling expenditure data on extension efforts for only one year it becomes clear that it is impossible to provide a comprehensive overview over extension efforts over time.

3.4 Gap analysis

Any data on actual or planned expenditure have considerable limitations in comparability even within the available time series due the German reunification in 1990 and to the numerous revisions of the different systems of categorization (NABS in 2007, NACE in 2008; *Leistungsplansystematik* in 2011, German classification of economic activities in 1993, 2003 and 2008).

No data prior to 1980 could be identified; if it exists at all, it may be hidden in paper archives in the federal and state ministries. The longest continuous data series are available for the GBAORD, which date back to 1980 for total and 1981 for agricultural expenditure. GERD data for agricultural expenditure with some time dimension is only available in the FOS systematic for the government and the higher education sector (HERD biannual from 1981 and consecutive from 1993 on; GOVERD from 1993 on). Germany basically does not report GERD data by NABS. In addition to the GERD data Germany reports on actual agricultural government R&D expenditure data using its own system broken down by funding areas and funding priorities, which also provides figures back to 1981. BERD data on agricultural expenditure is only available on a biannual base from 1997 and on annual base from 2001 on. As described above, however, it is assumed that BERD does not approximate the actual business R&D efforts.

Information on GERD and GBAORD at the state (*Länder*) level is not available. However approximation can be made using the Expenditures for R&D of the public sector scientific institutions. BERD figures are available at state level, but due to anonymisation are not meaningful.

4. RECENT TRENDS REGARDING INVESTMENT IN AGRICULTURAL RESEARCH

4.1 Analysis of available statistics

4.1.1 Public

Public R&D funding (GBAORD) has increased between 2005 and 2010 and is slightly decreasing since 2013, remaining on a rather high level as Figure 9 shows.

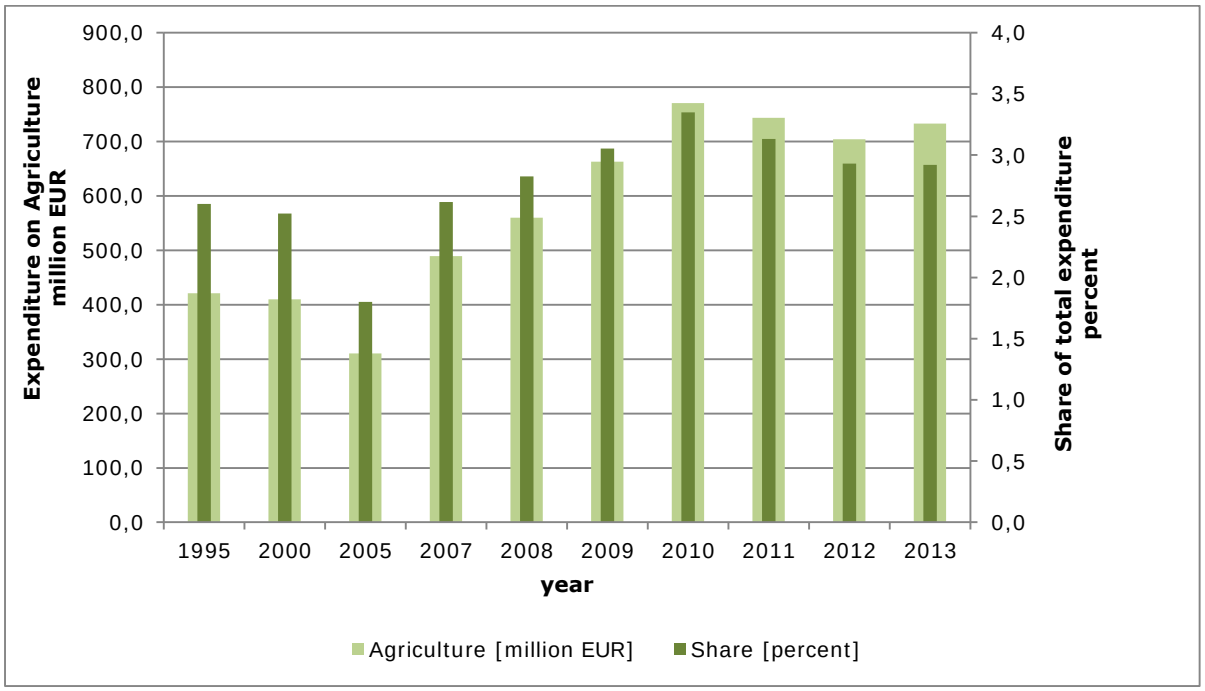

Figure 9 Public R&D expenditure (GBAORD) on agriculture (NABS 2007) and share of total expenditure.
Source: (BMBF 2014a)

Public funding will continue to increase. Between 2010 and 2013 € 13.3 billion have been provided for education and research funding. The governmental budget, adopted in the end of June 2014 foresees further € 3 billion for R&D, safeguarding the 3%-objective for R&D funding. The budget of the four big non-university research organizations, Helmholtz, Max-Planck, Leibniz and Fraunhofer as well as of the German research organization will continue to increase annually by 5%. In addition the excellence initiative as well as programme lump funds will receive another € 730 million, strengthening research at Higher Education Institutions. As part of the High-Tech-Strategy projects which contribute to societal and global challenges as e.g. the so-called *Energiewende* (transition in the energy system) are funded with € 2.1 billion (which is, compared to 2009 an increase of 13%, compared to 2005 of 66%) (BMBF 2014b). In general, the above described budget leaves financial room for the *Länder* which is supposed to be used for investments in education and research. There is no contract, however, obliging them which is why some interviewees doubt if the *Länder* will eventually use the money to fund their respective research institutes.

The German Research Foundation (DFG) is the largest non-governmental research funding organisation in Germany with a focus on knowledge-oriented research. In terms of DFG funding the field of 'Veterinary medicine, agriculture and forestry' is a relatively small field with a slightly increasing amount of funding by DFG in absolute numbers (cf. also section 2.1).

Relatively, the funding volume decreases however:

- Higher education institutes and non-university research institutes in the field received altogether € 91.1m in 2002-2004, which is 2.5% of the total DFG fund.
- In the period 2005-2007 the number increased to € 115.8m, which equals 2.1%.
- Between 2008 and 2010 the institutes received a total of € 115.5m, 1.7% of the total DFG funding budget.

DFG funding plays an important role for higher education institutes. In the respective field of research in the period of 2005-2007 higher education institutes acquired € 98.6 million third party funds from DFG. In the period 2008-2010 DFG funding was still important for higher education institutes (€ 95.1million). Overall, third-party funding gains weight for higher education institutes in this field of research: in the period of 2005-2007they acquired in total € 108 million third-party funds, and €145.6 million the period 2008-2010.

The same applies to non-university research institutes active in the field: Especially direct R&D funding by the federal government as well as EU's Seventh Framework Programme play a far more prominent role which is even increasing in the last years (Deutsche Forschungsgemeinschaft 2012).

Interview results support the described development. In the last 6 years the federal Thünen-Institute for example is increasing in terms of personnel and research funds, though the federal basic funding has stayed at € 70 million. Currently, additional € 14 million are third-party funded and more than half of the 500 employees are third-party funded (interview, TI).

4.1.2 Private

Private spending (BERD data) on R&D in the field of 'agriculture, forestry and fisheries has increased steadily since 2001 (cf. Figure 10).

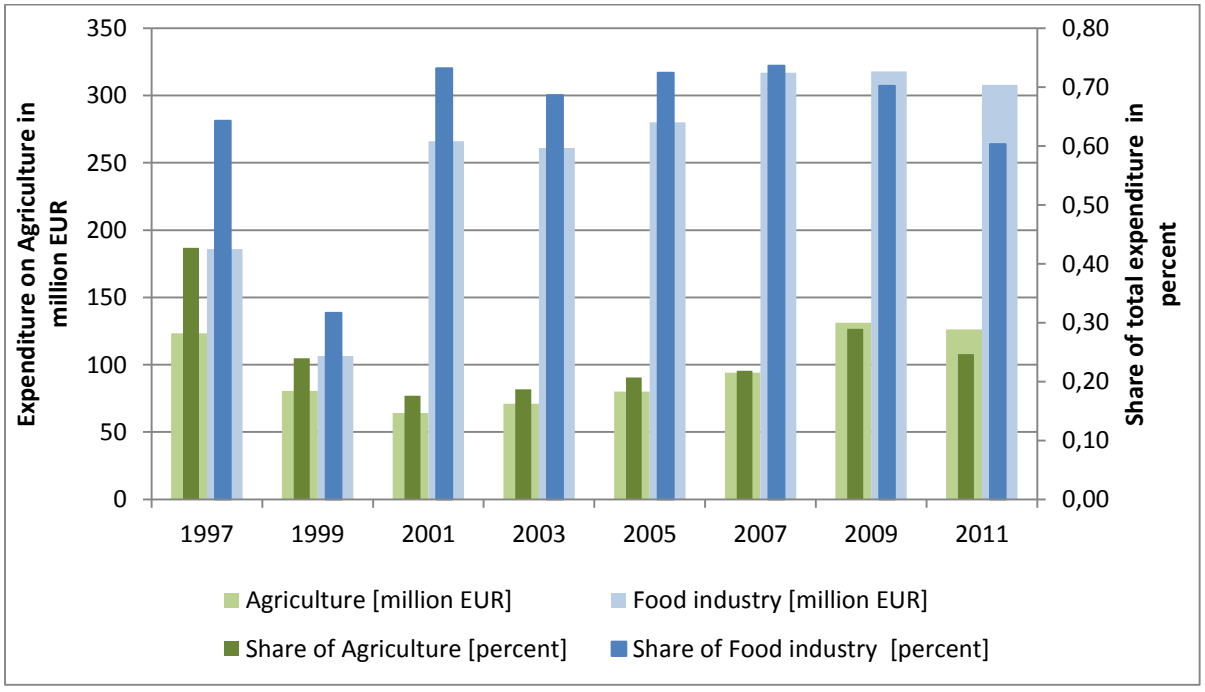

Figure 10 Private R&D expenditure on agriculture (BERD data) and share of total expenditure. Source: (Kladroba 2013)

In comparison to other research fields, enterprises invest relatively little in R&D for agriculture and forestry. Section 3.1 already highlighted the issues of the BERD data limiting option for analysis. As the Stifterverband itself expressed, 'It is not a sector at the cutting edge of innovation', Stifterverband, personal communication, 07.08.14). In contrast to this statement an interviewee estimated that enterprises spend 15 to 20% of their turnover on R&D and expects a further increase: it becomes constantly more difficult

to achieve innovations leading to a higher agricultural revenue (e.g. the field of resistance breeding has become increasingly complex). Another interviewee estimated that private spending on agriculture must be around € 3 billion.

A quick review supports this assumption: In 2013, one company alone, Bayer Cropscience ('one of the world's leading research-intensive companies in the agricultural industry'), spent € 857 million (€ 779 million in 2012) on R&D (Bayer 2014).

Therefore, one interviewee assumes, that BERD numbers in the field are low, because (some?) enterprises only report to the Stifterverband numbers of externally performed research. On the other hand Bayer CropScience e.g. spends around one third of their R&D funds for these external cooperations.

4.2 Results from the consultation on recent trends

4.2.1 Volumes of expenditure

In Germany, agricultural sciences were in crisis until the end of the 1990s. In the last years the interest in agricultural research has increased again due to the global challenges, all of them being connected with agricultural issues. Volumes of expenditure nowadays indicate that the German government highly appreciates agricultural research. In spite of the financial crisis and the needs to economise there is a steady increase in agricultural research funds (BMEL 2014, interview). In 2006, the BMEL has set up an innovation programme, with a budget of around € 40m per year. Its objective is to generate innovation in agriculture as well as related upstream and downstream sectors. In addition, there are several BMBF initiatives in pre-competitive fields, like GABI (now PLANT2030) on genome analysis of cultural plants and FUGATO on animal genetics.

In terms of basic funding of agricultural research institutions the increase in importance is not detectable. Federal research institutes receive solid basic funding, third-party funding increases. The Thünen-Institute e.g. received in the last years € 70m per year basic funding, and acquired last year € 14m third-party funding. More than 50% of staff is third-party funded.

Basic funding of universities is decreasing, especially in terms of funding of personnel. Third-party funding is substantial for every higher education institute and will continue increasing, especially in terms of topic oriented calls (cf. 4.2.3)

There is a lot of private money, which is invested in agricultural and related research. In 2013, Bayer CropScience spent around € 800 million (cf. 4.1.2), AGCO Fendt around € 70 million. In comparison to these numbers € 37 million which are provided by BMEL for the innovation programme seem relatively low. On the other hand, several interviewees stress that private enterprises and public research organizations work increasingly together. Bayer CropScience e.g. is working together with external research institutes, spending around one third of their R&D funds for these external cooperation. DFG numbers show as well that for the non-university research organisations (e.g. Leibniz institutions) direct governmental and/or industrial R&D funding is of high importance (Deutsche Forschungsgemeinschaft 2012).

Several interviewees feel that expenditure volumes are adequate, criticize however the absence of a strategic and holistic funding approach with clear priority setting (cf. 4.2.3).

4.2.2 Trends in research input

Research institutions, though publicly financed, have been exposed to a growing competition between each other. Permanent positions have been cut down, while a growing share of money is third-party funded. As a consequence there is more fluctuation in personnel, meaning less continuity, less possibilities to carry out long term research, less inter-institutional permanent networks. In addition, inter-institutional competition grows. Some faculties e.g. developed systems of boni for successful third-party fund raising, peer-reviewed publications etc.

There are multiple funding organizations and programmes (cf. 4.2.3), funding popular themes at the same time, often without harmonization and often for a duration of 2 or 3 years – which is counterproductive in terms of achieving applicable solutions for the emerging and existing challenges (cp. 4.2.5) (Isermeyer 2014). The Science Council published a survey on agricultural sciences in 2006 giving impetus to a process of restructuring. Striving for a postulated profile some agricultural faculties have appointed new professors from related fields of sciences (e.g. molecular biology). In addition, the reward system of higher education institutes is currently based on peer reviewed publications as well as on acquired third-party funding. As a consequence there is more orientation towards basic research: successful basic researchers are appointed professorships in agricultural faculties which were strong in applied science. Consequently, training and education in universities is less practical; a tendency which is enforced by the Bologna process.

In 2008, the federal departmental research institutes have been restructured in order to make them 'fit for the future' (BMELV 2008) and to reduce costs (interview, non-ministry) (cf. section 2.1). As a consequence the existing institutes have been merged along four pillars: crop production, animal husbandry, nutrition and rural development/economy/forestry. The newly constituted institutes received from then on lump sums and were free in their human resources decisions. The process was accompanied by a considerable reduction of staff which is now nearly finished (BMEL, interview). The initial starting point for restructuring was the evaluation of agricultural sciences and the evaluation of federal research institutes of the Science Council.

Other restructuring processes took place at Länder level. Often these initiatives are motivated by cutting costs and may comprise cutting down global households, reduction of number of faculties etc.

Infrastructure regulations currently differ between universities and federal research organisations. With the 'Freedom of Science Act' (Wissenschaftsfreiheitsgesetz) at the end of 2012, universities are free to plan and carry out investments in infrastructure (cf. section 2.3). Federal research organizations are supposed to have a similar act in the next years, but currently are dependent on ministry decisions on infrastructure – and thus have to negotiate annually both the household and infrastructure funding.

In general, the heterogeneous agricultural research landscape in Germany seems to consolidate. The Germany Agricultural Alliance (DAFA) was founded for example, and has developed several strategies (on aquaculture, protein, lifestock farming) (cp. 2.1, 2.3, 4.2.3, DBV, interview).

4.2.3 Funding mechanism and priority settings

Funding mechanisms

There are different funding organizations and programmes operating at different public levels (EU, federal, state) as well as private (foundations like DBU, VW, Robert-Bosch, Bill-Gates and industry enterprises and industrial associations) which influence or try to influence with their respective funds future research direction. An introduction into the funding mechanisms of the BMEL has been given in section 2.3.

Agriculture and agricultural sciences receive increasing attention in the federal ministries. Besides 'classic' ministries like the BMEL and the BMBF other ministries, such as the BMU and BMZ show increasing interest in agricultural research. All of the ministries funding principles are in line with the Federal Budget Regulation (*Bundeshaushaltsordnung*, BHO), which means they issue calls, have experts review the applications, receive a funding recommendation by the experts, which is sometimes changed for political reasons (e.g. unforeseeable budget cut-downs).

In the frame of the bioeconomy strategy funds are increasing. The development of the bioeconomy strategy was led by the BMBF; other ministries participated, the BMEL e.g. is

responsible for the political bioeconomy strategy. Currently, an interministerial working group on bioeconomy is supposed to safeguard a common strategy approach. Generally, BMBF and BMEL harmonize their calls for proposals. BMEL issues calls for proposals on specific topics and understands its funding as contract research with a strong result-orientation. 'It is not a funding but a problem solving ministry' (BMEL, Interview). BMBF funding is more oriented towards basic research and issues more fundamental research questions. As a result interviewees feel that BMBF research is freer to undertake future oriented, i.e. long term research while BMEL research is facing more public awareness and thus funds more mainstream research. 'If research on genetic engineering is publicly written off, as it currently is, there will be zero BMEL funding' (interviewee, non-ministry).

In addition ministries at *Länder* level issue calls on agricultural topics. Although all of these calls are problem oriented it becomes obvious that subjects are influenced by the political affiliation of the ministry: If the Green Party is part of the government calls are 'greener'.

While in general ministry-related interviewees feel that there is a working inter-ministerial exchange and a working coordination process at different political levels, other interviewees have the impression of a low degree of coordination. The limitations of the internet platform FISA online as a coordinating instrument has already been discussed in section 2.3 (interview, non-ministry).

The largest organisation funding knowledge-oriented research, DFG, uses open project funding as main mechanism (cf. 2.1). Funding proposals for the selected topic - either from a particular discipline or using an interdisciplinary approach - can be submitted by individual scientists, groups of scientists or universities. Following an initial examination whether formal requirements are met, the proposals are evaluated for their scientific quality. Funding decisions are taken in a multi-layered process by voluntary reviewers. On the basis of this expert review, the proposal is furthermore assessed by a review board (constituted of elected members), and the final decision is taken by a grants committee. Some interviewees pointed out, that in a relatively small research field with a generally increasing number of proposals it was necessary to ask scientists of related fields as reviewers, baring the danger that the innovation or meaning of the research question under concern might not be valued adequately. They proposed to involve more international reviewers in the process to solve this issue. The above-described DFG funding mechanism gives freedom to scientists to carry out research on self selected topics. Institutional basic funding is another opportunityto follow own research interests and in order to carry out long-term research which is not influenced by short project funding periods. Basic funds are cut down, however, and for public funds other than DFG, thematic calls for proposals are issued. The importance of private funds depends on the respective subject in the field of agricultural sciences. Agricultural Engineering e.g. acquires more industrial research funding than agricultural economists. Besides industrial funding, there are different foundations like the Deutsche Bundesumweltstiftung, the Landwirtschaftliche Rentenbank, the Stiftung Kulturlandschaft, Robert-Bosch-Stiftung, VW-Stiftung as well as some NGOs, financing smaller research projects. Some interviewees expect these funds to increase, others hint on the fact that interest rates are low leading to decreasing funds of foundations.

Priority setting

There are different bilateral and multilateral formal and informal meetings in order to define research priorities, e.g. the Bioeconomy Council or SCAR.

Another example which was mentioned by several interviewees is the Initiative Group Agriculture and Nutrition Research, launched in 2001. A growing circle of farmer interest groups, industry interest groups, researchers and ministries comes together and exchanges on emerging topics. At the outset the group was initiated out of 'concern for agricultural research' in Germany (DBV, interview) which became evident in the decreasing funding for agricultural research in the early 2000s. The group therefore aimed at – among other objectives - initiating a strong network, advocating a strong strategic research of

international importance, and public private research partnerships on subjects such as food chains, food safety, and renewable resources.

There is an ongoing exchange on research priorities in the frame of the German Agricultural Research Alliance (DAFA). Different specialist fora of the research community discuss strategic issues. There is a constant exchange with advisory boards consisting of representatives of ministries, industry and farmer interest groups. Interviewees appreciate these opportunities of exchanging and networking and consider the process as fruitful. The call on livestock farming which was issued in 2012 in the frame of the innovation programme, can serve as an example for priority setting influenced by the exchange: The BMEL developed a research concept on animal husbandry as part of the German Charta on Agriculture (BMELV 2012), which was a starting point for the DAFA to work out a strategy on animal husbandry. The call contains most of the research priorities the DAFA suggested in the strategy.

Other coordination activities comprise e.g. German Innovation Partnerships (DIP) on agriculture, which have been mentioned as fruitful opportunity to agree with the industry on important topics to be funded. (BMEL 2014, interview)

In addition, there are informal and more intransparent processes: Topics emerge due to exchange between ministry representatives and experts, maybe in the frame of a conference, maybe through direct consultation. Same applies to the European level, where scientists use informal channels in order to place topics on the research agenda. Several interviews lead to the conclusion that the better the individual network, especially between a scientist and representatives of funding organizations are, the more opportunities to influence the research agenda there are.

In future, researchers attempt to work out policy alternatives in international consortia in order to receive more attention on policy proposals. In addition, it is necessary to foster public discussion by better tailoring policy proposals to target groups (Isermeyer 2014). It is felt that politicians (and sometimes ministries) have fewer opportunities to target medium and long term topics due to the need to react on current problems, therefore scientists need to bring in future related topics. Due to the above described developments at universities, especially federal research institutes are asked in this respect.

Several interviewees issue the need for a concerted strategy for agricultural research, outlasting the governmental election periods and leading to a better priority setting (cf. 4.2.5). Even the term bioeconomy was not clearly defined and used differently between ministries.

Currently, opportunities to participate in priority setting are limited for civil society organisations. A Civil Society Platform Research Turnaround (Zivilgesellschaftliche Plattform ForschungsWende, http://www.forschungswende.de/index.php) has been established featuring bioeconomy as one topic (cf. 4.2.5).

4.2.4 Type of research

At agricultural faculties the shares of funding for basic research and for applied research depend on the field and the interest of the different professorships. While some are successful and interested in basic research funded by DFG, BMBF or the EU, others rather apply for BMEL or industry projects. Federal research institutes carry out applied research and knowledge transfer, the latter mostly in the frame of political consultancy.

Some interviewees argue that academic research veers away from practice and that basic research has gained more importance. Successful basic researchers are appointed professorships in agricultural faculties which earlier had been strong in applied science. A major reason is seen in the reward system of science (cf.4.2.2). There is a need for a strategy how to better balance the types of research. Different interviewees stressed, that the scientific community should develop a rating system in which applied research is as reputable as basic research. Especially the funding side calls for more balance between

basic and applied research (BMEL, interview). The innovation programme of the BMEL e.g. therefore puts special emphasis on cooperation between business and research.

Beside basic and applied research, support on technology transfer is important: Especially for SMEs it turns out to be difficult to bring new ideas to the market. Several interviewees hint on the fact that investment in technology transfer is too little. The problem is, however, to make sure that funding is pre-competitive. The German Innovation Partnerships (DIP) as well as funding of the Landwirtschaftliche Rentenbank are currently opportunities to support SMEs.

In addition, the EU Commission's framework for state aid for research and development and innovation in 2006 (2006/C 323/01) made it less attractive for universities to carry out industry financed research, because universities had to calculate full-cost-pricing. While some *Länder* compensated these costs, others didn't. In the latter case industry projects became considerably less attractive. The new directive, issued in July 2014 (2014/C 198/01) should improve the situation.

Furthermore, on-farm research receives little attention in third-party funding. Some interviewees therefore advocate funding more transdisciplinary research.

4.2.5 Topics

The National Research Strategy Bioeconomy2030, published in 2010, has been developed against the background of the global challenges of the 21st century. Agricultural research necessarily deals with these global issues, often with national and regional specifics. Trade flows become more global and especially the financial crisis has led to a focus of agricultural economists on price volatility and forward-trading of agricultural products. Another internationally relevant and major topic is resource efficiency, not only in plant production but resource efficiency in general, which is also connected to climate efficiency (more efficient production, less GHG emissions). Nutrient circulation, sufficiency, soil-metagenome, population growth – there is a broad range of themes mentioned in the interviews, indicating that achieving a global sustainability is still the main challenge agricultural science needs to contribute to. In this respect Isermeyer (2014) states that research on these themes often leads to publications; applicable solutions, however, are still missing.

In Germany and neighbouring countries societal demands regarding agricultural production are currently another important topic, which means both less use of pesticides and water and, emerging as a top issue, animal welfare. Both issues are connected with public acceptance of agriculture. Meeting societal demands is an important issue when discussing future priority setting. Often it is not a question of the total amount of funds but on deciding what to focus on. Research on animal husbandry, for example, was mainly focused on productivity and not on needs of animals.

Smaller but still important issues are organic agriculture and aquaculture. Some interviewees feel, that in the frame of the bioeconomy discussion and related funding, organic agriculture (e.g. the BÖLN programme) was neglected and funds were too little. It is obvious that there is little interest of industry to invest in organic agriculture research, therefore public funds are of high importance in order to generate innovation.

Nutrition related topics are quality management (e.g. antibiotic residues) and nutritional habits (e.g. veganism). Examples of smaller problem driven topics are calls for proposals, the BMEL issued since 2008, dealing e.g. with avian flu or hybrid wheat breeding.

Generally, it is a big challenge to think more in systems: Instead of focusing in single areas of production the underlying idea should be that livestock production has an influence on crop production which has an influence on biodiversity (BMEL 2014, interview). This is connected with currently conflicting funding objectives: measures aiming at resource and climate efficiency may have negative effects on biodiversity and vice versa (DBV, interview).

There is a need for a strategy, developed in collaboration between scientists, ministries, NGOs, and the economy accompanied by a long-term funding in order to achieve applicable solutions on the above described challenges (Isermeyer 2014). Structural aspects would need to be addressed strategically as well: The unique selling point of agricultural sciences is that it includes all types of research. Currently, some interviewees feel that there are diminished faculties, which are not able any more to cover the whole spectrum of agricultural research and achieve a necessary degree of inter- and transdisciplinarity. The DAF (c.f. Table 4) suggested concentrating agricultural research in order to support the development of internationally successful clusters (as a role model example might serve Wageningen in the Netherlands). Some interviewees feel that German federalism is a problem in this respect and advocate a national master plan.

In addition, the above mentioned lack of basic funding of universities reduces the freedom of science and necessarily leads to a focus on mainstream research. Furthermore, long-term research is becoming increasingly difficult due to short project periods. As a consequence universities are currently not really able to contribute to a strategic research process on future challenges. At the same time, due to the growing pressure of raising third-party funds scientists often apply for calls on topics they are thematically not interested in or consider as irrelevant. Some interviewees feel that scientists should try to better influence agenda setting. On the other hand, it is the third-party fund pressure, the increasing third-party funding bureaucracy and connected tight projects leading to a situation where at least university researchers increasingly lack time to take influence.

Currently, knowledge transfer into practice is neither sufficiently taking place nor working effectively. The European Innovation Partnerships may be a good way in order to bring science and practice together, not only at regional level (which is currently the main level) but also at federal and international level (Isermeyer 2014). Some interview partners have the impression, however, that interest of scientists in these partnerships is rather low, which is connected with the reward system of science. In addition it is anticipated that the process of bringing the different partners together and find a common language is arduous: 'It will never work in theory, but will work in practice' (interview, interest group).

Knowledge transfer is also influenced by the reward system of science. It highly depends on the (often idealistic) interest or researchers to publish results not only in international scientific journals but also in German language scientific and non-scientific journals in order to have a broader practical community profit from it.

Generally, the increase in third-party funding may have contributed to the establishment of networks at European level.

4.3 Trends from other sources

Section 4.2.5 has already discussed ongoing strategic orientation of research and innovation policies. For the agricultural sector guidance from the federal level is provided particularly through the

- BMBF 2011. National Research Strategy BioEconomy 2030,
- BMELV 2012. Research and Innovation Needs Livestock,
- BMEL 2014. National Policy Strategy Bioeconomy.

In the Bioeconomy 2030 strategy the BMBF expresses its vision of a sustainable bio-based economy, 'which produces sufficient healthy food to feed the world and supplies quality products made from renewable resources.' More precisely the policy strategy Bioeconomy of the BMEL identifies 3 cross-cutting areas of activity: (A) coherent policy framework for a sustainable bioeconomy, (B) information and societal dialogue, (C) training and teaching. Thematic areas of action are (D) sustainable production of renewable resources, (E) growing markets, innovative technologies and products, (F) process and value added networks, (G) competition in land use, (H) international context.

Besides that, and in order to focus the European activities in this area and align them with the National Research Strategy BioEconomy 2030, the BMBF and the BMEL are both

involved in the European Joint Programming Initiative (JPI) with the topic Agriculture, Food Security and Climate Change (FACCE-JPI). The objective of this initiative is to improve the integration of research funding of the member states and establish a common research program. The following topics have been identified to be part of the research agenda (BMBF 2014):

- Sustainable food security under climate change
- Sustainable, environmentally friendly growth of agriculture, taking into consideration current and future climatic developments and availability of resources
- Balancing of trade-offs between food production, biodiversity and ecosystem services
- Adaptation to climate change throughout the entire value chain of food production
- Reduction of greenhouse gas production in agriculture and forestry

The Bioeconomy Council recommends the expansion of education and research capacities but does not provide more strategic guidance on agricultural research (Bioökonomierat 2014). However, it points out the importance of research to improve resource efficiency of agricultural production for improving the competitiveness of the German bioeconomy.

In terms of trends in the field of agricultural innovation, the German sector study (Bokelmann 2012) concludes that the agricultural sector has a relatively low level of R&D compared to other highly technical sectors. However, it identified an increasing tendency in innovation indicators. The study also showed that levels of innovation uptake differ between agricultural production fields (animal production, plant production, horticulture). An important finding was that besides the established (expected) knowledge flow from basic to applied research to advisory serviced to agricultural practice, there is another innovation strand from supplying industry and farmers themselves.

Results of the recent EU-initiated Community Innovation Survey (CIS) for Germany are published in Rammer et al. 2014. *Innovationsverhalten der deutschen Wirtschaft: Indikatorenbericht zur Innovationserhebung* 2013, however, agriculture, forestry, fisheries, and veterinary sector are explicitly not covered in the survey.

5. DISCUSSION

There are different levels of evaluation of agricultural research in Germany. The German Council of Science and Humanities (Wissenschaftsrat) evaluates scientific institutions (universities, universities of applied sciences and non-university research institutions), especially in terms of their structure and performance, development and financing. And the Science Council issues recommendations and prepares reports relevant to general issues regarding the system of science and higher education, selected structural aspects of research and teaching, and the strategic planning, appraisal and governance of specific fields and disciplines.

Federal research institutes are evaluated by the German Council of Science and Humanities in average every five years. National surveys on Agricultural Sciences in Germany were carried out in 1996 (Recommendations on International Agricultural Sciences) and 2006 (Recommendations on the Development of Agricultural Sciences in Germany in the context of neighbouring fields (horticulture, forestry and nutrition sciences). Both publications are available on the Council's website[9]. These two evaluations had a major effect on agricultural sciences in Germany, leading to the restructuring of federal research institutes and structural changes at the agricultural faculties of German universities.

Universities as a whole are as well evaluated by the Science Council, sometimes all of the universities of one state, sometimes one university, sometimes one faculty only. If a detailed list is of interest, IfLS may request it by the Council of Science.

As interviewees report, evaluation of the Science Council is out-put oriented, the primary measurement instruments are scientific quality criteria (citations, publications, sum of third-party funds, number of PhD students etc.). Some interviewees describe the Science Council as a capable and well-known evaluator, being in terms of reputation and appreciation of departmental research the best choice. Although the Council is independent, indicators are discussed with the government and 'the council is always open for good arguments' (BMEL 2014, interview). Within the scientific community the drawbacks of evaluation by the Science Council are discussed: Council experts often have no or little knowledge in the respective research field. In addition the experts themselves are embedded in their university context – and competition between research organizations is increasing. Furthermore, discussions within the scientific community support the impression that there seems to be a certain political influence on results.

As regards funding organizations, there seems to be no evaluation on a project basis. Some of the programmes are evaluated by external coordinators. The BMBF focuses the evaluations on scientific and economic output (not only patents but also creation of jobs). In addition there are internal self reflection processes, e.g. on the Bioeconomy strategy. A result is the action plan 'Guide to Bioeconomy' (*Aktionsplan Wegweiser Bioökonomie*)[10]. An external evaluation of the bioeconomy strategy is planned for next year. The DFG e.g. issues regular statistical reports and evaluative studies. In relation to the Excellence Initiative, Collaborative Research Centres and Research Training Groups, the DFG the DFG carries out annual surveys of funded research groups, in order to supplement the data collected during the processing of proposals. The focus is on scientific quality and output[11].

The Federal Office for Agriculture and Food carries out single evaluations of programmes, e.g. on the BÖLN, a federal programme on organic agriculture [1]. Funded projects are evaluated as a standard procedure regarding e.g. the achieved objectives, outcomes and identified research gaps. The BLE representative adduces that there is a general lack of

[9] http://www.wissenschaftsrat.de/nc//veroeffentlichungen/veroeffentlichungen-ab-1980.html (German only)
[10] all publications are German only, available at http://www.bmbf.de/en/index.php
[11] All of the evaluative studies are available at http://www.dfg.de/en/dfg_profile/evaluation_statistics/programme_evaluation/index.html.

appropriate evaluation methodology which is able to capture the wider impacts and the time lag of research adoption.

In order to improve, evaluation should be integrated at the stage of programming. A good practice example would be the evaluation of the BMBF Framework Programme Research for Sustainable Development (FONA), which is now in the third programming period and was evaluated at the end of each phase. In addition, evaluation should be politically independent and be carried out with open results. While some interviewees opt for an evaluation with a growing part of evaluators from industry and society, others vote for an international expert consortium. Evaluation should not be carried out generally across disciplines, because they have different preconditions and requirements. Either groups should be evaluated with similar preconditions or agricultural sciences could be better evaluated by comparing internationally.

Interviewees point out, that evaluation often requires a lot of effort for those organizations to be evaluated, because they need to provide information in a way that the evaluators are able to fulfill their job efficiently. Therefore the need of a (new) evaluation should be carefully considered – in order to avoid 'evaluitis' the question of 'what how often' should be discussed.

While scientific output is the established evaluation interest, the 'real' impact is not yet considered. Additional criteria would be necessary in order to measure societal impact. Some organizations carry out internal evaluations with a broadened catalogue of criteria (e.g. Thünen-Institute) in order to better capture impact. In addition, the Thünen-Institute sends out questionnaires to the ministries in order to evaluate their consultancy activities (ask about timeliness, understandability etc.).

Interviews convey the impression, that practical use is gaining weight: According to the BMEL representative the next evaluation of departmental research, carried out by the Science Council, is supposed to additionally take the actual contribution of institutions to problem solving into account. The DLG representative states that the DLG is increasingly asked as evaluation partner, especially in order to evaluate research results in terms of practical use. If application of results gain weight agricultural sciences will profit from the development, because in contrast to other research fields agricultural sciences cover the broad range from basic research to applied research to knowledge transfer.

6. CONCLUSIONS

Budget and expenditure data covering agricultural research in Germany has some weaknesses. While data is available from the early 1980s onwards, there are substantial gaps particularly in GERD data. Generally restrictions in comparability of time series apply to all indicators collected due to a number of revisions of the systematisation applied, and the German reunification. BERD data particularly for the agricultural sector, has a lot of limitations due to the voluntary nature of data collection. The best time series for Germany are GBAORD data, with the limitation that it only indicates planned and not actual expenditure. Besides the collection of internationally relevant indicators, the German government has its own systematic for categorising research expenditure by funding priorities. Numbers deviate substantially from the GERD data; however, general trends are similar.

The different indicators for research expenditure show increasing trends for the past 20 to 30 years; likewise total public expenditure for agriculture have been increasing. However, analysis of the public R&D expenditure (HERD and GOVERD) shows that the share of agriculture in the total actual public expenditure has been decreasing from 5.3% in 1993 to just above 4% in 2011. Private R&D expenditure (BERD) on agriculture and the food industry make up very low shares of the total private R&D expenditure (0.3% and 0.6%). Absolute expenditure for agriculture and food industry have shown slight upwards trends since the early 2000s, however, the shares in total expenditure do not show any clear trend. In any case analysis of BERD data has some limitations due potentially incomplete coverage.

Overall German public expenditure on agricultural research is expected to continue increasing, particularly focussing on aspects covered in the bioeconomy 2023 strategy. However, the downward trend of basic funding for public research institutes, particularly universities is anticipated to continue. Thus the importance of third-party funding is continuously increasing. Still the increase in third-part (EU and federal level) funding is not expected to be able to compensate the cuts in basic funding. At the federal level, the increases will mainly concern BMEL budget; in how far this will also apply to BMBF funding is not clear. In the likely case that BMBF funds for agriculture will also increase this is probably rather intended to support financing of universities, as the cooperation ban (between federal and state level) has been eased.

The thematic areas of agricultural research are in demand; however, agricultural sciences at universities are often not well positioned. This is attributed to the fact that despite the systemic nature of agricultural sciences scientist still have to satisfy the remuneration system of sciences. Opposed to that, interdisciplinarity is regarded a positive asset, which unfortunately does not always fit the institutional and structural framework conditions.

ANNEX I: LIST OF CONSULTED INSTITUTIONS

Organisation	brief description of organisation
Federal Office for Agriculture and Food (BLE)	As a federal institution for public law, directly accountable to the Federal Government, the Federal Office for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung, BLE) conducts its operations within the scope of business of the Federal Ministry of Food and Agriculture (BMEL). On behalf of the Federal Ministry for Food and Agriculture (BMEL), the BLE manages, technically and in terms of organization, various research projects in the fields of food, agriculture and consumer protection.
German Agricultural Society (DLG)	The DLG (Deutsche Landwirtschafts-Gesellschaft – German Agricultural Society) is an expert organisation with over 25,000 members and is a leading organisation in the agricultural and food sectors. The DLG's mandate is to promote technical and scientific progress. At DLG 200 full-time staff and 3,000 voluntary experts together develop solutions for the challenges facing the sector. The over 80 committees, work groups and commissions form the foundation for expertise and continuity in specialist technical work.
Johann Heinrich von Thünen Institute - Federal Research Institute for Rural Areas, Forestry and Fisheries	The Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, is a German research institute under the auspices of the German Ministry of Food and Agriculture (BMEL). It develops scientific basics as decision-making helps for the policies of the German government.
Martin Luther University Halle-Wittenberg Institute of Agricultural and Nutritional Science	The institute focuses on soil, plant, animal and nutrition sciences as well as agricultural socio economics. Research is based on 21 professorships.
University of Bonn Faculty of Agriculture	The faculty offers traditional agricultural subjects but also covers agricultural and food systems sciences and geodesy.
The German Farmers' Association Deutscher Bauernverband (DBV)	DBV is the professional representation of German agriculture and forestry and is an agricultural umbrella organisation. Its members are the 18 federal state farmers' associations, where more than 90 % of the about 380.000 German farmers are voluntary associated. Above 300 district organisations are a direct contact for the famers on the ground. 45 associations and institutions of the agricultural and rural sector are associated members.
Das Agrarbündnis (The agriculture alliance)	The AgrarBündnis is an independent alliance of 24 organisations in the field of agricultre, environment, animal protection, nature conservation, consumer and energy politics and has more than a million of members.
German Research Foundation (DFG)	The DFG (German Research Foundation) is the self-governing organisation for science and research in Germany. It funds knowledge-oriented research without stipulation of topics and utilises competition to select the best projects in terms of scientific quality. The DFG gives policy advice to parliaments, governments and public institutions as well as the general public on scientific issues.
The Federal Ministry of Food and Agriculture (BMEL)	A balanced, healthy diet and safe foods, clear information for consumers when purchasing food, strong and sustainable agricultural, forestry and fisheries sectors, and good prospects for our rural areas are important objectives for the BMEL

The Federal Ministry of Education and Research (BMBF)	The Federal Ministry for Education and Research (BMBF) funds agricultural research in the frame of the Bioeconomy strategy.
German Alliance for Agricultral Research (DAFA)	Within the German Agricultural Research Alliance different specialist fora of the research community discuss strategic issues. There is a constant exchange with advisory boards consisting of representatives of ministries, industry and farmer interest groups.

ANNEX II: ACRONYMS

Acronym	Name	English name/translation
AbL	Arbeitsgemeinschaft bäuerliche Landwirtschaft	Syndicate of Traditional Agriculture
AHA	Andreas-Hermes-Akademie	Andreas Hermes Academy
aid	infodienst Ernährung, Landwirtschaft, Verbraucherschutz e.V.	Information Service for Food, Agriculture, Consumer Protection
AKIS		Agricultural Knowledge and Innovation System
BDM	Bundesverband Deutscher Milchviehhalter	German Federal Association of Dairy Farmers
BERD	F&E-Ausgaben im Wirtschaftssektor / der Unternehmen	Business enterprise R&D expenditure
BfR	Bundesinstitut für Risikobewertung	Federal Institute for Risk Assessment
BLE	Bundesanstalt für Landwirtschaft und Ernährung	Federal Agency for Agriculture and Food
BMBF	Bundesministerium für Bildung und Forschung	Federal Ministry for Education and Research
BMEL	Bundesministerium für Ernährung und Landwirtschaft	Federal Ministry for Food and Agriculture
BMR	Bundesverband der Maschinenringe e.V.	Federal Association of Machinery Rings
BMU	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMWi	Bundesministerium für Wirtschaft und Energie	Federal Ministry for Economic Affairs and Energy
BÖLN	Bundesprogramm Ökologischer Landbau und andere Formen Nachhaltiger Landwirtschaft	Federal Framework Programme Ecologic Farming and other Forms of Sustainable Agriculture
CAP		Common Agricultural Policy
DAF	Dachverband wissenschaftlicher Gesellschaften der Agrar-, Forst-, Ernährungs-, Veterinär-, und Umweltforschung e.V.	Umbrella association of scientific societies of agricultural, forestry, nutrition, veterinary and environmental research
DAFA	Deutsche Agrarforschungsallianz	German Agricultural Research Alliance
DBFZ	Deutsches Biomasseforschungszentrum	German Biomass Research Centre
DBV	Deutscher Bauernverband e.V.	German Farmers´Association
DESTATIS	Statistisches Bundesamt	Federal Statistical Office
DFG	Deutsche Forschungsgemeinschaft	German Research Foundation
DIP	Deutsche Innovationspartnerschaft Agrar	German Agricultural Innovation Partnership
DLG	Deutsche Landwirtschaftsgesellschaft	German Agricultural Society
DLV	Deutscher Landwirtschaftsverlag	German Agricultural Publishing House
DRV	Deutscher Raiffeisen Verband	German Raiffeisen Association
DVS	Deutsche Vernetzungsstelle	German Networking Agency for rural areas
EIP		European Innovation Partnerships
ERDF		European Regional Development Fund
ESF		European Social Fund
FH	Fachhochschule	University of applied science

FISA	Forschungsinformationssystem Agrar / Ernährung	Science information system
FONA	Forschung für Nachhaltige Entwicklung	Research for Sustainable Development
FOS	Forschungsbereich	Field of Science
GABI	Genomanalyse im biologischen System Pflanze	Genome analysis in the biologic system plant
GAK	Gemeinschaftsaufgabe zur Verbesserung Agrarstruktur und Küstenschutz	Joint task 'improvement of the agrarian structures and coastal protection'
GBAORD	Staatliche Mittelzuweisungen oder Ausgaben für F&E	Government budget appropriations or outlays for R&D
GDP		Gross Domestic Product
GERD		Gross domestic expenditure on R&D
GOVERD	Interne Aufwendungen der Regierung für F&E	Government Intramural Expenditure on Research and Development
GWK	Gemeinsame Wissenschaftskonferenz	Joint Science Conference
ha		hectare
HERD	F&E-Aufwendungen im Hochschulsektor	Higher Education Expenditure on Research and Development
IALB	Internationale Akademie land- und hauswirtschaftlicher Beraterinnen und Berater	Federation of Rural Advisors
IVA	Industrieverband agrar	German agrochemical industrial association
JPI		European Joint Programming Initiative
KTBL	Kuratorium für Technik und Bauen in der Landwirtschaft e.V.	Association for Technology and Structures in Agricultural
m		million
NABS	Systematik zur Analyse und zum Vergleich der wissenschaftlichen Programme und Haushalte	Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets
OECD		Organisation for Economic Co-operation and Development
PLANAK	Planungsausschuss für Agrarstruktur und Küstenschutz	planning commission for the agrarian structure and coast protection
PROAKIS		Prospects for Farmers' Support : Advisory Services in European AKIS (FP7 project)
R&D		Research and Development
t		tonnes
VDL	Berufsverband Agrar, Ernährung, Umwelt	Professional Association Agricultural, Nutrition, Environment
VDLUFA	Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten	Association of German Agricultural Analytic and Research Institutes
VLF	Bundesverband Landwirtschaftlicher Fachbildung e.V.	Federal Association of Agricultural Vocational Training
VLK	Verband der Landwirtschaftskammern	Federation of Agricultural Chambers
ZAMF	Deutscher Wetterdienst, Zentrum für Agrarmeteorologische Forschung	German Weather Service, Centre for agrometeorological Research

ANNEX III: ADDITIONAL INFORMATION

Table 6 Key figures of number of farmers, trends and types of farms.

Indicator		Notes
Farming structure		
Number of Holdings (1,000)		total self-cultivated area
2010	299.1	*a simple error class of the relative
2012	288.2	standard error to less than ± 2%
2013*	285.0	
Agricultural holdings, by farm type:	**299,134**	In 2010, based on standard output
field crops	73,300	
horticulture	8,258	
permanent crops	23,397	
fodder crops	129,828	
granivores	19,285	
Mixed cropping	3,830	
Mixed livestock	10,589	
Mixed crop-livestock	30,647	
Livestock (1,000):	**173,170.4**	In 2010
Cattle	12,534.5	Only the main types are listed here
Dairy cow	4,164.8	
Pigs	27,571.4	
Poultry	60,450.0	
Average area of holdings (ha)	58.6	In 2013
Utilized agricultural area UAA (1,000)	16,699.6	In 2013
Employees in total (1,000)	637	In 2013
Agricultural Production in 2013		
cereals (harvest in 1,000 t)	**47,757**	
Common wheat	25,019	Only the main crops are listed here
Barley	10,343	
Grain maize and corn cob mix	4,387	
Rye and maslin	4,689	
vegetable (harvest in t)	**3,213,852**	
Carrots	583,587	Only the main vegetables are listed here
Onions	405,656	
White cabbage	427,159	
Asparagus	103,107	
fruit (harvest in 1,000 t)	**936**	
Apples	804	Only the main fruits are listed here
Plums	49	
Pears	39	
Stock of wine (in hl)	**11,483,293**	
White wine	6,641,040	
Red wine	4,842,253	
Import and export		
Products of agriculture and hunting		In 2013, in million EUR
Import	27,668	
Export	9,665	
Products of forestry		In 2013, in million EUR
Import	760	
Export	331	
Fish and Products of fishing		In 2013, in million EUR
Import	558	
Export	263	
Food Products		In 2013, in million EUR
Import	40,223	
Export	48,095	

Source: (EUROSTAT 2013; DESTATIS 2014a)

Figure 11 Advisory services systems in the federal states of Germany
Source: (Thomas 2007)

Table 7 List of German public agricultural research institutions

Acronym	Name	English name/function
Federal (departmental) Research Institutes		
JKI	Julius Kühn-Institut	plant production
FLI	Friedrich-Loeffler-Institut	animal health
MRI	Max Rubner-Institut	nutrition and food
TI	Thünen-Institut	rural areas, forestry and fisheries
Other federal institutions conducting resarch supported by BMEL		
BfR	Bundesinstitut für Risikobewertung,	Federal Institute for Risk Assessment
DBFZ	Deutsche Biomasseforschungszentrum.	German Biomass Research Centre
Leibniz institutions		
IAMO	Leibniz-Institut für Agrarentwicklung in Transformationsökonomie	Agricultural development in transforming economies
ZALF	Leibniz-Zentrum für Agrarlandschaftsforschung	agricultural landscapes research
ATB	Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V.	agricultural technology
	Leibniz-Institut für Gemüse- und Zierpflanzenbau Großbeeren/Erfurt e.V.	Vegetable and ornamental crops
	Deutsche Forschungsanstalt für Lebensmittelchemie	food chemistry, supported by the BMEL
	Leibniz-Institut für Nutztierbiologie	farm animal biology, supported by the BMEL
Universities		
	University Hohenheim	
HU	Humboldt-University Berlin	
	Martin-Luther University Halle Wittenberg	
	University Bonn	
	University Kassel	
	Georg August University Göttingen	
	University Rostock	
	Christian-Albrechts University Kiel	
TU	Technical University Munich	
	Justus-Liebig University Gießen	
Universities of applied science		
	Fachhochschule Kiel Standort Rendsburg	
	Hochschule für Technik und Wirtschaft Dresden	
	Fachhochschule Osnabrück	
	Hochschule Anhalt - Bernburg	
	Fachhochschule Bingen	
	Hochschule Rhein-Waal- Kleve	
	Hochschule Südwestfalen - Soest	
	Hochschule Weihenstephan / Triesdorf	
	Hoschschule für Wirtschaft und Umwelt Nürtingen	
	Hochschule Weihenstephan / Freising	

	Fachhochschule Eberswalde	
	Hochschule Neubrandenburg	
state departmental research organisations (not complete)		
	Kompetenzzentrum Weinforschung des DLR Rheinpfalz	RLP viticulture
	Landesamt für Ländliche Entwicklung, Landwirtschaft und Flurneuordnung, Abt. Landwirtschaft und Gartenbau	BB agriculture, horticulture
ARL	Akademie für Raumforschung und Landesplanung	NS
HeRo	Kompetenzzentrum HessenRohstoffe	HE
LAZBW	Landwirtschaftliches Zentrum für Rinderhaltung, Grünlandwirtschaft, Milchwirtschaft, Wild und Fischerei Baden-Württemberg	BW
LFA	Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern	MV
LfL	Bayerische Landesanstalt für Landwirtschaft	BAY
LfULG	Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie	SN
LIB	Länderinstitut für Bienenkunde Hohen Neuendorf e.V.	B, BB, SN, ST, TH Apiculture
LLFG	Landesanstalt für Landwirtschaft, Forsten und Gartenbau Sachsen-Anhalt	ST agriculture, forestry, horticulture
LLH	Landesbetrieb Landwirtschaft Hessen	HE
LSZ	Bildungs- und Wissenszentrum Boxberg - Schweinehaltung, Schweinezucht	BW pig raising
LTZ	Landwirtschaftliches Technologiezentrum Augustenberg	BW
LVAT	Lehr- und Versuchsanstalt für Tierzucht und Tierhaltung e.V. Ruhlsdorf/Groß Kreutz	BB animal breeding, husbandry
LVG	Staatliche Lehr- und Versuchsanstalt für Gartenbau Heidelberg	BW
LVWO	Staatliche Lehr- und Versuchsanstalt für Wein- und Obstbau	BW Viticulture, fruit production
LWG	Bayerische Landesanstalt für Weinbau und Gartenbau	BAY viticulture horticulture
TLL	Thüringer Landesanstalt für Landwirtschaft (TLL	TH

Table 8 Number of agriculture and food research institutions by federal state and type of funding

Federal states	Federal	State	Private	NGO
Baden-Württemberg	3	31	39	8
Bavaria	4	24	49	7
Berlin	11	7	21	6
Brandenburg	7	16	12	3
Bremen	2	3	10	3
Hamburg	0	4	5	2
Hessen	2	14	25	6
Mecklenburg-Western Pomerania	6	7	10	2
Lower Saxony	9	21	63	7
Northrhine Westfalia	9	27	61	16
Rhineland-Palatinate	1	15	19	1
Saarland	0	1	2	0

Saxony	4	10	28	7
Saxony-Anhalt	4	7	22	6
Schleswig-Holstein	2	7	14	2
Thuringia	0	8	12	6
Total	**64**	**202**	**392**	**82**

Source: Fisaonline [URL: http://www.fisaonline.de/index.php?lang=en&act=research_inst&res_view=yes]

Table 9 Expenditure by GERD (total and agriculture FOS 4), and by funding area (Leistungsplansystematik) for selected years 1981 to 2012

year	1981	1985	1989	1993	1997	2001	2005	2009	2012
All areas									
All sectors	**15108.8**	**22515.6**	**30777.5**	**39010.3**	**42671.1**	**52002.0**	**55739.0**	**67014.9**	**79380.7**
Business enterprise [12]	10420.8	16265.4	22261.1	26192.3	28783.2	36331.9	38651.0	45275.0	53790.1
GOVERD	2030.2	2870.9	3991.4	5933.3	6244.8	7145.9	7866.9	9931.7	11340.6
HERD	2577.7	3280.3	4382.1	6884.6	7643.2	8524.2	9221.1	11808.2	14250.0
Private non-profit sector	79.6	98.8	142.7						
FOS 4 Agricultural sciences									
GOVERD				350.6	372.6	423.0	428.0	563.4	664.5
HERD	109.3	142.3	195.8	331.1	330.1	353.3	328.1	410.3	n.a.
Private non-profit sector		2.0	7.3						
Funding area (*Leistungsplansystematic*)									
All funding areas	6060.6	7453.2	8301.2	10491.5	10123.1	11219.1	11140.1	14567.0	17325.3
Q +R; D	147.6	173.9	176.8	237	229.8	193.6	195	523.2	726.9

Sources: EUROSTAT, Deutscher Bundestag 1990:350f.; Deutscher Bundestag 1996:542;Deutscher Bundestag 1998:383; BMBF 2006:620ff.; BMBF 2010:428ff.; BMBF 2014:486

[12] No information for the Business enterprise sector for FOS 4 available, therefore this sector is not displayed below

Table 10 Public expenditure of states for advisory services in 2012, states farm structures

state	type of advisory system	2012 expenditures for advisory services			2012 farm structures		
		actual	planned	budget positions	Agric. holdings	UAA	average UAA/farm
		EUR			1000	1000 ha	ha
Baden-Württemberg	public, advisory rings		130000	Beratung nach § 9 LLG (Landwirtschafts- und Landeskulturgesetz)	43.1	1420.7	32.96
Bayern	public; advisory rings		5684000	Zuschüsse für die produktionstechnische und betriebswirtschaftliche Verbundsberatung in der Landwirtschaft	94.4	3126.1	33.12
Brandenburg	private; advisory rings			n.a.	5.5	1319.6	239.93
Hessen	public; advisory rings		10524100	Landwirtschaftliche und gartenbauliche Beratung	17.4	763.1	43.86
Mecklenburg-Western Pomerania	privat; advisory rings	1461400		Zuschuss des Landes an die LMS Agrarberatung GmbH (gesamt)	4.7	1343.1	285.77
Lower Saxony	Chambers of agriculture; advisory rings	995000 646000		Förderung der landwirtschaftlichen Beratung und Maßnahmen des ökologischen Landbaus; Förderung von Beratungsleistungen an landwirtschaftlichen Unternehmen	40.5	2596.4	64.11
Northrhine Westfalia	Chambers of agriculture; advisory rings		8500000	Erstattung von Verwaltungskosten, die der LK für die Wahrnehmung von Landesinitiativen entstehen	33.8	1446.6	42.80
Rhineland-Palatinate	public	269947 381800		Förderung der privaten Beratung in der Landwirtschaft; Zuschüsse zur landwirtschaftlichen Unternehmensberatung	19.2	698	36.35
Saarland	Chambers of agriculture; advisory rings	8000 9000		Zuschüsse für Bildung und Beratung in der Landwirtschaft; Beratung saarländischer Landwirtschaftsbetriebe	1.2	77.5	64.58
Saxony	public		18000	Rechts- und Beratungskosten	6.1	908.3	148.90
Saxony-Anhalt	private; advisory rings	0		Zuschüsse für die Beratung land- und forstwirtschaftlicher Betriebe	4.2	1171.4	278.90
Schleswig-Holstein	Chambers of agriculture; advisory rings		8544100 87600	Zuwendung an Landwirtschaftskammer (Maßnahmengruppe 21); Sonstige Ausgaben für den Bereich landwirtschaftliches Schulwesen und Beratung (Maßnahmengruppe 22)	13.6	990.4	72.82
Thuringia	private			n.a.	3.5	781.2	223.20

ANNEX IV: LIST OF TABLES AND FIGURES

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BMBF (2006): Bundesbericht Forschung 2006. Bonn, Berlin, 2006. [online] http://www.uni-oldenburg.de/fileadmin/user_upload/fzns/download/allg__Bundesbericht-Forschung-2006,property=pdf.pdf [accessed 14.10.2014].

BMBF (2010): Bundesbericht Forschung und Innovation 2010. Bonn, Berlin, 2010. [online] http://www.bmbf.de/pub/bufi_2010.pdf [accessed 03.09.2014].

BMBF (2014a): Bundesbericht Forschung und Innovation 2014. Bonn, Berlin, 2014. [online] http://www.bmbf.de/pub/BUFI_2014_Kurzfassung_bf.pdf [accessed 14.10.2014].

BMBF (2014b): Bundesregierung investiert in die Zukunft. [online] http://www.bmbf.de/de/96.php [accessed 29.09.2014].

BMELV (2008): Konzept für eine zukunftsfähige Ressortforschung im Geschäftsbereich des Bundesministeriums für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV). Endfassung. [online] http://www.bmelv.de/SharedDocs/Downloads/Ministerium/Forschung/KonzeptRessortforschung.pdf?__blob=publicationFile [accessed 19.08.2014].

BMELV (2012): Charta für Landwirtschaft und Verbraucher. [online] http://www.bmel.de/SharedDocs/Downloads/Ministerium/Charta/ChartaLandwirtschaftVerbraucherDownload.pdf?__blob=publicationFile [accessed 29.09.2014].

BMF: Die Struktur des Bundeshaushaltes. [online] http://www.bundeshaushalt-info.de/startseite/# [accessed 30.09.2014].

Bokelmann, W.; Doernberg, A.; Schwerdtner, W.; Kuntosch, A.; Busse, M.; König, B. et al. (2012): Sektorstudie zur Untersuchung des Innovationssystems der deutschen Landwirtschaft.

DESTATIS (2013): Mikrozensus. Bevölkerung und Erwerbstätigkeit Stand und Entwicklung der Erwerbstätigkeit in Deutschland. FAchserie 1 Reihe 4.1.1 2012. [online] https://www.destatis.de/DE/Publikationen/Thematisch/Arbeitsmarkt/Erwerbstaetige/StandEntwicklungErwerbstaetigkeit.html [accessed 07.10.2014].

DESTATIS (2014a): GENESIS-online Datenbank. [online] https://www-genesis.destatis.de/genesis/online/logon [accessed 19.08.2014].

DESTATIS (2014b): Land- und Forstwirtschaft, Fischerei. Landwirtschaftliche Bodennutzung und pflanzliche Erzeugung. Fachserie 3 Reihe 3 2013. Wiesbaden. [online] https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/LandForstwirtschaftFischerei/LandForstwirtschaft.html [accessed 07.10.2014].

DESTATIS (2014c): Land- und Forstwirtschaft, Fischerei. Arbeitskräfte, Agrarstrukturerhebung. Fachserie 3 Reihe 2.1.8 2013. Wiesbaden. [online] https://www.destatis.de/DE/Publikationen/Thematisch/LandForstwirtschaft/Betriebe/Arbeitskraefte.html [accessed 07.10.2014].

DESTATIS (2014d): Volkswirtschaftliche Gesamtrechnung. Wichtige Zusammenhänge im Überblick. 2013. Wiesbaden. [online] https://www.destatis.de/DE/Publikationen/Thematisch/VolkswirtschaftlicheGesamtrechnungen/ZusammenhaengePDF_0310100.pdf?__blob=publicationFile [accessed 19.08.2014].

DESTATIS (2014e): Wirtschaftsrechnungen. Laufende Wirtschaftsrechnungen Einnahmen und Ausgaben privater Haushalte. Fachserie 15 Reihe 1 2012. Wiesbaden. [online] https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/EinkommenKonsumLebensbedingungen/Konsumausgaben/Konsumausgaben.html [accessed 07.10.2014].

Deutsche Forschungsgemeinschaft (2012): Förderatlas 2012. Kennzahlen zur öffentlich finanzierten Forschung in Deutschland. 1. Auflage. Weinheim: Wiley-VCH (DFG-

Publikationen). [online] http://www.dfg.de/download/pdf/dfg_im_profil/evaluation_statistik/foerderatlas/dfg-foerderatlas_2012.pdf [accessed 29.09.2014].

Deutscher Bundestag (1990): Faktenbericht 1990. zum Bundesbericht Forschung 1988. Bonn, 1990. [online] http://dipbt.bundestag.de/doc/btd/11/068/1106886.pdf [accessed 14.10.2014].

Deutscher Bundestag (1996): Bundesbericht Forschung 1996. Bonn, 1996. [online] http://dipbt.bundestag.de/doc/btd/13/045/1304554.pdf [accessed 14.10.2014].

Deutscher Bundestag (1998): Faktenbericht 1998 zum Bundesbericht Forschung. Bonn, 1998. [online] http://dipbt.bundestag.de/doc/btd/11/068/1106886.pdf [accessed 14.10.2014].

DFG (2014): Facts and Figures 2013. [online] http://www.dfg.de/download/pdf/dfg_im_profil/geschaeftsstelle/publikationen/flyer_zahlen_fakten_2013_en.pdf [accessed 29.09.2014].

EU SCAR: Agricultural knowledge and innovation systems in transition. A reflection paper. Brussels: EUR-OP.

EUROSTAT (2013): Agriculture, forestry and fishery statistics. 2013 edition. 2013 ed. Luxembourg: Publications Office of the European Union (Pocketbooks). [online] http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-FK-13-001 [accessed 25.06.2014].

Hoffmann, V. (2002): Beratung landwirtschaftlicher Betriebe. Bund und Länder weiterhin in der Pflicht (51) (7)S. 329−331.

Isermeyer, F. (2003): Aus dem Institut für Betriebswirtschaft, Agrarstruktur und ländliche Räume. Für eine leistungsfähige Agrarforschung in Deutschland. Braunschweig.

Isermeyer, F. (2014): Agrarpolitisches Fachgespräch mit Professor Isermeyer. Sonderbeitrag. In: *Agrar Europe* (33)S. 1−5.

Kladroba, A. (2013): FuE-Datenreport. Tabellen und Daten. Unter Mitarbeit von Ruth Hellmich. Essen, 2013.

Ober, S. (2004): Agrarforschung Deutschland. Im Auftrag der Zukunftsstiftung Landwirtschaft. [online] http://make-sense.org/fileadmin/Daten-KAB/KAB-2004/Zusatzinfos/ZSL_Agrarforschung.pdf [accessed 04.09.2014].

Paul, C.; Knuth, U.; Knierim, A.; Tim Nadh, H.; Klein, M.: AKIS and advisory services in Germany. Report for the AKIS inventory (WP3) of the PRO AKIS project. [online] http://www.proakis.eu/publicationsandevents/pubs [accessed 19.08.2014].

Senat Bundesforschung: Bundesforschung im Agrar- und Ernährungsbereich. [online] http://www.bmelv-forschung.de/fileadmin/dam_uploads/Forschung/Praesentation_Bundesforschung_Senat_2014.pdf [accessed 19.08.2014].

Thomas, A. (2007): Landwirtschaftliche Beratung in der Bundesrepublik Deutschland - eine Übersicht (2). In: *B&B Agrar*. [online] https://www.aid.de/fachzeitschriften/bub/bubonline/bub_2007_02_os_thomas_lw_beratung_in_dtl.pdf [accessed 19.08.2014].