UNIVERSITY OF HOHENHEIM

Privatization of Agricultural Advisory Services and Innovation Systems - The Case of Brandenburg, Germany

Dissertation

to obtain the doctoral degree of Agricultural Sciences (Dr. sc. agr.)

Faculty of Agricultural Sciences
Institute of Social Sciences in Agriculture
Communication and Advisory Services in Rural Areas (430a)
Prof. Dr. Andrea Knierim

submitted by: Ulrike Knuth, M.Sc.

from Berlin, Germany

2021

This thesis was submitted as a doctoral dissertation in fulfillment of the requirement for the degree "Doktor der Agrarwissenschaften" (Dr. sc. Agr. / Ph.D.) to the faculty of Agricultural Sciences at the University of Hohenheim in March 2021.

Date of oral examination: 07.10.2021

Examination Committee
Head of the Examination Committee: Prof. Dr. Stefan Böttinger
Supervisor and Reviewer: Prof. Dr. Andrea Knierim
Co-Reviewer: Prof. Dr. Wolfgang Bokelmann
Additional Examiner: Prof. Dr. Christine Wieck

Acknowledgements

This life-research-project would not have come about or been completed without the support of many different people and organizations. In the first place, I would like to thank my supervisor Prof. Dr. Andrea Knierim, for all your professional and personal support, your encouragement to start this project in the first place and your guidance to stick it out - against so many odds. Thank you for the freedom to let it become MY project, even if that meant many detours and extra loops. Thank you for following up with valuable questions and recommendations that made me think and go one step deeper. Additionally, I would like to acknowledge the willingness to review this dissertation and the support of Prof. Wolfgang Bokelmann.

Thanks to all the farmers and consultants and all the interviewees, who gave me their time and were willing to discuss with me my questions with a lot of openness.

I would especially like to thank my co-authors - Andrea, Babu and Julia, for putting up with me, working with me, and being so patient with me.

Then there are friends and colleagues, I am deeply grateful to have them in my life. First of all, Carsten, who was by my side and invested so much time in me, when I was ready to quit, and who patiently, accompanied me through needle eyes like paper submission or completion of the overall thesis; who made me realize "It's worth it". Specials thanks also go to Anja, Caro, Marlene, André, Andreas, Jenny, and many others, who I have forgotten here to mention, for practical as well as mental support along this journey.

I am deeply grateful for my family, especially my children, for their patience with me and their willingness to give up a lot of family time, over endless years - again and again. I know, you are overjoyed that this is being concluded and we can open new life chapters together.

And over all, I have to thank God for giving me the strength, to work through all this, finalize this thesis, and let go, submit and leave the rest up to him - and the reviewers.

Executive Summary

The European regulations on Rural Development of the last two decades brought Agricultural Advisory Systems back onto the political agenda. Along with the introduction of Cross Compliance (CC), Member states were obliged to review their Farm Advisory System or to build up new infrastructure. The importance of innovation generation, knowledge dissemination and on-going learning in rural areas has been emphasized, and Agricultural Advisory Systems are regarded one important partner. A further development over the last 30 years has been a wave of privatisation of AAS in Europe due to the pressure of decreasing public budgets.

This cumulative dissertation examines the dialectic of increased and changing demands on Farm Advisory Systems on the one hand and the effects of privatization on the other hand. Privatization of agricultural advisory services in European Member States has been a process for decades. Both within Europe and Germany, the German federal state of Brandenburg has an Agricultural Advisory System with a comparatively high level of privatization and commercialization. It was therefore selected as an excellent case to address the development and the impacts of privatization.

The goal of this dissertation is a) to investigate and show the effects of privatisation of the advisory service in Brandenburg for the farmers and the advisor and b) to examine more closely specific aspects with the purpose to improve the Agriculture Advisory Service in Brandenburg. Special attention is given to the advisors' situation, Cross Compliance advice and innovation networks. Leading research questions were: i) What were the consequences of privatization specifically for the situation of advisors, their capacities and competences? (RQ1), ii) What are the responsibilities of public authorities to steer a (privatized) advisory system and innovation networks within pluralistic AKIS? (RQ2), iii) How was the EU's FAS obligation implemented and thus, how is advice on Cross Compliance with FMS as a policy-induced innovation implemented and adopted in Brandenburg and Germany? (RQ3), iv) How successful are innovation networks as an instrument to fill the interaction gap of the AAS in Brandenburg? (RQ 4).

Relevant conceptual frameworks for advisory services in this thesis include the 'Agricultural knowledge System (AKS)' (Nagel 1979), the 'Agricultural Knowledge and Information System (AKIS)' (Röling and Engel 1990) and the Agricultural Innovation System (AIS)' (Hall et al. 2006). Systems of agricultural advisory services (AAS) are embedded in a larger national or regional Agricultural Knowledge and Innovation System (AKIS).

New forms of cooperation and networking between different private, public, and non-governmental actors such as the European Innovation Partnership (EIP) made the concept of Agricultural Knowledge and Innovations Systems (AKIS) more popular. Through the implementation of EU obligations to establish a Farm Advisory System (FAS), the existing AAS in Brandenburg had to be adapted, which created new challenges on the AAS but also on farmers. This dissertation contributes to the empirical evidence on the functioning of AKIS and AAS in general and provides public authorities in Brandenburg with longitudinal information to be

used for future farm advice- and innovation-related policies, to make the AAS more adaptable to fit the new challenges driven from the changing environment for farmers.

The cumulative thesis builds on 4 articles published from 2013 till 2018. The articles analyze qualitatively and discuss the view of agricultural advisors and farmers through a series of semi-structured interviews, and analyze applied Farm Management Tools and assess new cooperation forms like innovation networks. Chapter 2 describes the development of the situation of private farm advisors in Brandenburg over a longer period of more than 15 years, from before until complete commercialization of the service in 2000. It shows which topics advisors (can) address and which they cannot, which clients they work with and which they do not, and it provides data on their basic work situation. It also gives insights on their networking activities. The following chapter 3 provides recommendations for public authorities regarding their responsibilities in pluralistic AKIS in Europe, which can also be applied to Brandenburg.

Chapter 4 provides an analysis of Cross Compliance advice to farmers with Farm Management Systems (FMS) as one public responsibility in AKIS. A special focus is pointed to farmers' usage of FMS in Brandenburg and qualitative comparison of FMS in Germany. In chapter 5 the cooperation of various actors from science and practice in Brandenburg is examined using the example of the innovation network for climate change adaptation. Innovation networks can be considered as one important instrument to cope with the challenges of AKIS privatization in Brandenburg by filling the interaction gap. This chapter presents an analysis of collaboration success factors and shows how crucial repeated participation, appropriate information management, and inclusive as well as responsive network practices are. Chapter 6 discusses the results regarding the development of Brandenburg's AKIS and its Agricultural Advisory System (AAS) during the period of complete privatization (2002 until 2017), in which the research of chapter 2 thru 5 was conducted. Chapter 7 gives an update of Brandenburg's AKIS and advisory system development from 2017 on, when AKIS and advisory services returned on the political agenda, and new policies emerged, which support innovation networks and advisory services. Chapter 8 concludes policy and research recommendations. The following figure 2 gives an overview of the thesis' structure.

"If Brandenburg's advisors want to profit from the up-coming EU policy instruments for the enhancement of knowledge transfer and innovation generation in rural areas, more pro-active engagement for networking and cooperation will be necessary. Awareness creation and incentives from the federal state of Brandenburg would be useful measures." This was the main conclusion of the analysis of the advisors' situation in Brandenburg (chapter 2). Looking from today's point of view some of that has happened. There are few farm advisors from Brandenburg involved in innovation networks like INKA BB or networks based on Art. 35 in EC Reg. 1305/2013 (cooperation measure in the European Rural Development Fund). The 2019 coalition agreement of the Brandenburg government contains the plan to set up a competence centre for agricultural advisory services. Based on the findings of this thesis, it is recommended that such a centre would address the following topics: agricultural advice on public goods, socio-economic advisory services, promotion of education and training,

and certification of advisors e.g., via the Certificate for European Consultants in Rural Areas (CECRA). Additionally, networking among consultants as well as between authorities, associations and consultants should be core tasks, e.g., exchange regarding the design of agri-environmental measures.

The study of policy-induced innovation networks within INKA BB regarding collaboration success and its influencing factors highlights the importance of repeated participation, appropriate information management, and inclusive as well as responsive network practices. This goes in line with the recommendations to public authorities (chapter 3) regarding their tasks in steering pluralistic advisory services in AKIS, where (policy-induced) innovation networks and other rural multi-actor networks are considered a successful advisory format and complementary to classical advisory services (e.g., in a one-to-one approach). They are capable to increase interactions within a regional AKIS, especially in 'weak' AKIS situations with low levels of interaction or public AKIS infrastructures. However, policy-induced multi-actor innovation networks in rural areas should be open to the diversity of knowledge providers and stakeholders in a region. Topics need to be drawn from problems, challenges and opportunities as perceived by farmers.

Regarding bureaucratic requirements, the study on Farm Management Systems (FMS) shows that there is a need for support of farmers in dealing with the increasing legal and environmental or market-relate requirements. Furthermore, FMS need to be designed a participatory way that integrates farmers' expectations. This dissertation comprises research work from different projects that relate to the development of the AKIS and the Farm Advisory System in Brandenburg. It also integrates – especially in the discussion - insights of the author gained by observing the development of AAS in Brandenburg over a period of 15 years. Technical innovations are likely to lead to strong changes in agricultural advisory systems. Examples are decision support systems in the form of apps for mobile phones, video-tutorials and or the distribution of information via social media. Some of the FMS analysed in chapter 4 are no longer in use and novel technologies have replaced them or will do so in the future. However, the methods used in this thesis to assess FMS' characteristics are transferrable to other information management systems and the insights gained therefore also valuable for the future.

Zusammenfassung

Die europäischen Verordnungen zur Entwicklung des ländlichen Raums der letzten zwei Jahrzehnte brachten die landwirtschaftlichen Beratungssysteme wieder auf die politische Agenda. Zusammen mit der Einführung der Cross Compliance (CC) wurden die Mitgliedsstaaten verpflichtet, ihr landwirtschaftliches Beratungssystem (FAS) zu überprüfen oder eine neue Infrastruktur aufzubauen. Die Bedeutung der Innovationsgenerierung, der Wissensverbreitung und des kontinuierlichen Lernens im ländlichen Raum wurde hervorgehoben, und die landwirtschaftlichen Beratungssysteme werden als ein wichtiger Partner angesehen. Eine weitere Entwicklung in den letzten 30 Jahren war eine Welle der Privatisierung von AAS in Europa aufgrund des Drucks der sinkenden öffentlichen Budgets.

Diese kumulative Dissertation untersucht die Dialektik von gestiegenen und sich verändernden Anforderungen an landwirtschaftliche Beratungssysteme einerseits und die Auswirkungen der Privatisierung andererseits. Die Privatisierung der landwirtschaftlichen Beratungsdienste in den europäischen Mitgliedsstaaten ist ein jahrzehntelanger Prozess. Sowohl innerhalb Europas als auch in Deutschland verfügt das Bundesland Brandenburg über ein landwirtschaftliches Beratungssystem mit einem vergleichsweise hohen Grad an Privatisierung und Kommerzialisierung. Es wurde daher als ein hervorragendes Fallbeispiel ausgewählt, um die Entwicklung und die Auswirkungen der Privatisierung zu untersuchen.

Ziel dieser Arbeit ist es, a) die Auswirkungen der Privatisierung der Beratung in Brandenburg für die Landwirte und die Berater zu untersuchen und aufzuzeigen und b) spezifische Aspekte mit dem Ziel der Verbesserung der landwirtschaftlichen Beratung in Brandenburg zu analysieren. Besonderes Augenmerk wird dabei auf die Situation der Berater, die Cross Compliance Beratung und die Innovationsnetzwerke gelegt. Leitende Forschungsfragen waren: i) Welche Folgen hatte die Privatisierung speziell für die Situation der Berater, ihre Kapazitäten und Kompetenzen?; ii) Was sind die wesentlichen Aufgaben der öffentlichen Hand zur Steuerung von (privatisierten) Beratungssystemen und Innovationsnetzwerken in pluralistischen AKIS?, iii) Wie wurden die EU Vorgaben für landwirtschaftliche Beratungssysteme (FAS) umgesetzt und dementsprechend Cross Compliance Beratung mit Betriebsmanagementsystemen als politikinduzierte Innovation in Deutschland und Brandenburg eingeführt und angenommen?; iv) Wie erfolgreich sind Innovationsnetzwerke als Instrument zur Schließung der Interaktionslücke der AAS in Brandenburg?

Relevante konzeptionelle Rahmen für Beratungsdienste in dieser Arbeit sind das 'Landwirtschaftliche Wissenssystem (AKS)' (Nagel 1979), das 'Landwirtschaftliche Wissens- und Informationssystem (AKIS)' (Röling und Engel 1990) und das 'Landwirtschaftliche Innovationssystem (AIS)' (Hall et al. 2006). Systeme der landwirtschaftlichen Beratung (AAS) sind eingebettet in ein größeres nationales oder regionales landwirtschaftliches Wissens- und Innovationssystem (AKIS).

Neue Formen der Kooperation und Vernetzung verschiedener privater, öffentlicher und nicht-staatlicher Akteure wie die Europäische Innovationspartnerschaft (EIP) haben das Konzept der landwirtschaftlichen Wissens- und Innovationssysteme (AKIS) populärer gemacht. Durch die Umsetzung der EU-Verpflichtungen zum

Aufbau eines landwirtschaftlichen Beratungssystems (AAS) musste das bestehende AAS in Brandenburg angepasst werden, was neue Herausforderungen an das AAS, aber auch an die Landwirte stellte. Diese Dissertation trägt zu den empirischen Erkenntnissen über die Funktionsweise von AKIS und FAS im Allgemeinen bei und liefert den Behörden in Brandenburg Längsschnittinformationen, die für künftige landwirtschaftliche Beratungs- und Innovationspolitiken genutzt werden können, um das FAS anpassungsfähiger zu machen, damit es den neuen Herausforderungen gerecht wird, die sich aus dem veränderten Umfeld für Landwirte ergeben.

Die kumulative Thesis baut auf 4 wissenschaftlichen Artikeln auf, die von 2013 bis 2018 veröffentlicht wurden. Die Artikel analysieren qualitativ die Sichtweise von landwirtschaftlichen Beratern und Landwirten durch eine Reihe von halbstrukturierten Interviews, analysieren angewandte Farm Management Tools und bewerten neue Kooperationsformen wie Innovationsnetzwerke. Kapitel 2 beschreibt die Entwicklung der Situation der privaten landwirtschaftlichen Berater in Brandenburg über einen längeren Zeitraum von mehr als 15 Jahren, von der Zeit davor bis zur vollständigen Kommerzialisierung der Dienstleistung im Jahr 2001. Es zeigt, welche Themen die Berater bearbeiten (können) und welche nicht, mit welchen Kunden sie arbeiten und mit welchen nicht, und es liefert Daten zu ihrer grundsätzlichen Arbeitssituation. Es gibt auch Einblicke in ihre Vernetzungsaktivitäten. Das folgende Kapitel 3 gibt Empfehlungen für die öffentliche Hand hinsichtlich ihrer Verantwortung in pluralistischen AKIS in Europa, die auch auf Brandenburg übertragbar sind.

Kapitel 4 bietet eine Analyse der Cross-Compliance-Beratung von Landwirten mit Farm-Management-Systemen (FMS) als eine öffentliche Aufgabe in AKIS. Ein besonderer Fokus wird auf die Nutzung von FMS durch Landwirte in Brandenburg und den qualitativen Vergleich von FMS in Deutschland gelegt. In Kapitel 5 wird die Zusammenarbeit verschiedener Akteure aus Wissenschaft und Praxis in Brandenburg am Beispiel des Innovationsnetzwerkes zur Anpassung an den Klimawandel untersucht. Innovationsnetzwerke können als ein wichtiges Instrument zur Bewältigung der Herausforderungen der AKIS-Privatisierung in Brandenburg angesehen werden, indem sie die Interaktionslücke füllen. Dieses Kapitel präsentiert eine Analyse der Erfolgsfaktoren der Zusammenarbeit und zeigt, wie entscheidend wiederholte Partizipation, angemessenes Informationsmanagement und inklusive sowie responsive Netzwerkpraktiken sind. In Kapitel 6 werden die Ergebnisse zur Entwicklung des brandenburgischen AKIS und des landwirtschaftlichen Beratungssystems (AAS) während des Zeitraums der vollständigen Privatisierung (2002 bis 2017) diskutiert, in welchem die Untersuchungen für Kapitel 2 bis 5 durchgeführt wurden. Kapitel 7 gibt einen aktuellen Überblick über die Entwicklung des brandenburgischen AKIS- und Beratungssystems seit 2017, als AKIS und Beratungsdienste wieder auf die politische Agenda kamen und neue politische Maßnahmen entstanden, die Innovationsnetzwerke und Beratungsdienste unterstützen. Kapitel 8 schließt mit Empfehlungen für Politik und Forschung.

"Wenn Brandenburgs Beraterinnen und Berater von den anstehenden EU-Politikinstrumenten zur Stärkung des Wissenstransfers und der Innovationsgenerierung im ländlichen Raum profitieren wollen, ist ein stärkeres proaktives Engagement für Vernetzung und Kooperation notwendig. Bewusstseinsbildung und Anreize seitens des Landes Brandenburg wären sinnvolle Maßnahmen." Dies war das zentrale Ergebnis der Analyse der Beratersituation in Brandenburg (Kapitel 2). Aus heutiger Sicht ist einiges davon eingetreten. Es gibt nur wenige

landwirtschaftliche Berater aus Brandenburg, die in Innovationsnetzwerken wie INKA BB oder in Netzwerken auf der Grundlage von Art. 35 der VO (EU) 1305/2013 (Kooperationsmaßnahme im Europäischen Fonds für die Entwicklung des ländlichen Raums) eingebunden waren. Im Koalitionsvertrag 2019 der brandenburgischen Landesregierung ist die Einrichtung eines Kompetenzzentrums für landwirtschaftliche Beratung geplant. Basierend auf den Erkenntnissen dieser Arbeit wird empfohlen, dass sich ein solches Zentrum mit folgenden Themen befasst: landwirtschaftliche Beratung zu öffentlichen Gütern, sozioökonomische Beratung, Förderung der Aus- und Weiterbildung sowie Zertifizierung von Beratern z.B. über das Certificate for European Consultants in Rural Areas (CECRA). Darüber hinaus sollte die Vernetzung der Berater untereinander sowie zwischen Behörden, Verbänden und Beratern eine Kernaufgabe sein, z.B. der Austausch über die Gestaltung von Agrarumweltmaßnahmen.

Die Untersuchung von politikinduzierten Innovationsnetzwerken innerhalb von INKA BB hinsichtlich des Kooperationserfolges und seiner Einflussfaktoren verdeutlicht die Bedeutung von wiederholter Partizipation, angemessenem Informationsmanagement und inklusiven sowie responsiven Netzwerkpraktiken. Dies deckt sich mit den Empfehlungen an die öffentliche Hand (Kapitel 3) hinsichtlich ihrer Aufgaben bei der Steuerung pluralistischer Beratungsangebote in AKIS, wo (politikinduzierte) Innovationsnetzwerke und andere ländliche Multi-Akteurs-Netzwerke als erfolgreiches Beratungsformat und komplementär zu klassischen Beratungsangeboten (z.B. im Eins-zu-Eins-Ansatz) angesehen werden. Sie sind in der Lage, die Interaktionen innerhalb eines regionalen AKIS zu erhöhen, insbesondere in "schwachen" AKIS-Situationen mit geringen Interaktionsniveaus oder öffentlichen AKIS-Infrastrukturen. Öffentlich induzierte Multi-Akteurs-Innovationsnetzwerke im ländlichen Raum sollten jedoch offen für die Vielfalt der Wissensanbieter und Akteure in einer Region sein. Die Themen müssen sich aus den Problemen, Herausforderungen und Chancen ergeben, wie sie von den Landwirten wahrgenommen werden.

Hinsichtlich der bürokratischen Anforderungen zeigt die Studie zu Farm Management Systemen (FMS), dass es einen Bedarf an Unterstützung der Landwirte im Umgang mit den zunehmenden gesetzlichen und umwelt- bzw. marktbezogenen Anforderungen gibt. Darüber hinaus müssen FMS partizipativ entwickelt werden, um die Erwartungen der Landwirte zu integrieren. Die vorliegende Dissertation umfasst Forschungsarbeiten aus verschiedenen Projekten, die sich auf die Entwicklung des AKIS und des landwirtschaftlichen Beratungssystems in Brandenburg beziehen. Sie integriert auch - vor allem in der Diskussion - Erkenntnisse der Autorin, die sie durch die Beobachtung der Entwicklung des Beratungssystems (AAS) in Brandenburg über einen Zeitraum von 15 Jahren gewonnen hat. Technische Neuerungen werden voraussichtlich zu starken Veränderungen in landwirtschaftlichen Beratungssystemen führen. Beispiele sind Entscheidungsunterstützungssysteme in Form von Apps für Mobiltelefone, Video-Tutorials und oder die Verbreitung von Informationen über soziale Medien. Einige der in Kapitel 4 analysierten FMS sind nicht mehr im Einsatz und neue Technologien haben sie ersetzt oder werden dies in Zukunft tun. Die in dieser Arbeit verwendeten Methoden zur Bewertung der Eigenschaften von FMS sind jedoch auf andere Informationsmanagementsysteme übertragbar und die gewonnenen Erkenntnisse daher auch für die Zukunft wertvoll.

Table of Contents

List of Acronyms and Abbreviations

AAS	Agricultural Advisory System
AIS	Agricultural Innovation System
AKIS	Agricultural Knowledge and Information/Innovation System
CAP	Common Agricultural Policy
CC	Cross Compliance
EAFRD	European Agricultural Fund for Rural Development
EIP	European Innovation Partnership
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAS	Farm Advisory System
FMS	Farm Management System
GDR	German Democratic Republic
MLUL/ MLUK	Ministerium für Ländliche Entwicklung, Umwelt und Landwirtschaft (until November 2019)/ Ministerium für Landwirtschaft, Umwelt und Klimaschutz (since 2019) *[Ministry of Agriculture of Brandenburg, Germany]*
OECD	Organization for Economic Co-operation and Development
SCAR	EU's Standing Committee on Agricultural Research
SWG	Strategic Working Group
WBAE	Wissenschaftlicher Beirat für Agrarpolitk, Ernährung und gesundheitlichen Verbraucherschutz beim Bundesministerium für Ernährung und Landwirtschaft (BMEL) *[Scientific Advisory Council on Agricultural Policy, Nutrition and Consumer Health protection oft he Federal Ministry for Nutrition and Agriculture]*

List of Tables

List of Figures

Chapter 1

Introduction

1 Introduction

In the Common Agricultural Policy (CAP) for the period 2014-2020, the importance of innovation generation, knowledge dissemination and on-going learning in rural areas has been emphasized, and agricultural advisory services are mentioned as one important partner. New forms of cooperation and networking between different private, public and non-governmental actors such as the European Innovation Partnership (EIP) made the concept of Agricultural Knowledge and Innovations Systems (AKIS) more popular (COM 2021/2115).

Regarding the future CAP after 2020, agricultural advisory services are considered as an important political instrument. Recommendations on EU-level are provided by the Strategic Working Group (SWG) on AKIS of the Standing Committee on Agricultural Research (SWG SCAR-AKIS), which published - among others - a policy brief on future advisory services (SWG SCAR AKIS4 2018). However, Member States design and govern their own AKIS and including advisory systems. This needs a regional view, taking into account the specific agricultural structures as well as knowledge infrastructures. In Germany, recent policy recommendations to the government endorse advisory services, for example, to support the implementation of agri-environmental measures at farm-level (Feindt et al. 2018) and to promote risk management instruments to farmers (Grethe et al. 2018). However, these recommendations do not specify how advisory systems should be designed on the national or regional level to ensure that advisors are capable (financially and capacity-wise) to offer advice on agri-environmental measures and that all farmers have access to it. Particularly in the eastern federal states of Germany, agricultural advisory services are widely privatized and commercialized.

1.1 Problem statement

Privatization of agricultural advisory services in European Member States has been a process for decades. Public withdrawal from providing and/or funding agricultural advisory services was expected to support the emergence of efficient private advisory providers, to lead to more demand-driven advice and to improve the allocation of resources (Labarthe and Laurent 2013; Klerkx et al. 2006; Kidd et al. 2000). Additional reasons for public withdrawal can be found in budget restrictions and structural considerations. Labarthe and Laurent (2013) describe two trajectories of state disengagement in Europe. The first one is characterized by a progressive shift of public funding of extension services to the delivery of these services by private companies e.g. in France, Netherlands or Denmark. The second trajectory includes various forms of decentralization - particularly in Southern European countries like Spain, Italy or Greece – and resulted in the increasing commercialization of public extension services and individual billing of farmers. Garforth et al. (2003) highlight the advantages of diversity in provision of

advice and information to land managers, but also point out the challenge to ensure (potential) clients to find their way around the pluralistic array of private (and public) sector advice providers.

The privatization and commercialization process is characterized by dismantling of coordinating bodies and has several side effects. Several studies found that small-scale farms or resource poor farms faced difficulties in acquiring adequate knowledge as they became less visible or rather less profitable as target clients. Hence, they had less direct interaction with advisors, making it difficult to co-produce knowledge relevant to their needs (Rivera 1993; Kidd et al. 2000; Labarthe and Laurent 2013). Furthermore, several studies conclude that privatization has led to less cooperation and interaction between different private organisations and between public research and private advisory organisations of a growing pluralistic AKIS community (Rivera and Cary 1997; Klerkx and Proctor 2013; Prager et al. 2016). Finally, addressing public goods' provision, e.g., agri-environmental topics, is seldom a focus of private advisors and needs coordinating bodies to be addressed. Where there are no coordinating bodies for environmental information and advice, those topics are usually not addressed (Klerkx and Jansen 2010; Prager et al. 2016). If coordinating bodies exist, Klerkx and Jansen (2010) recommend a policy mix of awareness raising (pull measures) and capacity building among advisors (push measures). Both, within Europe and Germany, the German Federal State of Brandenburg has an Agricultural Advisory System (AAS) with a comparatively high level of privatization and commercialization (Prager et al. 2016). It was therefore selected as an excellent case to address the development and the impacts of this privatization, and to study whether the above-mentioned negative consequences of privatization are also prevailing in Brandenburg. Which consequences of privatization were to be observed here, especially with regard to target clients or 'public goods' issues? Given this high level of privatization, have coordinating activities of public authorities been sufficient to ensure well-working information flows and advice available to all farmers?

Besides the trend of privatization and commercialization or maybe because of its observed negative consequences worldwide as well as in Europe, the European regulation on Rural Development (EC 2003) brought agricultural advisory systems (AAS) back onto the political agenda. Along with the introduction of Cross Compliance (CC), the question of how to support farmers to comply with CC regulations was discussed. The concept of an obligatory 'Farm Advisory System' (FAS) for Member States became part of the European regulation and made the availability of advisory services – at least on CC standards - binding for all EU member states. From 2007 on, Member states were obliged to review their farm advisory system or to build up new infrastructure. For financing these systems, Member states were able to use funds provided by the CAP's second pillar. Questions arise like, how Brandenburg implemented this obligated "Farm Advisory system"? And did it sufficiently support farmers to comply with CC-standards?

1.2 The case Brandenburg – its advisory system and farm structure

Until the German reunification in 1990, the Federal State of Brandenburg belonged to the former German Democratic Republic (GDR). While in the western part of Germany, extension has historically been decentralized and rather diverse, the situation in the GDR was more uniform. Extension was part of an overall system promoting socialist agricultural development under the direction of party and state officials. It was provided by so-called Scientific-technical centres and free of charge. Within this framework, activities adapted to the individual needs of cooperatives and state farms were possible, including direct contacts between farms and universities, research contracting, and hiring of specialists. The quality of extension advice received until 1989 has been regarded as excellent by farmers long after the reunification (Nagel and Heiden 2004; Bokelmann et al. 1996; Ahrends et al. 1989).

Following the re-unification of Germany, the extension system of the GDR radically changed because of the new political and economic situation. In Brandenburg, this included a transformation from a public state-dominated system to at first high levels of privatization and later to full commercialization. Nagel and Heiden (2004:30) describe the development of the Brandenburg's AAS after 1990 as follows:

"[…] it was explicitly a bottom-up approach with decision-making resting with the farmer. From the very beginning, an organizational set-up was envisaged which would keep government service as small as possible. Major elements of the reform included: a) advisory service provision by private firms or persons, b) extension costs borne by farmers but partly subsidized by the state, c) full privatization within ten years and d) extension advice provision only to organized groups".

Full privatization was realized in 2002 despite resistance of farmers' organizations and advisory firms. While by the mid-nineties, farmers and advisors were still cautiously positive towards privatization (Bokelmann et al. 1996), later analyses revealed much disillusionment and scepticism with privatization. Many agricultural advisors stated that an agricultural advisory system with an active governing part of public authorities to ensure knowledge flows does not exist in Brandenburg (Nagel and Heiden 2004; Knuth 2008).

With respect to the agricultural enterprises, Brandenburg has a very heterogeneous farm structure with drastic differences. On the one hand, around 50% of the approximately 5500 farms are small part-time farms below 50 ha, and on the other hand, about 6% of all farms are large enterprises with a surface of 1000 ha and more. These latter farms cultivate almost 50% of the overall agricultural area in the state (Office for statistics Berlin-Brandenburg 2020). This structural diversity has many implications for the agricultural sector of the state and in particular leads to the questions of who are the farmers reached by private advisory services and who are not reached, which topics are in demand, and what contents are not requested.

1.3 Theories and concepts

Relevant conceptual frameworks for advisory services include the 'Agricultural knowledge System (AKS)' (Nagel 1979), the 'Agricultural knowledge and information system (AKIS)' (Röling and Engel 1990) and the 'Agricultural innovation system (AIS)' (Hall et al. 2006).

The AKS concept as the first known system approach to advisory services brings together the 'research subsystem', the 'user subsystem' and the 'dissemination subsystem' as core elements. Nagel (1979) relates the functioning of the AKS to the solution of six functional problems, which are need identification, generation of knowledge, operationalization, dissemination, utilization and evaluation of experiences. The research subsystem is understood as the generator of knowledge, the dissemination subsystem as its transmitter and the user subsystem as its integrator in the stock of agricultural practices. The three subsystems are represented by a number of organizations.

The AKIS concept emerges 10 years later with a rather similar understanding. Röling (1990:1) defined AKIS as a set of agricultural organization and/or persons, and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval and integration, diffusion and utilization of knowledge and information, with the purpose of working synergistically to support decision making, problem solving and innovation in a given country's agriculture or domain thereof. The 'Agricultural Innovation System' concept (AIS) is defined by Hall et al. (2006, p.vi-vii) as "a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance. The innovation systems concept embraces not only the science suppliers, but the totality and interaction of actors involved in innovation."

According to Klerkx et al. (2012) both, the AKIS and the AIS concept developed rather parallel than consecutive; AKIS evolved from the extension perspective, while AIS was developed from a research perspective. Labarthe et al. (2013) identify two views on the coexistence of the AKIS and the AIS concept: either as competing notions or as complementary notions built for different aims.

Birner et al. (2006; 2009) picked up the AKIS concept and developed the 'best fit framework' for analyzing and developing agricultural advisory systems, aiming to lead away from the idea of importing best practice approaches, e.g., the standardized model of train-and-visit approach. Instead, they recommend building capacity among policy-planners, managers, and researchers to identify modes of providing and financing advisory services that 'best fit' the specific conditions and development priorities of their country or region. The framework with its full name "From 'best practice' to 'best fit'" is a specific analytical concept for designing and analyzing 'pluralistic agricultural advisory services' as one important element of AIS, 'disentangling' systems of agricultural advisory services into i) governance structures, ii) capacities and management as well as iii) advisory techniques. This framework was recently adapted by OECD (2015) for evaluating 'green growth initiatives in agriculture'.

In the context of agricultural advisory services, the terms "system" and "services" are often used synonymously. However, systems are more complex than services (Knierim et al. 2017). While agricultural advisory services include actors as well as activities, agricultural advisory systems (AAS) also include the education, training and certification of advisors, as well as financing/public support.

Systems of agricultural advisory services (AAS) are embedded in a larger national or regional Agricultural Knowledge and Innovation System (AKIS) (figure 1).

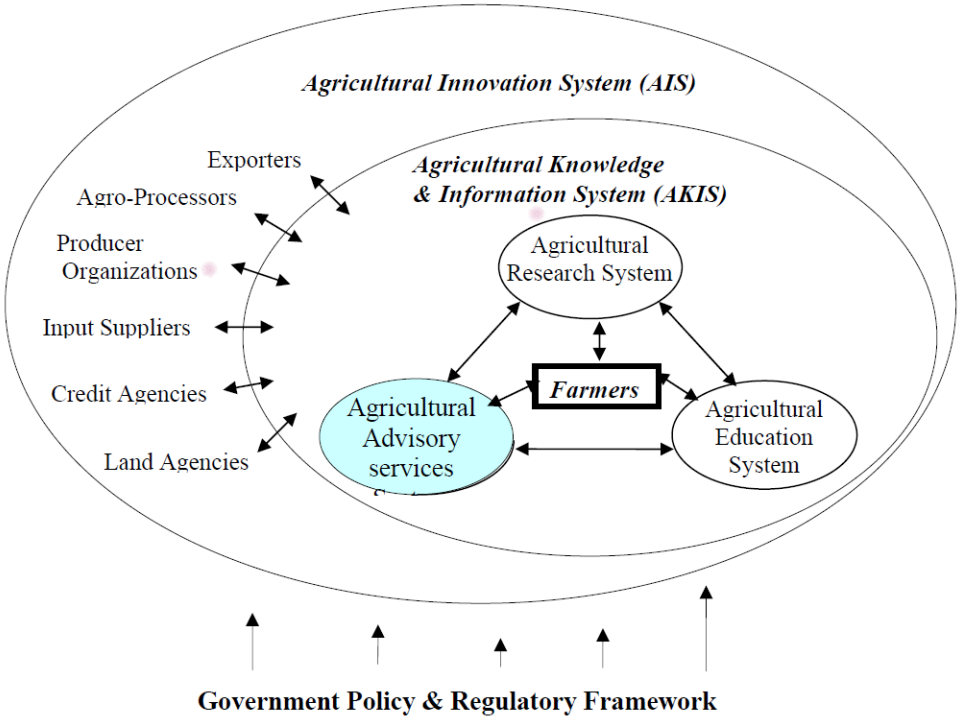

Figure 1: Agricultural Advisory Services as component of an Agricultural Knowledge and Information System (AKIS) (source: Birner et al. 2006)

Providers of advice differ from country to country, or region to region. They are public, private or farmer-based organizations, or often are a combination of all three. "Public extension services have been replaced by pluralistic advisory services. Behind this semantic change (from extension to advisory services, which can be found in many EU countries such as France, United Kingdom, the Netherlands, and Germany) stands the growing role of private actors" (Labarthe and Laurent 2013, p.240). At the time of writing, the most recent analyses of AKIS can be found in Knierim et al. (2015), where AKIS diagrams for 6 EU countries are presented from an infrastructural viewpoint. They also show shortcomings of the concept. The five categories of actors closely related to Birner et al. (2009): farmer-based organizations, non-governmental organizations, private, public as well as research & education, reveal severe limitations, as they are not exclusive. This hinders a comparative view, in particular quantitative analyses throughout Europe, which is considered necessary knowledge to discuss the potential of funding schemes delegating new organizations to these functions. Knierim et al. (2017) depict the pluralism of

agricultural advisory service providers in Europe and conclude that despite the diversity not all client groups are reached by providers.

The EU obligation to establish a Farm Advisory System (FAS) shall help beneficiaries to become more aware of the relationship between agricultural practices and management of farms on the one hand, and standards relating to the environment, climate change, good agricultural condition of land, food safety, public health, animal health, plant health and animal welfare on the other. The obligation to support farmers to fulfil Cross Compliance (CC) requirements, was first established with (EC) Regulation 1782/2003 and refined in (EC) Reg. 1306/2013. The implementation of FAS in EU member states was initiated by rural development authorities and took place within the existing institutional settings at national or regional level. Largely, it resulted in two distinct organizational forms: (i) in a number of states, the FAS were newly established in parallel to existing agricultural advisory systems (e.g. Bulgaria or Hungary) while (ii) in other countries existing agricultural advisory systems were updated and complemented with the 'FAS' component (e.g. Germany, Netherlands, Denmark).

1.4 Research purpose and objectives

The overarching question is in how far Brandenburg's Agricultural Advisory System (AAS) is capable to support farmers' ability to cope with the current economic, legal and environmental challenges ahead of them. Have all farmers a chance to receive the necessary information and support to comply with all EU regulations (e.g. Cross Compliance, greening etc.), are there sufficient possibilities for (all) farmers to co-produce new knowledge and practices in order to adapt to climate change challenges? If not, which changes are necessary to reach a well-working AAS. What are responsibilities of public authorities to steer AAS?

The goal of this cumulative dissertation is on the one hand to investigate the consequences of privatization in advisory systems and on the other hand to examine more closely specific aspects with the purpose to improve the AAS in Brandenburg. Special attention is given to the advisors' situation, Cross compliance advice and innovation networks. Leading research questions were:

i) What were the consequences of privatization specifically for the situation of advisors, their capacities and competences? (RQ1)

ii) What are the responsibilities of public authorities to steer a (privatized) advisory system and innovation networks within pluralistic AKIS? (RQ2)

iii) How was the EU's FAS obligation implemented and thus, how is advice on Cross Compliance with FMS as a policy-induced innovation implemented and adopted in Brandenburg and Germany? (RQ3)

iv) How successful are innovation networks as an instrument to fill the interaction gap of the AAS in Brandenburg? (RQ 4)

Thus, the following chapters deliver important insight in the ongoing development of an AKIS and including advisory services on Member state-level. In Germany, it is necessary to look at the "Bundesland" (federal state)-level, as public responsibility for steering AKIS and farm advice lies here. This dissertation contributes to the empirical evidence on the functioning of AKIS and AAS in general and additionally, provides public authorities in Brandenburg with longitudinal information to be used for future farm advice- and innovation-related policies.

1.5 Outline of thesis and contribution of papers

Chapter 2 describes the development of the situation of private farm advisors in Brandenburg over a longer period of more than 15 years (before and after complete commercialization in 2000. It shows which topics advisors (can) address and which they cannot, which clients they work with and which they do not, and it provides data on their basic work situation. It also gives insights on their networking activities. The following chapter 3 provides recommendations for public authorities regarding their responsibilities in pluralistic AKIS in Europe, which can also be applied to Brandenburg. Chapter 4 provides an analysis of Cross Compliance advice to farmers with Farm Management Systems (FMS) as one public responsibility in AKIS related to the EU FAS regulation. A special focus is pointed to farmers' usage of FMS in Brandenburg and qualitative comparison of FMS in Germany. In chapter 5 the cooperation of various actors from science and practice in Brandenburg is examined using the example of the innovation network for climate change adaptation. Innovation networks can be considered as one important instrument to cope with the challenges of AKIS privatization in Brandenburg by filling the interaction gap. This chapter presents an analysis of collaboration success factors and shows how crucial repeated participation, appropriate information management, and inclusive as well as responsive network practices are. Chapter 6 discusses the results regarding the development of Brandenburg's AKIS and its Agricultural Advisory System (AAS) during the period of complete privatization (2002 until 2017), in which the research of chapter 2 thru 5 was conducted. Chapter 7 gives an update of Brandenburg's AKIS and advisory system development from 2017 on, when AKIS and advisory services returned on the political agenda, and new policies emerged, which support innovation networks and advisory services. Chapter 8 concludes policy and research recommendations. The following figure 2 gives an overview of the thesis' structure.

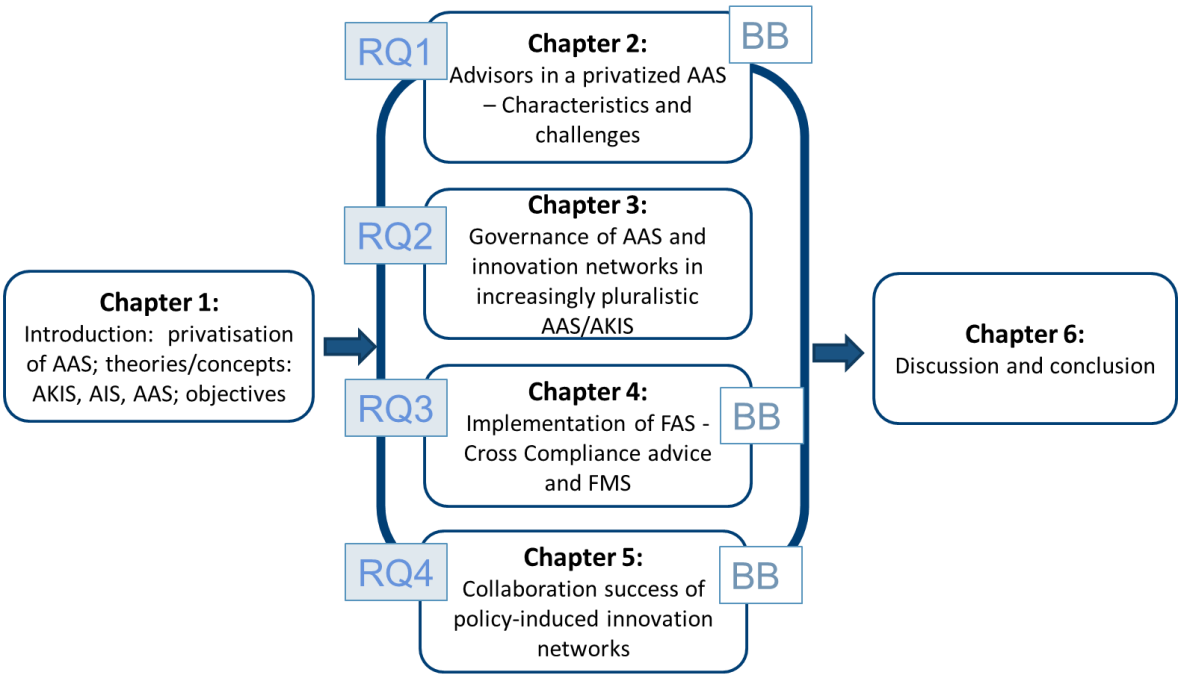

Figure 2: thesis outline

REFERENCES

Ahrends, Klaus; Goldhahn, Renate; Groschoff, Kurt; Heinrich, Richard; Müller, Wolfgang; Thiede, Ulrich; Wirsig, Hermann (1989): Landwirtschaft der DDR - Theorie und Praxis. Berlin: Dietz Verlag.

Birner, Regina; Davis, Kristin; Pender, John; Nkonya, Ephraim; Anandajayasekeram, Ponniah; Ekboir, Javier et al. (2009): From Best Practice to Best Fit. A Framework for Designing and Analyzing Pluralistic Agricultural Advisory Services Worldwide. In: *The Journal of Agricultural Education and Extension* 15 (4), pp. 341–355. DOI: 10.1080/13892240903309595.

Birner, Regina; Davis, Kristin; Pender, John; Nkonya, Ephraim; Anandajayasekeram, Ponniah; Ekboir, Javier et al. (2006): From "best practice" to "best fit" - a framework for analyzing pluralistic agricultural advisory services worldwide. Washington, D.C. (DSGD Discussion Paper No.37).

Bokelmann, Wolfgang.; Hirschauer, Norbert; Nagel, Uwe Jens; Odening, Martin (1996): Landwirtschaftliche Beratung im Land Brandenburg. Eine Evaluierung erster Erfahrungen. Weikersheim: Margraf Verlag (Kommunikation und Beratung, Sozialwissenschaftliche Schriften zur Landnutzung und ländlichen Entwicklung, Band 9).

European Union (EU) (2003): COUNCIL REGULATION (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001: Official Journal of the European Union (L270), p. 151.

COM 2021/2115: REGULATION (EU) 2021/2115 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 2 December 2021 establishing rules on support for strategic plans to be drawn up

by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) No 1307/2013 Official Journal of the European Union L435/1

Feindt, Peter H.; Bahrs, Enno; Engels, Eve-Marie; Hamm, Ulrich; Herdegen, Matthias; Isselstein, Johannes; Schröder, Stefan; Wätzold, Frank; Wolters, Volkmar; Backes, Gunter; Brandt, Horst; Engels, Johannes; Graner, Andreas; Tholen, Ernst; Wagner, Sven; Wedekind, Helmut; Wolf, Heino (2018): Für eine Gemeinsame Agrarpolitik, die konsequent zum Erhalt der biologischen Vielfalt beiträgt. Stellungnahme des Wissenschaftlichen Beirats für Biodiversität und Genetische Ressourcen beim Bundesministerium für Ernährung und Landwirtschaft. Berlin.

Garforth, Chris; Angell, Brian; Archer, John; Green, Kate (2003): Fragmentation or creative diversity? Options in the provision of land management advisory services. In: *Land Use Policy* 20 (4), pp. 323–333. DOI: 10.1016/S0264-8377(03)00035-8.

Grethe, Harald; Arens-Azevedo, Ulrike; Balmann, Alfons; Biesalski, Hans Konrad; Birner, Regina; Christen, Olaf; Gauly, Matthias; Knierim, Ute; Latacz-Lohmann, Uwe; Martinez, José; Nieberg, Hiltrud; Offermann, Frank; Pischetsrieder, Monika; Qaim, Matin; Renner, B.; Schmid, Julia C.; Spiller, Achim; Taube, Friedhelm; Voget-Kleschin, Lieske; Weingarten, Peter (2018): Für eine gemeinwohlorientierte Gemeinsame Agrarpolitik der EU nach 2020: Grundsatzfragen und Empfehlungen. Stellungnahme des Wissenschaftlichen Beirats für Agrarpolitik, Ernährung und gesundheitlichen Verbraucherschutz beim Bundesministerium für Ernährung und Landwirtschaft (WBAE). In: Berichte über Landwirtschaft Juni 2018 (Sonderheft 225). DOI: 10.12767/buel.v0i225

Hall, Andy; Janssen, Willem; Pehu, Eija; Rajalahti, Riikka (2006): Enhancing Agricultural Innovation. How to Go Beyond the Strengthening of Research Systems. Washington, D.C.

Kidd, A. D.; Lamers, J. P. A.; Ficarelli, P. P.; Hoffmann, Volker (2000): Privatising agricultural extension. caveat emptor. In: *Journal of Rural Studies* 16 (1), pp. 95–102. DOI: 10.1016/S0743-0167(99)00040-6.

Klerkx, Laurens; Grip, Karin de; Leeuwis, Cees (2006): Hands off but Strings Attached. The Contradictions of Policy-induced Demand-driven Agricultural Extension. In: *Agriculture and Human Values* 23 (2), pp. 189–204.

Klerkx, Laurens; Jansen, Jolanda (2010): Building knowledge systems for sustainable agriculture. supporting private advisors to adequately address sustainable farm management in regular service contacts. In: *International Journal of Agricultural Sustainability* 8 (3), pp. 148–163. DOI: 10.3763/ijas.2009.0457.

Klerkx, Laurens; Proctor, Amy (2013): Beyond fragmentation and disconnect. Networks for knowledge exchange in the English land management advisory system. In: *Land Use Policy* 30 (1), pp. 13–24. DOI: 10.1016/j.landusepol.2012.02.003.

Klerkx, Laurens; van Mierlo, Barbara; Leeuwis, Cees (2012): Evolution of systems approaches to agricultural innovation. concepts, analysis and interventions. In: I. Darnhofer, D. Gibbon und B. Dedieu (Ed.): Farming Systems Research into the 21st Century: The New Dynamic, pp. 457–483.

Knierim, Andrea; Boenning, Kinga; Caggiano, Monica; Cristóvão, Artur; Dirimanova, Violeta; Koehnen, Timothy; Labarthe, Pierre; Prager, Katrin (2015): The AKIS concept and its relevance in selected EU member states. In: *Outlook on Agriculture* 44 (1), pp. 29–36. DOI: 10.5367/oa.2015.0194.

Knierim, Andrea; Labarthe, Pierre; Laurent, Catherine; Prager, Katrin; Kania, Jozef; Madureira, Livia; Ndah, Tim Hycenth (2017): Pluralism of agricultural advisory service providers – Facts and insights from Europe. In: *Journal of Rural Studies 55*, pp. 45–58. DOI: 10.1016/j.jrurstud.2017.07.018.

Knuth, Ulrike (2008): Landwirtschaftliche Beratung in Brandenburg aus der Sicht der Berater. Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät, Berlin.

Labarthe, P.; Laurent, C. (2013): Privatization of agricultural extension services in the EU. Towards a lack of adequate knowledge for small-scale farms? In: *Food Policy* 38, pp. 240–252. DOI: 10.1016/j.foodpol.2012.10.005.

Labarthe, Pierre; Caggiano, Monica; Laurent, Catherine; Faure, Guy; Cerf, Marianne (2013): Deliverable WP.2-1. Deliverable of Workpackage 2 within the EU 7th Framework Programme project PRO AKIS - Prospects of Farmers' Support: Advisory Services in European AKIS: Advisory Services within AKIS: International debates.

Nagel, Uwe Jens (1979): Knowledge Flows in Agriculture. Linking Research, Extension and the Farmer. In: *Zeitschrift für Ausländische Landwirtschaft* 18 (2), pp. 135–150.

Nagel, Uwe Jens; Heiden, Kirsten von der (2004): Germany. Privatising Extension in Post-Socialist Agriculture - The Case of Brandenburg. In: William Rivera und Gary Alex (Hg.): Volume 2. Privatisation of Extension Systems. Washington, D.C.: The World Bank, pp. 30–34.

Office for statistics Berlin-Brandenburg (2020): Agrarbericht Brandenburg. Online available at: https://agrarbericht.brandenburg.de/abo/de/start/agrarstruktur/unternehmen-flaechenausstattung/ checked 23.04.2022.

Organisation for Economic Co-operation and Development (OECD) (2015): Fostering Green Growth in Agriculture. Paris: OECD Publishing (OECD Green Growth Studies).

Prager, Katrin; Labarthe, Pierre; Caggiano, Monica; Lorenzo-Arribas, Altea (2016): How does commercialisation impact on the provision of farm advisory services? Evidence from Belgium, Italy, Ireland and the UK. In: *Land Use Policy* 52, pp. 329–344. DOI: 10.1016/j.landusepol.2015.12.024.

Rivera, William (1993): Impacts of Extension Privatisation. In: *Journal of Extension* 31 (3). pp.28-29

Rivera, William; Cary, John (1997): Chapter 22. Privatizing Agricultural Extension. In: Burton E. Swanson, Robert P. Bentz und Andrew J. Sofrankko (Ed.): Improving Agricultural Extension - A reference manual. Rome: Food and Agriculture Organization of the United Nations (FAO).

Röling, Niels G.; Engel, Paul G. H. (1990): Information technology from a knowledge system perspective - Concepts and issues. In: *Knowledge, Technology & Policy* 3 (3), pp. 6–18.

Röling, Niels G. (1990). The agricultural research-technology transfer interface: a knowledge systems perspective. In: David Kaimowitz (Ed.): Making the link - Agricultural research and technology transfer in developing countries, pp. 1-42.

Strategic Working Group (SWG) of the Standing Committee of Agricultural Research (SCAR) on Agricultural Knowledge and Innovation Systems (SWG SCAR AKIS4) (2018): SWG SCAR-AKIS Policy Brief on the Future of Advisory Services. Online available at: https://ec.europa.eu/eip/agriculture/sites/default/files/policy_brief_on_the_future_of_advisory_services_scar_akis_06102017.pdf checked on 16.03.2021.

Chapter 2

Characteristics of and challenges for advisors within a privatized extension system

This chapter is based on the publication:

Knuth, Ulrike; Knierim, Andrea (2013): Characteristics of and Challenges for Advisors within a Privatized Extension System. In: *The Journal of Agricultural Education and Extension* 19 (3), pp. 223–236. DOI: 10.1080/1389224X.2013.782166.

Available online at: https://www.tandfonline.com/doi/abs/10.1080/1389224X.2013.782166

Journal of Agricultural Education and Extension
Vol. 19, No. 3, 223–236, June 2013

Characteristics of and Challenges for Advisors within a Privatized Extension System

ULRIKE KNUTH and ANDREA KNIERIM
Leibniz-Centre for Agricultural Landscape Research, Müncheberg, Germany

Abstract Purpose: *The aim of this article is to provide evidence on the consequences of the privatization process in Brandenburg with a focus on the agricultural advisors' situation. Before the background of future European Union (EU) expectations on Farm Advisory Systems (FAS), their capacities and competences to respond to such challenges are discussed.*
Design/methodology/approach: *Data from three empirical studies, conducted over a time span of 15 years, and with partially similar research questions, are analysed comparatively. All studies used a mixed qualitative and quantitative research design relying on structured, face-to-face interviews and an online survey, respectively, among advisors and others.*
Findings: *Face-to-face communication remains predominant in the advisor–client relationship. The intensity of advisory services to the single farmer in terms of farm visits was reduced. Linkages of the advisors within the overall knowledge system became fragmented and partially one-sided. Nevertheless, most advisors appreciate the demand-driven relationship they have with their clients. In contrast, the information flow from public authorities is viewed more critically.*
Practical implications: *If Brandenburg's advisors want to profit from the up-coming EU policy instruments for the enhancement of knowledge transfer and innovation generation in rural areas, more pro-active engagement for networking and cooperation will be necessary. Awareness creation and incentives from the federal state of Brandenburg would be useful measures.*
Originality/value: *The article combines results from three empirical studies which are so far only published in German and this allows for a longitudinal appraisal and comparative view.*

Key Words: Agricultural advisory service, Privatization, Farm management system, Germany, Agricultural knowledge system

Correspondence address: Ulrike Knuth, Leibniz-Centre for Agricultural Landscape Research, Müncheberg, Germany. Email: ulrike.knuth@zalf.de; Andrea.Knierim@zalf.de

1389-224X Print/1750-8622 Online/13/030223-14
http://dx.doi.org/10.1080/1389224X.2013.782166

Introduction

Privatization and AKIS

Brandenburg is one of the East German federal states. It introduced a privatized agricultural extension system in 1992, two years after Germany's reunification. From the mid 1990s on, public subsidies were continuously reduced until 2002, when full privatization was reached. Since then, advisors offer services to those farmers who are willing to pay for them in full, that is, without any state support such as contracting-out or vouchers. Also, since 2007 no attempt has been made in Brandenburg to use national regulation for the support of advisory services.

An overview of the international literature indicates that the process of privatization results, in general, in more pluralistic advisory systems (Rivera and Alex 2004). Agricultural advisors in private consulting companies and public institutions are no longer the only providers of knowledge and information to farmers. The original triangle of agricultural knowledge and information systems (AKIS) composed of 'research', 'extension' and 'farmers' (Nagel 1979; Röling 1988) has been enlarged to create complex systems with a broad variety of actors. New players come from the private sector (industry, vocational education and training) as well as from the public sector (research institutions, secondary education) and the emerging third sector that includes non-governmental organizations (NGOs) and farmer's unions. In parallel, more attention is paid to the diversity of functions provided within such a system; and, among them, the generation and implementation of innovations has gained a core importance (World Bank 2006). And more recently it was also stressed among European decision-makers that 'it is important to realise that there are many more actors in the food chain, that directly influence the decision making of farmers and their innovations' (EU SCAR 2012, 8). This diversity of organizations requires a greater effort in coordination and networking, because 'a system can only be effective, if the subsystems are well-connected and cooperate productively' (Hoffmann 2010, 10). Within such pluralistic systems, state intervention usually aims at promoting the public interest and assuring social welfare by ensuring the delivery of specific services to specific audiences (for example, socio-economic advice for poorer farmers delivered by public authorities). Besides coordination and interest representation, a third form of state intervention is the exercise of control by putting in place 'safeguarding instruments' to ensure the nature and quality of private extension (Alexopoulos, Koutsouris and Tzouramani 2009).

In theory, the expected benefits of privatization are the greater efficiency of service provision in terms of costs and resource allocation, increased provider accountability, a demand-driven elaboration of contents, and an emphasis on benefits and results. Furthermore, competition is assumed to ensure constant improvement in the quality and diversification of goods (Klerkx, de Grip and Leeuwis 2006; Kuhry et al. 2002). On the other hand, disadvantages and risks of privatization of advisory services include: (i) cooperation within an agricultural advisory system is considerably reduced; (ii) increased competition may result in the withholding of knowledge generated and exchanged in agricultural knowledge systems; (iii) privatized systems tend to have a bias towards larger, wealthier farms when 'small scale farmers have little access to what once was considered a public good—agricultural information and its transfer' (Rivera 1993, 1); and (iv) topics of public interest such as environmental

problems or the sustainable development of agriculture are addressed less often, and if dealt with it is with a rather short-term perspective by contracting out short-term projects (Leeuwis 2000; Labarthe 2009; Rivera 1993; Klerkx, de Grip and Leeuwis 2006).

In many member states of the EU, diversification and privatization of agricultural extension systems has been—in one way or another—an observable trend in the last two decades (Rivera and Alex 2004; Klerkx, de Grip and Leeuwis 2006; Alexopoulos, Koutsouris and Tzouramani 2009). Politically, this time span was also characterized by a slow but continuous shift towards the integration of sustainability issues in the European Common Agricultural Policy (CAP) (Labarthe 2009; Ingram 2008). And, it was in this realm that all the EU member states were obliged since 2007 to establish a Farm Advisory System (FAS), which shall support farmers to at least fulfil the Cross Compliance (CC) requirements resulting from European Council (EC) Regulation 1782/2003. A mid-term EU-wide evaluation of the implementation of FAS in the member states (European Commission 2010) compared their features with regard to effectiveness, efficiency and relevance. It recommended that advisors should extend their topics and also transmit knowledge on environmental aspects of farming, for example, related to water protection and/or climate change. With the recent proposal on the CAP 2014–2020, the importance of innovation generation, knowledge dissemination and on-going learning in rural areas has been emphasized (COM 2011) and agricultural extension systems are mentioned as one important partner in this context.

The concept of AKIS is used to describe and analyse complex communication and interaction processes among manifold different actors in rural areas that support innovation generation and developments towards increased sustainability (EU SCAR 2012). Innovation generation requires advisors to adopt new roles named as follows, for example, intermediaries, (knowledge) brokers, (process) facilitators or change agents. Cristóvão, Koutsouris and Kugler (2012) give an overview of the current scientific discussion about such new roles in agricultural extension systems. They argue, that 'extension might well benefit from seeing itself more as a facilitator of change, empowering farmers to experiment, contributing to building networks and exchange their knowledge and observations. The group of farmers then enter a social learning process facilitated by the extensionist' (Cristóvão, Koutsouris and Kugler 2012, 216). Koutsouris (2012) points out that intermediation (facilitation and brokerage) has yet to be thoroughly described and operationally defined, and underlines that changes, especially in (higher) education institutions, are necessary to train advisors for fulfilling this new role of an intermediary.

Current Tendencies in the German Agricultural Advisory Services

Germany comprises 16 federal states (*Bundesländer*), which are each responsible for the organization and financing of agricultural advisory systems. Beside a Working Group, where federal states' desk officers for advisory services exchange their views and experiences, there is no national coordination. Hence, there are 16 different forms of providing agricultural extension in Germany, and—due to a general shortage of public funding—all of them are in the process of becoming more or, ultimately, fully privatized. Behind these increasingly complex systems three main

types of agricultural extension providers are historically predominant: (i) the state agricultural office (public extension providers closely related to the state ministry of Agriculture and its subordinated authorities on the regional level), (ii) the chambers of agriculture (semi-public institution financed mainly by state support and farmers' obligatory membership fees, offer advice both by charging the end user and free of charge depending on the subject) and (iii) private consulting and advisory companies. Additionally, advice circles exist in some states, originally especially in the north of Germany (Hoffmann, Lamers and Kidd 2000; for the most recent (at the time of writing) overview on the various systems in all the German federal states see Thomas 2007).

European Council (EC) Regulation 1782/2003 led to some coordinating activities on the national level in Germany; especially, the option of financial support for the implementation of Farm Management Systems (FMS) through a national regulation (GAK) was introduced. Still, it remained the choice of individual federal states to make use of this option and implement programmes through the establishment of appropriate advisory services. Similarly, secondary education and, to some extent, research fall under the mandate of the federal state ministries. Thus the AKIS in Germany appears poorly coordinated and decreasingly transparent and controllable because of its pluralism and strong trend towards privatization. Diminishing budgets and competition between knowledge providers hinder necessary cooperation and coordination (Hoffmann 2010).

A German instrumental particularity for the support of farmers' compliance to EU regulations is the application of FMS. The Federal Ministry for Agriculture (BMELV) recommended the implementation of FMS within the framework of FAS to the federal states, defining it as an instrument for the systematic documentation and analysis of production processes and thus a basis for continuously improving overall farm performance (BMELV 2006). Depending on the advisory system's organization (private, public, semi-private) FMSs were developed in each federal state by either public institutions (such as the state offices in Bavaria, Saxonia or Baden-Württemberg), chambers of agriculture (Lower Saxony, Schleswig-Holstein) or private consulting companies (Thuringia, Mecklenburg-West-Pomerania, Brandenburg, Saxonia-Anhalt).

An FMS consists of (i) a checklist for self-assessment (which can be individualized for each farm—if available in an electronic version), (ii) a data entering system for documentation and (iii) a set of additional information material on the background of requirements. Some FMSs only refer to the CC requirements while others include the requirements of additional quality management or certification systems such as organic farming. FMSs are available on paper and/or as a CD or as electronic versions. Most German FMSs can be bought along with or without advisory services that support the system's implementation on the farm. In four federal states subsidies are offered to implement FMS in combination with advisory services. The aim of this advisory service is the critical/neutral view on the farm location and its production processes, which the farmer does not necessarily have (Knierim et al. 2011).

The aim of this article is to shed light on the consequences of the privatization process in Brandenburg and to provide detailed insights especially on the advisors' situation. Data from three consecutive studies are combined to illustrate the characteristics, tasks and roles of this actor group as part of the AKIS during a

time span of 15 years. The overarching question in this article is whether and how, with what indicators this privatization process can be captured and meaningfully illustrated. Specific attention will be given to changes concerning: (a) quantifiable characteristics of the advisor–client relationship, (b) extension issues and topics, (c) the methods and instruments and (d) the interactions of advisors within the agricultural knowledge system. Such changes will be assessed in terms of both observable and measurable characteristics as well as subjective perspectives on the basis of selected data.

We consider Brandenburg's agricultural extension system as one typical example of a privatized system in Europe. With regard to the changing political frame conditions, and particularly the increasing attention given to advisory systems in recent political documents, a second objective of this article is therefore to discuss the capacities and competences of the agricultural advisors in Brandenburg to respond to such possible future options and requirements.

A brief description of the sources utilized in this article (and their methodology) is presented. Next, the results section is differentiated to deal with the characterization of advisors, the topics they are mostly dealing with, the methods and instruments they apply and their positions and linkages within the agricultural knowledge system of Brandenburg. Finally, the discussion deals with advisors' options and restrictions and conclusions are drawn with regard to future challenges that are induced by the EU CAP.

Sources and Methods

Four empirical studies (Bokelmann et al. 1996; Dimter, Knierim and Nagel 2008; Knierim et al. 2011; Knuth 2008) have been undertaken in Brandenburg within the last 20 years to appraise and evaluate certain aspects of its advisory system:

- Bokelmann et al. (1996) investigated the status quo of the advisory system, which was established after Germany's reunification in the early 1990s.
- In 2006 two empirical studies were conducted in parallel, which evaluated the advisory system ten years after the study of Bokelmann et al. ('Brandeburg's advisory system revisited'). While the main questions of the 1996 study were repeated, in order to allow for comparisons, a focus was placed on the consequences of the privatization process for both the advisory firms and the farmers. The farmers' perspective was published in Dimter, Knierim and Nagel (2008) and the advisors' perspective has been documented in an MSc thesis by Knuth (2008). Essential results of the latter are included in this article.
- Knierim et al. (2011) investigated the implementation of the FAS 2003 in Brandenburg and evaluated it with regard to the requirements stemming from EU Regulation 1782/2003, especially with regard to CC.

Thus, this article combines results from three empirical studies which so far are only published in German, either as books (Bokelmann et al. 1996; Knierim et al. 2011) or electronically (Knuth 2008). As the research designs were (almost) totally (Knuth 2008) or partially (Knierim et al. 2011) based on the Bokelmann et al.'s (1996) study,

it is now possible to analyse selected data sets from these three studies to allow for a longitudinal appraisal and comparative view.

The first two studies (Bokelmann et al. 1996; Knuth 2008) took a mixed qualitative and quantitative approach and relied on a questionnaire design and on face-to-face interviews. Open questions were used to investigate the advisors' personal experiences with the privatization process. In the first study, the sample consisted of 35 advisors, which represented approximately 30% of all advisors at that time (Bokelmann et al. 1996,14). In the second study, 23 advisors out of 20 advisory firms were reached on the basis of the latest available list (personal communication from the ministry 2003). The 32 firms mentioned here had all been contacted, however only 15 replied. Additionally, another eight advisors were identified through the internet. In both studies the gender of the advisors was not noted.

The third study (Knierim et al. 2011) relied on (i) expert interviews in several EU countries and German federal states and a broader empirical study in Brandenburg. For the latter, expert interviews, a representative telephone survey among farmers and an online survey with private advisors were conducted. Roughly 130 advisors were contacted by email on the basis of an unpublished list provided by the Brandenburg Ministry of Agriculture (MIL). Out of the total number of advisors, there is a public list of 51 advisors who are certified as 'Cross Compliance advisors' by the MIL. The response rate to the online survey of 41% of the contacted advisors (53 out 130) was satisfactory. However, a high percentage of the respondents did not complete the full questionnaire, so that for several results only a reduced sample of answers is available. Although an attempt was made to survey the gender not all advisors answered this question, so no reliable statements with regard to this point can be made in this article.

Results

Agricultural Advisors and Their Clients

Knuth (2008) revealed that approximately 130 advisors in 50 consulting firms offer advisory services to farmers in Brandenburg. The largest firm employs about 30 advisors and has roughly 1000 clients. The main partner of this company is the Farmers' Association of Brandenburg (*Landesbauernverband*, LBV) and other agriculture related associations. The remaining consulting companies are mostly smaller, with the number of employees ranging from 1–12 people. According to the interviewees, a decline in the number of employees has been observed since full privatization in 2001.

The main expertise of the advisors is economics; in 2011, 28 out of 39 advisors who answered this question had a specialization in enterprise management or farm economics, frequently in combination with a production topic like dairy or plant production (Knierim et al. 2011). Also Knuth (2008) confirms that the main specialization of almost 75% of the advisors is related to economic aspects or business consultancy, dealing with investment planning combined with the question of the kinds of subsidies available. These figures highlight a certain shift towards economics, as in 1996 only 21 out of 35 advisors indicated a particular farm economics orientation (Bokelmann et al. 1996). It should also be noted that currently

the profession seems not to be very attractive for young professionals as only two people out of 39 advisors are younger than 40 years old (Knierim et al. 2011).

Clients of advisors in Brandenburg are rather larger farms (with six or more employees) as well as other agriculture related groups, for example, state and rural district authorities and associations involved in rural development planning, agricultural contractors, and, recently, new actors related to renewable energies (especially biogas) (Knuth 2008). This finding can be specified with regard to the farm size: Knierim et al. (2011) state that while on average two-fifths of all farmers in Brandenburg have a contract with an agricultural advisor, this is highest in the group of farms with 500–1000 ha (7 out of 9) and lowest in the group of famers below 50 ha (1 out of 11).

A comparison between the three studies (1996, 2008 and 2011) concerning the nature of the relationship between advisors and farmers shows a clear reduction in the intensity of the advisor–farmer relationship (Table 1). This is reflected in the increase of the number of farms per advisor and advisory firm, as well as in the increase of the distance travelled by advisors per year while on farm visits. Another indicator of this change is the decrease in the average number of client visits per year from 12 down to 6 per year between 1996 and 2008.

Advisory Topics

According to Knuth (2008), in general, topics of high importance in advisors' activities have been related to farm economics, as Figure 1 shows. The top topics have been investment planning often combined with matters of financing, business planning and farm development issues. Many advisors did not differentiate between those topics. Another important topic in this context was the acquisition of subsidies, not only the yearly application but also acquisition of public financial support for farm-related investments. The advisors described their job as 'searching in the jungle of public funding for individual farm financing solutions'. A further aspect of farm financing was the preparation of negotiations with a bank (Knuth 2008).

The comparison with the study results of Bokelmann et al. 1996 (Figure 1) reveals that the topics of high importance have not changed a lot over the years. Economy-related topics as mentioned above are still the most important compared to production-related topics. Cross compliance, as a new topic, gained a certain relevance for the advisors' work. Additionally, new topics mentioned by the advisors were direct marketing and renewable energy.

Table 1. Overview of the intensity density of advisor–farmer relationships 2011–2008–1996.

Indicator	2011 (N = 25*)	2008 (N = 23)	1996 (N = 35)
Number of farms per advisor	32	27	24
Number of farms per advisory firm	125	87	48,5
Distance to the client in km	–	100	82
Distance in km/year driven by the advisor	–	38,000	26,000
Client visits/year	–	6	12

Notes: *Not all advisors who responded answered this question.
Sources: Bokelmann et al.(1996), Knuth (2008) and Knierim et al. (2011).

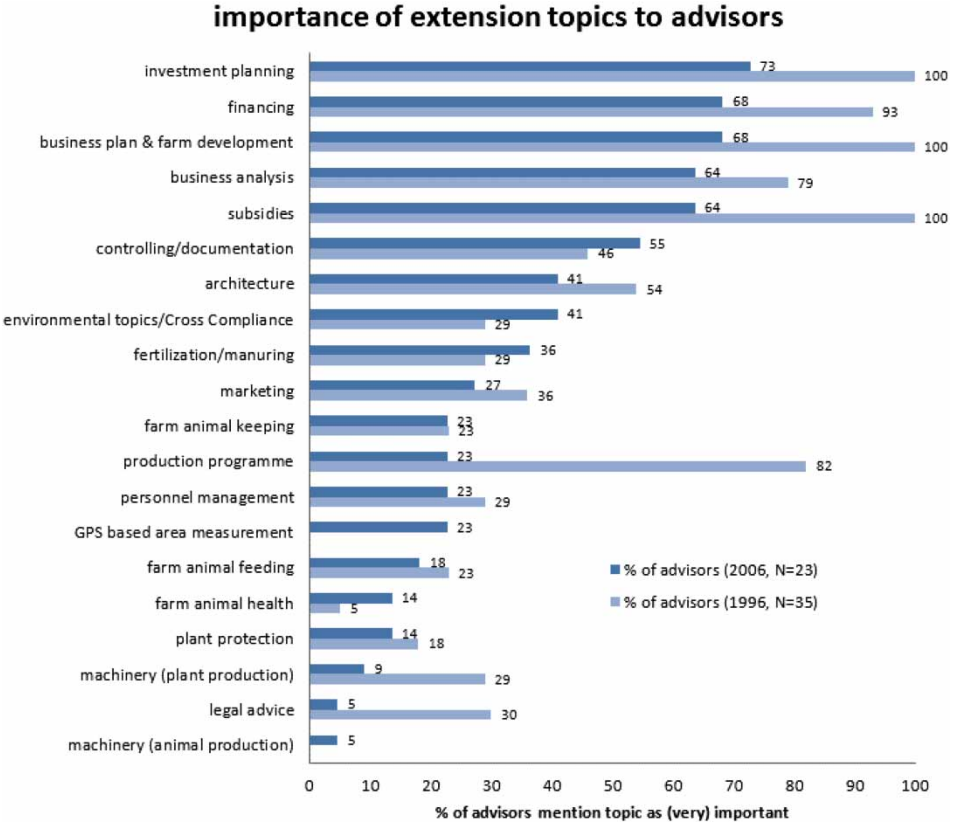

Figure 1. The importance of agricultural extension topics to advisors.
Source: Author's own figure based on data from Knuth 2008 and Bokelmann et al. 1996.

Knierim et al. (2011) showed that, in advisory practice, CC is rarely claimed by farmers as an agricultural extension issue and that advisors do not easily distinguish CC from other farm-related topics. Topics, which are tackled very often and related to CC are fertilization and plant protection. In the context of the 'health check' of the CAP, new challenges for the agricultural sector emerged, which included energy efficiency, renewable energy, nature conservation and biodiversity, water management and protection as well as climate change and adaptation. As those topics were expected to become relevant for advisory services in the future, Knierim et al. (2011) investigated Brandenburg's advisors' attitudes towards and current involvement with them. The results showed that more than two-thirds of the surveyed advisors already gave advice on subjects related to renewable energy (for example, biogas) and resource efficiency, half of them on nature conservation and a few were dealing with water efficiency and climate change thus far. Most advisors who are not yet active with providing advisory services related to the new challenges are interested in doing so in the future. More than half of all interviewed farmers ($n = 71$) stated an interest in information and advisory services related to all the topics pertaining to the new challenges; most frequently they mentioned improvements in energy efficiency and water efficiency.

Advisory Methods and Instruments

All the three studies indicate that the dominant advisory method used by Brandenburg's advisors is one-on-one advice. Knuth (2008) showed that even though farm visits per year decreased (as shown above), the increased use of new communication technologies like mobile phones and email seemed to compensate for this decrease in face-to-face (on farm) contact. This finding was confirmed for CC-related advice in 2011.

In Knuth (2008) group consulting and seminars were rated as clearly less relevant compared to bilateral communication. The reasons given were closely related to the privatization process, referring to the lack of public financial support for such events organized by private advisory firms. The interviewees also stated the growing importance of advisory services in terms of preparing and monitoring projects in a face-to-face farm advice scenario: 'I advise a client over the period of many years, but do not visit his farm every quarter of the year. Instead I rather develop and supervise projects like the construction of a stable or a green house.' Already, Bokelmann et al., in 1996, noted that group consulting methods were seldom used.

It should also be noted that in 2005 the interest of Brandenburg's private advisors in developing an FMS and the hope for being part of the new agricultural extension market field of CC was fairly high. Despite the fact that the state authorities of Brandenburg did not offer any financial support for FMS and therefore the need for the certification of an FMS did not exist, there had been the request by one advisory firm to have its FMS certified by the MIL. However, as noted in 2010, the majority of the interviewed farmers did not request CC-related advisory services from private advisory firms. If farmers needed CC-related information they frequently used other sources, preferentially the rural district agricultural authorities (Brandenburg comprises 14 rural districts). In other German states the demand for FMS and accompanied advice varied considerably. It was fairly high in some states with very active advisors, especially in the first years after CC regulation was introduced (2005–2007). Since then, the demand for FMS has declined significantly in all states. In Brandenburg, CC-related advice is mainly delivered without the use of FMS. Obviously, advisors have developed a 'muddling through' attitude in this field: some use several FMS in parallel; some have developed their 'own FMS' and others use proper checklists and documentation material based on documents they received from neighbouring German states. The interviewed advisors recommended that the supply of a CC checklist by the Brandenburg state authorities would be a useful support tool. Hereby it became obvious that the information needs of the advisors are not well satisfied by the public authorities, especially concerning timely information on changes in regulations as well as on state-wide results of CC checks (Knierim et al. 2011).

Cooperation and Linkages Within the AKIS

Although the three studies were not conceived to refer to Brandenburg's AKIS as a whole, the questions of whether and how relationships and interactions between the various actors exist were addressed under different angles. Taking the renewed political interest on the functioning and the performance of an AKIS into account (COM 2011; EU SCAR 2012), some relevant findings are presented here.

Concerning cooperation between advisors from different private firms, a trend towards lower levels of cooperation in the course of privatization becomes evident: as reported by Bokelmann et al. (1996, 38): 'advisors actively exchanged information between the different agricultural extension providers. Course instructors are exchanged and especially expertise on complex problems is being exchanged'. In 2006 more than half of the interviewed advisors (12 out of 23) were rather opposed to cooperating with advisors belonging to a company other than their own. The main reasons offered for such an attitude were the market competition and the fear of having to give away know-how or even losing clients. Four out of 23 advisors mentioned that they cooperated only with advisors in other federal states and then quite intensively (Knuth 2008).

Cooperation linkages with other institutions, for example, to equipment suppliers, rural district authorities, research institutions, lawyers, tax consultants or insurance companies, exist and are mainly used to collect specific information. The relationship with universities was mentioned by five out of 23 advisors, whose activities included student internships and conjoint bachelor and master theses (Knuth 2008).

Knierim et al. (2011) revealed the rural district agricultural authorities as an important information source for advisors concerning the CC regulations. Interestingly, also, more farmers use personal contact to the rural district agricultural authorities (58 out of 71) than using a private advisor (21 out of 71) for CC advice. All three studies mention the perceived need to improve the information exchange between advisors and Brandenburg's agricultural authorities on all levels (state and rural district) in general. Already in the 1990s, advisors wished for better participation and information about new subsidy regulations and joint activities like seminars and research (Bokelmann et al. 1996, 51). A working group on the 'Development of the advisory system in Brandenburg', comprising advisors and farmer association representatives as well as state ministry officers, existed temporarily in the 1990s, but met only once (in 2009) after full privatization. Public training activities seem to have improved as the 'Brandenburg Agricultural Academy' (BLAk) was established shortly after the study was published in 1996. BLAk offers training for advisors and farmers in the fields related to farm management, like communication, agricultural legislation, management and book keeping, as well as personnel management. According to Knierim et al.'s (2011) findings, BLAk's activities related to CC were evaluated as of utmost importance by the advisors as compared to other information sources delivered from Brandenburg authorities.

In all three studies the advisors were asked to evaluate the advisory system of Brandenburg, in general. The advisors first gave a mark and then, most of them, commented on their appraisal. In Knuth (2008) and Knierim et al. (2011) the advisors gave a rather average mark and appreciated the demand-driven elaboration of contents and the training activities of the state authorities as positive aspects of the privatized advisory system. One prominent negative aspect the advisors mentioned was the low level of information exchange and cooperation especially with the state authorities. In parallel, the state ministry declared a difficulty keeping regular contact with private advisors, as they are not well self-organized in terms of for example, having an 'advisors' network/association' and thus do not speak as one voice (personal communication with state ministry 2010). The evaluation of 1996 found

higher satisfaction (mark above average) of the advisors with the system, which at that time was still substantially subsidized (up to 90% of the personnel costs).

Discussion

From our studies, a number of adverse impacts of privatization in Brandenburg can be highlighted: (i) the deficits of information exchange, especially between advisors and public authorities, (ii) the reduction of cooperation among agricultural extension providers, (iii) an increased number of clients over larger distances who are less frequently visited, and (iv) a change in the clients' group, which is expressed in a clear shift towards larger farms. Smaller and/or financially less wealthy farms seem to be dropping out of the extension system. That advisors are aware of these critical consequences became evident during a discussion session held with CC certified advisors. However, their entrepreneurial interests to, for example, address small-scale farmers are limited as they do not expect (enough) profit.

It is interesting that the advisors themselves are only partially or not at all dissatisfied with the privatized system. Hence, in their perspective (some of) these negative implications are considered as hindering factors but not to such a degree as to generally object to or substantially transform a privatized system. Our studies induce here significant gaps in advisors' perceptions and analytical interests with regard to the functioning of the advisory system and its improvement as part of the AKIS. Further research on whether this is a Brandenburg specific phenomenon or more widely occurring in the context of privatized extension is necessary.

With regard to extension topics, the most important ones relate in general to financial and farm investment issues. In comparison, farmers' need for advice and information in order to comply with CC rules seems to be relatively low. This result could be explained on the one hand by the lack of interest on the part of farmers, and on the other hand by the relatively high education level of farm managers in Brandenburg. Indeed, more than two-thirds of the surveyed farm managers in the study of Knierim et al. (2011) had obtained a college degree; furthermore, they proactively consult technical journals and the internet in order to fulfil their information needs. Hence, it seems that the advisors mostly 'react' to farmers' requests. However, this 'efficiency orientation' on the advisors' side leads to hardly any proactive agenda setting, despite the fact that advisors have been found to hold accurate ideas about farmers' future knowledge and information interests. Unfortunately, the agricultural authorities have not been active in this direction either, and thus there is no public agenda setting on agricultural topics of wider societal interest either.

Methodologically, advisors in Brandenburg do not appear to be very innovative. Group consulting methods have been completely abandoned since the subsidized advisory services ceased and neither interest in nor activity on this issue was found in the 2008 and 2011 studies. Also, the implementation of FMS in Brandenburg has not been successful, as each advisor adjusted the available instruments according to his needs. Accordingly, no common efforts were made in the advisors' community to push one FMS or to create transparency on the different systems. We consider this a clear sign for the privatization-induced individualization of advisors where difficulties to cooperate increase without the helping hand of public authorities.

Summarizing, we state that advisors in Brandenburg do not see themselves in a proactive role, for example, striving for their interests in communication and interaction with the ministry or seeking more efficiency in knowledge exchange and awareness creation through group approaches. Here severe constraints become visible to act as facilitators for, for example, participatory learning processes and to enhance sustainable agricultural practices.

Conclusion

The current article examined the privatization of the Brandenburg state's (East Germany) extension services through the utilization of the findings of three relevant empirical studies which so far are only published in German (Bokelmann et al. 1996; Knuth 2008; Knierim et al. 2011).

The combined elaboration of the findings of the three studies produced results which are not surprising with regard to the expected effects of privatization documented in international literature. On the contrary, they largely confirm them. In the first place, it is obvious that nowadays in Brandenburg the involved actors—advisors, farmers and state authorities—fully comply with this specific mode of service provision. The results of the present article clearly show that this specific mode of extension has several deficits and shortcomings. For example, farmers from smaller farms or those in economic difficulties have no chance for low-cost access to advisory services. Additionally, environmentally friendly land use practices and sustainability issues in agriculture are not at all addressed by these actor groups.

However, the latter especially certainly deserves more attention on the part of, at least, the advisors: The EU-level declaration on the further development of the FAS-related policy, based on the evaluation of the application of FAS among the member states (European Commission 2010), recommends that advisors should increasingly convey policy objectives along with their background rationale to farmers. In this respect, the 'new challenges', that is, topics that translate societal interests into agricultural practices, are of utmost importance. Furthermore, within the frame of the next generation of the CAP (2014–2020), knowledge transfer and innovation generation in rural areas shall be enhanced through various instrumental and institutional approaches (COM 2011). Agricultural advisors can play a pivotal role as intermediaries and facilitators in this context. However, a proactive engagement for cooperation and methodologies for group interaction and networking seem to be essential features.

The degree to which Brandenburg's private advisors will be able to be successful within such a new policy framework and secure their income options is highly debatable given their current characteristics and professional orientations. Obviously there are no profession-internal drivers that encourage (some) advisors to reach for new horizons. Actors that are currently better situated to induce such changes would be state authorities (by their political mandate) or research bodies (by the way of third-party funded action-research projects).

Summarizing, the privatized agricultural advisory services in Brandenburg are definitely in need of more exchanges and interaction with other AKIS actors, for example, to improve the continuous input of processed information into the knowledge system. This dialogue also needs an improved level of self-organization

by the private advisors, which they assume to be difficult because of market competition. This process should be organizationally supported by the state of Brandenburg, for example, with the re-activation of the formally existing working group on the advisory system in Brandenburg.

References

Alexopoulos, G., A. Koutsouris, and I. Tzouramani. 2009. "The Financing of Extension Services: A Survey Among Rural Youth in Greece." *The Journal of Agricultural Education & Extension* 15 (2): 175–188.

BMELV, ed. 2006. *Empfehlungen zur Durchführung der Beratung unter Berücksichtigung der Anforderungen der Verordnung (EG) Nr. 1782/2003 zu Cross Compliance. Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz*, Bonn: Bundesministerium fur Ernahrung, Landwirtschaft und Verbraucherschutz.

Bokelmann, W., N. Hirschauer, U. J. Nagel, and M. Odening. 1996. *Landwirtschaftliche Beratung im Land Brandenburg. Eine Evaluierung erster Erfahrungen*. Weikersheim: Margraf Verlag.

COM. 2011. *Proposal for a Regulation of the European Parliament and of the Council on Support for Rural Development by the European Agricultural Fund for Rural Development (EAFRD)* (627). Brussels: European Commission.

Cristóvão, A., A. Koutsouris, and M. Kugler. 2012. "Extension Systems and Change Facilitation for Agricultural and Rural Development." In *The Farming Systems Approaches into the 21st Century: The New Dynamic*, edited by I. Darnhofer, D. Gibbon and B. Dedieu, 201–227. Dordrecht: Springer.

Dimter, S., A. Knierim, and U. J. Nagel. 2008. "'Farmers' Use of Brandenburg's Privatised Extension." 8th European IFSA Symposium: Workshop VI: Change in Knowledge Systems and Extension Services: Role of New Actors 6. bis 10. Juli in Clermont-Ferrand (Frankreich).

European Commission. 2010. "Report from the Commission to the European Parliament and the Council on the application of the Farm Advisory System as defined in Article 12 and 13 of Council Regulation (EC) No 73/2009." COM(2010) 665 final edition. Brussels: European Commission.

EU SCAR. 2012. *Agricultural Knowledge and Innovation Systems in Transition—A Reflection Paper*. Brussels: European Commission.

Hoffmann, V. 2010. "Beratung im ländlichen Raum – Institutionelle Aspekte in der Zukunft. Vortrag bei der 3. Gemeinsamen Fachtagung: Beratung der Zukunft – Zukunft der Beratung: Neue Beratungsansätze für den ländlichen Raum". [Presentation during the conference: advisory services in the future – future of advisory services – new options for extension provision in the rural area]. Evangelische Akademie, Hofgeismar, 30 October.

Hoffmann, V., J. Lamers, and A. D. Kidd. 2000. "Reforming the Organisation of Agricultural Extension in Germany: Lessons for Other Countries." Agricultural Research and Extension Network, Network Paper No. 98.

Ingram, J. 2008. "Agronomist—Farmer Knowledge Encounters: An Analysis of Knowledge Exchange in the Context of Best Management Practices in England." *Agriculture and Human Values* 25: 405–418. doi:10.1007/s10460-008-9134-0.

Klerkx, L., K. de Grip, and C. Leeuwis. 2006. "Hands Off but Strings Attached: The Contradictions of Policy-Induced Demand-Driven Agricultural Extension." *Agriculture and Human Values* 23 (2): 189–204. doi:10.1007/s10460-005-6106-5.

Knierim, A., U. Knuth, C. Rupschus, and N. Schläfke. 2011. *Cross Compliance Beratung – Eine vergleichende Bewertung der Situation in Brandenburg*. Weikersheim: Margraf Publishers.

Knuth, U. 2008. "Landwirtschaftliche Beratung in Brandenburg aus der Sicht der Berater [Agricultural advisory services in Brandenburg from the advisors' view point]." Masters thesis., Humboldt-Universität zu Berlin.

Koutsouris, A. 2012. "Facilitation and Brokerage: New Roles for Extension." *Journal of Extension Systems* 28 (1): 18–27.

Kuhry, B., A. Van der Torre, E. Eggink, J. J. Jonker, and E. Pommer. 2002. *De Vierde Sector, Achtergrondstudie Quartaire Sector* [The fourth sector—a background study]. The Hague, the Netherlands: Sociaal en Cultureel Planbureau (CPB).

Labarthe, P. 2009. "Extension Services and Multifunctional Agriculture. Lessons Learnt from the French and Dutch Contexts and Approaches." *The Journal of Environmental Management* 90 (Supplement 2): S193–S202. doi:10.1016/j.jenvman.2008.11.021.

Leeuwis, C. 2000. "Reconceptualizing Participation for Sustainable Rural Development: Towards a Negotiation Approach." *Development and Change* 31 (5): 931–959. doi:10.1111/1467-7660.00184.

Nagel, U. J. 1979. "Knowledge Flows in Agriculture: Linking Research, Extension and the Farmer." *Zeitschrift für Ausländische Landwirtschaft* 18 (2): 135–155.

Rivera, W. 1993. "Impacts of Extension Privatisation." *Journal of Extension* 31: 3.

Rivera, W., and G. Alex. 2004. "Extension System Reform and the Challenges Ahead." *The Journal of Agricultural Education and Extension* 10 (1): 23–35. doi:10.1080/13892240485300051.

Röling, N. 1988. *Extension Science: Information Systems in Agricultural Development*. Cambridge: Cambridge University Press.

Thomas, A. 2007. "Landwirtschaftliche Beratung in der Bundesrepublik Deutschland – eine Übersicht." *B&B Agrar* (2): I–XVII.

World Bank. 2006. *Enhancing Agricultural Innovation: How to Go Beyond the Strenghtening of Research Systems*. Washington, DC: World Bank. Accessed January 18, 2013. http://siteresources.worldbank.org/INTARD/Resources/Enhancing_Ag_Innovation.pdf.

Chapter 3

Interaction with and Governance of increasingly pluralistic AKIS – A changing role for advisory services

This chapter is based on the publication:

Knuth, Ulrike; Knierim, Andrea (2016): Interaction with and Governance of increasingly pluralistic AKIS - A changing role for advisory services. In: European Commission, Directorate-General for Research and Innovation, *Agricultural knowledge and innovation systems towards the future : a foresight paper*, Publications Office, 2016

Available online at: https://data.europa.eu/doi/10.2777/324117

3 Interaction with and governance of increasingly pluralistic AKIS - A changing role for advisory services

Privatization and commercialization in agricultural advisory systems have been ongoing processes for over 30 years now. One could question whether the public sector should still play a key role in such systems. The expected benefits of privatization are greater efficiency of service provision in terms of costs and resource allocation, increased provider accountability, a demand-driven elaboration of contents, and an emphasis on benefits and results. Competition is assumed to ensure constant improvement in the quality and diversification of goods (Klerkx et al. 2006).

Nevertheless, implications of privatizing or commercializing advisory services are described as (1) the tendency toward a reduction of linkages both among organizations and among farmers in the exchange of agricultural and other relevant information; (2) the tendency to enhance advice for large-scale farms and to emphasize less on small-scale or less commercial farming; (3) the advancement of knowledge as a saleable commodity which makes it prone to interest biases of the advisor1 (Rivera and Cary, 1997) and (4) the diminishing emphasis on public-good information regarding for example environmental issues, mostly dealt with in a rather short-term perspective (Labarthe 2009; Klerkx et al. 2006). Still recently, it was confirmed that knowledge gaps exist for example with regard to the effectiveness of advisory services for agri-ecological practices (OECD 2015). And, there are also a number of farmer groups that are not reached by these advisory services. E.g. regarding small-scale or less commercial farmers, Labarthe and Laurent (2013) point out, that "the dismantling of coordinating authorities has made these farms less visible as a target client and that less direct interaction with advisors makes it more difficult to co-produce knowledge that is relevant to small farms' needs. Back office activities have been restructured in a way which does not serve small farms' needs".

In practice, diversity in the provision of advice is a fact; different providers are required for different clienteles, with public providers and funding focusing more on smaller-scale and less commercial farmers. Supporting farmers to find their way around the multiplicity of sources and information is crucial (Garforth et al. 2003, Feder et al. 2011). Therefore, researchers that have analysed the change processes in advisory systems clearly state that the government should continue to fund some provision of advice and information and play a key role in governing and coordinating AKIS and integrated advisory services, because there are significant market failures in the supply of and demand for advice and information (Garforth et al. 2003; Rivera and Cary 1997).

[1] We refer to 'private advisory services' as independent entrepreneurial organisations or individuals while advice provided as a co-service of a commercial transaction (e.g., provided by input industries etc.) is not considered here.

The EU FP7-funded research project PRO AKIS (www.proakis.eu) aimed at providing such a situational analysis of agricultural advisory services on EU-level and to answer the following question: How and from what sources can farmers get reliable and relevant knowledge, orientation and support to continuously evolve, to successfully solve problems and to respond to external expectations and development opportunities? The PRO AKIS focus was to investigate the agricultural advisory services across Europe within the context of Agricultural Knowledge and Information Systems (AKIS). Besides an inventory of the current AKIS institutions and interactions in the EU member states, PRO AKIS used a case study approach to investigate the challenges of today's pluralistic AKIS: i) small-scale farmers' access to relevant and reliable knowledge, ii) bridging scientific research topics and farmers' demands and iii) offering appropriate support for diverse rural actors that form networks around innovations in agriculture and rural areas.

The PRO AKIS inventory revealed that the European AKIS are increasingly gaining an institutional diversity and that notably, advisory services are provided by manifold different organisations. This organisational heterogeneity (public or private sector, farmer-based or civil society organisations) results in a diminishing importance of classical, well-established interaction and communication ways. Moreover, there is a growing necessity to develop new horizontal and vertical linkages and to frequently coordinate knowledge flows beside purposeful steering and government activities.

Against this background, the findings of PRO AKIS, in particular the case studies and related synthesis reports, were being systematically analysed, enriched with material from stakeholder involvement through synthesis seminars, workshops and the final conference with the goal to identify challenges and emerging tasks that derive from this increasing diversity for public administration. In the following text, policy recommendations on the role of the government and support to multi-actor innovation networks are proposed. An early version of these recommendations was presented in the SWG AKIS workshop in Antwerp, Belgium (March 2015) and thoroughly discussed there in breakout groups. Additionally they were discussed and further developed within the PRO AKIS project work repeatedly. The discussion results from both working processes were used by the authors to develop the recommendations presented in the following, which regard the role and responsibilities of public administration (section 3.1) and further focus on how to design, maintain and implement innovation networks (section 3.2). The recommendations are, where suitable, illustrated by PRO AKIS examples, and further literature is reviewed and discussed. The chapter is closed with some short conclusions (3.3).

3.1 Roles of public administration in governing increasingly pluralistic AKIS

Rivera and Cary (1997) speak of a "key role of the public sector and […] its responsibility as a coordinating agent". But what are the respective tasks of such a key role? The following questions of Rivera and Cary (1997, p. 10) help to define these tasks: Whether and to what extent should the public sector:

> "(i) Attend targeted audiences unserved by the private sector?
> (ii) Coordinate multiple extension providers?
> (iii) Serve as the final reference or arbitrator of conflicting information?
> (iv) Assure accountability of both public and private extension services to the public? and
> (v) Facilitate the operation of the complex [of extension services] through regulation and information provision?"

Answers are manifold and have to be derived from individual country's situational analyses and institutionally adapted solutions, instead of formula like "one fits all", because, as Garforth et al. (2003, p. 332) reason, "[…] sustainable rural communities and economies are more likely to emerge from creative processes of identifying problems and opportunities, and developing strategies for dealing with them, than from the implementation of a package of measures developed by others".

The following sections describe the necessity for AKIS diagnoses and possibilities for its implementation (section 3.1.1), discuss as well as give examples on how much and what kind of public advisory infrastructure is needed (3.1.2), show the added value of monitoring and evaluation activities (3.1.3) and point out opportunities for promoting professionalism and quality management of agricultural advisory services (3.1.4).

3.1.1 Conducting AKIS diagnoses

Public authorities and coordinating bodies concerned with agricultural advisory systems may use and promote the AKIS concept as a diagnostic tool for public actors at national and regional level; suitable competencies and methodologies should be acquired.

The PRO AKIS inventory revealed that the AKIS concept is appropriate to systematically guide the characterization of infrastructures and coordinating mechanisms, supporting the analysis of system integration and fragmentation (Knierim et al. 2015). PRO AKIS case studies exposed gaps between public advisors and public research or experimental stations (Bavaria/Germany, Bulgaria), public advisors and private consultants (Bavaria/Germany), public research and private consultants (Brandenburg/Germany) or demonstration farms and public advisors (Poland). Case studies often concluded

that increasing interaction between AKIS actors could substantially improve knowledge exchange and innovation capacities of a region – and showed in this way the usefulness of an AKIS diagnosis.

A (regular) AKIS diagnosis, esp. if done in a participatory way, has the potential to increase interaction in a region between knowledge producers, providers and users and therefore enhance participation in and capacities for innovation projects, such as aimed at within the EIP framework. Additionally, such diagnoses have the potential to ground targeted governmental interventions to support cooperation between farmers, advisors, scientists and other actors of AKIS in solving problems. Addressing more specifically the level of Rural Development Program (RDP) decision making, policy makers will find an AKIS diagnosis appropriate to identify and describe the relevant actors (education, research, advisory services, public and private knowledge providers and users etc.) for a certain agricultural topic/sector, to recognize strengths and weaknesses of the AKIS and to search for gaps and missing interactions among actors and understand influence and power relationships. Special attention should be paid to the divergent knowledge needs of farm-level actors, according to e.g., farm size, gender, education level or professional orientation.

A possible start and participatory approach to an AKIS diagnosis could be a regional 'AKIS conference' inviting concerned and interested AKIS actors to exchange information about their own organisations' activities as well as to discuss and collect views on the functioning of the regional AKIS with regard to the innovation capacities of farm managers. Relevant actors should include the private and the public sector as well as actors from non-governmental and farmer-based organisations either from the agricultural sector in general or from single branches (horticulture, pig production etc.) or orientations (e.g., organic, conventional integrated farming etc.). A well-established methodological approach for a participatory AKIS diagnosis is the 'Rapid Appraisal of Agricultural knowledge systems' (RAAKS), which was developed in 1990s by the Wageningen University and tested in many different agricultural extension contexts (FAO 2015). RAAKS consists of the following three phases: 1) problem identification, 2) constraints and opportunities and 3) action planning; and it aims at "improving the problem-solving capacity of stakeholders through improved communication and joint learning" (Salomon and Engel 1997). The framework of Birner et al. (2009), recently adapted by OECD (2015) for evaluating 'green growth initiatives in agriculture', provides an analytical concept for an AKIS, 'entangling' advisory services into governance structures, capacities, management and advisory services. It further points out related contextual factors that are relevant for the design and development of national or regional AKIS, such as the policy environment or the market access of farm households.

3.1.2 How much and what kind of public advisory service infrastructure?

Public authorities need to provide advisory services' infrastructure or public support of private independent advisory services particularly regarding public goods topics and less favoured groups of farmers.

Forms of organization and financing of an agricultural advisory system within a region are manifold and diverse. The scheme of Rivera (1996) distinguishing between 'who delivers and who funds' is helpful to quickly have on overview on aspects of institutional design for advisory services. The PRO AKIS case studies revealed the on-going commercialization trend and the growing diversity of actors in this field. When distinguishing between private and public as well as farmer-based organisations (FBO) and NGO service providers (according to Birner et al. 2009), diverging goals for the provision of advisory service within these organisations can be expected. This often leads into a lack of adequate services for specific groups of farmers, e.g. small scale or resource poor farmers as important actors in rural development. Furthermore, services that sensitize farmers for environmental topics such as water and nutrient management or biodiversity are often not profitable for private providers, e.g., because the number of potential clients is too small (Rivera and Cary 1997; Labarthe 2009; Klerkx et al. 2006).

The case studies conducted in PRO AKIS show different levels of responsibility taken up by public authorities for such advisory tasks. For example, in Scotland a mix of public, private commercial and non-governmental actors is involved in the provision of advice, with strong governmental intervention (Prager and Thomson, 2014). The 'monitor farms programme' appears to be a successful farmer led and governmental supported programme to enhance farm development which integrates a broad range of rural actors from all sectors private, public, NGO, FBO) (Creaney at al. 2014). On the other hand, in Brandenburg Germany, only private advisory companies exist without any public advisory infrastructure or public regional support, e.g. for building up such networks like Monitor farms. Existing innovation networks, which are funded by federal public research funds, fulfil gaps only for a short time missing a long-term perspective for ongoing interaction within this regional AKIS (Boenning and Knierim 2014) and sustainability issues in agriculture are not addressed by private advisors (Knuth and Knierim 2013).

There is a variety of options for publically funding advisory services, ranging from traditional advisory service provision by public bodies, policy induced rural networks (cf. section 7.2), maintenance of experimental stations and monitor farms, to providing financial support for farmers to use private advisory services (voucher systems, incentivized extension programmes). What is appropriate in a regional context can be very different and research and evaluation of the manifold mechanisms for intervention are limited. A case study from Ireland reports on the one hand that rewarding farmers' participation in extension programmes encourages participation, especially with cohorts of farmers that pre-

viously eschewed such programs (Läpple and Hennessy 2015a). On the other hand, an additional study revealed that farmers who joined the discussion group of the extension programme before the financial incentive significantly improved their farm performance, as measured in gross margins and yields, while farmers who joined after the financial incentive was introduced, did not significantly improve their farm performance after the extension programme. This led the authors of the study to question the financial usefulness of rewarding farmers for participating in extension programmes (Läpple and Hennessy 2015b). The evaluation of a complex government funded support service for 'Nutrient Management' in the Netherlands questioned some of the conceptual and practical assumptions of such interventions and proposed that it may be more effective and efficient for governments to build more permanent institutions to facilitate the development of the agricultural knowledge market than to invest into voucher systems (Klerkx et al. 2006).

Such more permanent institutions can be public organisations or public funded networks, which act as platforms of knowledge exchange, coordinating multiple suppliers of advisory services, research and education institutions and other AKIS actors. Feder et al. (2011:31) speak of a need for "some regulatory oversight of private-sector extension activities, particularly when public funding is involved". A rather simple example for such 'oversight' is the provision and updating of a list of (certified) advisors in a region that also provides information on the scope of the service providers' work. Another option is a web-based platform on farming policy and subsidy related information for farmers and advisors. More participatory, interactive approaches are related to events that support the AKIS diagnosis mentioned earlier. To integrate private advisors in such events merits specific attention as this needs a certain level of trust and a cooperative relationship between public authorities and advisors in order to motivate for a form of participation that has no direct influence on the advisors' income.

Public funding is also required to ensure knowledge flows between research and farmers (especially small-scale and resource-poor farmers). If "Business as usual" research activities, e.g. state financed field trials are endangered by diminishing the budget, one base for qualified region-specific agricultural advice disappears. Publicly investing in regionally applied agricultural research is crucial, but without access for all (public and private) advisors to publicly funded research results, knowledge flows and innovation processes in a region are hindered. A good way to support interaction between research, advisors and other actors of a pluralistic AKIS is to publically support co-location of different public and private organisations. One example for such an infrastructural support are the topic-related competence centres in Lower Saxony, Germany (here on grasslands and on organic farming), which allow for exchange and the establishment of linkages in an informal way. Furthermore, such centres could also be a way to better connect education and advice providers in a given region.

3.1.3. Monitoring and evaluation of advisory systems

Systematic evaluation and monitoring of advisory services need to be encouraged by public authorities in order to make comparisons of different advisory systems possible.

The PRO AKIS inventory revealed a great diversity of AKIS in Europe, where a comparative view and aggregation was not easily possible, and concluded that there is insufficient data available to assess the impact of advisory services (e.g., who has access to what services, outcomes of advisory service provision). Similar evidence is observed for the OECD countries: "Available evaluation studies are largely qualitative, mainly focused on 'snapshot' evidence and often based on small numbers of participants, interviews and surveys (OECD 2015: 7) This is particularly problematic in a context of rapid and fundamental structural changes in AKIS. Hence, the here recommended AKIS perspective should not only aim at evaluating and assessing knowledge infrastructures but also include monitoring activities on information exchange and 'knowledge flows' in order to observe and acknowledge the performance of interaction processes.

As an AKIS diagnosis is a single analytical step at a certain moment, monitoring and evaluation is meant as a public responsibility to be fulfilled repeatedly. It becomes increasingly important as advisory services and innovation activities receive more and more attention within Rural Development Programmes (RDP). Monitoring of advisory services may include the observation of both the demand and the supply side of the advisory market, particularly if more private than public actors determine the system. Information collected by public authorities could include which actors are out there on the market, which topics are covered, where are gaps or topics which are covered or not by the existing services, and the effectiveness of advisory service-related policy instruments and coordination initiatives. It could further include observations regarding in how far the various groups of farmers can access services, e.g., by Läpple and Hennessy (2015a) for Ireland. It is also important to check within the regular evaluations of RDP, in how far these programs have changed existing AKIS infrastructures and vice versa in how far AKIS infrastructures provide necessary conditions for certain RDP measures.

Structural funding for regular monitoring activities or result-oriented support for single evaluation activities provided by public administration on European or national level could enhance monitoring and evaluation activities in respective regions and improve the availability of sufficient data. This data could then be used also for targeted comparative assessments of AKIS components between and within most European countries.

3.1.4 Towards transparency and quality management in the agricultural advisory 'market'

Transparency about quality of advisory services needs to be enhanced and support for training, education and acknowledgement procedures of advisors is recommended.

The diversity of public and private advisory service providers as well as the funding opportunities for advisory services in the rural development measures have led to the development of selection procedures and/or accreditation schemes for advisors. Certification schemes – mostly for single advisors and their organisation - are developed by public authorities, defining minimum standards (e.g. infrastructure, educational level, professional experience) in order to approve for participation in public extension programmes. There are many different ways to certify or choose advisors for public-funded services, but comparative exploration and evaluation of existing certification schemes is yet missing. For public authorities it could be helpful to invest into monitoring and evaluation and comparative research on selection procedures and accreditation schemes for advisors in order to obtain transparency about the degree of competition in the advisory market. A common instrument of professional organisations to assure a certain quality of services is the certification. Advantages of such a tool would be that a comparable standard of service provision can be assumed and by this a certain transparency within the market is created so that farmers get a better overview. Also, advisors disposing of such a certificate could expect a comparatively higher pay for their services.

However, with regard to agricultural advice there is yet no widely accepted, overarching certification scheme in the EU. Along with the increasing pluralism in advisory systems, a number of professional associations have emerged in the last decades, which concentrate their activities on the enhancement of advisors' competences, networking and knowledge exchange. Among them, one of the oldest associations is the German speaking "International academy of rural advisors" (IALB), founded in 1961 (www.ialb.org). Annual organisational meetings mainly focus on the exchange of trainers, of experience, the atonement of educational issues, benchmarking and accordingly on the cooperation in education and counselling. Another one is the European Federation of Agricultural Consultancy (EFAC), an independent association of professional agricultural consultancy organisations in Europe, focussing on tax, financial, legal and economic advice (www.efac.net). The most recent organisation at the European level is the European forum for agricultural and rural advisory services (EUFRAS) (www.eufras.eu).

Regarding competence enhancement and certification of advisors, IALB developed the competence development standard CECRA (Certificate for European Consultants in Rural Areas) (www.cecra.net) which would – if widely adopted – serve as a quality certification. As it stems from a professional organisation across German speaking countries, mostly Swiss, Austrian and German organisations are

involved as providers of training. However, since just recently, EUFRAS started to take a coordinating role in rural advisor qualification and certification in Europe by joining CECRA, a broader dissemination and adoption of the scheme become more likely. Also, the new CAP fosters the discussion and awareness creation in this regard as it allows for the funding of advisory service on the basis of competitive procedures. In Germany, some authorities take (selected) CECRA standards as benchmarks for approving advisors for public funded extension within the new CAP. Summarising, public authorities should not hesitate to make acknowledgement procedures and standards of advisors a topic of discussion and agreement.

3.2 Public support for rural multi-actor innovation networks

Network structures have gained increasing attention for enhancing innovation capacities in a region or in a certain sector (Weyer 2008; Worldbank 2012). Innovation networks, namely operational groups, are the core element for funding under the policy scheme of the "European Innovation Partnership for Agricultural Productivity and Sustainability" (EIP) and its related measures in the EAFRD and the Horizon 2020 research programme of the EU. When looking at existing multi-actor innovation networks, it becomes obvious, how diverse they can be. There are policy-induced networks that focus on research and development of something new – an innovation. Other funded networks rather focus on knowledge exchange and learning without having in mind to develop an innovation but rather innovative capacities of farmers or demonstrate the implementation of an innovation, e.g. in networks of demonstration or monitor farms. Then, there are also networks that are an association focussing on institutionalized cooperation and interaction with regard to a certain topic or interest, often not funded by public money, but through membership fees. Furthermore, the term 'network' is being used synonymously for many different forms of groups working together, such as group consulting, transdisciplinary research project groups or political interest groups and more.

PRO AKIS has studied in depth five, quite diverse networks regarding funding, actor composition and content in order to find out about which features of the networks enhance farmers' ability to co-innovate in cooperation with other actors. These case studies highlight a diverse range of multi-actor learning and innovation networks in agriculture and rural areas respecting their structure, content and dynamics (Boenning and Knierim 2014; Caggiano 2014; Creaney et al. 2014; Madureira et al. 2014).

Synthesising the PRO AKIS case studies it can be concluded that rural multi-actor innovation networks are a successful advisory format, as they "are actually able to deliver advisory services within innovative formats that overcome some of the limitations of the conventional advisory systems. They enable multi-topical advice, enhance the farmers' role as creators, co-creators and converters of

knowledge, and reduce the distances (geographical and cognitive) between farmers and other actors, such as researchers and experts" (Madureira et al. 2015p.13).

Therefore, rural multi-actor networks should be understood as complementary to classical advisory services, as they are capable to increase interactions within a regional AKIS, especially in 'weak' AKIS with low levels of interaction or public AKIS infrastructures. When policy makers decide to invest into 'networking' in a rural region by designing policies to initiate new networks, special attention needs to be paid to several different aspects. In the following sections, selected insights from the PRO AKIS case studies are used to highlight appropriate public authorities' activities regarding the initiation phase and the actor composition of innovation networks, the potential role of advisory services and the communication within and the funding of such networks.

3.3 Building up rural multi-actor innovation networks

Publicly induced multi-actor innovation networks in rural areas should be open to the diversity of knowledge providers and stakeholders in a region. Topics should be drawn from problems, challenges and opportunities as perceived by farmers.

Ideally, networks are initiated bottom-up and find their own ways of funding. In case of policy-induced innovation networks tailored around projects, which produce new solutions to certain problems or aim to enhance the capacities of farmers to change practices, PRO AKIS observed, that it is crucial to draw the networks' topics and issues from the problems of the farmers. Topics addressed by such networks, which are relevant to the farmers, have to be seen as a key feature for participation (Madureira et al. 2015). The farmers are therefore better to be integrated early into the process of designing such networks. For a successful cooperation between diverse actors, in particular scientists and farmers, questions need to be formulated together in the beginning. This requires an 'open attitude' for ideas expressed on both sides, in particular to overcome personal interests; being willing to consider different ideas an innovation potential is challenging but essential to the success of such programs (Creaney et al. 2014). Another way to ensure a common understanding is to search for participants as in the way of one innovation network studied by PRO AKIS: "For complementing the list of practical partners, the university professor looked for farmers in the relevant regions who had finished agricultural studies at his university", thus assuming a common language and an easy understanding with new cooperation partners (Boenning and Knierim 2014:15).

'Diversity of knowledge providers' as used above means that all actors (no matter if they are a public, private or charitable organisation) have a chance to participate, if they have relevant knowledge and competences for the topic of the network. 'Multi actor' should therefore not be limited to the agricul-

tural background or only farming or research, but all actors in a rural landscape or concerned by the issue should be involved. Not all actor groups (research, education, farmers, NGOs) need to participate in every network; the composition depends on the topic. This is a principle already in use in the EIP framework and the PRO AKIS case studies have found similar well working constellations. For example, the Scottish Monitor farms programme shows how the interaction of the farmers (as the core actors) is enhanced by integrating further actors into the group meetings such as private advisors and scientists as well as industry partners.

When designing rural multi-actor innovation networks, special attention needs to be paid to the composition of the network and the risk of large established players 'taking over' and pushing their interest to the disadvantage of less powerful actors. The government could act as a transparency creating and levelling force and filter risk out in the beginning by creating conditions so that everybody has an equal chance to participate. Characteristics such as (farm-level) resources, especially economic power, but also gender roles and the belonging to certain sociodemographic groups may be taken into account in order to avoid power asymmetries in a network. Besides the mentioned conditions in the beginning, along the working process a good inside and outside communication strategy is needed.

3.4 Collective learning processes, facilitation and trust within the network

Collective learning processes are crucial for enhancing innovation capacities of actors in a network. Successful networks leave time and space for social concerns as trust-building activity, and ensure the fulfilment of different roles and functions, most importantly the facilitation role.

A mixture of different methods during meetings including demonstrations, invited talks, field trials and intensive, facilitated discussions are essential to achieve collective learning processes. Meetings on a regular basis provide repeated opportunities to experience changes in farm practice and learn about farm improvement as a result of changes. Both characteristics could be observed in the monitor farm networks and have resulted in high participation rates:

"A key motivation […] is the social aspect to the monitor farm network, which contributes to boosting participation rates, overcoming farmer isolation, as well as building new, and reinforcing existing, connections between farmers in a local area, both on a personal and business level. [The participants] benefit from the opportunity to share struggles, questions, ideas and solutions, whilst also benefitting from a type of informal benchmarking through participation" (Creaney et al. 2014).

Fulfilment of the facilitation role is quite important and the facilitator of an innovation network, sometimes also named innovation broker, needs to have specific competences to steer the processes of lev-

elling different interests and managing the innovation process. Batterink et al. (2010) speak of "orchestrating innovation networks" and describe the following three functions to be fulfilled by an innovation broker: i) innovation initiation, ii) network composition, iii) and innovation process management. They further provide best practice examples of innovation brokers from four in-depth case studies in the Netherlands, Germany and France.

Innovation process management should also include, that network actors continuously re-interpret the context in which they move. "This constant reflection […] needs to be supported by dedicated facilitators and monitoring and evaluation methods aimed at system learning. This implies, that agricultural innovation policies should, instead of aiming to fully plan and control innovation, foster the emergence of such flexible support instruments that enable adaptive innovation management" (Klerkx et al. 2010). Theoretical frameworks could be used as foundation for designing communication processes of innovation networks – either as a funder, participant or facilitator. Regarding the levelling of different interests, Tisenkopfs et al. (2014) point out the importance of issue framing and relationship framing and give suggestions how to facilitate such learning processes. They identify actor roles and methods that help agricultural networks to frame issues of common interest, deal with divergent interests collaboratively and align network members for concerted action. Sol et al. (2013, p.35) propose a theoretical framework for social learning, in which "trust, commitment and reframing are interrelated aspects and emergent properties in the process of social learning". Public or private advisory service providers of a region should be able to take up the following functions in networks: clarifying knowledge needs of farmers; brokering of information (also outside the network), facilitating connections amongst actors; promoting learning and dissemination; translating data, information or knowledge into lay terms and monitoring network success.

Trust among actors is a main driver for enrolment and successful learning and innovation in a multi-actor network. Network events that include overnight stays, opportunity to join dinner or other informal social interaction encourage trust among participants. Knowing each other before a project or a network starts, is also a resource for trust, as in the case of the policy-induced innovation network in Brandenburg studied by PRO AKIS. This revealed "a network of numerous personal relationships among individual project participants that date back before and go beyond the project. Those longer-term relationships contributed arguably to the high level of trust and cooperation in the network" (Boenning and Knierim, 2014:22).

The other side of such personal relationships beforehand is the danger of having a 'closed shop' as a network, where new or not-yet-known actors in the field are excluded. This should in particular be avoided when networks and their projects are funded by public money. Public support instead needs to enhance the inclusion of less voiced groups such as less skilled small-scale or 'less powerful on the market' farmers (e.g. social farming, or farms from less powerful agricultural subsectors), and simul-

taneously support the participation of pioneer farmers which can contribute to the networks cohesiveness. A 'nursery period' (e.g. of six months) as suggested by some interviewees in the Scottish program could be a helpful 'stepping stone' into the project. It could be used as a trust building phase and aims to increase productivity during the formal project period, overcoming a lack of familiarity amongst all involved in the project and clarifying expectations of participants beforehand (Creaney et al. 2014).

3.5 Public financial support of networks

Providing financial support for rural multi-actor networks merits specific attention from an institutional perspective.

Networks can be used to fill gaps in national or regional AKIS resulting from structural weaknesses, but funded networks should be rather output-oriented; networks should not be funded because they are networks, but because of the added value of their project (i.e., a set of targeted activities rather than structures). This has implications for the interaction and cooperation dynamics between the actors involved, as project funding tends to strengthen production of outputs, and in some cases at the expense of relationship development.

The structure of funding schemes will impact the composition of actors and content. Funding of networks risks i) channelling funding to large established players, excluding smaller, less powerful players and ii) supporting 'closed shops', if the interaction with the broader audience and the transfer of generated knowledge is not an integrated goal of the network. Advisors can play an important role in reaching such goals by taking up functions in networks like clarifying knowledge needs of farmers; brokering of information (also outside the network), facilitating connections amongst actors; promoting learning and dissemination; translating data, information or knowledge into lay terms and monitoring network success. But taking into account the pluralism of existing advisory service providers and the growing share of private advisors, who often operate on a fee for service base only, specific attention needs to be paid on how to reach them and motivate them to be part of innovation networks. The case of the innovation network in Brandenburg shows, that especially independent private advisors are not easily part of such networks and have to overcome a number of hindrances before becoming engaged2 (Boenning and Knierim 2014).

[2] Private advisors in Brandenburg repeatedly argued, that time is a scarce source and participation in research networks is not income – relevant for them. Rewarding their participation out of the project budget might be one solution, but is contradictory to public advisors, who might participate because it is part of their work description.

The question how sustainable a policy-induced network is or rather should be, becomes an increasing important question. All policy-induced networks have a certain 'life span', in which they are funded. Continuing the cooperation between the actors in new projects might be reasonable with regard to the project content, but new funding is not always accessible. Hence, continuing supports may be necessary, particularly for newly formed networks. Ongoing support should be based on monitoring and evaluation of respective networks. National entities should take over the responsibility for monitoring and assessing the success (including inclusivity) of publicly supported networks. However, it always depends on the network's project goals and content. In case of the Scottish monitor farms, part of the networks' success were new contacts between farmers in the community and therefore it could be observed: "whilst a more structured, self-organized discussion group is unlikely to follow the formal monitor farm programme without facilitation support, the interviewees express hope that informal farmer collaboration will continue, in terms of information and knowledge exchange, building on the links established by the monitor farm network" (Creaney et al. 2014:37).

3.6 Summary and conclusions

Summarising, it can be concluded that although pluralism in AKIS as well as in advisory services is increasing and the size of public advisory services is diminished, public authorities have a range of responsibilities and many options for action. Their roles are changing and become more diverse towards governance of AKIS, creation of transparency, enhancement of linkages, targeting of public support according to public interests and quality assurance.

To govern AKIS successfully, public authorities should adapt the AKIS concept as an analytical and conceptual tool and need to develop new competences to conduct AKIS diagnoses in cooperation with relevant public, private and charitable AKIS actors in a region. Successful methodologies such as RAAKS exist. Conducting AKIS diagnoses as well as encouraging monitoring and evaluation of funded innovation networks, advisory services and interactions within a given region are the key responsibilities in governing pluralistic AKIS. Results of such analytical processes can be used to develop new or improve existing policies in particular regarding advisory services within Rural Development Programs or other funding schemes. Mechanisms for organizing and funding advisory services for public goods issues need to be further analysed in a comparative way regarding their effectiveness. Current open questions for designing suitable policies for advisory services, which consider the ongoing societal changes in rural areas, are associated with mechanisms for public calls for funded advisory services and related criteria for the selection procedure.

Farmers in pluralistic AKIS need support for "finding their way around" among the diverse public and private providers of advice. Creating transparency and steering the competition between private independent advisory service providers is therefore the responsibility to be fulfilled by public authorities.

Transparency about and assurance of quality of advice providers can be created by supporting monitoring and evaluation measures and certification initiatives for advisory services. Within multi-actor innovation networks, public authorities can adopt different roles – they can be a powerful driver through the offer of financial incentives and the provision of infrastructures, an institutionalised facilitator of a network's process or a sole partner as any other. However, in whatever role public authorities are engaged, it is their task to create awareness for societal objectives and the maintenance of public goods and to enhance the integration of the diverse farmer groups into rural development processes.

REFERENCES

Batterink, Maarten H.; Wubben, Emiel F. M.; Klerkx, Laurens; Omta, S. W. F. (2010): Orchestrating innovation networks. The case of innovation brokers in the agri-food sector. In *Entrepreneurship & Regional Development* 22 (1), pp. 47–76. DOI: 10.1080/08985620903220512.

Birner, Regina; Davis, Kristin; Pender, John; Nkonya, Ephraim; Anandajayasekeram, Ponniah; Ekboir, Javier et al. (2006): From "best practice" to "best fit" - a framework for analyzing pluralistic agricultural advisory services worldwide. Washington, D.C. (DSGD Discussion Paper No.37).

Birner, Regina; Davis, Kristin; Pender, John; Nkonya, Ephraim; Anandajayasekeram, Ponniah; Ekboir, Javier et al. (2009): From Best Practice to Best Fit. A Framework for Designing and Analyzing Pluralistic Agricultural Advisory Services Worldwide. In *The Journal of Agricultural Education and Extension* 15 (4), pp. 341–355. DOI: 10.1080/13892240903309595.

Boenning, Kinga, Knierim, Andrea (2014): Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Case study report on a policy-induced agricultural innovation network in Brandenburg. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. December 2014.

Caggiano, M. (2014): Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Anti-Mafia Innovation network: from land to fork! Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. November 2014.

Creaney, R.; McKee, A.; Prager, K. (2014): Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Monitor Farms in Scotland, UK. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. November 2014.

FAO (2015) Rapid Appraisal of Agricultural Knowledge Systems (RAAKS). http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/Refer/RAAKS.htm. checked on 08.06.2015

Feder, G.; Birner, R.; Anderson, J. R. (2011): The private sector's role in agricultural extension systems. potential and limitations. In *Journal of Agribusiness in Developing and Emerging Economies* 1 (1), pp. 31–54. DOI: 10.1108/20440831111131505.

Garforth, Chris; Angell, Brian; Archer, John; Green, Kate (2003): Fragmentation or creative diversity? Options in the provision of land management advisory services. In *Land Use Policy* 20 (4), pp. 323–333. DOI: 10.1016/S0264-8377(03)00035-8.

Klerkx, Laurens; Grip, Karin de; Leeuwis, Cees (2006): Hands off but Strings Attached: The Contradictions of Policy-induced Demand-driven Agricultural Extension. The Contradictions of Policy-induced Demand-driven Agricultural Extension. In *Agriculture and Human Values* 23 (2), pp. 189–204. DOI: 10.1007/s10460-005-6106-5..

Klerkx, Laurens; Aarts, Noelle; Leeuwis, Cees (2010): Adaptive management in agricultural innovation systems. The interactions between innovation networks and their environment. In *Agricultural Systems* 103 (6), pp. 390–400. DOI: 10.1016/j.agsy.2010.03.012.

Knierim, A.; Boenning, K.; Caggiano, M.; Cristóvão, A.; Dirimanova, V.; Koehnen, T. et al. (2015): The AKIS Concept and its Relevance in Selected EU Member States. In *Outlook on Agriculture* 44 (1), pp. 29–36. DOI: 10.5367/oa.2015.0194.

Knuth, Ulrike; Knierim, Andrea (2013): Characteristics of and Challenges for Advisors within a Privatized Extension System. In *The Journal of Agricultural Education and Extension* 19 (3), pp. 223–236. DOI: 10.1080/1389224X.2013.782166.

Labarthe, Pierre (2009): Extension services and multifunctional agriculture. Lessons learnt from the French and Dutch contexts and approaches. In *Journal of Environmental Management* 90 Suppl 2, S193-202. DOI: 10.1016/j.jenvman.2008.11.021.

Labarthe, Pierre; Laurent, Catherine (2013): Privatization of agricultural extension services in the EU. Towards a lack of adequate knowledge for small-scale farms? In *Food Policy* 38, pp. 240–252. DOI: 10.1016/j.foodpol.2012.10.005.

Läpple, Doris; Hennessy, Thia (2015a): Exploring the Role of Incentives in Agricultural Extension Programs. In *Applied Economic Perspectives and Policy* 37 (3), pp. 403–417. DOI: 10.1093/aepp/ppu037.

Läpple, Doris; Hennessy, Thia (2015b): Assessing the Impact of Financial Incentives in Extension Programmes: Evidence From Ireland. Evidence From Ireland. In *J Agric Econ* 66 (3), pp. 781–795. DOI: 10.1111/1477-9552.12108.

Madureira, L., Ferreira, D., Pires, M. (2014): Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. The berry networks in Portugal. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. December 2014.

Madureira, L., Koehnen, T., Ferreira, D., Pires, M., Cristovão, A., Baptista, (2015). Designing, implementing and maintaining agricultural/rural networks to enhance farmers' ability to innovate in cooperation with other rural actors. Final Synthesis Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS. May 2015.

OECD (2015): Fostering Green Growth in Agriculture: The role of Training, Advisory Services and Extension Initiatives. OECD Green Growth Studies. OECD Publishing. Paris

Prager, K.; Thomson, K. (2014): AKIS and advisory services in the United Kingdom. Report for the AKIS inventory (WP3) of the PRO AKIS project.

Rivera, William; Cary, John (1997): Chapter 22. Privatizing Agricultural Extension. In: Burton E. Swanson, Robert P. Bentz und Andrew J. Sofrankko (Ed.): Improving Agricultural Extension - A reference manual. Rome: Food and Agriculture Organization of the United Nations (FAO).

Rivera, W. M. (1996): Agricultural extension in transition worldwide. Structural, financial and managerial strategies for improving agricultural extension. In *Public Administration and Development* 16 (2), pp. 151–161. DOI: 10.1002/(sici)1099-162x(199605)16:2<151::aid-pad868>3.0.co;2-s.

Salomon, M. and P. Engel (1997). Networking for innovation - A participatory actor-oriented methodology. Amsterdam, Royal Tropical Institute.

Sol, Jifke; Beers, Pieter J.; Wals, Arjen E. J. (2013): Social learning in regional innovation networks. trust, commitment and reframing as emergent properties of interaction. In *Journal of Cleaner Production* 49 (0), pp. 35–43. DOI: 10.1016/j.jclepro.2012.07.041.

Tisenkopfs, Talis; Kunda, Ilona; šūmane, Sandra (2014): Learning as Issue Framing in Agricultural Innovation Networks. In *The Journal of Agricultural Education and Extension* 20 (3), pp. 309–326. DOI: 10.1080/1389224X.2014.887759.

Weyer, J. (Ed) (2008): Soziale Netzwerke – Konzepte und Methoden der sozialwissenschaftlichen Netzwerkforschung [social networks – concepts and methods for sociological network research]. Oldenbourg Verlag. München.

World Bank (2012). Agricultural Innovation Systems - An Investment Sourcebook. Washington DC, World Bank.

Chapter 4

Adoption of Farm Management Systems for Cross Compliance – An empirical case in Germany

This chapter is based on the publication:

Knuth, Ulrike; Amjath-Babu, T. S.; Knierim, Andrea (2018): Adoption of Farm Management Systems for Cross Compliance - An empirical case in Germany. In: *Journal of Environmental Management* 220, S. 109–117. DOI: 10.1016/j.jenvman.2018.04.087.

Journal of Environmental Management 220 (2018) 109–117

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

Adoption of Farm Management Systems for Cross Compliance – An empirical case in Germany

Ulrike Knuth [a, *], T.S. Amjath-Babu [a], Andrea Knierim [a, b]

[a] Leibniz Centre for Agricultural Landscape Research (ZALF) e.V., Institute of Socio-Economics, Eberswalder Str. 84, 15374 Müncheberg, Germany
[b] University of Hohenheim, Institute of Social Sciences in Agriculture, Rural Sociology, Schloss 1C, 70599 Stuttgart, Germany

ARTICLE INFO

Article history:
Received 10 November 2017
Received in revised form
30 March 2018
Accepted 20 April 2018

Keywords:
FMS
Farm Advisory System
FAS
Common Agricultural Policy
Environmental management
Cross Compliance

ABSTRACT

In Germany, Farm Management Systems (FMS) have been introduced as a support to farmers' compliance with environmental and other regulations, aiming at the increase of farm level performance and sustainable farming practices. Different kinds of FMS were developed and promulgated with various approaches, determined by each federal state's agricultural advisory system. Knowledge on the FMS' uptake and effectiveness has been lacking so far. The overall aim of this paper is to provide an analysis of the implementation process and selected outcomes of the policy-driven instrumental innovation of FMS. In particular, the objectives are i) to reveal how and with what success the introduction of FMS has been realised in Germany and ii) to analyse and discuss the FMS' adoption in the federal state of Brandenburg. For the first part of the study, we elaborate a situational analysis of the policy implementation through a desk study and expert interviews. In the second part, selected results from a farmers' survey in Brandenburg are presented and a switching regression model is developed to assess the factors responsible for the uptake of FMS and to understand the role of FMS in improving the confidence in complying with Cross Compliance regulations. We found a high degree of diversity among FMS developed in the different federal states. FMS adoption rates varied, but were generally low. Institutional environment seems to have a significant influence as the same FMS had very different adoption rates among federal states. For Brandenburg, our findings show that farmers' confidence to face CC check was increased by the adoption of FMS. However, counterfactual scenario analysis proved that especially farmers who did not adopt FMS would have benefitted most if they had adopted the tool. Our study shows that there is a need for systems supporting farmers in dealing with bureaucratic requirements. Future FMS should be easy to understand, adaptable to individual farmers' needs and be available at low costs. Furthermore, there is a need to design FMS in a participatory way that integrates farmers' expectations.

1. Introduction

The concept of 'Cross Compliance' in agriculture (CC) evolved as an economic measure in the United States. The term CC refers to attachment of certain regulations (e.g., environmental requirements) to direct payments under agricultural policy (Meyer et al., 2014). The European Union introduced CC in 2003 with the aim to increase farm sustainability, defining standards regarding the environment, food safety, plant (and animal) health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental conditions (GAEC). Farmers are obliged to comply with them, if they want to be eligible for the 'single farm payments'. These regulations include two elements: (1) The Statutory Management Requirements (SMR), which refer to almost 20 legislative standards in the field of the environment, food safety, animal (and plant) health and animal welfare and (2) the GAEC obligation, which refers to a range of standards related to protecting soil, maintaining soil organic matter and structure, avoiding the deterioration of habitats, and exercising water management practices (EC, 2003). Widely, CC was perceived as an additional challenge for farmers, given the already complex European farming regulations and documentation requirements as well as increasingly demanding quality assurance standards to be fulfilled for marketing of products. Not surprisingly, scepticism regarding the capacity of farmers to comply with CC regulations surfaced shortly after introducing the scheme. Policy makers

* Corresponding author.
E-mail address: knuth@zalf.de (U. Knuth).

https://doi.org/10.1016/j.jenvman.2018.04.087

expected that farmers will need support to introduce the CC requirements into their daily farm managerial routines (ADE, 2009a; Celio et al., 2014).

Along with the introduction of CC in the EU, how to support farmers to comply with CC was discussed (Schramm and Spiller, 2003; Entrup et al., 2007). Farm-Audit similar to quality assurance certification schemes emerged as a first idea within the CAP Mid-term review in 2002. Later, this idea was replaced by the concept of an obligatory 'Farm Advisory System' (FAS) for Member States and combined with increased public control of agricultural land use by establishing the 'Integrated Administration and Control System' (IACS) (Schramm and Spiller, 2003). Consequently, FASs were included within the regulation regarding CC and the Single Payment Scheme (EC, 2003), making the availability of advisory services on CC standards binding for all EU member states by 2007.

1.1. Implementation of CC & FAS in Germany

The implementation of FAS in the EU member states was initiated by the rural development authorities and took place within the existing institutional settings at national or regional level. Largely, it resulted in two distinct organisational forms: (i) in a number of states, the FAS were newly established in parallel to existing agricultural advisory systems (e.g. Bulgaria or Hungary) while (ii) in other countries existing agricultural advisory systems were updated and complemented with the 'FAS' component (e.g. Germany, Netherlands, Denmark). An evaluation of the policy implementation at member state level was conducted (ADE, 2009a) shortly after their implementation at member state (MS) level. Despite limited evidence, this evaluation came to the conclusion that FAS contribute to awareness raising among farmers, of material flows and on-farm processes related to environmental, food safety or animal health aspects, and that they support the implementation of CC requirements. Furthermore, the core approach of on-farm, one-to-one advice based on checklists (in 18 MS implemented by 2008) was assessed to be particularly effective compared to off-farm or one-to all approaches (ADE, 2009b). Apart from this initial assessment, little is known so far about results and impacts of FAS on CC as there has been no second evaluation since 2009. A recent overview study on European agricultural advisory services as one key actor for farmers' access to relevant and reliable knowledge concluded that the data available to evaluate the impact of the advisory services (Knierim et al., 2017) is insufficient for meaningful assessment, a situation that is reported to prevail broadly in OECD countries (OECD, 2015).

Together with Great Britain, Italy and Belgium, Germany is one of the few European countries where the implementation of agricultural advisory systems is mandated at a regional (state) level, which resulted in considerable institutional diversity (Hoffmann et al., 2000). In addition to this diversity and in contrast to all other EU member states, the German implementation of FAS was combined with the dissemination of farm management systems (FMS). In this context, an FMS is defined as "an instrument for systematic documentation and analysis of production processes, aimed at continuously improving overall farm performance" (BMELV, 2006:1f). Strengthening of farm-level self-control and optimisation process through FMS became a political priority as manifested in a national subsidy scheme called 'Framework plan for the joint task of improving agricultural structure and coastal protection' (GAK) (BMELV, 2009; Boland et al., 2005). FMS was assumed as a facilitating agent of farmers' compliance to CC and consecutively, public support for CC related farm advice was linked to the introduction and implementation of this instrument. The national ministry for Agriculture (BMELV) recommended the implementation of FMS to the federal states. Depending on the state-level advisory system, FMS were developed by public institutions, agricultural chambers or independent private consulting companies. Between 2007 and 2013, the national FAS policy provided financial support for advisory services combined with FMS. It ended with the start of the new CAP period (2014–2020) and app. 15 Million Euro were spent (BMEL, 2017).

Thus, we frame the introduction of FMS in Germany as a policy driven innovation process in the agricultural sector aimed at increasing farm sustainability (Herrera et al., 2016). As farmers' adoption of environment-related instruments and practices is a complex process, usually influenced by a broad range of socio-structural and situational determinants (Siebert et al., 2006; Burton, 2014), we consider the German setting a unique occasion to study a policy-driven instrumental innovation.

1.2. Objectives of the study

The overall aim of this paper is to provide an analysis of the process and outcomes of the policy-driven instrumental innovation embodied in FMSs that targeted enhancement of farm level performance and sustainability through ensuring CC. Based on review of policy documents and current literature, we elaborate the aims and characteristics of FMS as defined within the German policy framework and categorise them within the context of agriculture-related management systems. Additionally, the state of empirical evidence and discussion on factors influencing farmers' FMS adoption is summarised. The current work investigates whether farmers' modified behaviour with regard to (CC) is indeed related to the adoption of a new information management tool. We use qualitative and quantitative data from a German case study on FMS and CC-related advisory services generated from expert interviews and a farmers' survey.

The objectives are i) to reveal how and with what success the introduction of FMS has been realised in Germany and ii) to specifically analyse and discuss the impact of FMS' adoption in ensuring CC in the German federal state of Brandenburg. For the first objective, we adopt an explorative approach and elaborate a situational analysis of the policy implementation. Specific research questions addressed are: (a) with what measures and methods did the state-level, agricultural advisory services develop and implement FMS, and (b) what adoption results were reached? For the second objective, we present an in-depth analysis of factors determining the adoption of FMS in Brandenburg. The specific research questions addressed here are: (c) what determined the adoption of FMS and (d) did FMS contribute to enhancing CC?

2. Conceptual background of FMS adoption

2.1. Farm Management Systems – aims and characteristics

The term 'farm management system' as used in the German subsidy scheme (BMELV, 2009), is not defined in scientific literature so far. Table 1 gives an overview – based on literature and expert interviews - of the most important farm management related systems, their aims and characteristics, and examples. While common denominators are their ordering and control functions, they are specific with regard to whether they address the whole or only parts of the farm's management with an aim of either supporting internal management or external transparency creation, or both.

Within the German subsidy scheme, FMSs (row 1 in Table 1) are defined as systems to support self-control of farm enterprises and to improve overall farm performance. The use of FMS is supposed to increase quality of products and processes, to ascertain the traceability of products, improve animal welfare and protection, to

Table 1
Farm management related systems in Germany, own compilation.

	Farm management related system	abbreviation	aims and characteristics	Examples
1	Systems for supporting self-control in farm enterprises	FMS	aim: to support systematic documentation and self-control to prove compliance to at least legal and subsidies related requirements or also combined with certification related requirements; in Germany only; paper or software-based systems based on checklists	GQS; KKL (2005–2011); CroCos (2005–2013)
2	Quality assurance programmes	QS	aim: to meet trade and market quality requirements, higher standards than basic legal requirements for farming; (regular) certification audit included	GlobalGAP, Fairtrade, EU Eco label; in Germany: QS (meat); QM (milk)
3	Environmental Management Systems	EMS	aim: improvement of environmental performance in organisations including legal compliance, continuous improvement process following own aims, environmental statement or performance report; government supported, certification included	EMAS (Eco Management and Audit Scheme); EFP Canada,
4	Operational management tools for single farming tasks or farm branches	OT	aim: efficient data and information management on-farm (documentation, planning, optimization, control, analysis, etc.); often software-based	Field cards, herd management programmes, sheets for economic farm assessment

contribute to an environmentally friendly production, to increase the work place security and to warrant an efficient implementation of the new standards from the EU regulation (BMELV, 2006). The policy differentiated between two levels of systems: i) 'systems to improve overall farm performance' (basic level) and ii) 'comprehensive FMS' (advanced level). The main difference is certification, which is compulsory for funding for the advanced level (BMELV, 2009).

FMS consist, in general, of (i) a checklist for self-control, (ii) a filing system for documentation and (iii) a set of additional information material on the background of requirements. Some FMS only refer to the CC requirements while others include requirements of additional quality management or certification systems such as QS, EurepGap, EMAS or ecological farming (row 2 in Table 1). FMS are available on paper and/or additionally a CD or as electronic version only (Zapf, 2009). Checklists in certification based quality assurance systems can include the same criteria as checklists for CC in FMS. Thus, it has become one aim of some German FMS to include all criteria available to develop a generic database. Depending on certification programmes or environmental management schemes each farm participates (Zapf, 2009), the database can be used to develop a customized farm-specific checklist that including all relevant criteria. This corresponds with research developments which seek to create documentation systems for automated (internal) compliance control in agriculture (Sørensen et al., 2010; Nash et al., 2011; Nikkilä et al., 2012).

Environmental Management Systems (EMS) are closely related to FMS as defined above, and frequently go beyond the legal requirements in their management goals. Additionally, they have the aim to provide information and tools to inform the public about the environmental performance of a farm. Investigated examples are the EMS supporting programmes in Australia (Cary and Roberts, 2011) or the Environmental Farm Plans (EFP) in single provinces in Canada (Atari et al., 2009; Knierim, 2007), and in New Zealand (Manderson et al., 2007). The latter ones in particular, are rather planning tools than documentation tools like FMS. Operational management tools differ from FMS, when they address only particular farming tasks or farm branches like herd management or field cards for plant production. They are not considered systems to address the whole farm.

2.2. Factors influencing farmers' FMS adoption behaviour

Farmers' adoption of innovations has been an object of scholars' interest for more than fifty years and a vast number of empirical studies exist. One impressive proof are the publications of E.M. Rogers and his colleagues, as compiled in the classical reader 'diffusion of innovations' (published in its 5th edition in 2003). However, although these authors propose both innovation characteristics and procedural steps of the process as cross-cutting success features, there are also critics who emphasise the situational contingency of innovation adoption (Hoffmann, 2007; Albrecht, 1973). Hence, it is necessary to extend the analysis to subjectively perceived fostering and hindering factors (Hoffmann et al., 2009) and to broaden the range of considered influencing factors towards the embedding social system, e.g. the role of family members, colleagues, neighbours and communities of practice (Siebert et al., 2006).

Frequently, studies on farmers' adoption behaviour concentrate on farm and farmer characteristics to be influential including e.g. age and gender of farmer, farming experience, formal education, farm income, size and type of business etc. – a convention that is criticised for its frequent lack of unequivocal demonstration of cause-effect relations (Siebert et al., 2006; Burton, 2014). Farmers' beliefs and subjectively perceived norms and constraints have equally been reported as averagely to strongly influencing factors on (intended) behavioural change (e.g. Werner et al., 2017). Recent studies on farmers' search for information and knowledge exchange in the context of innovation processes provided evidence on the importance of both, peers and colleagues as well as advisors as influencing innovation related decision making (Klerkx and Proctor, 2013; Oreszczyn et al., 2010).

Looking closer at studies addressing farmers' adoption of farm management related systems, we identified only a small number of empirical research mostly stemming from Canada and Germany. Atari et al. (2009) investigated participation in the environmental farm plan (EFP) in Novo Scotia, Canada and found a positive relation given with farm income, years of farming experience, and type of agribusiness while a negative relation was observed with age and formal education. Higher participation rates could be observed among livestock producers, similar to EFP implementation in Ontario, Canada and the Countryside Stewardship Scheme in England (Atari et al., 2009). Adoption of Farm Management Information systems as computer-based technologies/software are related to most importantly age, formal education and skills related aspects such as learning style or information management. The farm-advisor relationship may also contribute, but is not considered as important as formal education and farmers' opinions and experiences (Alvarez and Nuthall, 2006). Therefore, "Farmers with small farms, being 50 years or older, with less formal education, and with learning styles that emphasize either concrete experience or active experimentation, in contrast to reflective observation or abstract conceptualisation, are less likely to use software than colleagues exhibiting different characteristics" (Alvarez and Nuthall, 2006:

p.58).

Knierim (2007) argues that the Environmental Farm Plan (EFP) programme in Ontario, Canada can be considered a success with regard to FMS adoption, with approximately 27.000 farmers participating in the initial trainings and more than 50% of Ontario's farmers being at least partially enrolled in the programme. Fostering factors included an active role of farmers' organisations in developing and implementing EFP as well as intensive cooperation of several other corporate actors from the public and private agricultural sector (Knierim, 2007:353). Financial incentives, which are often assumed as key drivers for adoption, played a less important role (Atari et al., 2009; Knierim, 2007), instead facilitated learning processes through motivating group training events, where informal information exchange as well as phases of individual reflection, assessments and activity planning are assumed to be important. Nevertheless, cost free access in the initial phase, as it was the case in Ontario, is assumed to be very helpful.

Factors impacting on satisfaction with different quality management systems in Germany were investigated by Enneking et al. (2007). They concluded that socio-demographic factors have no influence and that instead the gains in image, in sales and in production efficiency are important factors. A system's costs were found to be less influencing than (expected) effects from its implementation. Application trainings were described as highly appreciated by farmers and follow-up events for participating farmers to clarify questions, inform on news and refresh motivation were recommended.

3. Material and methodology

3.1. Research approach and data collection

We combined an explorative, Germany-wide overview on FMS adoption with an in-depth study on influencing factors in the German state of Brandenburg. We made use of a mixed method approach and complemented qualitative expert interviews with a quantitative survey (Punch, 2005). The data source of the study is part of an exploratory study on CC related advisory services conducted for the Ministry of Agriculture in Brandenburg in 2009 (Knierim et al., 2011). It included a desk study, 13 semi-structured interviews with experts on agricultural advisory services and FMS from national and state level authorities and a questionnaire-based telephone survey with 71 farm managers in Brandenburg.

The desk study analysed websites on German FMS, reports and grey documents from public authorities and statistics received through interviews. Expert interviews were recorded, summarised, crosschecked following a protocol and authorised by the interviewee. The telephone survey was conducted with a sample stratified according to farm size, representative for the heterogeneous farm structure in Brandenburg (Knuth and Knierim, 2013). The questionnaire contained mainly closed questions regarding CC related advisory services including the use of FMS. In this paper, we present an analysis of selected responses pertaining to farmers' information needs and experience with FMS. The questionnaire was discussed with two experts on FMS and pretested with four farmers and thereupon modified.

3.2. Data analysis

We performed a manual content analysis of the interviews' transcripts and the desk study material to distinguish FMS characteristics (content wise, costs, ways of using them), adoption and farmers' assessments of the systems (Punch, 2005). The farmers' survey response rate was satisfying, as from 140 contacted farm managers 71 completely filled questionnaires were collected. Data was checked for plausibility, digitalized and a descriptive analysis was conducted with IBM SPSS.

Secondly, the impact of FMS adoption on meeting the cross compliance obligations was quantitatively analysed. In order to answer questions regarding the adoption of FMS and its impact on confidence to face administrative checks on CC, it is necessary to understand the counterfactuals i.e. would there be any change in confidence level if farmers who did not adopt the FMS were to adopt the system or if the adopters were to dis-adopt the system. The confidence level of farmers regarding CC regulations was measured by the following question: “Imagine, you are being informed that your farm is going to be checked on CC in the following days by the administrative bodies. Do you feel safe in all fields of CC?“ Interviewees were asked to assign a score between 0 and 100. The problem in hand fits well for an endogenous switching regression model (Ghimire and Kotani, 2015),where

$$A^i = 1 \; if \; \beta Z^i + u^i > 0 \tag{1}$$

$$A^i = 0 \; if \; \beta Z^i + u^i \leq 0 \tag{2}$$

where A^i is the adoption of FMS system and Z^i are determinants of its adoption.

In case of confidence in meeting CC requirements, this leads to two regime equations

$$\text{Regime 1} : C^i = \gamma_1 X_1^i + \varepsilon_1^i, \; if \; A^i = 1 \tag{3}$$

$$\text{Regime 2} : C^i = \gamma_2 X_2^i + \varepsilon_2^i, \; if \; A^i = 0 \tag{4}$$

Equation (3) indicates the confidence level when FMS is adopted, while equation (4) represents the confidence level when there is no adoption of FMS. The model is estimated using the “Movestay” package of STATA software. The set of explanatory variables related to adoption of FMS viz. education level of farmers, size and type of farms, previous experience on checks for CC, organizational linkages of farmers etc. are selected on the basis of previous literature described in section 2.2. The variables included in the model are explained further in Table 4 in the result section.

4. Results

The results of the exploratory study at federal states' level and of the Brandenburg case study on the effect of FMS on CC of farms are provided in the sections below.

4.1. FMS implementation and adoption in Germany

The study among experts clearly reveals the diversity of the German FMSs and that adoption of FMS in Germany is low to very low in most states. FMS were developed by various actors across the states (Table 2, column 2). While some public agencies engaged in their development (e.g. Baden-Wuerttemberg), in other cases, adaptations of the FMS developed by the national farmers' association (KKL), which is a comprehensive checklist (all possible requirements a farm has to comply with) that can be customized according to farm level specifics, were disseminated (Bavaria, Lower Saxony).

Regarding the FMS characteristics, a basic and a comprehensive version can be distinguished: basic FMS only refer to CC requirements in their checklist (e.g. CroCos in Brandenburg, Saxony-Anhalt or Mecklenburg-West-Pomerania), while comprehensive FMS go beyond CC and include requirements of quality management or other certification systems (e.g. GQS in Baden-

Table 2
Overview of FMS in selected German states (2010).

Federal state	Main advisory system	Widely spread FMS[a]	FMS characteristics		FMS advice subsidized?	Uptake by farmers in the state in %[c]
			CC or CC+	Costs[b] in €		
Lower Saxony	Chambers	BMS/KKL	CC+	670 for FMS + advice	yes	20
Bavaria	Mixed	Mein Bauernh of check (KKL)	CC+	65 for training	no	15
Saxony	Mixed	GQS SN	CC+	35	no	11
Saxony-Anhalt	Private	CroCosST	CC	95	no	2,5
		CroCosST-KKL		400	no	
Thuringia	Private	USL-CC; CCM-IAK	CC	–	yes	7
			CC	600		
Mecklenburg-West Pomerania	Private	CroCos-KKL	CC+	500 for FMS + advice	No	5
Baden-Wuerttemberg	Mixed	GQS $_{BW}$	CC+	55	yes	5
Brandenburg	Private	CroCosLAB	CC	250	no	–
		CroCosKKL	CC+	350	no	–

[a] The FMS in this column are commonly known by the acronym presented.
[b] If nothing else mentioned, costs for a handbook including a checklist as paper version for first year of purchase; yearly update costs are not included.
[c] Source: expert interviews 2009; CC = checklist refers only to CC legal requirements, CC+ = checklist can be adjusted to farm specific and includes additional to CC legal requirements, other requirements like QS, organic farming, etc. The FMS adoption figures relied on sales and/or were estimated by experts.

Württemberg or KKL in Lower-Saxony) (cf. FMS characteristic 'CC' and 'CC+' in Table 2). FMS were made known to farmers by public authorities at state level, so that in all states at least one FMS was available. Similar to the FMS development, also a huge diversity of the institutional setup for the provision of CC-related advice became evident: In some cases, it was carried out by official agencies only (e.g. Baden-Württemberg, Hessen, Saxony), in others by official agencies in collaboration with farmers' organisations (Bavaria), or by the agricultural chambers (Lower Saxony, Rhineland-Palatinum, Schleswig-Holstein) or by private advisory enterprises (Brandenburg, Saxony-Anhalt, Thuringia).

Costs of FMS ranged between 0 and 1000 Euro per unit, in states with private advisory systems often higher than in public or mixed systems. Subsidies for advice related to the introduction of FMS were available only in 5 out of 16 states. The main advisory approach was one-to-one advice. Only in Bavaria, a group approach was implemented by the state-level farmers' union, training farmers to use the KKL checklist independent of advisors. Additionally, some states provided a cost-free official CC checklist (e.g. Mecklenburg-Pomerania) or offered cost-free advice on single aspects of CC without FMS (e.g. Bavaria). Although widely propagated, the system KKL was not longer updated at national level after 2011 because of overall low uptake numbers, and only two single versions on federal state level (KKL$_{BY,}$ BMS/KKL) were continued.

The overall FMS adoption figures in Germany were lower than expected by experts and the views on the future of FMS for CC were predominantly negative. This was especially evident in private advisory systems. Apparently, in the first years of implementation of CC and related FMS support (2005–2007) adoption figures were high in some states, though declined in subsequent years. Several experts related the low uptake of FMS with farmers' first experiences in CC checks which they described as less alarming than expected. Highest overall uptake could be observed in Lower Saxony with 20% of all farmers, a state with semi-public advisory services (agricultural chamber) and subsidized FMS development and implementation. One expert at national level evaluated the group approach in Bavaria - off-farm trainings on how to use KKL$_{BY}$ to be more effective than the one-to-one approach in all other KKL-implementing states. Also surprising is the fact that the FMS GQS in Baden-Wuerttemberg, developed by a public authority and promoted in adjusted versions by several further German states, had a relatively low uptake with only 5% of all farmers adopting it.

4.2. Cross compliance and FMS adoption in Brandenburg

In Brandenburg, the existing agricultural advisory system is exceptional within Germany as well as within Europe, as it is completely privatized (Knuth und Knierim, 2013). Therefore, farm advice related to Cross Compliance had to be paid by farmers only, and FMS that support CC were developed by private consultancy firms and promoted without subsidies. Two such FMS viz. CroCosLAB, CCM-AHB, received official recommendation from the Ministry of Agriculture. CroCosLAB is basically a management handbook including a checklist restricted to CC requirements. It is not possible to generate a farm specific checklist.

Before investigating the use of FMS, we present farmers' response on what topics they needed information or advice and how often (cf. Table 3). The selected topics were items chosen to cover the regulations of Statutory Management Requirements (SMR) and GAEC obligation (EC, 2003) aiming to check farmers' information demand for all farm management aspects of CC. For some cases, this selection, resulted in thematic overlap (e.g., general biodiversity and farm bird biodiversity), which is already inherent to the categorization of Cross Compliance regulation. Our results show that farmers mainly need assistance with fertilizers and pesticide related regulations, KULAP and Natura 2000 policy instruments as well as animal health and diseases issues. They seldom seek advice on topics such as application of sewage sludge, grassland protection and animal friendly stable construction. Table 3 also shows only few items on which some farmers often take advice, specifically pesticides usage and animal health. A weighted score is created to rank the CC topics with regard to information demand. Noticeable, is the high number of farmers that claim not to need information (22% or more mentioned 'never'). This may relate to the disproportionately high education level within the sample, as 70% (50 out 71) have a university degree (Knierim et al., 2011).

The interviewed farmers' understanding of FMS was broad and included all systems listed in Table 1. Therefore, 44 out of 71 farmers stated to use an FMS while only five out of them used an FMS, which was explicitly developed to support CC (CroCos LAB) and recommended by the Ministry of Agriculture. A quarter of sampled farmers (18 out of 71) depended on regional Quality assurance systems (QS or QM) and 11 mentioned "self-developed systems" (Fig. 1). The State Ministry's recommendation for two FMS

Table 3
Farmers' stated demand for information & advice on CC-topics (N = 71) in Brandenburg, Germany.

CC topics	R1 (often)[a]	R2 (sometimes) [a]	R3 (seldom) [a]	R4 (Never)	Weighted Score[b]	Rank
Application and storage of fertilizers and its documentation	6	34	9	22	44,6	1
KULAP/Natura 2000 area	9	26	9	24	43,1	2
Application and storage of pesticides and its documentation	11	25	7	28	42,3	3
Animal health/diseases	12	19	13	26	41,4	4
Safe handling and storage of food and feed	6	23	18	23	39,0	5
Crop rotation and organic soil matter balance	6	18	19	28	34,3	6
Safe storage of hazard substances, e.g.: diesel, machine oil	2	22	21	25	33,8	7
Protection of landscape features	4	19	17	31	31,5	8
Protection of biodiversity	1	21	21	27	31,4	9
Mitigation/prevention of erosion	2	20	19	30	30,5	10
Herd register and animal identification	7	16	12	36	30,5	10
Bird protection	3	17	15	36	27,2	12
Maintenance of fallow land	1	16	16	38	23,9	13
Animal friendly stable construction	3	10	19	38	22,9	14
Grassland protection/possibilities for ploughing up grassland	1	13	19	38	22,5	15
Application of sewage sludge	0	3	4	63	4,8	16

[a] Frequency: **often**: more than once per year, **sometimes**: once per year, **seldom**: less than once per year.
[b] Weighted Score: (3*R1 + 2*R2 + R3)*100/(number_of_responses*3).

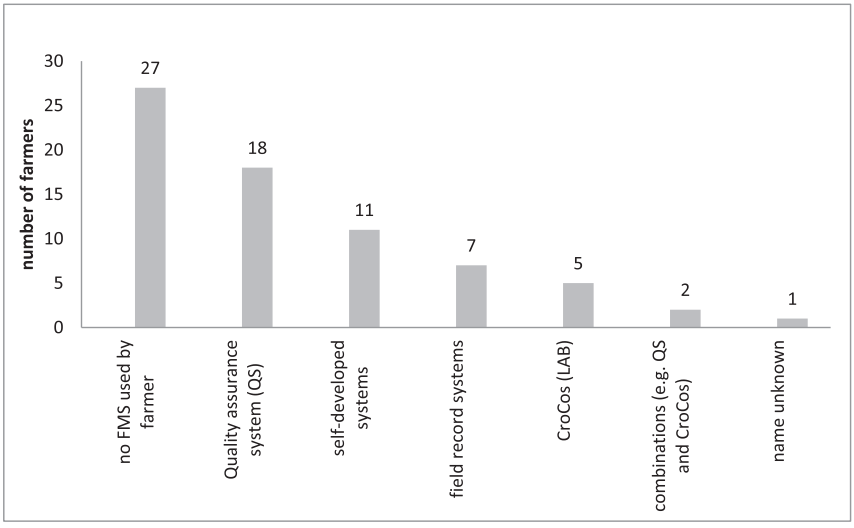

Fig. 1. Adoption of FMS and related systems in Brandenburg.

was only known by 8% (6 out of 71). Farmers, who stated that they used an FMS, were asked how helpful they find it for compliance with CC requirements. Roughly half of them (24 out of 44) evaluated their system as overall helpful (grade 1 or 2). Those farmers that evaluated their system as partly (or not at all) helpful, most often used quality assurance systems (9 out 12). Regarding CC checks, 53 out of 71 interviewed farmers mentioned some degree of confidence in case they would be checked. Among the 17 farmers, who explicitly mentioned to be least confident were 11 farmers who used a quality assurance system, operational tools or systems they had developed themselves while six did not use an FMS or related system.

Due to data limitations, farm managers (regimes) are grouped as non-adopters and adopters. Adopters include users of either quality assurance systems, operational systems/tools or other market-offered/commercial systems. Farmers who mentioned 'self-developed system' are considered non-adopters.

4.3. Factors influencing FMS adoption and confidence in Brandenburg

The estimated switching regression results are provided in Table 4. The estimated adoption equation shows that education of the farmers, size of the farm and costs of farm advisory services are the major factors in adoption of FMS and related systems in the state of Brandenburg. Farmers that spent high on advisory services tended to adopt FMS or related systems. It is also clear that frequency of administrative checks on CC compliance drives the adoption of FMS in Brandenburg. In case of confidence, regime equations show that size of the farm and the adoption status of FMS are the major factors that affected the confidence level in meeting CC. Education level did not affect the confidence level but affected the adoption of FMS. The influence of FMS on the confidence level is explained by the counterfactuals described in next section.

4.4. Counterfactual scenario

In order to understand the impact of adoption of FMS on the confidence level of farmers on readiness for an administrative check on CC on their farms, two counterfactual scenarios are estimated using the regime equations. Firstly, observed confidence level of farmers who adopted an FMS and predicted confidence using regime equation (1) is compared to a scenario of "without FMS" predicted by regime 2 equation. Fig. 2 shows that the

Table 4
Estimated regime equations and adoption equations using endogenous switching regression model.

Regime	Variables	Explanation	Coefficients
Confidence level of adopters in meeting CC requirements			
	Edu-dummy1	Attained at least University Education = 1 or else 0	−19.59
	Size_200_500	Farm size between 200 and 500 ha	−89.55**
	Size_500_1000	Farm size between 500 and 1000 ha	−65.22**
	Size_1000_cons	Farm size more than 1000 ha	−52.46**
		Constant	228.98**
Confidence level of non-adopters in meeting CC requirements			
	Edu-dummy1	Attained at least University Education = 1 or else 0	−10.92
	Size_200_500	Farm size between 200 and 500 ha	−28.62
	Size_500_1000	Farm size between 500 and 1000 ha	−91.41**
	Size_1000_cons	Farm size more than 1000 ha	−9.15
		Constant	69.0**
FMS adoption			
	Size_200_500	Farm size between 200 and 500 ha	2.61**
	Size_1000	Farm size more than 1000 ha	1.98**
	Edu-dummy1	Attained University Education = 1	1.89**
	Size_500_1000	Farm size between 500 and 1000 ha	2.39**
	Checkd2	Already checked for CC	0.23**
	Edu-dummy2	Attained Apprentice level Education = 1	1.50**
	Membership	Member of farmer organisations	0.25
	Costsf1	Cost of advisory services	0.16*
	Pigpoultry	Pig and Poultry farm	0.10
	Mixfarm	Mixed farm	−0.14
	_Cons	Constant	−5.44**

** Significant 0.05 level and * 0.1 level.

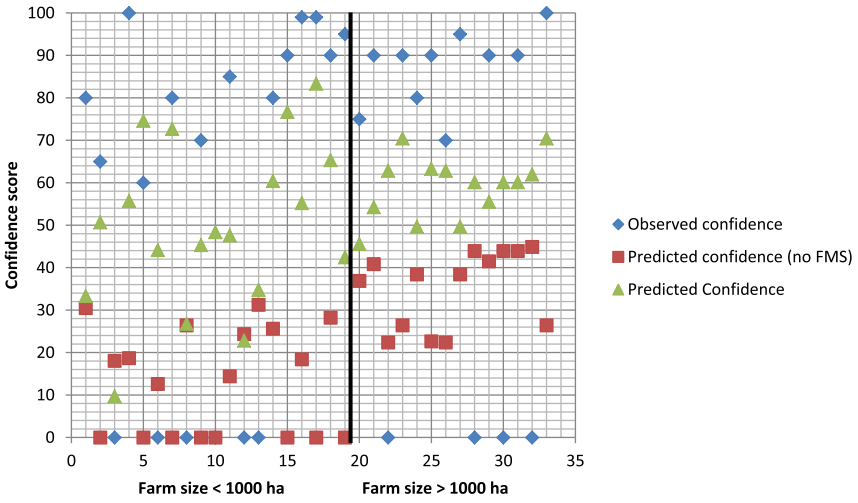

Fig. 2. Farmers' confidence scores in counterfactual scenario of dis-adoption of FMS by adopters.

predicted level of confidence of farmers who adopted the FMS decreases from an average score of 53 to a score of 22 in case of 'no FMS scenario' (dis-adoption). It is to be noted that mean observed confidence (against CC check) of farmers who adopted FMS is 59.5 out of 100. The average gain of confidence by farmers who adopted the FMS is 31 points. Fig. 2 also shows that large farmers with more than 1000 ha are much more confident in complying CC without FMS adoption.

Fig. 3 shows a scenario where the farmers who did not adopt FMS adopt the FMS. The estimated relation shows that most of the farmers would become fully confident if they adopted the FMS. It is to be noted that mean predicted and observed confidence of farmers who did not adopt the FMS is 63 out of 100. Comparing Figs. 2 and 3, it can be noticed that non-adopters predicted to be more than 50% confident to face a CC check without an FMS while the adopters are less than 50% confident to face a CC check without the FMS system. Because of the already high confidence level, the non-adopters could become 100% confident with adoption of an FMS system irrespective of the size of their farm.

5. Discussion

5.1. Adoption of FMS in Germany

The diversity of FMS developed in Germany is striking and fits to the diverse landscape of advisory systems in the country. This is due to the delegation of responsibilities for FAS implementation to each federal state. The results in Table 2 show overall low but diverging adoption figures for FMS in each state. They suggest that FMS characteristics, e.g. certification included or not, and the institutional environment including subsidies and different advisory approaches are influencing factors. Further research is needed to investigate the influence of the institutional environment of FMS support, in particular subsidies to use advisory services to

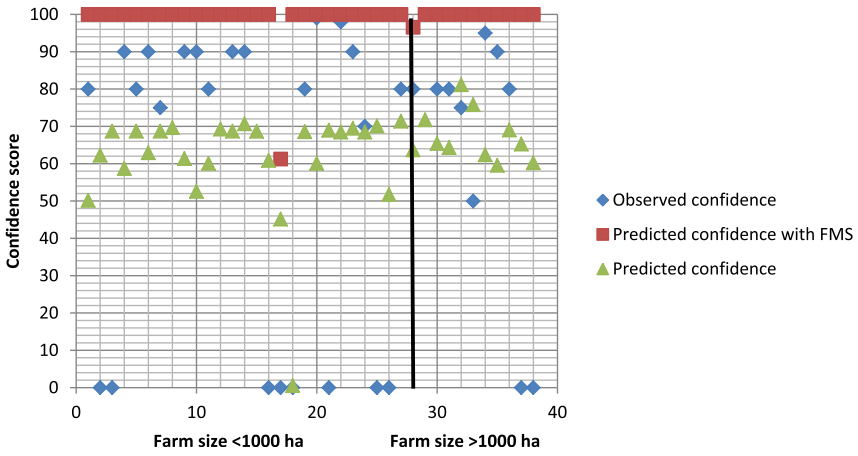

Fig. 3. Farmers' confidence scores in counterfactual scenario of adoption of FMS by non-adopters.

implement an FMS and other innovation support measures. Gunningham (2007) pleads for an optimal policy mix of regulation, economic instruments, education and information as well as self-regulation.

In addition, the role of market support measures in FMS adoption and related policy arrangements merits more research efforts. Advantages for farmers from using FMS beside improved preparation for and reducing risks during inspections, lie in opportunities to market their products at higher prices (Kempa and von Haaren, 2012). Certificate or product labels are considered important for widespread adoption of environmental management systems (Cary and Roberts, 2011; Gunningham, 2007). Hence, it will be important to integrate marketing opportunities to FMS in order to drive adoption with the ideal option of an FMS that can augment existing quality management systems (QS) and ensure good farm management practices as well as explore commercial options while helping to maintain the farm stewardship (Enneking et al., 2007).

An aspect closely related to software-based farm information management systems is that "the system must be configurable to suit a range of farm(er) characteristics" (Alvarez and Nuthall, 2006: 48). The FMS named KKL was such a system aiming to include all possible requirements to be applied by a farm in Germany and to be adjustable to provide a farm specific checklist. The fact that it did not provide additional marketing opportunities could be a reason for it to fail as a federally promoted system. Nevertheless, in Bavaria this system adjusted to regional condition combined with a group advice/training approach and cost-free access to generate a farm-specific checklist promoted by the Bavarian Farmers Union was quite successful. Here, we might see a confirmation of the importance accorded to group training approaches for successful dissemination (Atari et al., 2009; Knierim, 2007), which was equally considered by experts as more successful than one-to-one advisory approaches in other KKL implementing states.

5.2. Adoption in Brandenburg

The survey results show a low adoption rate of officially recommended FMS in Brandenburg. The calculated scores of topics requiring information or advice (Table 3) indicate overall low information demand which we attribute to the high level of education among the interviewed farm managers. We tend to confirm that formal education is an important influencing factor for information management skills, as it enhances the ability to cope with administrative procedures (Alvarez and Nuthall, 2006; Siebert et al., 2006). The differential of coefficients on university and apprentice level education on adoption of FMS supports such an argument. It may need further investigation on how to design FMS that can be easily used by farmers of any educational level.

The counterfactual in Fig. 3 shows that farmers who did not adopt the FMS are those that would have benefitted most from their adoption. The farmers who are adopters have gained additional confidence as depicted in Fig. 2. Nevertheless, it is to be noted that farmers who actually adopted the FMS were those with comparatively lower confidence than the other group. It also shows that the farmers with less than 1000 ha are likely to adopt an FMS to increase the confidence to meet CC requirements. The evidence provided by the analysis points to the fact that FMS can be potentially an instrument to improve CC, especially if the compliance checks are more stringent.

5.3. Concluding remarks

The current research work sheds light on the previously unexplored field of how FMS systems influence the CC among European farmers. Though limited in geographical coverage, the findings show that the FMS is useful in enhancing the compliance of environmental requirements. The striking evidence is that non-adopters could have benefitted most if they had adopted the tool. This suggests an inadequate design of FMS in Brandenburg. The officially recommended version is rather used by farmers with lower confidence on CC, lower farm sizes and enough education to understand the complex tool as well as those who were checked by the officials on meeting CC requirements. There is the possibility of implementing FMS in Brandenburg that can offer multiple services by integrating with QS systems or certification systems and which can offer support to market the products. There is also a need to explore additional requirements for their enhanced use. The comparison of the results at federal state level shows that additional research is needed to check the influence of institutional environment on FMS adoption (e.g. group approach, subsidies for FMS related advisory services) to come up with an optimal policy mix within the respective context. Our study shows that there is a need for systems supporting farmers in dealing with bureaucratic requirements. Future FMS should be easy to understand, adaptable to individual farmers' needs and be available at low costs. Furthermore, there is a need to design FMS in a participatory way that integrates farmers' expectations. A detailed analysis on information needs, interface design requirements, expectations on support provided to market/label the products and cost considerations is necessary.

Acknowledgements

This material is based upon work supported by the Ministry of Agriculture Brandenburg, Germany under the project “Evaluation of the Farm Advisory System for Cross Compliance in Brandenburg with special focus on FMS”. Special thanks go to Carsten Paul for his constructive proof-reading.

References

ADE, 2009a. Evaluation of the Implementation of Farm Advisory System - Final Report – Descriptive Part. European Commission, Brussels.
ADE, 2009b. Evaluation of the Implementation of Farm Advisory System - Final Report – Evaluation Part. European Commission, Brussels.
Albrecht, H., 1973. Book Review of : Rogers, E.M. And F.F. Shoemaker (1971): Communication of Innovations. The Free Press, New York, 476 pp. Sociologia Ruralis 13 (3/4). pp. 294-299.
Alvarez, J., Nuthall, P., 2006. Adoption of computer based information systems: the case of dairy farmers in Canterbury, NZ, and Florida, Uruguay. Comput. Electron. Agric. 50, 48–60.
Atari, D.O.A., Yiridoe, E.K., Smale, S., Duinker, P.N., 2009. What motivates farmers to participate in the Nova Scotia environmental farm plan program? Evidence and environmental policy implications. J. Environ. Manag. 90, 1269–1279.
Boland, H., Thomas, A., Ehlers, K., 2005. Expertise zur Beratung landwirtschaftlicher Unternehmen in Deutschland. Eine Analyse unter Berücksichtigung der Anforderungen der Verordnung (EG) Nr. 1782/2003 zu Cross Compliance. In: E.u.L. (Ed.), Bundesministerium für Verbraucherschutz. Bonn.
Bundesministerium für Ernährung und Landwirtschaft (BMEL), 2017. Ausgaben und Empfänger "Einzelbetriebliche Managementsysteme", personal communication, 20.7.17.
Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV), 2009. Rahmenplan der Gemeinschaftsaufgabe „Verbesserung der Agrarstruktur und des Küstenschutzes (Framework plan for the joint task 'improving agricultural structure and coastal protection). BMELV, Bonn.
Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV), 2006. Empfehlungen zur Durchführung der Beratung unter Berücksichtigung der Anforderungen der Verordnung (EG) Nr. 1782/2003 zu Cross Compliance.
Burton, R.J., 2014. The influence of farmer demographic characteristics on environmental behaviour: a review. J. Environ. Manag. 135, 19–26.
Cary, J., Roberts, A., 2011. The limitations of environmental management systems in Australian agriculture. J. Environ. Manag. 92, 878–885.
Celio, E., Flint, C.G., Schoch, P., Grêt-Regamey, A., 2014. Farmers' perception of their decision-making in relation to policy schemes: a comparison of case studies from Switzerland and the United States. Land Use Policy 41, 163–171.
European Council (EC), 2003. No 1783/2003 of 29 September 2003 amending Regulation (EC No 1257/1999) on support for rural development from the EAGGF. Off. J. L 270 (21), 10.
Enneking, U., Obersojer, T., Kratzmair, M., 2007. Faktoren für die Zufriedenheit mit Qualitätssystemen aus Sicht der Primärerzeuger. Agrarwirtschaft 56, 112–124.
Entrup, V.N.L., Beck, J., Groeblinghoff, F.-F., 2007. Criteria for the documentation of Cross Compliance commitments of agricultural enterprises and other requirements regarding the development of single-farm management systems (under EC Reg 1782/2003 and GAK framework plan fort he period 2005-2008). Ber. Landwirtsch. 85, 358–389.
Ghimire, B., Kotani, K., 2015. A Counterfactual experiment on the Effectiveness of Plastic Ponds for Smallholder Farmers: a Case of Nepalese Vegetable Farming. Kochi University of Technology, School of Economics and Management.
Gunningham, N., 2007. Incentives to improve farm management: EMS , supply chains and civil society. J. Environ. Manag. 82, 302–310.
Herrera, B., Gerster-Bentaya, M., Knierim, A., 2016. Stakeholders' perceptions of sustainability measurement at farm level. Stud. Agric. Econ. 118, 131–137.
Hoffmann, V., 2007. Book review: five editions (1962-2003) of everett rogers' diffusion of innovations. J. Agric. Educ. Ext. 13, 147–158.
Hoffmann, V., Lamers, J., Kidd, A.D., 2000. Reforming the Organisation of Agricultural Extension in Germany: Lessons for Other Countries. Agricultural Research & Extension Network (AgREN). Network Paper No. 98.
Hoffmann, V., Gerster-Bentaya, M., Christinck, A., Lemma, M., 2009. Rural Extension Volume 1: basic Issues and Concepts, third ed. Margraf Publishers.
Kempa, D., von Haaren, C., 2012. A documentation system for environmental farm management: requirements and demands. Ber. Landwirtsch. 90, 395–416.
Klerkx, L., Proctor, A., 2013. Beyond fragmentation and disconnect: networks for knowledge exchange in the English land management advisory system. Land Use Policy 30, 13–24.
Knierim, A., 2007. Farm management systems and voluntary action: what can Germany learn from Canada? Int. J. Agri. Resour. Gov. Ecol. 6, 341–359.
Knierim, A., Knuth, U., Rupschus, C., Schläfke, N., 2011. Cross Compliance Beratung - Eine vergleichende Bewertung der Situation in Brandenburg. Margraf Publishers GmbH, Weikersheim.
Knuth, U., Knierim, A., 2013. Characteristics of and challenges for advisors within a privatized extension system. J. Agric. Educ. Ext. 19, 223–236.
Knierim, A., Labarthe, P., Prager, K., Kania, J., Laurent, C., Ndah, T.H., 2017. Pluralism of agricultural advisory service providers – facts and insights from Europe. J. Rural Stud. 55, 45–58.
Manderson, A.K., Mackay, A.D., Palmer, A.P., 2007. Environmental whole farm management plans: their character, diversity, and use as agri-environmental indicators in New Zealand. J. Environ. Manag. 82, 319–331.
Meyer, C., Matzdorf, B., Müller, K., Schleyer, C., 2014. Cross Compliance as payment for public goods? Understanding EU and US agricultural policies. Ecol. Econ. 107, 185–194.
Nash, E., Wiebensohn, J., Nikkilä, R., Vatsanidou, A., Fountas, S., Bill, R., 2011. Towards automated compliance checking based on a formal representation of agricultural production standards. Comput. Electron. Agric. 78, 28–37.
Nikkilä, R., Wiebensohn, J., Nash, E., Seilonen, I., Koskinen, K., 2012. A service infrastructure for the representation, discovery, distribution and evaluation of agricultural production standards for automated compliance control. Comput. Electron. Agric. 80, 80–88.
OECD, 2015. Fostering Green Growth in Agriculture. OECD Publishing, Paris.
Oreszczyn, S., Lane, A., Carr, S., 2010. The role of networks of practice and webs of influencers on farmers' engagement with and learning about agricultural innovations. J. Rural Stud. 26, 404–417.
Punch, K.F., 2005. Introduction to Social Research. Quantitative and Qualitative Approaches, second ed. Sage Publications.
Schramm, M., Spiller, A., 2003. Farm-Audit-und Farm-Advisory-System-Ein Beitrag zur Ökonomie von Qualitätssicherungssystemen. Ber. Landwirtsch. 81, 165–191.
Siebert, R., Toogood, M., Knierim, A., 2006. Factors affecting european farmers' participation in biodiversity policies (*review*). Sociol. Rural. 46, 318–340.
Sørensen, C.G., Fountas, S., Nash, E., Pesonen, L., Bochtis, D., Pedersen, S.M., Basso, B., Blackmore, S.B., 2010. Conceptual model of a future farm management information system. Comput. Electron. Agric. 72, 37–47.
Werner, M., Wauters, E., Bijttebier, J., Steinmann, H.-H., Ruysschaert, G., Knierim, A., 2017. Farm level implementation of soil conservation measures: farmers' beliefs and intentions. Renew. Agric. Food Syst. 1–14.
Zapf, R., 2009. Bewertung der Nachhaltigkeit landwirtschaftlicher Betriebe. Kuratorium für Technik und Bauwesen in der Landwirtschaft, Darmstadt.

Chapter 5

Policy-induced innovations networks on climate change adaptation – An ex-post analysis of collaboration success and its influencing factors

This chapter is based on the publication:

Schmid, Julia C.; Knierim, Andrea; **Knuth, Ulrike** (2016): Policy-induced innovations networks on climate change adaptation – An ex-post analysis of collaboration success and its influencing factors. In *Environmental. Science & Policy* 56, pp. 67–79. DOI: 10.1016/j.envsci.2015.11.003.

Environmental Science & Policy 56 (2016) 67–79

Contents lists available at ScienceDirect

Environmental Science & Policy

journal homepage: www.elsevier.com/locate/envsci

Policy-induced innovations networks on climate change adaptation – An ex-post analysis of collaboration success and its influencing factors

Julia C. Schmid [a,*], Andrea Knierim [a,b], Ulrike Knuth [a]

[a] Leibniz Centre for Agricultural Landscape Research (ZALF) e.V., Institute of Socio-Economics, Eberswalder Str. 84, 15374 Müncheberg, Germany
[b] University of Hohenheim, Institute of Social Sciences in Agriculture, Subdivision Rural Sociology, Schloss, 70599 Stuttgart, Germany

ARTICLE INFO

Article history:
Received 13 April 2015
Received in revised form 15 October 2015
Accepted 5 November 2015
Available online 21 November 2015

Keywords:
Environmental governance
Joint knowledge production
Transdisciplinary research
Network collaboration success
Evaluation
Rural development

ABSTRACT

This study is about 16 policy-induced innovation networks on climate change adaptation, i.e., subsidised multi-actor networks that are initiated by research institutes and formed around a particular real-life problem aiming at joint development, test, and implement adaptation measures. The political-administrative context is Germany, and the institutional context is a joint research framework in which each network works independently on a particular topic, but remains bound to the principle of practical and solution-oriented research carried out in close partnership between scientific and extra-scientific actors. Our objective is to provide empirical insights into the processes and outcomes of such networks and to systematically analyse the networks' collaboration success and its influencing factors. To this end, collaboration success is operationalised as a three-dimensional metric including (1) the practitioners' satisfaction with the cooperation, (2) their perceived learning effects, and (3) their perceived implementation capacity. Results show a decreasing level of success throughout the three dimensions and particularly a gap between knowledge acquisition and learning on the one hand and implementation, i.e., transforming the knowledge into action, on the other. While the positive relationship between these dimensions is confirmed, results of correlation analysis highlight the importance of repeated participation, appropriate information management, and inclusive as well as responsive network practices. We discuss the results against our existing knowledge on multi-actor collaborative research and deduce (methodological) lessons learnt as well as future research needs.

1. Introduction

Multi-actor innovation networks represent an emergent and increasingly prominent research and development (R&D) strategy to tackle complex societal problems (Beers and Geerling-Eiff, 2014; Sol et al., 2013; Kolleck, 2013; Moschitz et al., 2015; Hermans et al., 2015). Climate change and its impacts on farming, hydrological systems, and other natural resource systems is such a problem. While scholarly and policy efforts were initially directed to climate change mitigation, adaptation gained importance around the end of the 20th century, not least as a response to previous political failure in mitigation efforts (Bassett and Fogelman, 2013). Adaption though is a complex concept and task. Conceptual key questions are: How can one pro-actively prepare for uncertain, contested and highly context-specific environmental change? How can adaptation research be carried out? Put differently, how to find out which socio-technical strategies are more effective, applicable, and acceptable? As evidenced by a growing number of publically funded research programmes (e.g., 'Knowledge for Climate' in the Netherlands, or 'Klimzug' in Germany) the answer is increasingly found in knowledge co-production approaches, often in so-called innovation networks.

Networks have been frequently described as a success model for innovation processes in the economic literature (Weyer, 2011; Hughes, 1987). As policy-instruments in environmental governance, they are a relatively recent phenomenon. Here, networks are increasingly considered an appropriate organisational form for the coordination of heterogeneous actors from different societal spheres, as functioning networks reflect and rely on the voluntary cooperation among autonomous partners at equal level (Powell, 1990; Weyer, 2011; Willke, 2001). The main distinguishing characteristics compared to other forms of networks, e.g., pure knowledge networks (Feldman, 2012), are (i) the clear goal-orientation and focus on

* Corresponding author.
E-mail addresses: julia.schmid@zalf.de (J.C. Schmid), andrea.knierim@uni-hohenheim.de (A. Knierim), ulrike.knuth@zalf.de (U. Knuth).

http://dx.doi.org/10.1016/j.envsci.2015.11.003
1462-9011/

innovation, i.e., a socio-technological novelty that lasts in a given social system, (ii) the external driving force of network development, and, (iii) the specific role of science actors as the majority of policy-induced innovation networks are research-led. Taken the wider literature on networks into account, policy-induced innovation networks can, thus, be characterised as externally subsidised, collaborative and goal-oriented networks (cf. Kilduff and Tsai, 2003; Mandell and Keast, 2007) comprised of a finite set of scientific and extra-scientific actors who, together, seek to co-produce new and socially robust answers to a given real-world problem (cf. Sol et al., 2013), while typically governed by and through a scientific lead organisation (cf. Provan and Kenis, 2008). Emphasis is given to the realisation of an interactive change process that brings improvements for the actors involved through knowledge generation and implementation.

Due to the particularities outlined above (goal-orientation, clear system boundaries, roles attributed to actors), networks as policy-instrument are very similar to knowledge co-producing projects (Beers and Geerling-Eiff, 2014). The underlying collaboration practices essentially refer to the concept of transdisciplinary knowledge production, i.e., "situated knowledge production" (Rosendahl et al., 2015) following what has been termed a 'Mode 2 knowledge production" (Nowotny et al., 2001; Gibbons et al., 1994). Therefore, in the context of environmental governance, the focus is on collaborative multi-actor learning processes, from which collective problem-solving strategies are expected, which, in turn, are believed to enhance innovation diffusion leading to enhanced environmental effectiveness (Hegger and Dieperink, 2014).

Since joint knowledge production approaches and innovation networks are a recently enhanced phenomenon in environmental governance, it is to no surprise that knowledge of actual collaboration processes in such networks and of the dynamics, premises, and outcomes of it is both scarce and needed (Hegger et al., 2014; Hermans et al., 2015; Beers and Geerling-Eiff, 2014). Above all, there is a striking lack of peer-reviewed literature seeking to systematically address the question of whether at all, and under which conditions, the acclaimed benefits of collaborative research processes unfold (Blackstock et al., 2007; Podesta et al., 2013; Voorberg et al., 2014; Zscheischler and Rogga, 2015). As Hegger et al. (2014: 1050) put it: "we lack the necessary insights into assessing if joint knowledge production does what its proponents claim it to do". Or, in the words of Zscheischler and Rogga (2015: 39), reviewing the peer-reviewed literature on transdisciplinary research (TDR) in land use science: "the societal effects of TDR projects remain unclear and uninvestigated in most empirical studies. The sheer existence of outputs appears to justify the success of TDR, but the impacts of the solution to the problem have hitherto hardly been investigated" (cf. also Polk, 2014). This requires not only more empirical studies but, particularly, studies systematically investigating cause-effect relationships between potentially influencing variables and outcomes, and, if possible, comparative research amongst a number of cases (Voorberg et al., 2014; Podesta et al., 2013; Hegger et al., 2014, 2012; Hegger and Dieperink, 2014; Lang et al., 2012). Moreover, there is a particular need to focus on practitioners' perspectives. Not only because it is them who can most appropriately assess the type and degree of societal effects (Walter et al., 2007; Blackstock et al., 2007) but also because current investigations of transdisciplinary research practices suffer from a science and process-centred bias (Zscheischler and Rogga, 2015, cf. section 2).

We respond to this research gap by reporting upon a retrospective comparative study of 16 similarly designed policy-induced innovation networks targeting different innovations for climate change adaptation in northern Germany. Our objective is to systematically analyse what we term *network collaboration success*. In particular we examine (i) what practitioners learned in the networks, (ii) the degree to which commonly expected outcomes are reached and how they are related to each other, and (iii) whether and how certain structural and procedural network characteristics influence these outcomes.

By applying a comparative perspective, we aspire to contribute to a better understanding of the processes and outcomes of innovation networks on climate change adaptation, thereby assisting comparisons of future empirical findings. Moreover, we strive to contribute to the development and discussion of meaningful quantitative metric approaches appropriate to substantiate systematic innovation network assessment and to guide future innovation-driven research agendas.

2. Evaluating collaboration success – conceptual frameworks and empirical evidence

Conceptual frameworks to evaluate collaborative research processes and outcomes exist (e.g., Blackstock et al., 2007; Hegger et al., 2012; Walter et al., 2007) but they are fairly difficult to compare due to different foci and goals, underlying theoretical assumptions, and operationalisations of criteria. Frameworks developed for transdisciplinary research practices in sustainability science can, according to Carew and Wickson (2010: 1149), be differentiated as to the focus they put either on the context, the process or the outcome of research. Particularly pronounced seems to be the difference between process-oriented frameworks and outcome-oriented frameworks – with the latter being far less proposed and applied in sustainability science evaluation studies (Walter et al., 2007; Wolf et al., 2013). Process-centred frameworks (e.g., Hegger et al., 2012) use as success indicators criteria that are supposed to capture the quality of collaborative research processes – assuming, but not measuring that a successful process will ultimately lead to the desired outcomes. Outcome-oriented frameworks (e.g., Walter et al., 2007), in contrast, seek to verify whether the expected benefits or aims of collaborative research practices have been reached – which equally demands the definition of a success metric, this time based on outcomes.

Collaborative research practices have intended outcomes both in science and in practice (Lang et al., 2012; Walter et al., 2007). Carew and Wickson (2010) refer to these outcomes as peer approval, mutual learning, and problem solving. As for outcomes in the social sphere, the predominant reasoning underwriting most of the sustainability science literature on collaborative research processes is that: (i) participants will be more satisfied with the processes and outcomes of such research, due to its knowledge co-producing agenda and its generic problem- and solution-orientation, (ii) that they perceive enhanced individual and collective learning effects, and (iii) that this leads to an increased ability to act upon the problem that has been addressed – leading to transformation of actual practices and, thus, to more environmental effectiveness (Tisenkopfs et al., 2014; Klerkx et al., 2012; Lang et al., 2012; Jahn et al., 2012).

This chain of presumptions, however, has not been systematically studied empirically, i.e., whether participants who report that they are satisfied with the processes and knowledge produced, also perceive enhanced learning effects and whether this, in turn, leads to an increased ability to act, is as yet, a mere assumption. While only a very limited number of studies systematically address this third dimension (enhanced capacity to act) (Walter et al., 2007; Wolf et al., 2013), existing results from case study research show, that though participants acknowledge that significant learning took place as a result of the collaborative research process, there is limited evidence for action resulting from it (Polk, 2014; Blackstock et al., 2007; Kelly et al., 2007; Lang et al., 2012; Wieck et al., 2012).

Regardless of the particular success definition, conducting evaluation demands further specification and measurement of

criteria deemed relevant to influence responsive variable(s) in a specific context. The number of potentially influencing variables is vast and no common categorisation exists. While scholarly work originating from transdisciplinary sustainability science, often draws on a general distinction between process and context variables (including not only the particular problem context but also the research context and the researcher/s context (cf. Carew and Wickson, 2010), works originating more from a network theory point of view refer to the three dimensions of 'structure', 'processes' and 'governance' (cf. Arranz and de Arroyabe, 2012; Kolleck, 2013).

Only a very limited number of retrospective studies evaluating collaborative research practises as a whole, focus on a clearly specified success-metric and base their analysis on a conceptual framework that clarify expected causal relations a priori. A notable and promising exception from the field of this study is provided by Hegger and Dieperink (2014). Hegger and Dieperink analyse the success of six collaborative climate change adaptation projects in the Netherlands using seven criteria from the four analytical dimensions (actors, resources, rules, and discourses) of the policy arrangement approach (see Hegger et al., 2012 for the development of the assessment framework). They apply a process-oriented perspective and specify as responsive variables a three-dimensional metric comprised by actors' perspectives on the credibility, salience and legitimacy of the knowledge produced. The success metric and the four dimensions of influencing factors were quantified using a simple scoring approach based on the analysis of project documents and supplementary interviews. While the authors acknowledge limitations in terms of missing explanatory variables, results point to two distinguishing success factors: The degree to which the broadest possible actor coalition was built and the presence of specific resources facilitating knowledge co-production processes (e.g., boundary spanning individuals and objects).

In contrast to Hegger and Dieperink (2014), the bulk of scholarly work does not seek to define and measure success explicitly. Most prominent are qualitative studies that draw on learning theories and triangulate data sources and methods to analyse how actors in such arrangements "are learning to learn" (Armitage et al., 2011) and what design features foster social learning situations (e.g., Bos et al., 2013). Particularly with the emerging view on networks as a promising R&D alternative, (elements) of social network analysis are increasingly applied (e.g., Kolleck, 2013; Dowd et al., 2014; Hermans et al., 2013; Armitage et al., 2011).

Studies systematically addressing the question of "collaboration success" from an outcome-oriented point of view are, however, still rare (Podesta et al., 2013; Hegger et al., 2014). Also, there are a limited number of studies systematically seeking to infer conclusions regarding the influence of certain variables. Exceptions in the fields of our study emerged only recently and with little mutual reference. Based upon the comparative studies provided by Edelenbos et al. (2011), Klerkx et al. (2010), Armitage et al. (2011), Podesta et al. (2013), Tisenkopfs et al. (2014), Hegger et al. (2014), and Hegger and Dieperink (2014). Table 1 subsumes most of the factors commonly assumed to influence knowledge co-production processes and outcomes. Not included are characteristics that refer to the researcher/s context (e.g., personal values and beliefs, capacities) as discussed by Carew and Wickson (2010).

Out of the factors condensed in Table 1, particularly the ones subsumed under the heading of "deliberative practices" received a lot of attention and also represent the ones underpinned more thoroughly by respective socio-psychological research on collaboration and competition and (social) learning theories. As for empirical evidence, results from qualitative case studies on collaborative research processes in general, and climate change adaptation in particular, overwhelmingly point to the importance of early and sustained participation practices (Podesta et al., 2013; Moschitz et al., 2015), the development of trust between partners

Table 1
Factors influencing processes and outcomes of collaborative research.

Category	Influencing factors
Structural traits of the collaborating group	Size, representativeness, heterogeneity, physical proximity, time of formation
Deliberative practices	Degree of deliberation and self-reflective practices, adaptability and flexibility/participants opportunity to influence decisions, quality and flow of information, knowledge co-producing methods and tools
Roles of actors and resources	Leadership and division of roles, presence of specific resources, reward structures
Other contextual factors	Political, social, economic, environmental context

(Home and Rump, 2015; Hermans et al., 2015; Sol et al., 2013), and self-reflective network practices (Klerkx et al., 2010; Edelenbos et al., 2011; Moschitz et al., 2015; Hegger et al., 2014; Tisenkopfs et al., 2014; Lang et al., 2012; Podesta et al., 2013) as preconditions for the desired co-production of knowledge, learning effects, and implementation.

All the same, other factors have been frequently assumed and/or shown to be relevant. This holds, on the one hand, for the variables describing structural traits of collaborating groups such as size and actor composition (Hegger and Dieperink, 2014; Tisenkopfs et al., 2014; Trimble and Lázaro, 2014; Hegger et al., 2014). On the other hand, empirical evidence points to the importance of dedicated leaders and different types of facilitators – often referred to as boundary spanning actors or brokers (Klerkx et al., 2010; Tisenkopfs et al., 2014; Kelly et al., 2007; Armitage et al., 2011), to available resources to manage complex multi-actor networks (Hegger and Dieperinck, 2014; Home and Rump, 2015), and supportive contextual factors such as favouring macro-economic system conditions or the need for influential external "innovation champions" (Klerkx et al., 2010; Blackstock et al., 2007; Armitage et al., 2011).

Empirical results as to what factors (and in which way) influence outcomes of collaborative group processes are, however, far from being conclusive. Many studies provide highly case-specific evidence, sometimes contradictory, and, occasionally, highly elusive in their cause-effect reasoning (see, for example, the recent review of reported barriers to adaptation research provided by Eisenack et al., 2014). What is particularly missing are more comparative studies that focus on an outcome-oriented success metric to verify whether expected benefits unfold in practice and whether the above-mentioned chain of influence between satisfied participants, learning effects and implementation in policy-induced innovation networks is observable.

3. The innovation networks – context and design

The empirical cases used to infer conclusions upon outcomes and influencing factors of collaborative network practices are 16 rural innovation networks each focussing on different adaptation strategies in the fields of agriculture, landscape and water management. All networks share commonalities regarding the place-based natural and institutional system environment and a transdisciplinary research design that was developed in a joint process of network configuration.

3.1. Location

All networks were established in the north-eastern state of Brandenburg, Germany – a structurally relatively weak region, experiencing many of the "typical problems" (e.g., low population density, out-migration, relatively high unemployment rates) of

European rural areas (EC, 2013; FSO, 2014). Large parts are covered with forest, Brandenburg has a high share of water bodies, and almost 50% of the area is farm-land. Consequently, the economic share of agriculture is the highest of all German states (2.9%), and attractive landscapes, combined with close proximity to Berlin, makes tourism an important economic factor for Brandenburg (Plieninger et al., 2007; SOBB, 2014).

Brandenburg has a moderate continental climate and is, despite its abundance of lakes, at risk of water deficit. With an average annual precipitation of under 600 mm and the predominance of sandy soils, Brandenburg is particularly vulnerable to climate change (Reyer et al., 2012). While considerable uncertainties in model based climate change impact assessment exists (Gädeke et al., 2014), assessments of past and future trends predict notable regional warming, a slight decrease in annual rainfall, a shift in precipitation from summer to winter, and a general increase in climate variability (Gerstengarbe et al., 2003). It is expected that this will worsen further the climatic water balance (Holsten et al., 2009; Hüesker et al., 2011), demonstrating the need for sustainable regional resource use strategies.

3.2. Transdisciplinary research design

The assumption that socially robust and applicable adaptation measures cannot be developed at the drawing board but only in close cooperation with the relevant practice partners has been the vantage point of networks formed in 2008–2009. Accordingly, a framework structure had been established – INKA BB ("Innovation Network on Climate Change Adaptation Brandenburg Berlin") – which supported actors in their initial task of uniting scientists and practitioners around a jointly perceived problem induced by climate change.

Being part of INKA BB, all networks under investigation were initiated and managed by scientists. They received funding for five years (2009–2014) through the Klimzug research programme, financed by the German Federal Ministry of Education and Research (www.klimzug.de). The joint approach of the innovation networks within INKA BB was achieved through four theory-driven design features (Knierim et al., 2010; Knierim, 2014):

i. All networks followed core transdisciplinary design criteria to ensure problem and actor-oriented research processes (Lang et al., 2012) so scientists assembled various practice partners on a voluntary basis around a challenge induced by climate change. Networks were only admitted once they were convincing regarding their actors' composition, their practice-related problem definition, and the existence of ideas for possible innovations.
ii. To facilitate self-reflective network practices and support self-evaluation, all networks agreed on a concept of phases throughout the project's course. This phase-based approach linked transdisciplinary situation analysis and planning with trial and implementation, and evaluation phases conducted in two consecutive loops (Schippers and Den Hartog, 2007; Knierim et al., 2010). To document the interactive processes and results, the scientists leading the networks compiled biannual network reports.
iii. As networks cannot be externally steered or directed top-down, changing the autonomous dynamic of a system can only be achieved through targeted 'lateral' intervention (Mayntz, 1997; Aenis, 2004). Therefore, all networks obtained methodological support from a team of social scientists providing manuals and workshops on social research and participatory methods, moderation and planning techniques. Furthermore, cross-sectional analyses of the aforementioned biannual reports were compiled and fed back into the individual networks to facilitate internal network monitoring.
iv. One further cross-sectional module was installed to provide regional data on climate change as requested by the individual networks. Data was fed back into the individual networks where the information was used by the scientific leaders to communicate results to all other actors. Workshops on modelling results and communicating of uncertain climate change data were held in the project's course of INKA BB – some in cooperation with the aforementioned team of social scientists.

3.3. Basic characteristics of the networks – application area, size and actor composition

The particular application areas of the 16 networks remain, despite the aforementioned commonalities of the natural and institutional system environment, diverse (Table 2). Also, networks vary in their actor composition and size, i.e., the two types of information that were initially available through the INKA BB database.

Agricultural networks are, on average, rather small (16 partners compared to 25 in water management and 29 in landscape networks), and the dominant partner type are private firms, i.e., in this case, farmers. All remaining networks show a relatively high share of participants from public administration, with the exception of network No. 10 which focused on tourist destination management.

4. Methodology of analysing network collaboration success

This study aims to analyse what we have termed *network collaboration success*. To this end we applied an outcome-oriented perspective and operationalised our dependent variable as a three-dimensional metric which we quantified by using the scoring of the networks' practice partners as given in an ex-post survey. To quantify potentially influencing variables, we used a three-step approach: Firstly, we extrapolated basic network characteristics from the initial INKA BB database (Section 3.3). Secondly, we analysed biannual network reports to derive further variables describing structural and procedural network characteristics. Thirdly, we utilised responses from the survey to generate variables that describe the responding practitioners and the procedural quality achieved in the networks.

4.1. Conceptualisation and measurement of network collaboration success

Based upon the frequently acclaimed benefits of collaborative research processes (Section 2), we operationalise network collaboration success as a three-dimensional metric comprising of the practitioners' assessment of the co-operation, their perceived learning effects, and their capacity to implement the developed and/or tested adaption strategies after the initial funding period terminated. To measure these dimensions we asked practice partners from all 16 networks four straightforward questions (Q1–Q3):

Q1: How do you assess the science-practice co-operation?

(Six-point scale based on reversed German school marks from 1 = unsatisfactory to 6 = very good)

Q2: Do you agree/disagree with the statement "I learned a lot in INKA BB"?

(Five-point scale from 1 = fully disagree to 5 = fully agree)

Q3: Did your participation in INKA BB enable you to implement and/or continue climate change adaptation measures?

(Three-point scale: 1 = no, 2 = not yet foreseeable, 3 = yes)

Table 2
Characteristics of the networks under study.

No.	Field of action and short title	Focus/innovation aimed at	Size[a]	Composition (% of partner per type)[b] A/B/C/D
	Agriculture			
1	Integrated agriculture	DSS[c] soil management	16	06/63/19/12
2	Organic agriculture	DSS crop rotation planner	18	06/56/16/22
3	Plant breeding strategies	DSS crop species and varieties	9	11/45/33/11
4	Pasture utilisation systems	Online information/advisory platform	18	06/61/17/17
5	Hydromorphic soils	Online information/advisory platform	26	31/39/19/11
6	Irrigation in crop production	DSS for field specific decisions on irrigation suitability in crop production	9	11/45/11/33
	Landscape			
7	Regional planning	Integrated regional planning strategy	25	80/08/08/04
8	Mixed woodlands	Forecasting and planning instruments	23	39/04/18/39
9	Administrative nature protection	Handbook for target definition and selection of protected goods	39	72/08/13/08
10	Tourist destination management	Guidelines for strategic planning; integrated water- and business management plans	28	07/71/14/07
	Water management			
11	Small river basins	Industry-wide water management concepts; pilot plants for the retention of rainwater	45	51/04/31/13
12	Large wetlands	DSS practical water resources management	17	59/06/24/12
13	Water resource planning	Water planning, management, and control modelling tools for the Lusatian river basins	23	65/09/04/22
14	Glacial lakes	DSS for sustainable lake management	40	40/15/23/23
15	Urban areas	New technologies for enrichment plants; monitoring concept for storage system control	12	33/33/17/17
16	Waste water management	Integrated community water management concepts & decentralised waste water disposal	11	55/00/36/09

[a] Size measured in number of organisational partners.
[b] A = public administration, B = private firms, C = interest groups/public association, D = science.
[c] DSS = decision support systems.

Questions were posed in a standardised Web survey of practice partners. The survey was designed and conducted in summer 2013 and let to a sample size of $n = 99$, which corresponds to an overall response rate of 26.8%. Response rates per network range between 87.5% (network no. 3 on plant breeding strategies, $n = 7$) and 11.1% (network No. 9 on administrative nature protection, $n = 4$). The sample is largely representative with respect to the two characteristics recorded in the original database, i.e., the practitioner's type of organisation (41 respondents from public administration, 34 private firms, 24 associations), and their fields of activity (agriculture: 36 respondents; landscape: 33; water management: 30).

Regarding each question, respondents were invited to make additional remarks and/or explain their scoring. Additionally, to find out what the respondents learned and valued about the collaborative process, a separate question asked for the three most important insights gained from participating in their networks. From this, the 99 survey respondents formulated 138 insights which were analysed and condensed into final three categories using an inductive coding process (Thomas, 2003) facilitated by the software Maxqda2. Citations were translated and appear in italics.

4.2. Qualitative content analysis of network reports – network variables

To open the black box of collaboration processes in the networks and to generate meaningful variables that characterise the networks beyond their size and composition (Section 3.3), original project descriptions and a total of 48 biannual network reports were analysed via the coding software Maxqda2. As with every qualitative data analysis, this process required several iterative steps of re-reading and examination. In an initial phase of text segmentation we used structured a priori codes referring to the categories of factors commonly assumed to influence knowledge co-production processes and outcomes (cf. Table 1), supplemented by codes referring to outcomes and further influencing variables as they came up in the reports. While the coding procedure was primarily conducted by the first author, intermediate results, i.e., codes and codings, were discussed and re-examined repeatedly with the other two authors – both of which were part of the team of social scientists providing methodological support throughout the five years of INKA BB (cf. Section 3.2).

Intermediate results were promising since the network reports contained not only manifold and diverse statements on network-internal processes and outcomes, but also on how certain structural and procedural facets of the research approach influenced the collaborations. Just one topic, "leadership and division of roles", was not addressed, while statements referring to resource constraints were particularly prominent. What restricted the variable generation, however, was that certain pieces of information were not available for the entire set of networks, e.g., precise information on network structures or more detailed information on methods used for the knowledge co-production processes.

Despite these difficulties, we were able to define four additional criteria against which the 16 networks could be clearly distinguished: the type of innovation pursued, whether the scientific network leaders focused on network consolidation, whether modelling tools were extensively used, and the degree to which an interactive evaluation strategy was applied throughout the process of collaboration (for a table that matches the networks to the following characteristics, see Table A1 in Appendix).

Type of innovation pursued: The networks' description regarding the type of innovation pursued rests upon a traditional binary distinction between incremental and radical innovation (Baregheh et al., 2009). The decisive element here is not what is new (e.g., a technology or an organisational procedure), but the degree of newness and particularly the "strategic and structural change it implies for an organisation to accommodate it" (Cooper, 1998). Within the set of networks, there are, on the one hand, those that

strive for stepwise, targeted changes or add-ons to existing practices (e.g., all agricultural networks). On the other hand, there are four networks in the landscape and water management clusters that clearly aim at more radical transformations of status quo procedures and technologies. Here, completely new procedures and tools are introduced, e.g., a new regional planning strategy based upon new instruments to categorise land use areas as in network No. seven.

Explicit a priori focus on network consolidation: The networks can be distinguished further according to whether or not the respective network leaders put an explicit a priori focus upon the consolidation of the network beyond the publicly funded period of five years. This information was retrieved from initial project descriptions. Here, it is framed as a complementary focus of the network leaders on an institutional innovation that can be considered as a proxy-variable for their pro-active attitude towards in-depth involvement of practitioners (Wellbrock and Knierim, 2014). As shown in Appendix, there are only six networks that explicitly state this aim at the beginning of the network cooperation.

Extensive use of modelling tools: Additionally, marked differences exist regarding the methods and tools used to generate new knowledge. We found eight networks, predominantly in the water management cluster, where the development of mathematical models was either at the core of the entire project (e.g., network No. 13) or where model-based simulation, impact, and risk analysis was extensively used (e.g., network No. 9). All these networks received a "yes" for the criterion "extensive use of modelling tools".

Interactive evaluation strategy: The last characteristic refers to one of the main design principles of INKA BB, i.e., recurrent interactive planning and evaluation of processes and outcomes to enhance reflexive group learning and ensure stakeholder-oriented targeting (Schippers and Den Hartog, 2007). The degree of participation in these events can be designated according to Pretty (1995) and Knierim et al. (2010) as interactive, which means that all partners participate in decision making processes. While all networks conducted such interactive evaluations in workshop settings in the first phase, evaluation procedures were subsequently increasingly transformed, e.g., respective network leaders used questionnaires or more informal forms of inquiry (Knierim et al., 2015). However, we found four networks (networks No. 2, 3, 9 and 10) in which such interactive strategies were maintained throughout the entire five years (indicated by a ++ in Table A1).

4.3. Variables that describe the procedural quality achieved in the networks

The last couple of potentially influencing variables analysed in this study refer to the procedural quality achieved in the networks. Three proxies are used, all of which are based on practice partners' assessments as given in the aforementioned survey: (i) the extent to which the responding practice partners are satisfied with the information provided on climate change, (ii) the share of respondents' concerns successfully introduced into the network (SRCSI), and (iii) the share of respondents' concerns for which solutions were proposed (SRCSP).

The respondents' satisfaction with the information provided was directly addressed via the question "How satisfied are you with the information provided on climate change?", to be assessed on a five-point scale ranging from 1 (very unsatisfied) to 5 (very satisfied). The SRCSI and SRCSP scores were calculated from original survey data following a two-step procedure: Firstly, the respondents were asked to name up to three of their most important concerns regarding climate change and adaptation. Subsequently, respondents were asked whether it was possible to place the particular concern on their network's agenda (yes/no), and whether solutions were proposed in the course of the network's lifetime (yes/no). Accordingly, we generated a five-point scale where zero meant that none of the concerns mentioned could be introduced/answered, while 1 indicated that all the concerns mentioned could be introduced/answered.

4.4. Overview of variables and hypotheses

Altogether, we defined 11 potentially influencing variables, grouped into four categories: personal characteristics of practitioners (Table 3, 1–2), networks' structural traits (Table 3, 3–5), networks' working approaches (Table 3, 6–8), and procedural quality achieved (Table 3, 9–11).

The respondents are characterised by their organisational type and their participation frequency (measured in terms of how often they participated in network meetings and workshops). Explicit hypotheses were only developed for this latter variable, assuming that respondents with more intense participation perceive the collaboration as more satisfactory (Q1), higher learning effects (Q2), and implementation capacities (Q3).

From the three variables describing the structural traits of the networks, we initially hypothesised the size of the network playing a decisive role since it can be assumed that collaborative practices are more manageable in smaller networks which, in turn, might be reflected in respondents scoring higher on Q1, Q2, and Q3. Additionally, we hypothesised more transformative and, thus, radical innovations to be more difficult to implement (Q3), not least since they require a concerted effort by a diverse set of actors.

As for the knowledge co-production approach taken in the networks, we considered that all of our three proxies take a decisive role for successful collaboration processes. Firstly, it is assumed that network managements, which initially stated explicitly the aim of developing a science-practice network, are more aware of the need for institutional innovations and thus, also show more inclusive network management practices, which, in turn, lead to practitioners being more satisfied with the cooperation (Q1) and enhanced learning effects (Q2). Secondly, we assume that an extensive use of formal, model-based knowledge production methods are less accessible for practitioners, leading to lower scores with the success metric. Thirdly, and in line with many other studies (e.g., Brandt et al., 2013; Podesta et al., 2013; Hegger et al., 2012, 2014; Blackstock et al., 2007), we expect a high degree of deliberation and room for reflexive practices to be an important prerequisite for the desired frame alignment between actors and successful knowledge co-production processes. Hence, we assume respondents from networks in which an interactive evaluation strategy was applied more intensively throughout the network's lifetime, to score higher on all dimensions of the success metric.

Finally, we assume all of the three proxies that describe the procedural quality achieved in the networks, as being a direct indicator for the first three success dimensions. That is, respondents being more satisfied with the information provided on climate change, and respondents with higher SRCSI and SRCSP scores are more satisfied with the overall collaboration (Q1), perceive higher learning effects (Q2), and a greater implementation capacity (Q3).

4.5. Data analysis

Data analysis was conducted using IBM SPSS 19.0 and followed a straightforward procedure: (i) we used descriptive statistics to analyse the respondents' assessments of the survey questions, and (ii) correlation analysis (mainly Spearman's rank order correlation) to detect the strength and significance of associations with our dependent variables. Additionally, we applied group differences

Table 3
Overview of potentially influencing variables and their expected associations with the four dimensions of network collaboration success.

No.	Categories and variables	Source	Initial hypothesis[a]		
			Cooperation (Q1)	Learning effects (Q2)	Implementation capacity (Q3)
	Practice partner characteristics				
1	Organisational type (public administration, private firm, association)	Survey	/	/	/
2	Participation frequency (<1 time per year, 1–2 times per year, >2 times per year)	Survey	+	+	+
	Structural traits of the networks				
3	Field of activity (agriculture, landscape, water management)	Database	/	/	/
4	Size of network (small, medium, large)[b]	Database	–	–	–
5	Type of innovation (incremental, radical)	Reports	/	/	–
	Approach taken in networks				
6	A priori focus on network development (no, yes)	Reports	+	+	/
7	Extensive use of modelling tools (no, yes)	Reports	–	–	–
8	Interactive evaluation strategy (no, yes)	Reports	+	+	+
	Procedural quality achieved				
9	Respondents' satisfaction with the information provided (five-point scale: 1 = very unsatisfied, 5 = very satisfied)	Survey	+	+	+
10	Share of respondents' concerns successfully introduced into the networks (SRCSI) (five-point scale: 1 = 0%, 5 = 100%)	Survey	+	+	+
11	Share of respondents' concerns for which solutions were proposed (SRCSP) (five-point scale: 1 = 0%, 5 = 100%)	Survey	+	+	+

[a] While a plus (+) indicates an assumed positive relation between variables, a minus (–) indicates a negative and a slash (/) that no explicit assumption was made.
[b] Compared to Table 2, the variable size has been transferred into an ordinal variable with small representing <19 actors, medium between 19 and 27 members, and large >28 members.

tests (Kruskall–Wallis H in the case of more than two groups, otherwise Mann–Whitney U) to validate the results. However, since group difference tests confirm the statistical tests of associations without exception, only the results of correlation analysis are presented.

5. Results

5.1. What respondents learned from and valued about network collaboration

As a first step we sought a better understanding of what respondents learned and valued from their participation in the networks. Such information was deduced from responses to the survey question "Which important insights did you gain from the collaboration?" Formulated insights were broadly grouped as referring to (i) climate change and its impacts, (ii) adaptation strategies, and (iii) the process of joint knowledge production and ways "to do" adaptation research (Table 4).

As indicated by the number in brackets behind the respective category, roughly one fifth of all responses refer to what can be classified as "system knowledge" (cf. Hirsch Hadorn et al., 2006) on climate change. Recurrent topics are the uncertainty and regional specificity of impacts and the general complexity of the topic. Responses such as "*climate change impacts are still very uncertain and location-specific*" or "*it is all more complex than I thought at the beginning of the project*" are typical examples, and show that many practitioners had rather limited knowledge on climate change (impacts) initially and that they perceive an enhanced understanding of the complex nature of the topic through network participation.

Insights that refer to adaptation and hence, the more narrowly defined content of research, are subsumed under the second category. Here, responses from participants of landscape networks are clearly under-represented. While some statements are fairly general, 43 responses refer to particular adaptation strategies, e.g., "*historical damming in winter is not necessarily adequate*". A prominent topic is the difficulty of implementing measures, almost exclusively formulated by respondents from water management networks focussing more on radical innovations. Here, statements refer to the multitude of public authorities involved or the difficulty "*to enforce environmental concerns against economic interests and political lobbying*". Finally, eight respondents (six, again, from water management networks) reported gaining no insights at all due to "*missing result transmissions*" or "*results not relevant for practice*".

The final category subsumes all insights that refer to collaborative processes in the networks and on ways "to do" adaptation research – with the majority formulated by landscape project respondents (24 insights out of 55). The most prominent topic under this category is coded here as "networking and regional actors". Practice partners prominently underline the key role of regional actors and particularly the necessity of a broad actor constellation and early and sustained participation practices. Further, a variety of learning experiences are described, such as "*gained further insights on how farmers/users think*" or "*there are many partners with similar interests*", and many participants point to insights they gained about the relationship between science and practice, often in combination with the topic of continuity and long-term orientation. The majority of statements underline positive aspects, such as the "*competence of scientific partners*" or the "*high value of such kind of research*". However, a total of eight practitioners also broach problematic aspects (e.g., epistemic barriers), or that they learned "*science extracts knowledge from practice without giving anything back*" or "*science is an unreliable stakeholder; does not need to live from what is produced*". Such critical aspects were stated by all types of partners participating in all kinds of networks.

The need for systemic orientations of regional actors and holistic approaches that need to be executed step-by-step are stated frequently. Typical examples include "*nature protection needs a systemic orientation*" or "*don't be overwhelmed by the wide range of action areas and problems; focus on project/aims and tackle all problems one by one*". Such insights are exclusively formulated by participants of networks focusing on rather radical adaptation strategies that require collective actions by public actors (networks number 7, 9, and 16).

Table 4
Important insights from and about network collaboration as described by respondents in the survey.

Category (number of insights)[a]	Codes (number of codings)[b]	Examples
Learning about climate change (24)	• Effects and impacts (12) • Uncertainty/complexity/ regional specificity (13) • Urgent field of action (3)	• "*The groundwater recharge will decrease by about 30%*"; • "*Climatic changes are not linear processes, in its impacts partly diffuse & paradox and regionally very different*"; • "*There is urgent need for action (. . .)*".
Learning about adaptation strategies (59)	• Adaptation is possible (6) • Particular measures (43) • Implementation (9) • None (8)	• "*There are multiple possibilities to reduce and cope with negative impacts of climate change*"; • "*The crop rotation (. . .) fits well in our region*"; • "*The implementation of (. . .) is almost impossible due to the multitude of public authorities involved*"; • "*None till now*"; "*results irrelevant for practice*".
Learning about collaborative processes and how "to do" adaptation research (55)	• Networking and regional actors (23) • Science – practice (21) • Long-term orientation (10) • Holistic/systemic/step by step (6)	• "*Attract many partners (. . .) the sum of forces activates the opportunities and potentials*"; • "*We need such kind of interdisciplinary research!*"; • "*Adaptation to climatic change is an ongoing process, research must accompany this process constantly*"; • "*The water catchment area needs to be viewed and analysed as a whole (. . .)*".

[a] Each of the 138 statements was assigned to one category according to the main topic addressed.
[b] The total number of codings is higher since several statements naturally refer to more than one code.

5.2. Network collaboration success – quantitative scoring

Subsequently, we measured the degree of network collaboration success reached in our sample. Results show a decreasing level of achievement over the three success dimensions (Table 5). While 68% of the respondents assess the co-operation in their network as good or very good, 50% mainly or fully agree with the statement that they have learned a lot in INKA BB. The average of this agreement question is 3.39, which corresponds to response 3 = "partly". Asked for the impact of network participation on the propensity to implement adaptation measures, the majority (n = 57) answered "not foreseeable yet" (response No. 2, mode not shown in Table 5), while roughly one fifth of the respondents (n = 20) clearly feel enabled to do so.

The decreasing level of success indicates that not every participant satisfied with the collaboration perceived high learning effects and a capacity to implement particular adaptation measures. Calculating Spearman's bivariate rank-order correlation (r), we found low associations between cooperation (Q1) and implementation (Q3) scores (r = 0.242, p = 0.022), but moderately strong positive associations between cooperation (Q1) and learning (Q2) scores (r = 0.506, $p < 0.0001$), and between learning (Q2) and implementation (Q3) scores (r = 0.523, $p < 0.0001$).

5.3. Variables associated with the practitioners' scorings of collaboration success

To infer conclusions upon the factors influencing perceived network collaboration success, we calculated correlation coefficients for potentially influencing variables with the success dimensions. To begin with, however, it seems reasonable to present the descriptive results of the respondents' assessment of our proxies for the procedural quality achieved in the networks (Table 6).

About 58% of all respondents were (very) satisfied with the information provided on climate change (n = 52), and roughly two thirds (68%) were able to introduce all of their concerns into the networks (SRCSI). Regarding whether solutions were also proposed for these concerns (SRCSP), the share decreases substantially. However, the mean in our sample is 2.93, which corresponds to a share of 50%, i.e., on average, a solution was proposed for every second concern.

Correlation analysis shows that it is only these three procedural quality variables that statistically influence each of the first three success scores significantly (Table 7). In all cases, associations are positive and moderately strong. The strongest correlation with the cooperation (Q1) and learning scores (Q2) has the respondents' satisfaction with the information provided on climate change, while the implementation capacity (Q3) in our sample is most strongly influenced by the share of respondents' concerns for which solutions could be proposed, i.e., the SRCSP scores.

Additionally, the participation frequency of the respondent, as well as the approach taken towards knowledge production seems to distinctively influence the success scores and particularly the respondents' satisfaction with the co-operation (Q1). As evidenced by the correlations presented in Table 7, practice partners were significantly more satisfied, the more they participated in network meetings, the more an interactive evaluation strategy was carried out and the less modelling tools dominated the knowledge generation process. Hence, all three initial hypotheses regarding these variables are confirmed by our analysis.

Table 5
Practice partners' assessment of network collaboration success.

No.	Assessment of. . ./agreement to. . .	Obs.	Ordinal variable				Binary variable			
			Mean	Std. dev.	[95% CI]		Mean	Std. dev.	[95% CI]	
Q1	*Science-practice cooperation* (1 = unsatisfactory to 6 = very good)	93	4.63	1.15	4.40	4.87	0.68	0.47	0.58	0.77
Q2	"*I learned a lot in INKA BB*" (1 = fully disagree to 5 = fully agree)	90	3.39	1.04	3.17	3.61	0.50	0.50	0.39	0.61
Q3	*Capacity to implement measures* (1 = no, 2 = not foreseeable yet, 3 = yes)	95	2.02	0.64	1.89	2.15	0.21	0.41	0.13	0.29

Scales were given as rating scales (Q1 and Q3) or as an agreement scale (Q2). Binary variables are set to unity if respondent chose response 5–6 ("good" and "very good" in Q1), 4–5 ("mainly agree" and "fully agree" in Q2), and 3 ("yes" in Q3).

Table 6
Practice partners' assessment of the procedural quality as revealed in the web survey.

Assessment of...	Obs.	Ordinal variable				Binary variable			
		Mean	Std. dev.	[95% CI]		Mean	Std. dev.	[95% CI]	
Information (1 = very unsatisfied to 5 = very satisfied)	90	3.53	0.78	3.37	3.70	0.58	0.49	0.47	0.68
SRCSI (1 = 0% to 5 = 100%)	78	4.22	1.35	3.91	4.52	0.68	0.47	0.57	0.79
SRCSP 1 = 0% to 5 = 100%)	69	2.93	1.73	2.51	3.34	0.32	0.47	0.21	0.43

Information = respondents' satisfaction with information provided on climate change, SRCSI = share of respondents' concerns successfully introduced into the network, SRCSP = share of respondent's concerns for which solutions were proposed. Binary variable in case of INFORMATION was set to unity if respondent chose response 4–5 ("positive" or "very positive"), in case of SRCSI and SRCSP if all concerns could be introduced and if for all concerns solutions were proposed (response 5).

Table 7
Statistically significant associations between the independent variables and the respondents' assessments of the cooperation, their learning effects, and their implementation capacity.

No.	Categories and potentially influencing variables	Cooperation (Q1)		Learning effects (Q2)		Implementation capacity (Q3)	
		N	$p < 0.05$	*N*	$p < 0.05$	*N*	$p < 0.05$
	Respondents						
1	Type/Affiliation	93	/	90	/	95	/
2	Participation frequency	85	0.522***	82	0.257*	86	/
	Structural traits of network						
3	Field of activity	93	/	90	/	95	/
4	Size of network	79	/	76	/	78	/
5	Type of innovation	74	/	73	/	73	/
	Approach taken within networks						
6	Focus on network development	74	/	73	/	73	/
7	Extensive use of modelling tools	75	−0.275*	74	/	74	/
8	Joint evaluation strategy	75	0.346***	73	/	74	/
	Procedural quality achieved						
9	Respondent's satisfaction with information provided	87	0.606***	83	0.572***	87	0.446***
10	Share of respondent's concerns successfully introduced (SRCSI)	75	0.453***	74	0.537***	74	0.356***
11	Share of respondent's concerns for which solutions were proposed (SRCSP)	69	0.337**	68	0.421***	68	0.462***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$ (all two-tailed). Associations have been analysed using Spearman's rank-order correlation (all ordinal variables) and by computing the Chi-square test for associations (nominal variables no. 1, 3, 5). Non-significant associations (indicated by a slash) are, for reasons of clarity, not depicted.

6. Discussion and conclusions

With this study, we set out to systematically analyse collaboration success in policy-induced innovation networks on climate change adaptation. Our overriding aim was to provide further empirical evidence on what can be expected from such collaborations and what factors influence the outcomes. We approached this aim by applying a quantitative success metric, capitalising on the rather extraordinary situation of having access to data from 16 parallel research networks working in a similar institutional setting. Results point to both lessons learnt and future research needs which we deem relevant not only for the research community focussing on knowledge co-production for climate change adaptation, but particularly for decision makers designing calls for these kind of approaches. In the following we will discuss the results with regard to the content of research (i.e., collaboration processes and outcomes in the networks) and the methodological implications they carry.

6.1. Learning and communicating about climate change (adaptation)

On a very general level, our study provides yet another empirical example that there is much to gain from participating in collaborative research processes, although such processes are difficult, challenging and results might fall short of initial expectations. Both qualitative and quantitative results point in this regard to the high importance of practitioners' acquisition of adequate system knowledge on climate change (Tables 4 and 7). At first hand, these results might not be surprising, since adequate information on climate change impacts and vulnerabilities is the natural vantage point for every research on climate change adaptation and thus, also for subsequent successful implementation of adaptation measures. Moreover, other scholarly research repeatedly points to the crucial role of information exchange on and awareness of climate change, and the appropriate handling of uncertainty in science-practice communication (Adger et al., 2009; Dilling and Lemos, 2011; Armitage et al., 2011; Dessai and van der Sluijs, 2007).

The sheer magnitude of the "sensitisation gap" of extra-scientific actors in INKA BB, however, was a surprise for most of the scientific actors involved – not least since it was implicitly assumed that practitioners voluntarily participating in the problem-oriented networks joined the projects mainly because they were already sensitised to a certain extent. Apparently, this assumption proved to be inadequate and a considerable amount of time and resources had to be devoted in order to account for it (Knierim et al., 2015). While this 'investment' seemed to have paid off very well in light of the results presented, future designs of policy-induced innovation networks on climate change adaptation should try to avoid such a misconception and address this need for adequate information more thoroughly already in the design stage.

Moreover, as roughly 40% of the practitioners were not entirely satisfied with the information provided (Table 6), the communication processes organised in workshops were obviously not

satisfactory throughout – pointing to the question of relevant factors beyond the participation frequency of practitioners.

This includes reflections about appropriate communication mechanisms and formats (Wirth et al., 2014) but also on general division of roles in communicating highly complex, uncertain, and contested knowledge on climate change in such networks. A growing body of scholarly contributions on climate change communication emphasise, in this regard, the general need for interactive and iterative communication formats and to elicit user needs in order to tailor information adequately (Dilling and Lemos, 2011). Further, the importance of 'soft success factors' that go beyond the content level are highlighted, e.g., the need to elicit emotions, to use appropriate visualisations and, particularly, the importance of accepted and "trusted messengers" (Moser, 2010; Wirt et al., 2014).

This latter issue (i.e., the need for trusted messengers) resembles the notion of boundary spanning individuals and knowledge brokering, as it is increasingly discussed in the innovation system literature. While several studies point to different network functions and the importance of dedicated leaders and different types of facilitators (e.g., Klerkx et al., 2010; Hermans et al., 2013; Tisenkopfs et al., 2014), we deem, for the particular case of policy-induced innovation networks micro-level studies on the specific roles, capacities and intentions of scientific actors (and their research institutes), as important. Hence, we argue for a more pronounced focus on what Carew and Wickson (2010) named the research and the researcher/s context. Since most policy-induced innovation networks are (and will continue) to be initiated and led by scientists, their assumed roles and actions are vital in managing and creating suitable knowledge co-production arrangements. Yet the way scientists master the challenges and assume the multiple roles associated with a shift towards collaborative research practices (e.g., being a reflective scientist, an intermediary, and a facilitator, cf. Pohl et al., 2010) remain to a large extent a black box – making it difficult to infer precise conclusions that go beyond a general call for training and reflexive monitoring practices.

6.2. Generating "actionable knowledge"

At the very heart of collaborative research projects is what one may term the generation of "actionable knowledge" to resolve sustainability problems (Lang et al., 2012). In this study we applied an outcome-oriented evaluation perspective to empirically validate whether participating practitioners perceived such a benefit arising from the INKA BB networks. While the quantitative values of perceived benefits cannot be compared, due to missing comparative studies, our results confirm the often assumed, positive relationship between the three aspects of satisfactory processes, learning, and implementation (Section 5.2). Moreover, our results make a strong claim on the importance of repeated participation and knowledge integration as the two factors commonly assumed to be conditional for successful collaboration processes (Polk, 2014; Hegger et al., 2012; Lang et al., 2012). However, we also found what one may term a gap between knowledge acquisition and learning on the one hand, and implementation, i.e., transforming the knowledge into action, on the other (Table 5).

Qualitative case study research within the realm of transdisciplinary sustainability projects does point to the same finding (Polk, 2014; Blackstock et al., 2007; Kelly et al., 2007; Lang et al., 2012; Wiek et al., 2012). Potential reasons, i.e., factors accounting for the limited conversions of measures planed and tested into action, are manifold and can be deduced from the wide range of factors influencing the outcomes in collaborative research practices described in Section 2. In the literature on climate change adaptation they are more generally discussed under the headings of 'barriers' or 'challenges' to climate change adaptation (cf. Eisenack et al., 2014; Wise et al., 2014). Particularly prominent in both strands are explanations that focus on unconducive institutional and political real-world arrangements (e.g., Kelly et al., 2007; Wise et al., 2014; Moser, 2009; Polk, 2014) – highlighting the necessity to attract support from "influential and powerful external innovation champions" (Klerkx et al., 2010), and to involve all "crucial actors" in the collaborative process itself (Hegger et al., 2012) which includes administrative authorities able to "lobby and translate results of an innovation in political terms" (Hermans et al., 2013).

To account for these needs, such a broad actor composition was made obligatory for all INKA BB networks studied (cf. Section 3.2) and all networks included important political-administrative actors higher up the hierarchy of the innovation system (e.g., public administrative authorities) and also important lobbying association (e.g., the regional Farmers' Union) (Table 2). However, while we were in this study not able to delve deeper into the question of if and how the networks' composition influenced the results, qualitative analysis indicated implementation difficulties particularly in networks focussing on more radical innovations (Section 5.2) – backing our initial hypothesis that the degree of transformational action required is a distinct factor for the perceived implementation capacity of practitioners. This initial hypothesis, however, was not confirmed by statistical analysis. Instead, it is besides the aforementioned crucial role of appropriate information management, particularly the share of respondents' concerns for which solutions were proposed (SRCSP), that is directly associated with the perceived implementation capacity (Table 7). Hence, the more practitioners acknowledged having received solutions for their concerns, the more they confirm "actionable knowledge" – an intuitively plausible result which strongly emphasises the need for inclusive, as well as responsive, network practices.

In this regard, we consider more in-depth studies on the appropriateness of methods and tools used to co-produce knowledge on climate change adaptation, as an important future research direction which has received too little attention to date (cf. McCrum et al., 2009). While answers to this question of appropriateness will (and need to be) highly contingent on the particular context, our results confirm previous research that point to trade-offs between highly formalised methods and the degree of flexibility and interaction necessary to assure the aforementioned inclusive and responsive processes in multi-actor collaborations (Edelenbos et al., 2011; Lang et al., 2012; Newig et al., 2008). This exists throughout the collaboration, but particularly in the early project stages, which are typically characterised by a multiplicity of problem perceptions, values, goals, and questions – which, in turn suggests at this stage the usefulness of open communication formats. However, how certain methods enable efficient and effective learning processes and in which contexts still requires more systematic evidence (cf. Newig et al., 2008).

6.3. On the merits and constraints of using a comparative, quantitative ex-post approach

In contrast to the vast majority of other studies on collaborative research processes in sustainability science, we used an outcome-oriented, predominantly quantitative approach based on ex-post assessments of practitioners. Further, we applied an explicit success metric, derived from literature analysis on frequently claimed benefits of collaborative research processes and operationalised by simple and straightforward questions. We neither provided nor tested a comprehensive causal model but relied with respect to the explanatory variables on information retrieved from network reports.

Such a research approach has both advantages and disadvantages. Clear advantages include the extraordinary situation of

having 16 parallel research networks working in a similar institutional setting. This provided the necessary grounds for a true comparative study and allowed to empirically explore relationships between potentially influencing factors and outcomes. Additionally, it was possible to operationalise collaboration success with the help of variables that were either empirically measurable or observable, as well as being easily understandable for practitioners and, thus, usable in other studies in order to test and elaborate on our approach.

As for disadvantages, we acknowledge a certain simplicity of the metric applied (e.g., regarding the learning dimension) and, thus, the continuing need for complementary qualitative in-depth studies of such issues. Further, we consider the limited number of potentially influencing variables analysed and the simple means of correlation analysis as restrictions. However, as in every empirical study, we can only focus on factors which we can quantify, and for which a sufficient variability in the data set is present. In this regard, our study faced the same challenges as the one conducted by Hegger et al. (2014), resulting in only a small number of explanatory variables tested.

Therefore, one of the major methodological lessons derived from this study is a profound need for more systematic comparative monitoring to generate a viable data basis against which retrospective cross-case evaluations can be performed more readily. If, as it is frequently stated, the newly emerging arrangement of policy-induced networks is to be assessed against the societal outcomes it promises to achieve, we need to open the black box of network processes not only via qualitative in-depth studies but also via transferable and easy to measure, though meaningful indicators. Apparently, such an enhanced targeted and systematic study of network processes needs to be thoroughly incorporated in the project's design and equipped with sufficient resources.

6.4. Concluding remarks

Systematic empirical research on social networks which produces quantifiable data for statistical metrics, is still more of an exception than the rule. Reasons are the complexity of the social field on the one hand, where the identification and isolation of meaningful process indicators is a challenge, and on the other hand, the fact that rarely a number of similar network processes are conducted simultaneously. However, as this type of policy-induced network research is now increasingly *en vogue*, more systematic and reliable evidence about factors determining networks' functioning and successes should be sought. Moreover, there is a particular need to (further) develop and test indicators that are easy to generate and which facilitate both practitioners and scientists in their reflexive self-monitoring.

Acknowledgements

This material is based upon work supported by the German Federal Ministry of Education and Research (BMBF) under the project "Innovation Networks for Climate Change Adaptation". We would like to thank Christian Franke and Michaela Reutter for their engagement and the two anonymous reviewers of this article for their valuable comments.

Appendix

Table A1
Overview of networks and network variables.

No.	Field of action and short title	Focus/innovation aimed at	Type of innovation[a]	Size[b]	Composition (% of partner per type)[c] A/B/C/D	Extensive use of modelling tools	Joint network evaluation
	Agriculture						
1	Integrated agriculture	DSS[d] soil management	I (+S)	16	06/63/19/12	No	+
2	Organic agriculture	DSS crop rotation planner	I (+S)	18	06/56/16/22	No	++
3	Plant breeding strategies	DSS crop species and varieties	I (+S)	9	11/45/33/11	No	++
4	Pasture utilisation systems	Online information/advisory platform	I (+S)	18	06/61/17/17	No	+
5	Hydromorphic soils	Online information/advisory platform	I (+S)	26	31/39/19/11	No	+
6	Irrigation in crop production	DSS for field-specific decisions on irrigation suitability in crop production	I	9	11/45/11/33	Yes	+
	Landscape						
7	Regional planning	Integrated regional planning strategy	R	25	80/08/08/04	No	+
8	Mixed woodlands	Forecasting and planning instruments	I	23	39/04/18/39	Yes	+
9	Administrative nature protection	Handbook for target definition and selection of protected goods	R (+S)	39	72/08/13/08	Yes	++
10	Tourist destination management	Guidelines for strategic planning; integrated water- and business management plans	I	28	07/71/14/07	No	++
	Water management						
11	Small river basins	Industry-wide water management concepts; pilot plants for the retention of rainwater	R	45	51/04/31/13	Yes	+
12	Large wetlands	DSS practical water resources management	I	17	59/06/24/12	Yes	+
13	Water resource planning	Water planning, management, and control modelling tools for the Lusatian river basins	I	23	65/09/04/22	Yes	+
14	Glacial lakes	DSS for sustainable lake management	I	40	40/15/23/23	Yes	+
15	Urban areas	New technologies for enrichment plants; monitoring concept for storage system control	R	12	33/33/17/17	Yes	+
16	Waste water management	Integrated community water management concepts and decentralised waste water disposal	R	11	55/00/36/09	No	+

[a] I = incremental, R = radical, S = explicit focus on network development.
[b] Size measured in number of organisational partners.
[c] A = public administration, B = private firms, C = interest groups/public association, D = science.
[d] Decision support systems.

References

Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D., Naess, L., Wolf, J., Wreford, A., 2009. Are there social limits to adaptation to climate change? Clim. Change 93, 335–354.

Aenis, T., 2004. Prozess – Organisation – Teams. Gruppenkommunikation und dezentrale Steuerung anwendungsorientierter Forschung, Kommunikation und Beratung, Bd. 61, Margraf Verlag.

Arranz, N., de Arroyabe, J.C.F., 2012. Can innovation network projects result in efficient performance? Technol. Forecast. Soc. Change 79, 485–497.

Armitage, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., Patton, E., 2011. Co-management and the co-production of knowledge: learning to adapt in Canada's Arctic. Global Environ. Change 21, 995–1004.

Baregheh, A., Rowley, J., Sambrook, S., 2009. Towards a multidisciplinary definition of innovation. Manag. Decis. 47, 1323–1339.

Bassett, T.J., Fogelman, C., 2013. Déjà vu or something new? The adaptation concept in the climate change literature. Geoforum 48, 42–53.

Beers, P.J., Geerling-Eiff, F., 2014. Networks as policy instruments for innovation. J. Agric. Educ. Ext. 20, 363–379.

Blackstock, K.L., Kelly, G.J., Horsey, B.L., 2007. Developing and applying a framework to evaluate participatory research for sustainability. Ecol. Econ. 60, 726–742.

Bos, J.J., Brown, R.R., Farrelly, M.A., 2013. A design framework for creating social learning situations. Global Environ. Change 23, 398–412.

Brandt, P., Ernst, A., Gralla, F., Luederitz, C., Lang, D.J., Newig, J., Reinert, F., Abson, D.J., von Wehrden, H., 2013. A review of transdisciplinary research in sustainability science. Ecol. Econ. 92, 1–15.

Carew, A.L., Wickson, F., 2010. The TD wheel: a heuristic to shape, support and evaluate transdisciplinary research. Futures 42, 1146–1155.

Cooper, J.R., 1998. A multidimensional approach to the adoption of innovation. Manag. Decis. 36, 493–502.

Dessai, S., van der Sluijs, J., 2007, December. Uncertainty and climate change adaptation – a scoping studyIn: Copernicus Institute for Sustainable Development and Innovation, Utrecht, Netherlands.

Dilling, L., Lemos, M.C., 2011. Creating usable science: opportunities and constraints for climate knowledge use and their implications for science policy. Global Environ. Change 21, 680–689.

Dowd, A.-M., Marshall, N., Fleming, A., Jakku, E., Gaillard, E., Howden, M., 2014. The role of networks in transforming Australian agriculture. Nature Clim. Change 4, 558–563.

EC – European Commission, 2013. Rural Development in the EU. Statistical and Economic Information. Report 2013, Luxembourg.

Edelenbos, J., van Buuren, A., van Schie, N., 2011. Co-producing knowledge: joint knowledge production between experts, bureaucrats and stakeholders in Dutch water management projects. Environ. Sci. Policy 14, 675–684.

Eisenack, K., Moser, S.C., Hoffmann, E., Klein, R.J.T., Oberlack, C., Pechan, A., Rotter, M., Termeer, C.J.A.M., 2014. Explaining and overcoming barriers to climate change adaptation. Nature Clim. Change 4, 867–872.

Feldman, D.L., 2012. The future of environmental networks – governance and civil society in a global context. Futures 44, 787–796.

Statistisches Jahrbuch, Wiesbaden, Germany.

Gädeke, A., Hölzel, H., Koch, H., Pohle, I., Grünewald, U., 2014. Analysis of uncertainties in the hydrological response of a model-based climate change impact assessment in a subcatchment of the Spree River, Germany. Hydrol. Process. 28, 3978–3998.

Gerstengarbe, F.-W., Badeck, F., Hattermann, F., Krysanova, V., Lahmer, W., Lasch, P., Stock, M., Suckow, F., Wechsung, F., Werner, P.C., 2003. Studie zur klimatischen Entwicklung im Land Brandenburg bis 2055 und deren Auswirkungen auf den Wasserhaushalt, die Forst- und Landwirtschaft sowie die Ableitung erster Perspektiven. PIK Report Potsdam-Institut für Klimaforschung (PIK), Potsdam.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M., 1994. The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies. SAGE, London/Thousand Oaks/New Delhi.

Hegger, D., Dieperink, C., 2014. Toward successful joint knowledge production for climate change adaptation: lessons from six regional projects in the Netherlands. Ecol. Soc. 19.

Hegger, D., Lamers, M., Van Zeijl-Rozema, A., Dieperink, C., 2012. Conceptualising joint knowledge production in regional climate change adaptation projects: success conditions and levers for action. Environ. Sci. Policy 18, 52–65.

Hegger, D., Van Zeijl-Rozema, A., Dieperink, C., 2014. Toward design principles for joint knowledge production projects: lessons from the deepest polder of The Netherlands. Reg. Environ. Change 14, 1049–1062.

Hermans, F., Klerkx, L., Roep, D., 2015. Structural conditions for collaboration and learning in innovation networks: using an innovation system performance lens to analyse agricultural knowledge systems. J. Agric. Educ. Ext. 21, 35–54.

Hermans, F., Stuiver, M., Beers, P.J., 2013. The distribution of roles and functions for upscaling and outscaling innovations in agricultural innovation systems. Agric. Syst. 115, 117–128.

Hirsch Hadorn, G., Bradley, D., Pohl, C., Rist, S., 2006. Implications of transdisciplinarity for sustainability research. Ecol. Econ. 60, 119–128.

Holsten, A., Vetter, T., Vohland, K., Krysanova, V., 2009. Impact of climate change on soil moisture dynamics in Brandenburg with a focus on nature conservation areas. Ecol. Model. 220, 2076–2087.

Home, R., Rump, N., 2015. Evaluation of a multi-case participatory action research project: the case of SOLINSA. J. Agric. Educ. Ext. 21, 73–89.

Hüesker, F., Moss, T., Naumann, M., 2011. Managing water infrastructures in the Berlin–Brandenburg region between climate change, economic restructuring and commercialisation. Erde 142, 187–208.

Jahn, T., Bergmann, M., Keil, F., 2012. Transdisciplinarity: between mainstreaming and marginalization. Ecol. Econ. 79, 1–10.

Kelly, G.J., Blackstock, K.L., Horsey, B.L., 2007. Limits to learning for developing a sustainable region: lessons from north-east Queensland. Aust. J. Environ. Manag. 14, 231–242.

Kilduff, M., Tsai, W., 2003. Social Networks and Organizations. SAGE, London/Thousand Oaks/New Delhi.

Klerkx, L., Aarts, N., Leeuwis, C., 2010. Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agric. Syst. 103, 390–400.

Klerkx, L., Mierlo, B., Leeuwis, C., 2012. Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In: Darnhofer, I., Gibbon, D., Dedieu, B. (Eds.), Farming Systems Research into the 21st Century: The New Dynamic. Springer, Netherlands, pp. 457–483.

Knierim, A., 2014. Stakeholder involvement for developing adaption innovations in rural areas: examples from Berlin-Brandenburg. In: Prutsch, A., Grothmann, T., McCallum, S., Schauser, I., Swart, R. (Eds.), Climate Change Adaptation Manual: Lessons Learned from European and Other Industrialised Countries. Routledge, London, pp. 128–135.

Knierim, A., Schmid, J.C., Knuth, U., 2015. Aktionsforschung zur Anpassung an den Klimawandel – Methodische Potentiale und Herausforderungen am Beispiel eines transdisziplinären Verbundprojektes in Brandenburg Berlin. In: Neuere Theorien und Methoden in den Wirtschafts- und Sozialwissenschaften des Landbaus [New Theories and Methods in Agricultural Economics and Social Science]Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e.V., Göttingen, pp. 81–94.

Knierim, A., Siart, S., Toussaint, V., Müller, K., Wiggering, H., 2010. Development of climate change adaptation strategies within the transdisciplinary network INKA BB, Building sustainable rural futures: the added value of systems approaches in times of change and uncertainty. In: Proceedings of the 9th European IFSA Symposium, 4–7 July 2010 in Vienna, Austria University of Natural Resources and Applied Life Sciences, Vienna. pp. 540–547.

Kolleck, N., 2013. Social network analysis in innovation research: using a mixed methods approach to analyze social innovations. Eur. J. Futures Res. 1, 1–9.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C.J., 2012. Transdisciplinary research in sustainability science: practice, principles, and challenges. Sustain. Sci. 7, 25–43.

Mandell, M., Keast, R., 2007. Evaluating network arrangements. Toward revised performance measures. Publ. Perform. Manag. Rev. 30, 574–597.

Mayntz, R., 1997. Soziale Dynamik und politische Steuerung. Theoretische und methodologische Überlegungen. Campus, Frankfurt, New York.

McCrum, G., Blackstock, K., Matthews, K., Rivington, M., Miller, D., Buchan, K., 2009. Adapting to climate change in land management: the role of deliberative workshops in enhancing social learning. EPG 19, 413–426.

Moschitz, H., Roep, D., Brunori, G., Tisenkopfs, T., 2015. Learning and innovation networks for sustainable agriculture: processes of co-evolution, joint reflection and facilitation. J. Agric. Educ. Ext. 21, 1–11.

Moser, S.C., 2010. Communicating climate change: history, challenges, process and future directions. Wires Clim. Change 1, 31–53.

Newig, J., Haberl, H., Pahl-Wostl, C., Rothmann, D., 2008. Formalised and non-formalised methods in resource management, knowledge and learning in participatory processes: an introduction. Syst. Pract. Action Res. 21, 381–387.

Nowotny, H., Scott, P., Gibbons, M., 2001. Re-thinking Science: Knowledge and the Public in an Age of Uncertainty. Polity Press, Cambridge.

Plieninger, T., Bens, O., Hüttl, R., 2007. Innovations in land-use as response to rural change—a case report from Brandenburg, Germany. In: Mander, Ü., Wiggering, H., Helming, K. (Eds.), Multifunctional Land Use. Springer Berlin, Heidelberg, pp. 369–385.

Podesta, G.P., Natenzon, C.E., Hidalgo, C., Ruiz Toranzo, F., 2013. Interdisciplinary production of knowledge with participation of stakeholders: a case study of a collaborative project on climate variability, human decisions and agricultural ecosystems in the Argentine Pampas. Environ. Sci. Policy 26, 40–48.

Pohl, C., Rist, S., Zimmermann, A., Fry, P., Gurung, G.S., Schneider, F., Speranza, C.I., Kiteme, B., Boillat, S., Serrano, E., Hadorn, G.H., Wiesmann, U., 2010. Researchers' roles in knowledge co-production: experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal. Sci. Publ. Policy 37, 267–281.

Polk, M., 2014. Achieving the promise of transdisciplinarity: a critical exploration of the relationship between transdisciplinary research and societal problem solving. Sustain. Sci. 9, 439–451.

Powell, W.W., 1990. Neither market nor hierarchy: network forms of organization. Res. Org. Behav. 12, 295–336.

Pretty, J.N., 1995. Participatory learning for sustainable agriculture. World Dev. 23, 1247–1263.

Provan, K., Kenis, P.N., 2008. Modes of network governance: structure, management, and effectiveness. J. Public Adm. Res. Theory 18, 229–252.

Reyer, C., Bachinger, J., Bloch, R., Hattermann, F., Ibisch, P., Kreft, S., Lasch, P., Lucht, W., Nowicki, C., Spathelf, P., Stock, M., Welp, M., 2012. Climate change adaptation and sustainable regional development: a case study for the Federal State of Brandenburg, Germany. Reg. Environ. Change 12, 523–542.

Rosendahl, J., Zanella, M.A., Rist, S., Weigelt, J., 2015. Scientists' situated knowledge: strong objectivity in transdisciplinarity. Futures 65, 17–27.

Schippers, M.C., Den Hartog, D.N., 2007. Reflexivity in teams: a measure and correlates. Appl. Psychol. 56,, 189-211.l.
SOBB, 2014. Statistisches Jahrbuch Brandenburg [Statistical Yearbook Brandenburg, Germany]. Statistical Office Berlin-Brandenburg, Potsdam.
Sol, J., Beers, P.J., Wals, A.E.J., 2013. Social learning in regional innovation networks: trust, commitment and reframing as emergent properties of interaction. J. Clean. Prod. 49, 35–43.
Tisenkopfs, T., Kunda, I., Šūmane, S., 2014. Learning as issue framing in agricultural innovation networks. J. Agric. Educ. Ext. 20, 309–326.
Thomas, D.R., 2003. A general inductive coding process for qualitative data analysis. Am. J. Eval. 27, 237–246.
Trimble, M., Lázaro, M., 2014. Evaluation criteria for participatory research: insights from coastal Uruguay. Environ. Manag. 54, 122–137.
Voorberg, W.H., Bekkers, V.J.J.M., Tummers, L.G., 2014. A systematic review of co-creation and co-production: embarking on the social innovation journey. Publ. Manag. Rev. 1–25.
Walter, A.I., Helgenberger, S., Wiek, A., Scholz, R.W., 2007. Measuring societal effects of transdisciplinary research projects: design and application of an evaluation method. Eval. Program Plann. 30, 325–338.
Wellbrock, W., Knierim, A., 2014. Unravelling group dynamics in institutional learning processes. Outlook Agric. 43, 187–191.
Weyer, J., 2011. Innovations-Netzwerke. In: Weyer, J. (Ed.), Soziale Netzwerke. Konzepte und Methoden der sozialwissenschaftlichen Netzwerkforschung. Oldenburg Verlag, München, pp. 219–245.
Wiek, A., Ness, B., Schweizer-Ries, P., Brand, F., Farioli, F., 2012. From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. Sustain. Sci. 7, 5–24.
Willke, H., 2001. Systemtheorie III: Steuerungstheorie, 3rd ed. UTB Verlag, Stuttgart.
Wirth, V., Prutsch, A., Grothmann, T., 2014. Communicating climate change adaptation state of the art and lessons learned from ten OECD countries. Gaia-Ecol. Perspect. Sci. Soc. 23, 30–39.
Wise, R.M., Fazey, I., Stafford Smith, M., Park, S.E., Eakin, H.C., Archer Van Garderen, E.R.M., Campbell, B., 2014. Reconceptualising adaptation to climate change as part of pathways of change and response. Global Environ. Change 28, 325–336.
Wolf, B., Lindenthal, T., Szerencsits, M., Holbrook, J.B., Heß, J., 2013. Evaluating research beyond scientific impact – how to include criteria for productive interactions and impact on practice and society. GAIA – Ecol. Perspect. Sci. Soc. 22, 104–114.
Zscheischler, J., Rogga, S., 2015. Transdisciplinarity in land use science – a review of concepts, empirical findings and current practices. Futures 65, 28–44.

Chapter 6

Discussion

Chapter 7

AKIS and Advisory System – back on the political agenda in Brandenburg

Chapter 8

Conclusion

6 Discussion

6.1 AKIS and Advisory System development during complete privatization

The AKIS in Brandenburg experienced severe disruptions; on the one hand as a result of the 1990 reunification and on the other hand as a result of complete privatisation of agricultural advisory services in 2002. After 2002, the Agricultural Advisory System in Brandenburg was characterized by an extraordinary level of privatization and commercialisation. Support from public authorities was largely absent, not only regarding funding but also regarding information and knowledge flows. This situation led to several deficits and a weak AKIS.

6.1.1. Lack of public support - coordination, cooperation and information flows reduced

Coordinating and networking activities by public authorities, which would ensure information flows (between advisors and other AKIS actors from research and education) and to support farmers' access to advice, was decreased to a minimum level. Linkages broke up and overall decreased.

These disruptions have severely impaired the trust of stakeholders in public authorities, in particular advisors and farmers. Advisors in Brandenburg complained about low-level information flow between different public authorities relevant to contents of advisory services. Brandenburg's MLUL strongly limited its engagement for maintaining a Farm Advisory System, to offering an annual advisors training on Cross Compliance, publishing an information brochure on Cross Compliance, and the accreditation of advisors. There was no financial support for farmers or advisors to offer or demand advisory services, e.g. related to agri-environmental topics or to implement Farm Management Systems (FMS). Concerning the interaction and cooperation among the group of private advisors the same trend towards a decreasing level in the course of full privatization became evident. Advisors valued the exchange with other private advisors at MLUL information events, but further cooperation was rather rejected on the grounds of market competition (chapter 2).

Additionally, the advisors criticised a lack of access to current information and research results in the agricultural sector in Brandenburg (chapter 2). Thus, due to this lack of well-functioning information flows und support, farm advisors in Brandenburg adapted, e.g. by using resources from other German states' research and advisory infrastructure (e.g., chambers of Agriculture). Nevertheless, interviews conducted with private advisors in 2006 and 2010, found that, the majority of them were more or less satisfied with Brandenburg's privatized Agricultural advisory system (AAS). In particular, the demand-driven elaboration of contents was appreciated, which is considered a main expected advantage from privatization processes (Klerkx et al. 2006; Kidd et al. 2000). This level of satisfaction surprised and might be explained with the experience of the first disruption of the AKIS and AAS just 20 years earlier

caused by the reunification in 1990, which might have strengthened the AKIS actors' resilience and adaptation capabilities to drastic changes of a system. A mentality of "we try to manage on our own without relying on or expecting public support" emerged – not only among advisors, but also among farmers.

The missing public support for FMS-related advisory services set a high threshold for Brandenburg's farmers to introduce FMS in their daily management routines (chapter 4). Surprisingly, only a few farmers complained about this situation. This could be due to the generally high educational level, especially, among large scale Farmers in Brandenburg (Federal Statistical Office Germany 2011), and on the other hand due to strong linkages between farmers and their local agricultural administration (chapter 2). However, this kind of informal knowledge flow could be criticised for its lack of transparency and equality.

Furthermore, the AKIS concept has not been on the agenda of public authorities, not in Europe (Knierim et al. 2015) and not in Brandenburg, and the shown missing linkages between the different actor groups impede the flow of knowledge and information. Funded networks can be used to fill gaps in regional AKIS. The policy-induced innovation network INKA BB (chapter 5) made chances and limitations of innovation networks visible. Learning and acquiring new knowledge was successful; integrating knowledge into one's own actions was more difficult. Success of such networks depends on repeated participation, appropriate information management and inclusive as well as responsive network practices. The latter requires appropriate facilitation and coordination skills of the network coordinator, no matter whether it is a researcher, advisor, farmer or policy-manager. This requires both, the willingness, as well as access to training and further education of such moderation and coordination skills in order to ensure methodological flexibility in such networks. Innovation networks as one way to fill gaps in a privatized AKIS have shortcomings, especially the short-term perspective of such networks, as their funding is mostly time limited. Trust between actors as a main success factor may be impeded, if knowing the cooperation has no long-term perspective. Additionally, the structure of funding schemes impacts the composition of actors and content (chapter 3). INKA BB also showed, independent private advisors are not easily part of such networks and have to overcome a number of hindrances before becoming engaged (Boenning and Knierim 2014).

6.1.2 Less profitable: small-scale farmers and agri-environmental issues?

Due to complete privatization, only farmers who could afford to pay for advice were able to receive it. Clients of agricultural advisory services in Brandenburg clearly shifted towards larger farms and small-scale or resource poor farms seemed to have dropped out of the advisory system (chapter 2). This result confirms earlier studies in Europe and worldwide (Labarthe and Laurent 2013, Kidd et al. 2000, Rivera 1993), which described small-scale/resource poor farms as becoming less visible or profitable as target

clients. Thus, they are excluded from "co-producing farm-level solutions by establishing service relationships with advisors so as to produce knowledge and enhance skills" (Labarthe et al 2013, p. 10).

Agri-environmental topics require a pro-active approach from consultants, as well as intensive and continuous communication processes (Nagel et al. 2002) and coordinating public authorities (Klerkx and Jansen 2010, Prager et al. 2016). While public extension services can afford to include these topics, in market-driven advisory services, the lack of direct economic benefit does not justify the costs. The results in chapter 2 and 4 also indicate this lack of agri-environmental advisory services in Brandenburg, e.g., Cross Compliance and the implementation of FMS were rarely demanded by farmers as an explicit advisory issue. It remains a research question, how to design regional organizational and financial structures of AKIS to promote environmental-friendly practices and related advisory services among farmers. Building up more permanent institutions to facilitate the agricultural knowledge market (Klerkx et al. 2006) might be one way, another more current discussed option is to obligate the farmer to take advice when being funded in agri-environmental schemes of CAP. Feindt et al. (2021) propose for the transformation of CAP starting in 2028, the mandatory use of advisory services on how to integrate environmental concerns into production from a certain farm-related funding level or certain farm size onwards.

Overall, the negative effects of decreasing cooperation and interaction and thus limited and increasing informal information flows between advisors, farmers and other actors of the AKIS described in earlier studies as a result of privatisation and commercialisation (Rivery and Cary 1997, Klerkx and Proctor 2013, Prager et al. 2016), became also evident in Brandenburg. These disadvantages clearly predominated the described advantage of increased demand-driven elaboration of advisory services and Brandenburg's AKIS can be considered a weak AKIS with severe deficits.

A stronger AKIS perspective among all actor groups could establish new institutional links and intensify the exchange. Chapter 3 describes different fields for governing AKIS and esp. the subsystem of advisory services (AAS) to enhance exchange and synergies between the different public and private actor groups or increase transparency. Transparency about and an indication of the focus and quality of advice providers is considered a minimum standard and should be supplemented by supporting monitoring and evaluation measures, certification initiatives for advisory services as well as targeted permanent training for advisors and improving linkages based on AKIS diagnoses. Most of these tasks can be considered important responsibilities for governing AKIS and advisory systems, which were inadequately fulfilled in Brandenburg between 2001 and 2017.

6.2 Conceptual reflections

In this thesis the usefulness of the concepts AKIS, AIS and AAS became apparent. The knowledge and information system approach (AKIS) helps to look both at necessary resources (infrastructural view) and interactions (process view) within the advisory system (AAS) and between advisors and other

knowledge system actors, in particular actors from research and education (Labarthe et al. 2013). Likewise, innovation-related networks (AIS) highlight the importance of peer-to-peer networks and knowledge exchange, e.g., in operational groups of EIP or cropping resp. stable schools (Vaarst et al. 2007; Scholz et al. 2018). These systems are complementary and novel developments combine the information and the innovation perspective under the term Agricultural Knowledge and Innovation System (also abbreviated AKIS). However, it is the author's opinion that a differentiation between AKIS, AIS and AAS is helpful (s. Tab. 1) to use them as an analytical tool and to support policy making according to specific needs. Agricultural Advisory System (AAS) as a subsystem of AKIS essentially focus on a trustful relationship between advisors and farmers, on the basis of which the farmers receive new information and possibly change their farm management.

Table 1: Differentiation between AKIS, AIS and AAS

	AIS – Ag. Innovation System	**AKIS - Ag. Knowlege and Information system**	**AAS – Agricultural Advisory System**
Relevant actors/ infrastructure	Farmers and other actors from the public, private and non-governmental sector:		
	All actors, which are relevant for the aimed innovation	Mainly: Advisory services, research, education, additionally: farmer-based organisations and other NGOs, public authorities, agricultural industries	Ag. advisory service providers, farmers, public authorities
Main focus	**Innovation/ change ->** result-oriented cooperation for an innovation	**Infrastructures/ resources and interactions** for Knowledge/information flow and knowledge production	**Advisory Services ->** farm advisor – farmer relationship and governance of advisory services

Additionally, it is necessary to bear in mind that there is not one national or regional Agricultural Knowledge and Innovation System, but there are many subsystems with regard to the specific agricultural (advisory) topics. For example, actors dealing with knowledge, related to chemical plant protection, may be very different from actors relevant for organic farms. Therefore, depending on the specific agricultural topic, it is most probably necessary to analyse more than one regional AKIS, especially for improving interactions and networking among the relevant stakeholders of a region. Additionally, the concept of farmers' microAKIS (Labarthe et al. 2018) might as well be considered.

6.3 Critical methodological and research process reflection

This dissertation comprises research work from different projects that relate to the development of the AKIS and the Agricultural Advisory System in Brandenburg. It also integrates insights of the author gained by continuously observing the development of AAS in Brandenburg over a period of 15 years. For this thesis, the view of agricultural advisors and farmers has been captured through a series of semi-structured interviews and analysed qualitatively. This method is particularly suited for exploring novel

fields of research because it allows to build on unforeseen information provided by interviewees. The results highlight the inner perspective of the actors and show that both farmers and agricultural advisors hold a critical view about the fully privatized agricultural advisory system in Brandenburg. Nevertheless, this qualitative approach provides a selective perspective due to small samples. Further research that also explores an outside perspective through the use of quantitative indicators of farm performance could complement the findings of this thesis. In this regard, a comparative analysis of the effects of different agricultural advisory systems in the German federal states would be highly informative.

Technical innovations are likely to lead to strong changes in agricultural advisory systems. Examples are decision support systems in the form of apps for mobile phones, video-tutorials and or the distribution of information via social media. Some of the FMS analysed in chapter 4 are no longer in use and novel technologies have replaced them or will do so in the future. However, the methods used in this thesis to assess their characteristics, are also transferrable to these new systems.

7 AKIS and Advisory System – back on the political agenda in Brandenburg

The period of complete privatisation from 2002 until 2017 revealed severe deficits within the AKIS and advisory system in Brandenburg. It became obvious, that more intervention and public support by public authorities was necessary. Although the research of chapter 3 thru 5 was done in this period, the author continued to observe the AKIS and advisory system of Brandenburg until today. A change could be observed in 2018 and the following years, mainly based on i) the implementation of new CAP related policies to promote cooperation and networks (Art. 35 of EC Reg. 1305/2013) and ii) a new state funded regulation to support farmers' demand of advisory services. Both policies are described in the following, as they are relevant to the conclusion drawn in chapter 8.

7.1 Cooperation regulation and European Innovation Partnership (EIP) based on EAFRD

The implementation of the European Innovation Partnership (EIP) and cooperation regulation (Art. 35 of EC Reg. 1305/2013) in Brandenburg with CAP (2014 -2020) brought AKIS and the advisory system back on the political agenda in Brandenburg and provided new ways for innovation and knowledge flow. New groups and networks have formed in Brandenburg and enliven the AKIS, especially regarding the topic of sustainability of agriculture. With a funding of more than 20 Mio Euro for the EU funding period 2014 to 2020, the federal state of Brandenburg provided the highest financial volume for EIP implementation in Germany (Rocha 2015). For Brandenburg and Berlin, a total of 25.6 million Euros were provided. Since the start of the programme, a total of 22 project applications have been approved in response to 4 calls for proposals, with a project duration of between 3 and 5 years (MLUK 2020).

The cooperation regulation "Promotion of cooperation for the implementation and dissemination of resource-, climate-friendly and climate-resistant land use and sustainable management" based on Art. 35 of EC Reg. 1305/2013 was implemented by the Ministry of Rural Development, Environment and Agriculture in Brandenburg in 2017. Since the start of the programme, a total of 21 project applications have been approved after three calls, which have a project duration of up to 4 years. Annual meetings of all project teams in 2018 and 2019 aimed at enabling and supporting exchange and longer-term cooperation. Many projects focus on biodiversity, climate protection and agrobiodiversity. Participants welcomed the possibility for an intensive exchange among the projects and encouraged the ministry to regularly organize such events in the future (MLUK 2019).

Regarding advisory methodology, group approaches, e.g., advisory circles have been absent for a long time in Brandenburg and the face-to-face approach of advisory services remains dominant. Nevertheless, new networks, which can be considered advisory circles, have recently developed through regulations such as EIP-operational groups and the cooperation regulation based on Art. 35 of EC Reg. 1305/2013 mentioned above. The new regulation on cooperation in Brandenburg led to interesting projects which filled gaps in Brandenburg's AAS. Of particular note is the organic arable farming network, which combines practical trials and networking and works in the format called cropping school on the basis of stable schools resp. farmer field schools (Scholz et al. 2018; Vaarst et al. 2007). It understands itself as an alternative to classical advisory services. Further projects funded with this regulation work on topics of wetland and grassland management and aim to develop new capacities in the field of agri-environmental advice by networking and advising farmers.

Another project of this cooperation regulation with relevance to gaps in the AAS in Brandenburg is a project focussing on biodiversity related farm advisory services in Brandenburg, where the author was actively involved in developing and implementing it. The project aims to develop, test and evaluate an advisory concept within 4 years and to develop policy recommendations for expanding and strengthening biodiversity-related advisory services in Brandenburg. The aim is to provide all farmers in Brandenburg in and outside protected areas with access to biodiversity advice at little or no cost and develop supporting infrastructure for farmers and advisors by establishing demonstration farms and further education for biodiversity advisors.

Such funded network projects may fil the gap of agri-environmental advice for the time of the duration of funding, but future activities in this field need new project funding or other ways of sustaining the structures and resources developed in such projects. In addition, only a limited number of farmers participate in these networks. However, it can be assumed that there is significantly more need for advice in these areas. How the advisory approaches and contents, which were developed in projects, can be transferred into longer-term structures, remains a task for those responsible for the project and those responsible for the funding regulation.

7.2 State-funded regulation to support the demand of advisory services

In 2017, a format called the Advisors' Day was organized in Brandenburg (MLUL 2017). It can be considered a participatory situational analysis of the AAS commissioned by the Ministry of Agriculture Brandenburg (MLUL), co-organized and co-facilitated by the author. Main participants were private advisors, representatives from farmers' organisations, representatives from the MLUL responsible for FAS and agricultural education in Brandenburg. Participants clearly pointed at the lack of state support. Thus, this event made severe shortcomings of Brandenburg's AAS visible and might have encouraged the MLUL to move away from the "zero subsidies" strategy. Shortly after, in 2018, the MLUL developed a funding regulation to subsidize advisory services related to agri-environmental topics and socio-economic advice (MLUL 2018). However, initial feedback on the regulation indicated difficulties with the practical application after the first call. The MLUL issued a first call for funding advisory cases in autumn 2018 and advisors had to turn in advisory cases to be funded by January 2019 and wait for approval before they start the counselling process with the farmer. Several advisors reported very long waiting periods (up to 6 months) until the approval of advisory cases Additionally, the calls were not issued at regular short-term intervals, which led to very low retrieval of funding by advisors (FÖL 2019). In-between, the regulation was revised, and a second call was published in June 2020 (MLUK 2021). Several before mentioned deficits of the regulation improved, most importantly, the application procedures for advisors were simplified and farmers can demand advice as often or in as many agri-environmental fields as necessary.

8 Conclusion

A core achievement of this research is the observation of the development of the agricultural advisory system in particular within the overall AKIS in Brandenburg over a period of ten years. The thesis revealed a number of deficits, some of which in the interim have been recognised and addressed by public authorities.

Brandenburg's approach towards agricultural advisory services has undergone strong changes, especially in the current EU funding period (2014-2020). There are many indications that the zero-subsidies strategy is no longer being pursued and a functioning Farm Advisory System is moving back onto the political agenda in Brandenburg. Advisory services and cooperation support approaches are being continuously developed. Examples are regulations to support operational groups within EIP and the regulation on cooperation (both based on EAFRD Regulation; Art. 35), as well as the Brandenburg's regulation to subsidize advisory services related to agri-environmental topics and socio-economic advice.

The findings of this study can further support this process of change by highlighting problems under the current system, in particular from the perspective of agricultural advisors, by suggesting formats for

dialogue and exchange, and by indicating novel approaches for monitoring of advisory services. Additional research should focus on comparative studies, e.g. to assess the effectiveness and efficiency of Brandenburg's regulation to subsidize advisory services and other interventions to support the AKIS and the Advisory (Sub)system.

8.1 Policy recommendations

Based on the findings of this thesis and the observations described in chapter 7, the following recommendations are given to Brandenburg's policymakers to further develop the federal state's system of agricultural advisory services as well as the Agricultural Knowledge and Innovation System:

- AKIS as a concept should be more strongly taken as a basis by policy-planners involved in administration related to agricultural education, research and advisory services. The new CAP drafts also demand this by proposing a description of the organisational structure of AKIS within the framework of the strategic plan (Art. 102 abs. 95) (BMEL 2019). A more intensive exchange between AKIS researchers in the state on the one hand, and those responsible for politics and administration on the other hand may be sought.
- A systematic comparative evaluation of EU-funded cooperation projects (EIP operational groups and other cooperation projects) at Brandenburg level would be advantageous for a further development of such regulations. Chapter 4 provides a suitable methodology for analysing success factors of such networks. Such an evaluation could be part of an AKIS diagnosis conducted on a regular term in Brandenburg. The continuation and further development of EIP is also recommended by the Scientific Committee on Agricultural Policy (Grethe et al. 2018) for the Further Development of the CAP.
- A privatized AAS requires mechanisms to capture advisory services, their providers and effectiveness, as well as gaps regarding client groups and content, in order to take countermeasures if necessary. Therefore, a continuous monitoring and evaluation system should be developed for the AAS and the AKIS as a whole. AKIS diagnosis is rather a snapshot and should be complemented by continuous monitoring.
- The Advisors' Day 2017 can be understood as one part of an AKIS diagnosis as it took a closer look at the AAS and should be repeated in regular term. It would help to improve linkages or even cooperation between different AAS actors. The format could also be used to discuss other fields of AKIS such as education and research, which were not represented in 2017.
- The regulation to co-finance demand of advisory services related to agri-environmental and socio-economic topics (MLUL 2018 and 2020) needs to be continued and further developed. Continuous application should be possible as well as prompt and reliable processing of grant applications is necessary.

- The promotion of sustainable practices in agriculture might benefit from an intensification of cooperation between the environmental and agricultural departments of the MLUK. Since 2012, for example, a concept for Water Framework Directive-related agricultural advisory services exists at the State Environmental Agency (Knierim et al. 2012), but this concept has not yet been implemented and was not known by the agricultural department of the MLUL (personal comm 2017).
- The training of agricultural advisors in Brandenburg should be strengthened. While this topic was not examined in detail in chapters 2 to 5, during the interviews for chapter 2 and years later during the Advisors' Day 2017, advisors expressed an urgent need for regional accessible training and further education.
- In particular, a training on advisory methods is required, as "the role of an 'advisor' is becoming less and less linear and moving towards coaching" (SWG SCAR AKIS4 2018). Experiential learning appears to be a promising approach to strengthen reflective practice of agricultural advisors (Gorman 2019).
- The 2019 coalition agreement of the Brandenburg government contains the plan to set up a competence centre for agricultural advisory services. Based on the findings of this thesis, it is recommended, that such a centre addresses the following topics: provision of agri-environmental and socio-economic advisory services, promotion of education and training, and certification of advisors e.g., via the Certificate for European Consultants in Rural Areas (CECRA) and coordination of monitoring of advisory services and AAS performance. Additionally, networking between advisors as well as between authorities, associations and advisors are considered core tasks, e.g., knowledge exchange regarding the design of agri-environmental measures.

8.2 Research recommendations

This thesis contributed to closing research gaps regarding the Agricultural Knowledge and Innovation System and in particular on the Agricultural Advisory System in Brandenburg. Further research should focus on the following questions:

- How effective is the current regulation to support the demand of agricultural advisory services in Brandenburg? Comparative quantitative studies appear to be best suited.
- How effective are the different regulation designs in Germany, that implement article 15 of ELER compared to other types of subsidizing demand of agricultural advisory services, especially federal such as GAK or state funds. The best-fit approach (Birner et al. 2009) delivers an approach based on transaction cost analysis for such comparative studies.

- Have all types of farms regarding size and production form access to advice when needed? To answer this question, advisory service could be integrated as an additional topic into the regular survey of all German farms ("*Agrarstrukturerhebung*").
- The EU-wide research project PRO AKIS delivered a momentary picture of the situation of agricultural advisory services in Europe at the time of 2015. Methods and mechanisms are necessary, that enable a continuous monitoring on demand and provision of agricultural advisory services and thus the functioning of FAS.
- What are functionable accreditation and certification schemes of agricultural advisors (in Europe/ Germany)?
- Which role do advisors take up when participating in innovation networks? In how far does that correspond with their role expected from them in theory with regard to the AIS concept?
- Is there a difference within the AKIS with regard to the organic farming sector and the conventional farming sector? In how far do the actors and ways to communicate and cooperate differ? The thesis would be: there are severe differences, especially regarding the level of communication and cooperation. If this assumption proves true, it might be useful to have a closer look at how to build new networks that build bridges between them.

REFERENCES

Birner, Regina; Davis, Kristin; Pender, John; Nkonya, Ephraim; Anandajayasekeram, Ponniah; Ekboir, Javier et al. (2009): From Best Practice to Best Fit. A Framework for Designing and Analyzing Pluralistic Agricultural Advisory Services Worldwide. In: *The Journal of Agricultural Education and Extension* 15 (4), pp. 341–355. DOI: 10.1080/13892240903309595.

Boenning, Kinga; Knierim, Andrea (2014): Designing, implementing and maintaining (rural) innovation networks to enhance farmers' ability to innovate in cooperation with other rural actors. Case study report on a policy-induced agricultural innovation network in Brandenburg. Report for AKIS on the ground: focusing knowledge flow systems (WP4) of the PRO AKIS project. December 2014.

Bundesministerium für Ernährung und Landwirtschaft (BMEL) (2019): EIP AGRI - Ausblick auf die neue Förderperiode nach 2020. In: 3. Bundesweiter Workshop für Operationelle Gruppen und Innovationsdienstleister. Deutsche Vernetzungsstelle ländlicher Raum. 14.03.2019 in Arnstadt.

Federal Statistical Office Germany, 2011. Land- und Forstwirtschaft, Fischerei: Landwirtschaftliche Berufsbildung der Betriebsleiter/Geschäftsführer Landwirtschaftszählung/Agrarstrukturerhebung 2010. Fachserie 3, Heft 1.

Feindt, Peter H.; Grohmann, Pascal, Häger, Astrid; Krämer, Christine (2021): Verbesserung der Wirksamkeit und Praktikabilität der GAP aus Umweltsicht, UBA-Text 91/2021, Dessau: Umweltbundesamt, 398 Seiten, online available at: https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-06-14_texte_91-2021_wirksamkeit_gap.pdf (open access), checked on 10.09.2022.

Fördergemeinschaft Ökologischer Landbau Berlin-Brandenburg (FÖL) (2019): Rückmeldungen zur Richtlinie zur Förderung von Beratungsdienstleistungen in Brandenburg (unpublished).

Gorman, Monica (2019): Becoming an agricultural advisor – the rationale, the plan and the implementation of a model of reflective practice in extension higher education. In: *The Journal of Agricultural Education and Extension* 25 (2), pp. 179–191. DOI: 10.1080/1389224X.2018.1559742.

Grethe, Harald; Arens-Azevedo, Ulrike; Balmann, Alfons; Biesalski, Hans Konrad; Birner, Regina; Christen, Olaf; Gauly, Matthias; Knierim, Ute; Latacz-Lohmann, Uwe; Martinez, José; Nieberg, Hiltrud; Offermann, Frank; Pischetsrieder, Monika; Qaim, Matin; Renner, B.; Schmid, Julia C.; Spiller, Achim; Taube, Friedhelm; Voget-Kleschin, Lieske; Weingarten, Peter (2018): Für eine gemeinwohlorientierte Gemeinsame Agrarpolitik der EU nach 2020: Grundsatzfragen und Empfehlungen. Stellungnahme des Wissenschaftlichen Beirats für Agrarpolitik, Ernährung und gesundheitlichen Verbraucherschutz beim Bundesministerium für Ernährung und Landwirtschaft (WBAE). In: Berichte über Landwirtschaft June 2018 (Sonderheft 225). DOI: 10.12767/buel.v0i225

Kidd, A. D.; Lamers, J. P. A.; Ficarelli, P. P.; Hoffmann, V. (2000): Privatising agricultural ex-tension. caveat emptor. In: Journal of Rural Studies 16 (1), pp. 95–102. DOI: 10.1016/S0743-0167(99)00040-6.

Klerkx, Laurens; Grip, Karin de; Leeuwis, Cees (2006): Hands off but Strings Attached. The Contradictions of Policy-induced Demand-driven Agricultural Extension. In: Agriculture and Human Values 23 (2), pp. 189–204.

Klerkx, Laurens; Jansen, Jolanda (2010): Building knowledge systems for sustainable agriculture: supporting private advisors to adequately address sustainable farm management in regular service contacts. In: International Journal of Agricultural Sustainability 8 (3), pp. 148–163. DOI: 10.3763/ijas.2009.0457.

Klerkx, Laurens; Proctor, Amy (2013): Beyond fragmentation and disconnect. Networks for knowledge exchange in the English land management advisory system. In: Land Use Policy 30 (1), pp. 13–24. DOI: 10.1016/j.landusepol.2012.02.003.

Knierim, Andrea; Boenning, Kinga; Caggiano, Monica; Cristóvão, Artur; Dirimanova, Violeta; Koehnen, Timothy; Labarthe, Pierre; Prager, Katrin (2015): The AKIS concept and its relevance in selected EU member states. In: *Outlook on Agriculture* 44 (1), pp. 29–36. DOI: 10.5367/oa.2015.0194.

Knierim, Andrea.; Paul, Caroline.; Knuth, Ulrike; Unger, Janine (2012): Landwirtschaftliche Fachberatung zur Umsetzung der WRRL. Wissenschaftliche Grundlagen für ein Beratungskonzept in Brandenburg; Endbericht. ZALF, Müncheberg.

Knierim, Andrea; Knuth, Ulrike; Rupschus, Christian; Schläfke, Nicole (2011): Cross Compliance Beratung - Eine vergleichende Bewertung der Situation in Brandenburg. Weikersheim: Margraf Publishers GmbH (Kommunikation und Beratung - Sozialwissenschaftliche Schriften zur Landnutzung und ländlichen Entwicklung).

Labarthe, Pierre; Sutherland, L. A.; Elzen, Boelie; Adamsone-Fiskovica, Anda (2018): Advisory role in farmers' micro systems of agricultural knowledge and innovation (microAKIS). In : 13th European IFSA Symposium. 13th European IFSA Symposium: Farming systems: facing uncertainties and enhancing opportunities. Chania, Greece, 02.07.2018. Available online at http://ifsa.boku.ac.at/cms/fileadmin/Proceeding2018/1_Labarthe.pdf , checked on 16.03.2021.

Labarthe, Pierre; Laurent, Catherine (2013): Privatization of agricultural extension services in the EU. Towards a lack of adequate knowledge for small-scale farms? In: *Food Policy* 38, pp. 240–252. DOI: 10.1016/j.foodpol.2012.10.005.

Labarthe, Pierre; Caggiano, Monica; Laurent, Catherine; Faure, Guy; Cerf, Marianne (2013): Deliverable WP.2-1. Deliverable of Workpackage 2 within the EU 7th Framework Programme project PRO AKIS - Prospects of Farmers' Support: Advisory Services in European AKIS: Advisory Services within AKIS: International debates.

Ministerium für Ländliche Entwicklung, Umwelt und Landwirtschaft des Landes Brandenburg (MLUL) (2017): Ergebnisprotokoll - 1. Beratertag in Brandenburg - 02. November 2017 (unpublished).

Ministerium für Ländliche Entwicklung, Umwelt und Landwirtschaft des Landes Brandenburg (MLUL) (2018): Richtlinie zur Förderung der Inanspruchnahme von landwirtschaftlichen Beratungsdienstleistungen vom 24. September 2018.

Ministerium für Landwirtschaft, Umwelt und Klimaschutz des Landes Brandenburg (MLUK) (2021): „Richtlinie des Ministeriums für Landwirtschaft, Umwelt und Klimaschutz des Landes Brandenburg zur Förderung der Inanspruchnahme von landwirtschaftlichen Beratungsdienstleistungen (Beratungsrichtlinie –BeRl) vom 11. Juni 2020 zuletzt geändert am 1. Januar 2021“ online available at: https://mluk.brandenburg.de/sixcms/media.php/9/Beratungsrichtlinie-BeRl-mitAnlagen1und2.pdf , checked on 10.09.2022.

Ministerium für Landwirtschaft, Umwelt und Klimaschutz des Landes Brandenburg (MLUK) (2020): Europäische Innovationspartnerschaft "Landwirtschaftliche Produktivität und Nachhaltigkeit (EIP-AGRI) - Land Brandenburg. Online available at https://eip-agri.brandenburg.de/eip-agri/de/projekte/ , checked on 24.02.2020.

Ministerium für Landwirtschaft, Umwelt und Klimaschutz des Landes Brandenburg (MLUK) (2019): Netzwerktreffen Zusammenarbeit Dezember 2019. MLUK; Referate 33 und 51. Online available at: https://mluk.brandenburg.de/mluk/de/start/service/foerderung/fachuebergreifend/zusammenarbeit-fuer-landbewirtschaftung-und-klimaschonende-landnutzung/ , checked on 16.03.2021.

Nagel, Uwe Jens; Heiden, Kirsten von der; Siebert, Rosemarie (2002): Public goods and privatised extension - the rocky road toward Agro-Environmental Extension. In: Extension and Rural Development: A Convergence of Views on International Approaches? Workshop, November 12-15, 2002, Washington DC, Sustainable Agricultural Systems and Knowledge Institutions, Agriculture and Rural Development. World Bank.

Prager, Katrin; Labarthe, Pierre; Caggiano, Monica; Lorenzo-Arribas, Altea (2016): How does commercialisation impact on the provision of farm advisory services? Evidence from Belgium, Italy, Ireland and the UK. In: *Land Use Policy* 52, pp. 329–344. DOI: 10.1016/j.landusepol.2015.12.024.

Rivera, William (1993): Impacts of Extension Privatisation. In: *Journal of Extension* 31 (3). pp.28-29

Rivera, William; Cary, John (1997): Chapter 22. Privatizing Agricultural Extension. In: Burton E. Swanson, Robert P. Bentz und Andrew J. Sofrankko (Ed.): Improving Agricultural Extension - A reference manual. Rome: Food and Agriculture Organization of the United Nations (FAO).

Rocha, Bettina (2015): Frischer Wind für die Agrarforschung. In: *B&B Agrar* (5), pp. 12–14.

Scholz, Sabrina; Bloch, Ralf; von Muenchhausen, Susanne; Haering, Anna (2018): Cropping School - An alternative to advisory services in Brandenburg, Germany? In: 13th European IFSA Symposium. 13th European IFSA Symposium: Farming systems: facing uncertainties and enhancing opportunities. Chania, Greece.

Strategic Working Group (SWG) of the Standing Committee of Agricultural Research (SCAR) on Agricultural Knowledge and Innovation Systems (SWG SCAR AKIS4) (2018): SWG SCAR-AKIS Policy Brief on the Future of Advisory Services. Online available at: https://ec.europa.eu/eip/agriculture/sites/default/files/policy_brief_on_the_future_of_advisory_services_scar_akis_06102017.pdf . Checked on 24.09.2022.

Vaarst, M.; Nissen, T. B.; Østergaard, S.; Klaas, I. C.; Bennedsgaard, T. W.; Christensen, J. (2007): Danish stable schools for experiential common learning in groups of organic dairy farmers. In: *Journal of Dairy Science* 90 (5), pp. 2543–2554. DOI: 10.3168/jds.2006-607.