Strengthening On-Farm Research in upper secondary agricultural education in Germany

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Abstract

On-farm research can be a tool for farmers to test new methods to adapt and build their farm resilience. Experimental competencies and specific on-farm research education in agriculture education are therefore needed. An option for the introduction of on-farm research in agricultural education is illustrated with a case study from Brandenburg, Germany. The case study shows how on-farm research is currently implemented in the curricula of upper-secondary agricultural education and gives an example of designing and implementing a teaching unit for master schools.

Keywords

Farmer's experiments, Agriculture Education, Knowledge promotion, Innovation development, Action Research

Introduction

Changing environments that have uncertain and disturbing impacts challenge farmers' abilities to adapt their farms and to create resilient businesses (Kummer et al. 2012). Experimenting with new cultivation techniques, innovative pest and disease management practices or alternative markets can help to identify appropriate adaptation strategies (Meertens 2008; Baldwin 2004; Kummer et al. 2012). On-farm research is one way to adapt new methods to build farm resilience and can be a tool for introducing innovations to farming activities within specific farm conditions (Bloch et al. 2015; Kummer et al. 2012); or as Scooby (2001, 11) phrases it "on-farm research is a powerful decision-making tool" and it "is one of the fundamental strategies involved in farmers' learning" Kummer et al. (2012, 2). On-farm research can be particularly important in regions with a high need for adaptation, resulting from, e.g. particular local conditions (annual rainfall, soil formation, climate change) or external factors (market fluctuations, rising energy prices or other trends). Farmers who have advanced experimental skills quickly realize the need for adapting their farming system and are able to set up on-farm research trials (Bundschuh and Knierim 2013).
In Western Europe and North America, on-farm research plays a significant role in developing and communicating innovative and best practice farming methods. However, little is known about how training and education in on-farm research and experimental skills is covered in agricultural education.

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The aim of this study, therefore, is to analyze i) if and how on-farm research education is covered in agricultural education and training in upper secondary agricultural education in the German federal state of Brandenburg and ii) present an example of how experimental competencies could be implemented in upper secondary agricultural education.

Background:

On-farm research is understood to be a type of research where the experiment takes place on the farm under real-life conditions with the original production (Andekerk et al. 2015; Meertens 2008; Baldwin 2004; Kummer et al. 2012). Other terms for on-farm research that are used in literature are ‘participatory on-farm research’ (Aendekerk et al. 2015), ‘on-farm experiment’ (Maat 2011; IBS-DR 2012), ‘on-farm trials’ (University of Readington 1998), ‘farmer’s experiments’ (Kummer et al. 2012) or ‘folk experiments’ (Bently 2006).
On-farm experiments usually include the following steps: 1) Define the study question (the goal and objectives of the experiment); 2) Plot layout and design (what treatments are to be used and what is the check plot or control); 3) Select a site in the field, 4) Implement the trial, 5) Collect data (what data will you collect and how will you collect it), and 6) Analyze and learn from the data (Meertens 2008; Ketterings 2012; FIBL et al. 2004).
While the definition of where the action is taking place is consistent in all references, the farmer’s role or the degree of farmer’s involvement and the experimental methods in on-farm research are not consistent. The IBD-DR (2012) identifies on-farm experiments as tests with a scientific goal and scientific methods of operation, comparable to scientists’ research results yielded by laboratory tests or on-station experiments. It also holds that tests that are done by farmers are not on-farm experiments. In contrast, others consider the involvement of farmers in on-farm research projects very important (Rempel 2002; Meertens 2008; Ketterings 2012). According to Rempel (2002) “True ‘on-farm’ research involves producers in experiment design, often in collaboration with scientists or extension educators”, while Meertens (2008) differentiates three types of on-farm research, based on the degree of the farmer’s participation:

Table 1: Types of on-farm research according to Meertens (2008).

Objective	Trial Type	Trial design	Trial management
Biophysical feasibility	1	Researcher-led	Researcher-led
Profitability, farmer assessment of prototypes	2	Researcher-led	Farmer-led
Acceptability: farmers’ own innovation, assessment	3	Farmer-led	Farmer-led

Finally, Bently (2006) differentiates between folk experiments and formal scientific research, stating that folk experiments rarely produce consistently written results compared to scientific research, because the results are for use by individual farmers or farmer groups only and are not intended for publication.

In this paper, On-Farm Research (OFR) is understood as an experiment that answers a study question asked by the farmer to find practical solutions to the farmer’s problems. This also means that the farmer plans and introduces the experiment at their farm, with or without help from other farmers, agriculture advisors or scientists.

General and agricultural education in Germany

In Germany federal states have the legislative power over the educational system. Commonly, students who have completed 9 years of compulsory primary schooling and lower secondary education move into upper secondary education. Depending on qualifications and entitlements, upper secondary education includes full-time general education or attendance at vocational schools, as well as a combination of vocational education and practical training within a "dual system". Tertiary education is offered by academic institutions of higher education such as universities (Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany 2014).

To be legally recognized as a professional farmer it is necessary to complete an agricultural apprenticeship of three years, including practical training on a farm and theoretical education at a vocational school ("dual system") (BA 2016). Further education within the "dual education system" goes towards a "master farmer" degree, which takes a further one and a half years (MLUL 2014). A completed apprenticeship and two years of professional experience as a farmer or five years of professional experience as a famer are prerequisites. To work on a corporate farm as a production manager or in other management positions generally requires a higher qualification such as 'master farmer' or an academic degree (Bachelor or Master).

OFR is usually part of academic agricultural education in Germany (HNE Eberswalde 2014, University of Kassel 2017). The main focus of this study, therefore, is how OFR and experimental skills are covered in upper secondary agricultural education (or in apprenticeship and master farmer in the dual education system).

Materials and methods

Study region

The German federal state *Brandenburg* in North East Germany was formed by the last glacial period. It is characterized by numerous lakes and rivers as well as heterogenic soil formations that range from extremely nutrient poor and unfertile to very fertile. The region is also characterized by low annual rainfall (< 600 mm/year) and a predominantly sandy soil which cannot retain much water. These conditions make the region particularly vulnerable to the expected impacts of climate change, such as rising average temperatures, more rainfall during the winter and less rainfall in summer, or to an increasing number of extreme weather events such as sporadic heavy rainfall or severe heat waves. This could cause significant damage to natural and agricultural systems (Reyer et. al 2012). Furthermore, volatile markets and rising land prices increase the pressure on farmers to constantly rethink and adapt their businesses (UBA 2016).

Brandenburg farms are characterized by very large agricultural areas. 6.4% of companies farm more than 1000 ha of agriculture land and manage nearly half (43.4%) of the agriculture land area in Brandenburg. While 61% of the agricultural companies with an area of only 5-100 ha manage a total of 5% of the total agricultural land area (status 2013, Amt für Statistik Berlin-Brandenburg 2014 a).

33% of farm managers in Brandenburg have an academic degree, either an upper secondary education degree such as the agricultural apprenticeship (16,5%) or a master farmer degree (18,5%), while almost one-third of farm managers (28%) have no formal agricultural education, relying only on practical experience (status 2013, Amt für Statistik Berlin-Brandenburg 2014 b). Accordingly, farmers in Brandenburg differ widely in their knowledge of OFR. While a few innovative farmers are interested in experiments, most farmers have little or no knowledge of experimental skills (Bloch et al. 2015).

The approach: Action Research

The basis of Action Research (AR) was formulated by Kurt Lewin in the 1940's in the US (Hine 2013; Unger et al. 2007). To find practice-relevant solutions for social problems he developed a new method of social research. AR involves the close collaboration of researchers and practitioners with the aim of investigating and influencing professional practice in a chosen field. Discussions about the AR approach are diverse (Unger et al. 2007). Nevertheless, four basic principles overarch all types of AR: 1) empowerment of participants, 2) collaboration through participation, 3) acquisition of knowledge and 4) social change.

In the field of education Stephen Corey from the Teachers College at Columbia University was the first to use AR. He considered that the value of AR lay in the change that occurs in everyday practice rather than generalizing to a wider audience. He saw the need for teachers and researchers to work together. Hence AR in education is defined as "a process in which participants examine their own educational practice systematically and carefully, using the techniques of research. […] specifically refers to a disciplined inquiry done by a teacher with the intent that the research will inform and change his or her practices in the future. This research is carried out within the context of the teacher's environment — that is, with the students and at the school in which the teacher works — on questions that deal with educational matters at hand" (Ferrance 2000, 1). Ferrance (2000) differentiates between four different types of AR, depending upon the participants involved: I) Individual teacher research, II) Collaborative action research, III) School-wide action research and IV) District-wide action research."

Independent of the area of application, AR is typically characterized by five phases: 1) Identification of problem area; 2) Collection and organization of data, 3) Interpretation of data, 4) Action based on data, and 5) Reflection (Hine 2013, see also Figure 1).

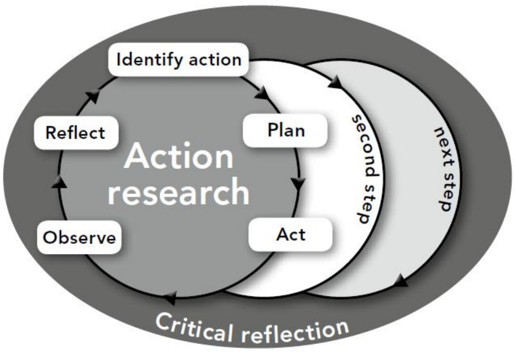

Figure 1 Action Research Cycle (New South Wales Department of Education and Training, 2010)

Realization and results of the case study

Identification of problem area and data collection: Status Quo Analyses

Head teachers and a representative from the department of agriculture, education and research for the Ministry of Rural Development, Environment and Agriculture of the Federal State of Brandenburg (MRDEA) were invited to two workshops with the aim i) to evaluate the status quo of the extent of coverage of experimental knowledge and skills in curricula and practical implementation in class and ii) to identify potential interest involving these topics. One

workshop focused on the education provided at master schools, and the other on education provided at vocational schools for apprentices.
The workshop that focused on master schools caught the interest of all head teachers and the ministry representative, while the workshop in apprentice vocational education did not motivate sufficient teachers to assure a fruitful group discussion. As an alternative, two individual expert interviews with head teachers were conducted.
The workshop and the interviews first examined the status quo of written information in OFR in the curricula. Secondly, every participant or interviewed teacher was asked whether and how OFR was implemented in class. Finally, the actual extent of OFR included in the curricula and its practical implementation in class was discussed. Elements that were missing or desirable were also identified.

For master schools, workshops showed that the topic of OFR was covered as a one-year, practical training project in the curriculum. All students must plan, design and manage an experiment on a farm, unassisted, in order to pass their final exam for master farmer. However, the results also showed that master schools offer little theoretical background or practical guidance. Reasons mentioned were: i) the lack of external professionals as teachers, and ii) the lack of suitable guidelines for OFR in German aimed at practitioners rather than scientists. Students often had difficulties in planning, managing and interpreting the results of their experiments in a scientific way. The need for assistance in teaching the basic principles and the practical needs and benefits of OFR were identified. Improvements for the current syllabus was also agreed upon.

In apprenticeship education, OFR is not part of the curriculum as the topic is considered better placed at higher education levels such as master schools or in academic education.

Interpretation of data: Planning the Unit of Teaching

As a result of the status quo analyzes, a teaching unit for master schools was designed based on basic didactic models such as the “mobile-model” (Knoll 2010) or the “Taxonomy of Significant Learning” (Dee Fink 2003). This included two handouts for students: an OFR guide of four pages and a guidebook on the documentation of their practical training project.

For apprenticeship education no further activities were planned.

Action based on data: realizing and testing the teaching unit for master farmers

A unit of teaching was organized at a farm active in OFR. An external professional gave a presentation about the basic principles of experimenting and the benefits of OFR. A field visit and discussion with a farm manager who demonstrated his field experiments and relevant technology took place. The unit also included a practical exercise on planning an OFR, two handouts on OFR and a documentation tool for a practical training project for individual students. Finally, an external professional facilitated the teaching unit and observed the process.

The location for the teaching unit was selected on a farm active in OFR in order to show that OFR is not just an academic topic or only aimed at scientists. The interview and field visit with the farm manager underlined the practical relevance and provided an opportunity to understand the need for on-farm research from a farmer’s point of view.
The practice exercise included a group exercise (2-3 students per group) where the students were able to develop a study question and plan their own experimental project. It turned out

that individually, most of the students had problems defining the purpose of their experiment and formulating the right study question. However, they were able to solve their problems in discussions with the other students and with guiding questions from the facilitator or teacher.
The unit of teaching served to inform students about basic OFR information, to create awareness about the topic and to encourage them in their own development of OFR.

This unit of teaching took place twice at three master schools: the first time 8 students and 2 teachers from one master school took part and the second time 16 students and 3 teachers from two different master schools participated in the workshop. Although the number of participants varied widely between the two workshops, there was a good working atmosphere and students' motivation did not change. The unit of teaching could be organized in small or large groups. It is advised that for larger groups more than one teacher should be involved in assisting students with the practical exercise.

Reflection: Evaluation of the Unit of teaching

Students, teachers, the ministry representative and the team members who designed the workshop were asked for their feedback directly after the workshop. The participants were able to answer closed and open questions in the group setting or to write them down anonymously. A second evaluation is planned for a year later to evaluate the impact of the teaching unit on the implementation of each student's experiment.
Students' and teachers' feedback was very positive. Information on the basic principles of OFR and the practical exercise on how to plan their own on-farm experiment supported by a scientist, were rated as good teaching practice. Most of the students said that the lecture about OFR helped them to better understand the steps for planning an experiment. The exercises helped them to find the correct research question and to understand why effective preparation for each experiment was important.
As a result of the evaluation and the final result of the AR, it was decided to introduce the teaching unit as a permanent element in the master school's curriculum. The teaching unit should be also be part of the board of examiner's programme in master schools.

Discussion

The case study showed that the AR approach was a good way: i) to evaluate the status quo of the extent of coverage of OFR in the curriculum and its practical implementation in class, ii) to identify potential interest in these topics, as well as iii) to design, realize and evaluate a unit of teaching and to plan further action.

The study showed that OFR makes up a large part of the education for master students if it is implemented in the curriculum as a one-year project that requires students to plan, implement and interpret an individual, on-farm experiment. The results also showed that a well-designed teaching unit is necessary to communicate the benefits of OFR. The evaluation of the first teaching unit showed that it served well as an introduction to OFR principles and demonstrated the preparation of a research question and the planning of the individual experiment.

It is assumed that a second evaluation will reveal the need for two further units of teaching about OFR: one to support students in the implementation of their experiment and another to help students analyze the results of their experiment. In addition, a second and third unit could help students to learn from each other.

The case study did not cover apprenticeship students as well as academic students, although these two groups represent a large share of farm managers in Brandenburg. This raises the question of whether another case study which aims i) to identify potential needs and ii) to involve OFR in apprenticeship or academic education should be undertaken.

The unit of teaching was successful. All participants (students, teachers and experts) gave consistent, positive feedback. The next step is to design a second and third unit of teaching to assist masters students with their experiments and to explore whether other federal states in Germany are interested in introducing the topic as part of their master farmer education.

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