# "What happens in the field is crucial!"

## Curricular and practical consequences of digitalisation and networking in agriculture

**MARKUS BRETSCHNEIDER**
Research Associate in the "Industrial and Technical Occupations" Division at BIBB

**How are tasks and competencies in the agricultural sector changing as a result of digitalisation and networking, and how does vocational education and training need to react? On the basis of technology deployed, this article investigates the issue of how skills, knowledge and competencies are currently changing in the recognised training occupation of farmer, and which requirements and consequences this is creating at the curricular and practical level. In light of the growing significance of process and system competencies and handling data, the teaching module "Information-based agricultural technology" will be used as an example to show how competencies relating to the systematic use of production data can be practically imparted and how trainers can be supported in their daily work.**

## Agriculture 4.0

Dealing with heterogeneity and diversity does not only impact upon vocational teaching activities. Such an approach is also taking hold in agricultural crop farming in a bid to act in a way that is suitable to the location. This is then referred to as "precision farming", or the specific cultivation of certain areas. The focus here is on identifying properties that exhibit local differences, such as in the supply of nutrients, in order to enhance qualities and yields by applying adapted land use intensities. Information from various sources – including soil, biomass and yield maps – is linked together for this purpose. This data is then supplemented by knowledge and experience in regards to the characteristics of a piece of arable land in order to be able to draw the right conclusions. The resultant areas of potential a location is able to offer are stored in a file in a sector specific way. Data relating to the nutrient requirements of different partial plots is, for example, then generated in the form of an application map. The farmer transfers this information to their tractor's on-board computer and sets up the fertiliser spreader by means of an app. Spreading then takes place with the assistance of a global navigation satellite system.

Changes in occupational activities of this nature, which have been triggered by digitalisation and networking, have been talked about for many years within the context of Industry 4.0. Within the scope of the initiative "VET 4.0 – Qualifications and competencies of skilled workers for the digitalised work of tomorrow", which was implement-
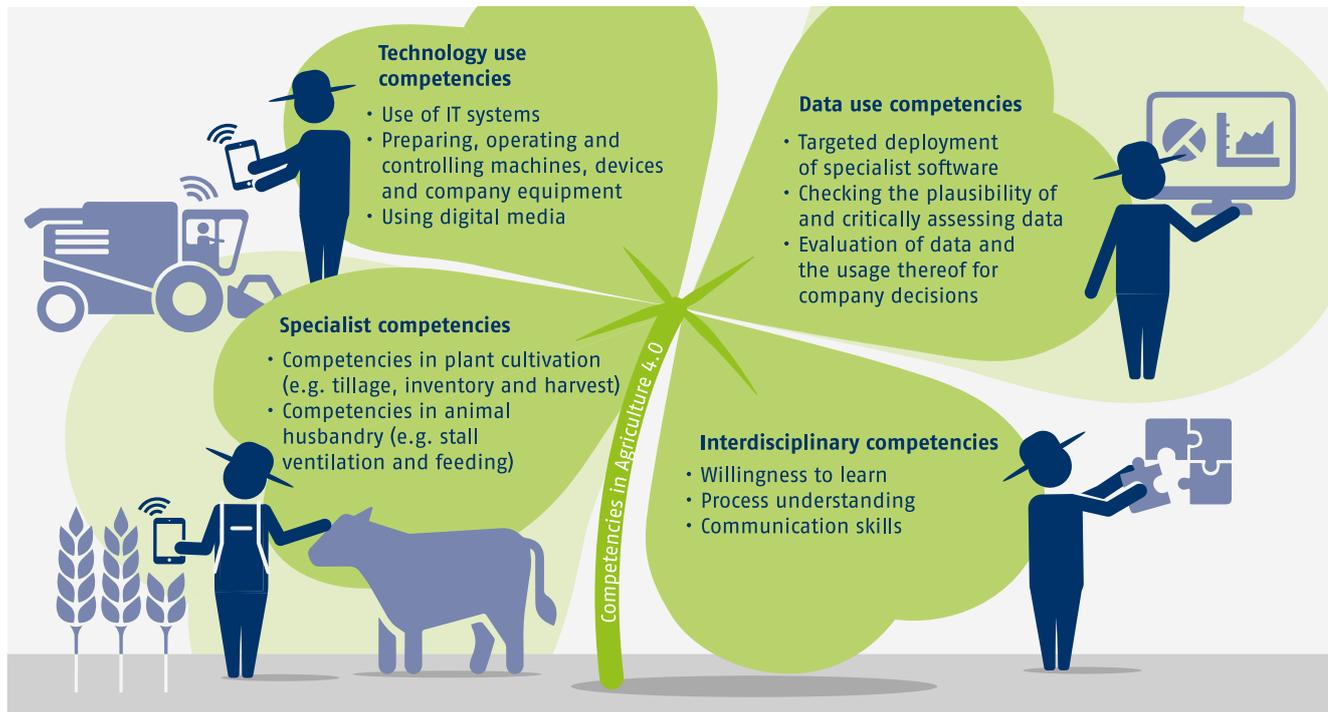
ed by the Bundesministerium für Bildung und Forschung (BMBF) [Federal Ministry of Education and Research] and BIBB between 2016 and 2018, a technology, occupation and qualification and skills screening process was also deployed in order to adopt an "Agriculture 4.0" perspective and to subject the training occupation of farmer to closer investigation (for more details cf. BRETSCHNEIDER 2019). The starting point for this procedure was a branch-related sectoral analysis, which served to develop occupation specific guides for expert interviews and for the selection of company case studies. A total of 58 persons were interviewed at an operational and strategic level. Some of these interviews were conducted within the framework of nine case studies of different branches within the agricultural industry. An online survey directed at skilled workers, managers and training managers was also carried out (cf. Table 1).

The questions were aligned to the occupational profile items in the existing training regulations and were also guided by indications and findings that emerged from the expert interviews and case studies. The study was supported by a group of experts from practice and politics.

## Changes to tasks and competencies

At the tasks and activities level, the first fundamental observation is that production processes are increasingly subject to digital, networked and in some cases autonomous control. In this sense, 70 out of the 88 online respondents

Figure

Main skills, knowledge and competencies for Agriculture 4.0



**Technology use competencies**
- Use of IT systems
- Preparing, operating and controlling machines, devices and company equipment
- Using digital media

**Data use competencies**
- Targeted deployment of specialist software
- Checking the plausibility of and critically assessing data
- Evaluation of data and the usage thereof for company decisions

**Specialist competencies**
- Competencies in plant cultivation (e.g. tillage, inventory and harvest)
- Competencies in animal husbandry (e.g. stall ventilation and feeding)

**Interdisciplinary competencies**
- Willingness to learn
- Process understanding
- Communication skills

Competencies in Agriculture 4.0

Source: Online survey within the scope of the BIBB/BMBF initiative "Qualifications and competencies of skilled workers for the digitalised work of tomorrow"

believe that dealing with data that relates to operational processes and the optimisation of such procedures will grow in significance in future. 17 persons are of the view that the situation will remain the same. Results regarding the monitoring and documentation of operational

Table 1

Database

| Method | Cases/ number |
|---|---|
| Company case studies | 9 |
| Expert interviews (total) | 58 |
| of which company-based skilled workers | 17 |
| of which company-based management staff | 13 |
| of which professional associations | 8 |
| of which chambers | 6 |
| of which federal institutions | 5 |
| of which inter-company training | 3 |
| of which vocational schools | 1 |
| of which institutes of higher education | 1 |
| of which others | 4 |
| Online questionnaires suitable for evaluation (total) | 88 |
| of which skilled workers* | 15 |
| of which management staff* | 30 |
| of which training managers* | 63 |

* Multiple responses possible

sequences and processes produce similarly high values (69 of 88 respondents think that the significance of this will increase, 18 are of the opinion that the level of importance will stay the same). Changes to tasks and activities in crop production and animal husbandry are not judged to be quite as significant. 48 respondents categorise these as staying the same, and only 35 and 31 persons expect a growing importance.

In overall terms, we may conclude that tasks and activities will either become more important or will at least retain their current significance. No tasks which will decline in significance could be identified. As a consequence, the spectrum of tasks and activities will expand as digitalisation and networking increase. This will mean that skilled workers *"will still need to gain a professional qualification and will now also require a technical qualification at the same time" (LaWi/FKA – Interview 23 – manager)*. Because farmers generally only use IT systems rather than programming or setting them up themselves, another result of the investigation is that there will be a need for support from external IT providers.

If we consider the assessments given by the respondents regarding the necessary skills, knowledge and competencies against this background, then the results of the online survey reveal a significant rise in importance in the areas of "Dealing with technology" and "Dealing with data" (cf. Figure). Aspects affected include the following.

- Targeted deployment of specialist software (67 of 88 responses)
- Use of IT systems (65 responses)
- Checking the plausibility of data (62 responses)
- Evaluation of data and use for company decisions (59 responses).

Although on the one hand there are reports of a simplification of tasks and activities in physical terms, the necessity to set up and operate machines also means a rise in requirements at the cognitive level.

Within this context, 58 of the 88 respondents also ascribe growing significance to the critical evaluation of information. The expert interviews also draw attention to the critical attitude needed when checking for inaccuracies in data recorded by sensors. *"A farmer must always be in a position to maintain operations, even if there is no electricity or network access," (LaWi/FKA – Interview 5)* stated one manager. Skilled workers bear a particular responsibility when dealing with crops and living animals. Within this context, there is now an added connotation to one of the contents firmly established in the present training regulations:[1] "Recognise procedures in agricultural operations with one's own senses, in particular with regard to crops, animals and technical processes, identify changes and draw conclusions." This does not in any way deny the areas of potential afforded by digital systems. Nevertheless, direct proximity to plants and animals is a key characteristic defining the identity of this occupation.

## Consequences at a curricular and practical level

The changes described give rise to the questions as to what the appropriate reaction should be. Are adjustments at the level of regulatory instruments necessary, or should the focus be more on practical training?

### Modernisation in terms of curriculum not required

Even though the existing training regulation has been in place for the comparatively long period of just under 25 years, the experts surveyed do not believe that modernisation is currently absolutely essential because of the digital shift. This may appear surprising at first glance. However, the specific structure of the training occupation provides both technologically neutral formulations and a high degree of flexibility. It encompasses a total of 17 branches from the two areas of crop production and animal husbandry (cf. Table 2).

Trainees are required to select two branches from each area. This means that it is possible to tailor training very closely to individual requirements. The formulations contain a high degree of abstraction as a consequence of the

Table 2

Branches of agriculture included in the recognised training occupation of farmer

| Crop production | Animal husbandry |
| --- | --- |
| Grain cultivation | Dairy cattle farming |
| Sugar beet growing | Cattle rearing or fattening |
| Potato cultivation | Sow management and piglet production |
| Grain maize cultivation | Pig rearing or fattening |
| Oil seed cultivation | Laying hen husbandry |
| Pulse cultivation | Poultry rearing or fattening |
| Arable feed production | Sheep husbandry |
| Grass land or pasture land | Horse keeping |
| Forestry | |

fact that the skills, knowledge and competencies to be imparted need to be realisable in each of the 17 branches. At a curricular level, formulations such as "Handle and maintain machinery, tools and works equipment" or "Operate feeding and drinking systems" (cf. farmer ordinance 1995) thus protect training contents against a "natural ageing" to a certain degree. As a consequence, the assessment of the persons interviewed is that current developments can (currently) fundamentally be mapped against the existing general training plan. Nevertheless, the introduction of an integrative occupational profile item of "Digitalisation of work, data protection and information security", such as that which entered into force in the industrial metal working and electrical occupations as of 1 August 2018[2], could represent a possible low threshold update.

What does this now mean for practical training? The company plays a key role in this regard. "What happens in the field is crucial!" The company providing training and the specific prevailing facts and circumstances of such a company set out important general conditions for competence acquisition when dealing with digitalisation. With regard to process management for the recording, analysis, monitoring and evaluation of data evaluation, the securing of a continuous data flow – such as within the context of the specific cultivation of agricultural areas – emerges as a new competence on which attention needs to be focused.

[1] Cf. Ordinance on vocational education and training in the occupation of farmer of 31 January 1995 – Federal Law Gazette, BGBl. I 1995 No. 8 of 16 February 1995, pp. 168–178

[2] Cf. Ordinance on Vocational Education and Training in the industrial electrical occupations of 28 June 2018 – Federal Law Gazette, BGBl. I 2018 No. 23 of 5 July 2018, pp. 896–974

## Supporting practical training with supplementary teaching modules

In order to support training at agricultural companies, the Dienstleistungszentrum ländlicher Raum Rheinhessen-Nahe Hunsrück (DLR RNH) [Service Centre for the Rural Area of Rhinehessen-Nahe-Hunsrück] has developed a teaching module entitled "Information-based agricultural technology". This is used to instruct future skilled workers in the State of Rhineland Palatinate in the creation of a data basis and in the application and evaluation of data within the scope of their inter-company training. The starting point here was a project headed by the Deutsches Forschungszentrum für künstliche Intelligenz (DFKI) [German Research Centre for Artificial Intelligence] between 2009 and 2012, which was used to support farmers in making decisions regarding yield optimisation and sustainability in crop production (cf. DFKI 2014).

The result was a 36-hour training concept – now expanded to encompass 80 hours to trace the stages of precision farming. Before this provision is delivered, a foundation is created by imparting competencies to handle spreadsheets, farm programmes for the planning and documentation of operations, and mobile apps. Beginning with the basic principles and possible deployment of automatic steering systems, the first step then involves the drawing up and use of digital maps for seeding, fertilisation and plant protection. This is followed by learning how to deal with guidance systems and how to evaluate the records of vehicle movements. The final stage focuses on yield maps, the linking of digital cartographic material, and sensor-aided fertilisation. Teaching units take place over the period of one day in groups of six or seven persons. Participants complete theoretical and practical training at three different learning venues at the site. The necessary equipment is made available by agricultural engineering companies. This also enables an insight to be gained into the systems of different providers. The module now forms an integral component of inter-company training. It was originally developed for pupils working towards the qualification of state certified technician in the specialism of agriculture.

The results of the investigation conducted by BIBB also show that training provision of this nature can be supplemented by the design of sample teaching and learning situations to support company-based trainers in their daily work. Conceivable approaches here include the use of guided texts to develop competencies on the basis of a self-contained activity. The "Agrar" Educational Server of the Federal Agriculture Information Centre already contains a range of materials used in eight of the 14 agricultural training occupations, including farmer. The topic of digital technologies could be added (www.leittexte.de, retrieved 09.04.2019).

## Autonomous technology or autonomous skilled workers?

From the point of view of the respondents, the changes described have thus far been perceived as a further development rather than as a new departure. This also ties in with the observation that companies are frequently cautious about pursuing digitalisation and initially tend to deploy stand-alone solutions. An inhibitory effect may sometimes be exerted by Internet provision in rural areas and by a lack of system compatibilities. For this reason, caution needs to be exercised in drawing conclusions for the modernisation of training regulations. The findings that emerge from the investigation relate to "pacemaker companies" in many cases and cannot automatically be transferred to all companies (providing training). Rapid technological progress in combination with the multitude of agricultural engineering providers is not the least of the reasons why growing significance is being attached to inter-company and school-based training in terms of creating a systematic overview of the current status of development and of the benefits, prerequisites and limitations of technologies. However, dealing with different company preconditions, different branches and different digital systems also represents a challenge which arises for the design of examinations. The question as to which standards with regard to breadth and depth should apply in order to map company practice which is extremely heterogeneous is also a matter of concern for the examination boards. Another issue potentially arising is how to secure the competence development and, to a greater extent, the competence retention of independently acting and self-reliant skilled workers who are dealing with autonomous technologies. The focus here needs to be on finding the right mixture between automatic control and control by skilled workers so as to enable the systems to act as genuine assistance systems. ◄

*(Translation from the German original in BWP 3/2019: M. Kelsey, GlobalSprachTeam, Berlin)*

**Literature**

Bretschneider, M.: Berufsbildung 4.0 – Fachkräftequalifikationen und Kompetenzen für die digitalisierte Arbeit von morgen: Die Ausbildungsberufe Landwirt/-in und Fachkraft Agrarservice im Screening (Wissenschaftliche Diskussionspapiere 204). Bonn 2019

Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI): Intelligente Wissenstechnologien für das öffentlich-private Wissensmanagement im Agrarbereich. iGreen. Schlussbericht. 2014