

Precision crop farming - Between dreams and reality

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Technologies that enable site-specific management of arable land often are regarded as an essential building block – if not a guarantee – for sustainable arable farming. Particularly in political papers at the European and national levels, euphoric expectations sometimes are raised. However, surveys show that these technologies still are not widely accepted in practice – indeed, their spread has largely stagnated for several years.

On the basis of our own work as well as discussions and workshops with practitioners, industry representatives, consultants and other scientists from the *agri benchmark* Cash Crop network, we would like to use the following theses to initiate a discussion about stumbling blocks and approaches to overcome them.

1 The entry into precision farming applications sometimes is associated with high investments and considerable uncertainty about the profits that can be achieved. This applies in particular to so-called "on-board systems," in which data collection and decision-making immediately follow each other. Technology, sensors, actuators, computing units and software as well as follow-up costs for site-specific applications are very capital-intensive here. Therefore, in many regions of Germany they can be used economically only on an inter-company basis – if at all. "Off-board systems" such as satellite images, on the other hand, can be used relatively cost-effectively on smaller farms.

As there is no concrete information on yield advantages or savings in operating resources, there is no direct (economic) advantage recognizable for many farm managers. For example, the use of drones to record the current situation in crops and to create application maps is technically possible and makes sense. However, in view of the low productivity per hectare and the legal requirements for their use, this technology can hardly be established economically on a broad scale. Greater acceptance of precision farming technologies in practice can be achieved only if a real economic advantage can be demonstrated.

"Soft" factors also can play an important role. As in the automotive sector, every user has preferences and the affinity for technology of each individual varies greatly. Making work easier can also be a decisive motivation, as can be seen from the success of automatic steering systems, which is not just tied to reducing overlap.

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2 The collection, processing and storage of data for site-specific measures, for the most part, is very complex and largely user-unfriendly. There are many "colorful" maps - on soil conditions, yields or precipitation. Turning the information into a useful farmyard soil map and deriving application maps often is difficult. In many cases, it is not at all clear which agronomic measure is appropriate for a surveyed or calculated crop condition.

In addition, data often have to be recorded manually (at least in part). These problems are exacerbated when the system boundaries of different brands must be overcome. Despite all the efforts of the past years -and decades - communication between machines is still one of the major "construction sites" in the industry.

3 There are too few site-specific (test) results for precision farming applications. The few scientific studies available to date on the economic effects are naturally very site-specific and/or often focused on individual elements. It therefore often is not possible for individual farmers to clarify whether and how the respective technology can be used economically under their specific site conditions. At the same time, annual effects play an essential role.

Furthermore, a direct comparison of "with" and "without" use of the technology often does not exist. This is where more decentralized on-farm trials could help. The more data points available in the different regions, the closer you can get to the reality of the individual farms. However, such trials also need to be organized.

4 Documentation requirements and stricter regulations for fertilization and crop protection could give digital tools a boost. The statutory documentation requirements are likely to increase further. Thanks to the possibilities offered by new technologies, many practitioners hope that such technologies will make work easier and improve efficiency and planning.

At the same time, farmers' hands increasingly are tied when it comes to fertilization and plant protection. In the future, precision farming therefore could focus less on production as the main interest, but rather the optimized use of resources in line with environmental requirements. This trend already can be seen to some extent. Whether the effects will be so resounding that the environmental policy goals can be realized in this way, however, remains to be seen. This is because these political goals are not necessarily those of the individual farmer.

5 Particularly in the case of site-specific nitrogen regulation, other factors can overshadow success. It is well known that plants absorb nitrogen only if sufficient water is available when it is needed. Unfortunately, water increasingly is becoming a scarce factor. Here, it is of little use to tweak the last few kilos with an expensive nitrogen sensor if the plants are not able to absorb the nitrogen at all due to a lack of rainfall.

At the same time, the symptoms of sulfur deficiency, for example, are similar to those of nitrogen deficiency. There is a risk here that digital applications will draw the wrong "conclusions." Instead, the farmer must be able to recognize the causes of long-term irregular crop development if site-specific management is to be crowned with success.

However, this step often is outsourced to service providers who use models or algorithms in which plant cultivation basis often seems unclear and not very transparent. How exactly the data are processed and what conclusions are drawn, the farmer usually does not know. Whether or not to trust this "black box" is almost a psychological question. Anyone who receives two different application maps from the same field from two service providers quickly loses trust.

6 Spot spraying systems are a "key" to saving crop protection products. However, there are a number of technical and economic challenges: How do you deal with residues that are difficult to calculate (especially when contractors do the application)? How is the simultaneous application of soil and contact herbicides handled?

Apart from that, the current prices for the technology make adoption less economically feasible in regions where farms tend to be smaller.

Although the remote methods (drone images with subsequent passage of the sprayer) are cheaper, they also are significantly less productive. In view of the herbicide savings, the practical potential appears to be subject to a wide regional and temporal range. In the long term, this technology offers even greater potential if the cameras can distinguish individual problem weeds/grasses from less problematic ones in crop stands, so that the damage threshold concept could be implemented.

Therefore, a new, joint, practice- and crop-oriented strategy of academic research, industry research, consulting, practice and politics is required in order to:

- develop the scientific basis for reliable, region-specific cause-and-effect relationships and thus enable efficient site-specific crop management,
- initiate and carry out systematic, regional studies on the effectiveness and economic efficiency of the technologies,
- design and develop training courses for farmers and users, and
- ensure the compatibility of IT systems.

Due to the expertise built up and the contacts in practice and consulting, the *agri benchmark* network is very well suited to supporting this work through a systematic, practical economic technology assessment.