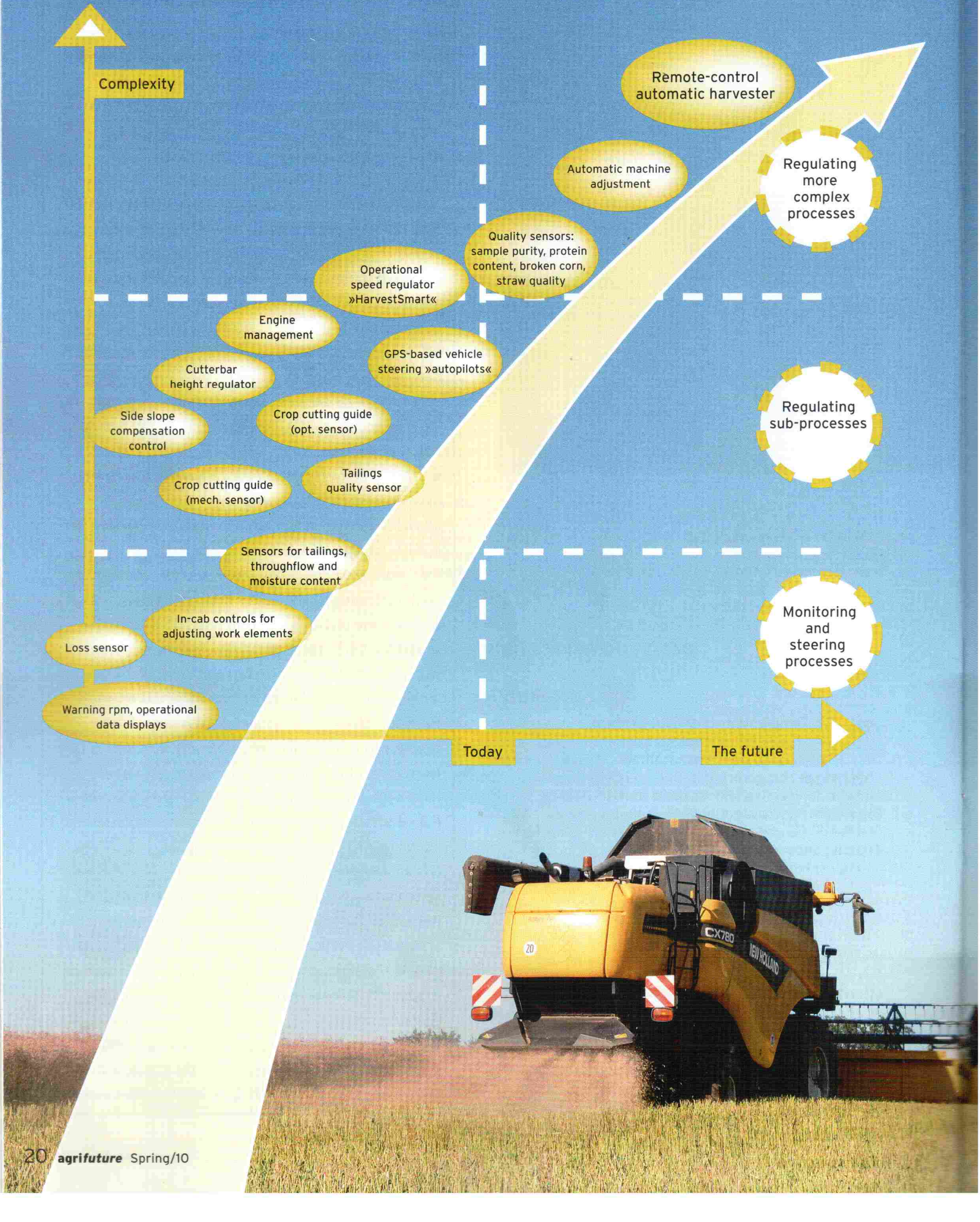
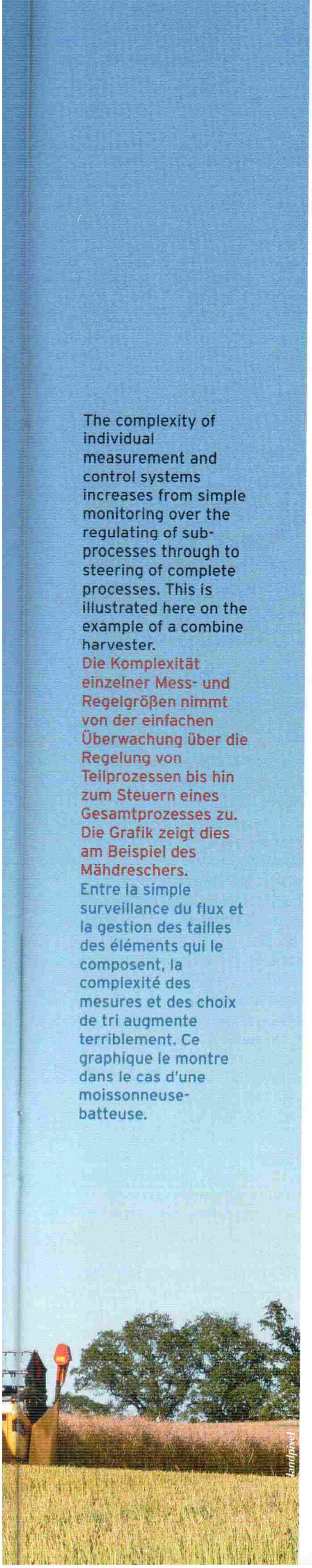
Modern information technology in a combine





The complexity of individual measurement and control systems increases from simple monitoring over the regulating of sub-processes through to steering of complete processes. This is illustrated here on the example of a combine harvester.
Die Komplexität einzelner Mess- und Regelgrößen nimmt von der einfachen Überwachung über die Regelung von Teilprozessen bis hin zum Steuern eines Gesamtprozesses zu. Die Grafik zeigt dies am Beispiel des Mähdreschers.
Entre la simple surveillance du flux et la gestion des tailles des éléments qui le composent, la complexité des mesures et des choix de tri augmente terriblement. Ce graphique le montre dans le cas d'une moissonneuse-batteuse.

Electronics

What the manufacturers are working on

Process monitoring and documentation have become an important part of the farmer's daily work. And letting this collected information flow into the controls of a machine and thus actively influence the production process is an important aim of farm machinery developments in recent years.

The tasks tackled by electronics in agriculture are diverse and can be divided into three groups. Nowadays much more than simple monitoring is involved, with progress towards increasingly complex controlling of partial or total processes. Starting with the practicality of satellite supported positioning ((D) GPS) and yield mapping which we've seen on farms for over 15 years now, the possibilities for electronics have expanded step by step. A further milestone in this technical development was the ability to vary sowing rates on-the-go and enable matching of cropping intensity to the requirements of soil and plant.

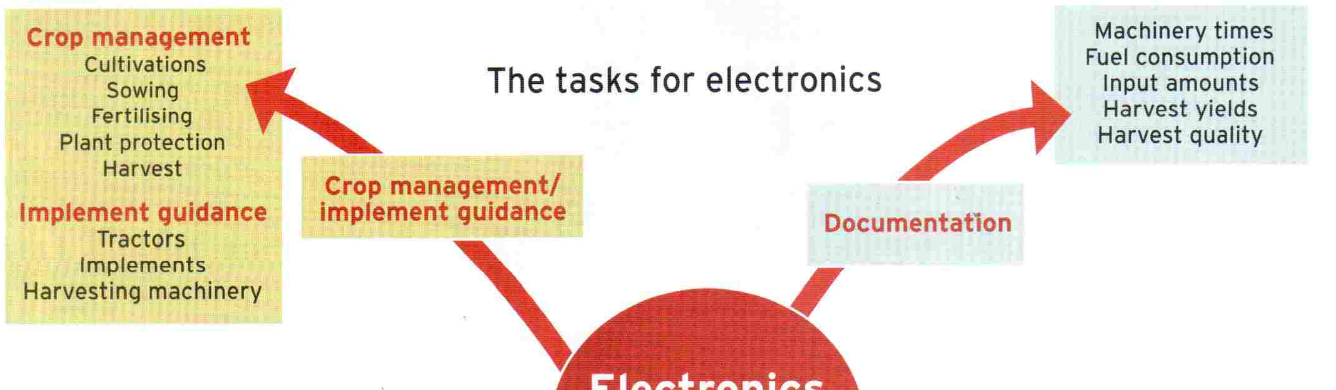
Cultivations. Matching cultivating intensity to actual soil structural requirements has been the aim of numerous trials for some years now. The texture, relief and humus content are important factors influencing working depth. Here, many systems for measuring soil conductivity have been introduced into practical farming. Hydraulic adjustment of working depth on the cultivator/disc harrow combination during field operations offers the possibility of continual variation. Many manufacturers already offer practical solutions in this respect. The extent of straw cover as parameter for adjusting working depth offers new sensor-based possibilities with a sensor for this approach being developed and tested within a German Federal Foundation for the Environment (DBU) research project in Kassel and Kiel.

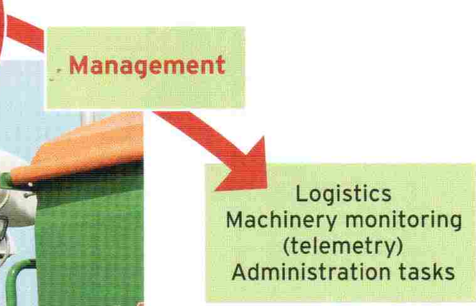
Sowing. Seeding rates can be matched to location yield potential via electronic adjustment of drill and precision seeder, with the technique available for some years now. In particular this approach allows optimisation of individual plant spacing, an interesting development for cereals, oilseed rape, beet and maize. In this way it's possible in specific parts of a field to establish more plants where there's more availability of moisture and nutrient supply. Among the technical innovations presented at Agritechnica 2009 were also solutions in this direction.

Fertilising. Crop nutrient absorption during the vegetation period can be calculated for every square metre from the harvest return recorded in the yield map and converted, with input of information on soil nutrient reserves, into a fertiliser rate decision. We've already seen a variety of sensors developed for assessing nitrogen as a mobile nutrient. These estimate the nutrient content and development stage of the plants and send a fertiliser recommendation in real time to the application implement. Applying fertiliser in this way enables a precise, site-specific steering of production in association with variety involved and production target.

Plant protection. N-sensors that assess biomass can also be applied for plant protection (growth regulators or fungicides). At Agritechnica a herbicide sensor was introduced that recognised weeds via leaf shape thus enabling precise application with the right spray or active ingredient group. This sensor should be on the market by 2011. But for targeted application of individual sprays, technical development of crop sprayers and the spray substances is necessary. Here, two different routes are being taken: One way being worked on features direct input systems while the other is being built around sprayers that have several tanks wherein different active ingredient groups can be mixed. Both systems enable precise treatment of weeds where they have exceeded their population damage thresholds.

Harvest. At harvesting there's the possibility of recording yield and quality. This means





the outcome of the preceding production strategies can be documented. The recording of quality-influencing parameters during the harvest enables precise selection for subsequent value-added processing. Optical sensor systems (NIRS) are already available offering information on quality-related parameters (e.g. dry matter, protein content, starch, fat). A silage harvester with NIRS system in the discharge spout offers immediate availability of dry matter readings during grass and maize forage harvesting allowing silage additive injection to be matched to moisture content or, in combination with a volume sensor, the production of a map of dry matter yield in the field.

The same optical measurement system with another calibration may also be used in the combine. Trials by Agrartechnik in Kiel show good results in this respect for the classic combining crops such as cereals, oilseed rape and grain maize. And there are further possibilities for the future. A compartmentalised grain tank in the combine in combination with NIRS or photo-optical sensor can enable selection during the harvest and free from GM grain or mycotoxins. This aspect is being researched currently at the University of Berlin.

Parallel tracking systems. Further possibilities for increasing productivity are offered by GPS supported parallel tracking systems in tractors and harvesters. With the help of various signal correction systems overlapping in fieldwork can be largely avoided. Especially the over-all availability of a high-precision RTK correcting signal (± 2 cm) is component of research at the Technical University of Kiel. Here, the number of required RTK antennae is the main cost factor. This cost could be substantially reduced through networking.

Process monitoring and documentation. The collected and processed data help towards comprehensive documentation of the production process and, through this, transparency that can mean a competitive advantage for the farmer in product marketing. Here, ISOBUS can help in the coupling of machines and implements from various manufacturers and in the simplification of their operation. Data exchange is standardised and so, independently from implement used, can also be centrally administered and analysed with the office software.

Through multi-manufacturer standardisation of hardware (ISOBUS) and software (ISO-XML), productivity in fieldwork, documentation and management is achievable. With this it's possible to document for transparency and thus further increase safety, both for the user of the technology and the consumer of the goods produced.

Outlook. Nowadays, technical solutions available mean that recording data is no longer a problem, although it's still difficult to reach concrete decisions based on the amount of information then available: huge amounts of data are collected, hardly any is further processed. Up until now this has mainly been because of the complicated, producer-specific solutions for evaluation and processing. A uniform standard is demanded for the collection and processing of information and this is offered by central communication and data exchange systems (ISOBUS, ISO-XML). Such technology should be seriously considered when deciding on future investments. Highlighted in this respect should be the new institutions AEF (Agriculture Electronic Industry Foundation) and Competence Center ISOBUS e. V. These organisations are powerful motors driving development forwards and thus encouraging other manufacturers to further develop their products.

To reduce variations in product yield and quality, manufacturers are working more strongly on various site-specific systems. The basis is the mapping of soil and its nutrient content. However, the results already promised by manufacturers are not to be expected quite yet in all areas.

The target of producing both economically and ecologically possibly requires new forms of machinery cooperation for the full exploitation of high-tech equipment.

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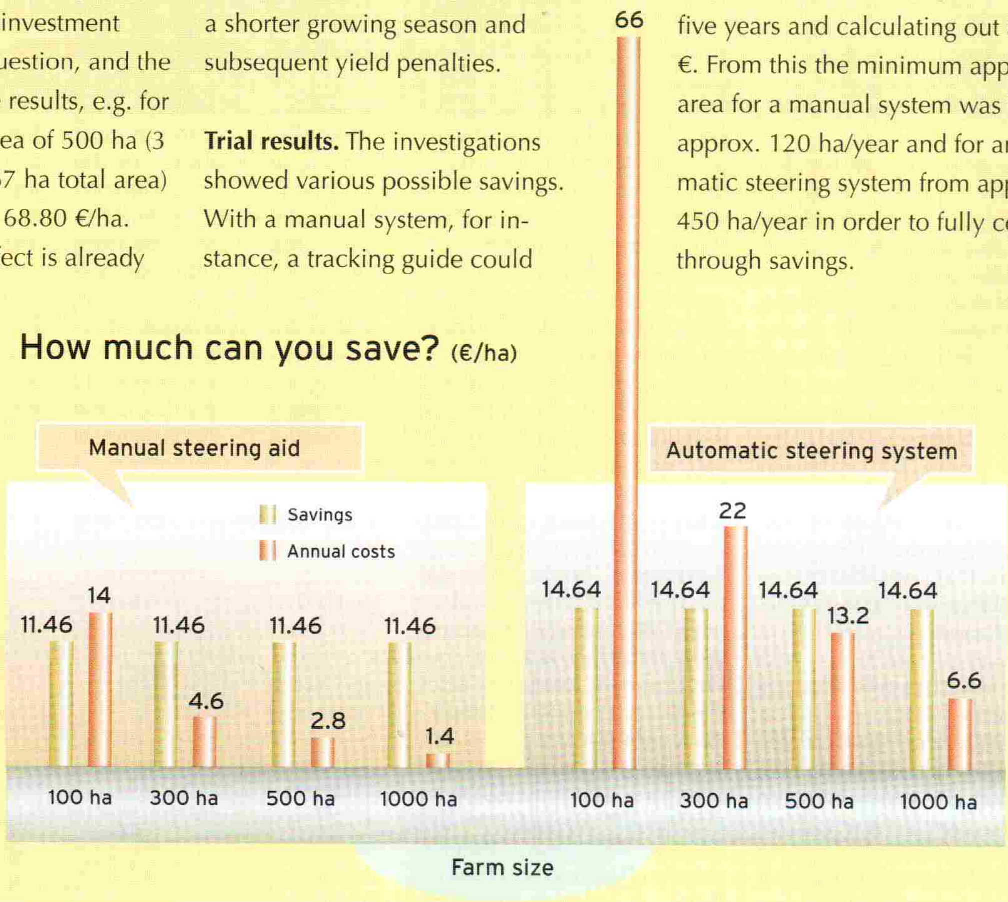
Agricultural electronics: The hits so far

Farmers use electronic aids only when they promise efficiencies in agricultural inputs, enable higher area performance and are also simple to operate. So far, these requirements have been met mainly in two areas: For site-specific fertiliser application and in the different parallel tracking systems.
Long-term N fertilising field trials by various institutions on the basis of different systems – from map-based and sensor-based application to direct sensor-steered fertilising with map superimposition – have returned different results according to region and location. Depending on investment costs for the system in question, and the annual extent of use, the results, e.g. for an annual application area of 500 ha (3 fertiliser applications, 167 ha total area) can range from 21.50 to 68.80 €/ha. With that, the savings effect is already more than the annual costs for the system.
Avoiding overlapping during fieldwork leads to work efficiency improvements and reduces inputs as well as implement wear. Parallel tracking systems can support the driver and, depending on the sophistication of the system, indicate the precise route, assist with actual steering or even offer fully automatic steering. Over and above this, the application of RTK-GPS based steering systems also leads to a definite reduction in so-called deadline costs. These are the costs that arise though delayed operations, especially of sowing. With an assumed increase in operational capability of from 5 – 10% through the introduction of steering systems 50 to 100 ha more could be drilled on a 1000 ha farm in the same time. Say weather conditions worsen and this area had to be drilled later, missing out on the ideal window. The result is a shorter growing season and subsequent yield penalties.

Trial results. The investigations showed various possible savings. With a manual system, for instance, a tracking guide could save 11.50 €/ha and as much as 14.60 €/ha with automatic steering. Precision of automatic systems could be still further improved through highly accurate correction systems (e.g. RTZ). The costs for a manual system differ substantially depending on manufacturer. In our own calculations we reckoned 5500 € with annual costs at five-year depreciation of 1400 €/year with interest at 6% and repair costs of 5%. According to manufacturer information 20,000 € can be taken as cost for a fully automatic steering system. Here too, annual costs were reckoned over five years and calculating out at 6600 €. From this the minimum application area for a manual system was from approx. 120 ha/year and for an automatic steering system from approx. 450 ha/year in order to fully cover costs through savings.



Σ Elektronik ist in vielfältiger Weise zum Zukunftstrend der Landtechnik geworden. Die Datenerfassung stellt dabei kein Problem mehr dar, allerdings ist die Verarbeitung der Daten wegen der vielen herstellerspezifischen Lösungen schwierig. Bei Investitionsentscheidungen sollte daher auf einen einheitlichen Standard der Kommunikations- und Datenaustauschsysteme geachtet werden.

Σ L'électronique est devenu à beaucoup d'égards une tendance d'avenir pour les machines agricoles. La saisie des données n'est plus un problème, mais leur traitement est difficile en raison des solutions spécifiques mises en œuvre par chaque constructeur. C'est pourquoi les décisions d'investissement devraient veiller au respect d'un standard commun pour communiquer et échanger les données.