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More precise irrigation

State of the art

Fig. 1: Nozzle boom with 72 m working range

In the past decades, it has been the goal of research and industry to use irrigation machines in order to distribute water on the field as evenly as possible. The current knowledge on soil heterogeneity makes the necessity of precision irrigation apparent. Parallel to this, progress in irrigation machine management can be observed. In addition, efforts are being made to improve irrigation control (irrigation management). These developments lead to more "intelligent" irrigation with better information as a basis for the farmer´s decision.

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In the past, the objective was to distribute irrigation water as evenly as possible. Today, however, precision irrigation is applied wherever possible in order to save water and energy. Better irrigation management helps to achieve this goal.

Technical improvements

Nozzle boom technology

Mobile irrigation machines with big guns are still being used. Hopes that the big gun may be superseded by the nozzle boom have not materialized so far (*Fig. 1*). Despite good water distribution and significant energy conservation achieved by the nozzle boom, this technology is not used widely enough. Operation has been improved significantly, and a considerable reduction of work time requirements has been realized. Unfortunately, capital demands grew with the number of technical details.

Precision irrigation

Concepts and developments in precision farming meanwhile include irrigation technology and irrigation management. The objective of precision irrigation is the reduction of the product-related expenditures (in this case water and energy) and the better consideration of environmental goals by taking the site-specific heterogeneity of the soil and the crops into account.

With increasing field sizes of approximately 50 ha which are irrigated by centre pivot machines, precision irrigation becomes necessary. The development of a precision irrigation strategy first requires the development and determination of management zones on the field. The application map is based on a farm soil map, the measurement of electric conductivity (EM 38) or aerial photographs, and soil sampling for the determination of soil water storage capacity at certain points, for example.

This concept is currently being implemented technically by means of mobile irrigators and centre pivot irrigators. In centre pivot machines, for example, each of the nozzles, which are 3 to 4 m apart, is controlled individually. The basis for the opening and closing of the individual nozzle is the application map. The travel speed of the machine should be constant. Flow rate and, hence, irrigation height are varied along the cross beam (radius) of the centre pivot machine. Initial farms are planning to equip their machines with this precision irrigation technology.

Mobile drip irrigation

In arid areas, evaporation rates are considerably higher than in humid climate zones. Therefore, it is important to improve available irrigation technology with regard to water conservation. Mobile drip irrigation allows water losses to be avoided and the operating pressure for water distribution to be reduced. Instead of irrigators or nozzles, the machines are connected to conventional drip tubes. Thanks to the low area-related capital requirements and the very low work time demand of centre pivot machines, this technology is used as a carrier- and water supply system for the drip tubes. The newly developed irrigation technique "mobile drip irrigation" combines the mentioned advantages of centre pivot irrigation and drip irrigation.

Even at a worldwide level, drip irrigation as a capital-intensive irrigation technique, which offers the possibility to save water and energy, has not reached the expected acceptance. In addition to the large capital requirements, the significant amount of worktime required for the assembly and disassembly of the drip irrigation system in one-year crop stands must be stated as a reason for this development.

A comparison of the annual process costs (figure 2) proves the large differences between centre pivot- and drip irrigation. Mobile drip irrigation almost reaches the cost level of centre pivot machines and is thus a remarkable improvement. Based on this analysis, mobile drip irrigation was developed.

Irrigation machine management

Monitoring and control of machines by means of remote control units and mobile telephones are increasing. In Germany, communication technology for irrigation systems is already being offered by five companies. The control of pumps via a mobile telephone is virtually standard today. For irrigators, specific company developments are offered, which can be grouped according to functions:

- Messages, such as the new start and the end of irrigation, malfunctions of irrigation, malfunction of energy supply (battery),
- Active controls, such as pump control, opening or shutting of irrigation valves, speed settings, starting or stopping of the machine;
- Fetch functions, such as remaining irrigation time, current flow rate or pressure, water quantity per field, precipitation, position of the machine.

The goal of such equipment is

- immediate information of the farm manager
- a better basis for decisions
- more specific irrigation control
- better exploitation of machine capacity.

This results in larger area capacity of the machines, which leads to lower process costs. The mobile, immediate control of the irrigation processes allow the farmer to react more quickly to malfunctions which lead to excessively high or low irrigation. This may also provide water savings.

Big gun sector adjustment

Automatic big gun sector adjustment has been developed so that the irrigator sector no longer needs to be adjusted manually after the beginning of irrigation. The problem was that a big gun must first irrigate towards the field after it has been assembled on roads or public paths so that the path or the road remain dry. At the end of irrigation, however, the irrigator sector angle must be set in the other direction so that the paths or roads on the opposite edge of the field also remain dry. In the past, the sectors had to be adjusted manually on the wet field while the irrigator was working. The danger of accidents due to quickly reversing irrigators in sector operation may not be underestimated. The solution offered by the company Cordes now provides a purely mechanical solution.

The irrigator manufacturer Komet solves this problem using "intelligent electronics" and the product "Vector Control" (*Fig. 3*). For two settings, the sector angle of the irrigator can be programmed freely between 0 and 360 degrees. A servomotor works according to this programme. Depending on the programmed irrigator cast and the travel speed, adjustment begins automatically. A small solar module and a battery supply the motor with energy. It is also possible to adjust the sector of the irrigator through remote control from the field´s edge.

Drip irrigation

The drip-irrigation technique is known as a water- and energy-saving irrigation technique. Despite its numerous advantages, this technique has been unable to gain more acceptance worldwide. On average, drip irrigation accounts for just one percent of the irrigated area. Several developments are underway in order to make future application more interesting for farmers or gardeners.

When drip irrigation tubes are used for underfloor irrigation, fine roots growing into the drip hole openings lead to more problems since they can cause the drip holes to clog within a short time, which makes even water supply impossible. A new development of the company Irritec & Siplast from Italy is intended to keep the emitters and their closer environment free of roots.

The new feature of the Rootguard system is that a herbicide is integrated into the tube wall material. Small quantities of the active substance Trifuralin are emitted as a gas during irrigation. According to the manufacturer, the development of roots near the emitters is prevented by the release of the herbicide, which also stops the fine roots from growing into the hole openings. According to information provided by the manufacturer, the system Rootguard from Siplast was approved for practical application in Italy and has been used successfully for seven years. Different studies by Italian research institutions confirm the claims of the manufacturer.

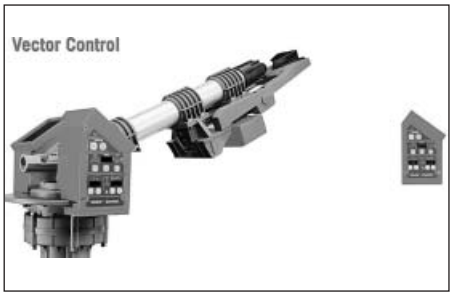

Fig. 3: Big gun with motor driven sector adjustment

Future prospects

The irrigator industry is constantly working on new developments and improvements. As a result, the systems are easier to handle, and operating safety improves. In addition, the goal of water- and energy conservation is being pursued.

In Germany, numerous irrigator variants will remain available. For vegetables and special crops, drip irrigation is increasingly going to replace row irrigation techniques if energy costs keep growing. Special developments, such as the mentioned underfloor irrigation system, are a remarkable improvement which allows the plants to be supplied with water even more specifically. In agriculture, centre pivot irrigation with water distribution through nozzles and, later, drip tubes are going to gain in importance.

In addition to technology, irrigation management is going to establish itself more and more. While in some cases the need for selective irrigation did not exist in the past, energy price development is making precise irrigation a necessity. This may even allow some irrigation applications to be dispensed with in some cases.

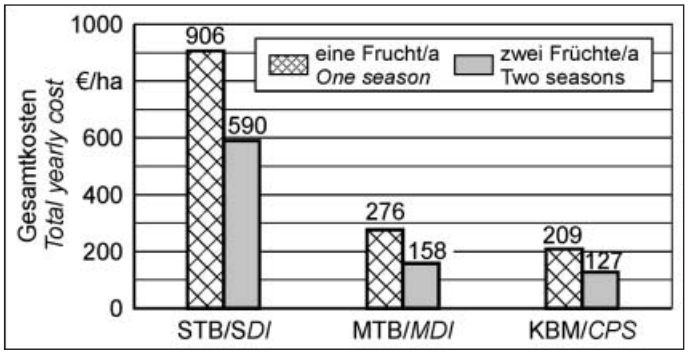

Fig. 2: Total annual costs of stationary drip irrigation (SDI), mobile drip irrigation (MDI), and a centre pivot machine (CPS). The comparison is based on an irrigated area of 50 ha.