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Variable-rate Technology: A Critical Element in Precision Water-saving Irrigation

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Editorial

For the current development direction of "low-input & sustainable agriculture", water and agro-chemicals need to be applied accurately according to actual situations in fields, pastures, and forests. Variable-rate technology (VRT) is increasingly being paid attention to in the field of agricultural engineering. In such an application, features of spray targets should inspected continuously, and be used as the foundation to optimize application operation and adjust spray volume and spray characteristics, so as to improve the effectiveness and accuracy application. The VRT in Accurate water-saving irrigation refers to a process, in which for fields and soil categories with different conditions the data acquired using advanced information acquisition techniques and equipment's are processed and analyzed, then the input instructions for variable rate applicator are given to the actuator to implement variable input actions so as to control the spray volume of nozzles in real-time. VRT is a technique of precision management implemented on arable land in order to maximize the yield of crops. Compared with the traditional large-area uniform spraying technique, the variable-rate spraying technology (VRST) can achieve water-saving irrigation, reduce operation costs, and alleviate the pollution to the environment [1]. Due to VRST is widely used in crop farming, animal husbandry, horticulture and forestry, the research and development (R&D) on variable-rate control and actuating mechanism is getting more and more attention and more and more relatively mature VRST systems have been developed based on techniques of information acquisition and real-time sensor [2].

The process of VRT includes three stages: the first is detecting period, acquiring the needed information of the precise-spraying target; the second is the period of optimized decision, optimizing and analyzing of target information to determine the spray volume and spray characteristics needed for the ideal spray deposition (such as spray droplet size and drop velocity; the third is the period of implementing variable-rate spray according to the required spray volume and spray characteristics (such as droplet size spectra). Among the three stages, implement of variable-rate spray is the critical stage for realize precision irrigation. Accurate spraying relies on reliability and perfection of variable volume control. In order to cater to different requirement of reliable volume control and spray characteristics, various types of variable-rate spray equipment's have been designed and developed, such as PWM-based intermittent variable-rate spray [3-5], the direct-injection spray [6,7], the compressed air (type) sprayer with the ground speed control [8], PWM-based continuous variable-rate spray [9-12], and so on.

In irrigation and drainage system, using VRT we can realize that:

i. For rough terrain, it is easy to naturally form the terraced fields with the moist lower parts and the dry height. In order to avoid the overall yield decrease, local variable-rate irrigation should be carried out in areas with poor growth.

ii. In order to avoid spraying on rocks or roads and avoid water contamination caused by spraying agro-chemicals into ponds and ditches, local variable-rate irrigation is needed.

iii. In severe drought years, in order to ensure a stable yield on a large area of farmland, the limited water should be used on the key parts and the irrigation on some crop areas could be abandoned. So that VRT is also needed.

iv. If two or more different crops are planted in one plot of field, irrigation quota on each crop is different so that VRT irrigation is necessary as well.

v. The uniformity of irrigation spraying can be compensated by the VRST when the speed of the vehicle loading with the spraying irrigation equipment is not uniform.

As can be seen from above, VRT plays an important role in precise water-saving irrigation and can improve resource utilization. So far, however, there is a lack of research on the relationship between the input in R&D of VRT equipment and the economic benefits by using the VRT. Normally, the VRT application area for precision irrigation is much less than the monitor area for using VRT in real farming. Some people often ask, is precision irrigation profitable? Is it possible to exceed the invested cost for R&D VRT? These are the first questions that we should consider in the process of development. Therefore, we should pay special attention to reducing subjectivity and one-sidedness when choosing a design solution. If the farmland is homogenous, there is no need for precision irrigation for specific areas. As a result, the designer must correctly handle the relationship between the developing scheme and the cost. All in all, with the advent of precision agriculture, precise irrigation is showing great development space and great business opportunities.

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