Supporting Greenhouse Cultivation Using Fertigation Control System ZeRo.agri

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In response to the request of a farmer in litate Village of Fukushima Prefecture in 2015, an old pipe greenhouse was refurbished and the ICT nutrient soil cultivation system "zero agri" was introduced as a prototype of the future agriculture in the village. Nutrient soil cultivation is a cultivation method in which liquid fertilizer is mixed with irrigation water and applied to plant stocks using drip irrigation tubes. Drip irrigation was first developed in Israel in the 1960s to save irrigation water. Meiji University and Routurek Networks Co., Ltd. developed the "Zero Agri" system to automate fertigation procedures in 2013 and market the system. The system consists of two components: (1) a control section and (2) a driving section. using sensors that simultaneously measure solar irradiance outside a greenhouse using a pyronometer, and soil temperature, soil moisture, soil EC (electric conductivity: strongly relates to nitrate concentration, which is a major fertilizer source) using a Hydro probe II. Data measured by the sensors are recorded with a data logger of the control section and transmitted to the cloud over the Internet, where the amount and concentration of liquid fertilizer to be applied and the supply time are calculated based on the data acquired via the Internet. The driving section consequently controls control signal parts to open and close solenoid valves to manage liquid fertilizer application. The liquid fertilizer is supplied to the field with an infusion irrigation tube. A thermometer/hygrometer, a web camera, etc. can also be installed along with the sensors.

As daily water and fertilizer requirements of crops are proportional to the amount of solar radiation, liquid fertilizer is applied in proportion to the amount of solar radiation per time. Moreover, by separately controlling the supply amount and the concentration of the liquid fertilizer, soil moisture and soil EC become constant values. It is possible to increase the demand of water and fertilizer according to growth stages of crops, thus to cope with a decline in the water demand of crops due to increases in water infiltrated into the rhizosphere from the lower soil layers in the greenhouse. It is possible for growers to change soil moisture and soil EC by observing growing conditions of the crops. In other words, this system is semiautomatic in cooperation with growers. Since a tablet terminal is used to change control procedures, all the data are stored in the cloud, and the "experiences and feelings" of the growers are digitized. These data can be used for cultivation in the following years, or it can be provided to growers with insufficient experiences. If the system is introduced in a certain area, comparison among good and poor growers can be used to improve all the growers' skills in the whole area.

In litate Village, before the earthquake, agriculture, mainly rice and dairy farming, was a major industry. Although villagers will return to the village from April 2017, there is no prospect of improvement in paddy rice price once collapsed by the nuclear accident. Also, since pastures are always exposed to the risk of radioactive pollution, there is no prospect of resuming dairy farming. Furthermore, due to the restriction of the topography, there is little possibility of agriculture utilizing large-scale upland fields. In such background there is a high possibility of protected horticulture that uses greenhouses. Based on our study in litate Village from 2015 to 2016, we concluded that a rotation of "spring summer pepper \rightarrow autumn lettuce \rightarrow two winter spring transplanted spinach" was fully applicable. "Zero Agri" adequately supported a commuter farmer, who is not reside in the village, to grow crops.

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