TOP INNOVATION IN MANAGEMENT OF AGRICULTURAL ACTIVITIES
(EFFECTIVE BIOLOGICAL AGRICULTURE UNDER IRRIGATION AND PROTECTING THE ENVIRONMENT)

НОВШЕСТВО В УПРАВЛЕНИИ СЕЛЬСКОГО ХОЗЯЙСТВА

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Abstract/Резюме. The report deals with the perspectives for developing ecologically based biological agriculture in Bulgaria, the European Union and the other countries. Innovative technology (for computerized monitoring the soil water deficit and scheduling the irrigation) replaces the periodical local (point) measurements of soil moisture. Its application helps to be realized appropriate energy level of soil moisture through ecologically accepted watering technique in each agricultural crop field. It ensures to be obtained the scientifically planned amount and quality of crop yield, saving over ten years on average 30 % of irrigation water and one third of nutrients added for plants.
KEY WORDS: IRRIGATION, DECISION SUPPORT SYSTEM, NEW INDEX FOR ESTIMATING WATER STATUS.

1. Introduction/Введение

The development of agriculture under irrigation has to be accomplished on the new eco-biological scientific basis (C h r i s t o v, 1989, 2008abcd), which was accepted by world leading scientists in USA, RF, etc. Technology based on it should be widely applied, according to the European requirements.

The scientific progress in biophysics of plant populations, soil and atmosphere physics, and ecology created actual prerequisites and practical possibilities for easy current taking into account the crop physiological features and ecological requirements when growing cultural plants in numerous agricultural fields (agroecosystems) for the first time in world.

New complex scientific basis is developed and tested under field conditions during a period of 30 years. Computerized ecological technology based on it, which has to be put into practices of biological agriculture under irrigation, is created (C h r i s t o v, 1992, 2004 and 2012).

The basis applies and links the separate top scientific and technological achievements developed in UK, USA, Japan, Ukraine and Bulgaria. For the first time in the world, two Bulgarian High Scientific Attainments, which are necessary for the universal scientific basis, are included in it.

The complex innovation system (Fig. 1) practically ensures the necessary coordination between the plant physiological and the ecological requirements.

2. Prerequisites and means for solving the problem/Предпосылки и средства для решение проблемы

2.1. Plant Physiological features. For the first time in the world agricultural science and practice, the physiological processes in cultural plants, which concern the water and nutrients, are practically taken into account **(**C h r i s t o v, 2004**)**. These processes are as follows.

1. The gradual decrease in soil moisture from field capacity (FC) to permanent wilting point (PWP) causes irreversible physiological processes with increasing intensity in the plant organism. For example, the established dependence of the losses, ΔY_{ec} (%), of maize grain yield on the drop, ΔL_{ec} ($J^{1/2}/kg^{1/2}$), of energy level of soil moisture at extreme-critical stage of ontogenesis only is shown in Fig. 2.

2. The degree of irreversible damage on plant is different under the same decrease in moisture of one and the same soil at separate stages of plant development (ontogenesis).

3. The maximal physiological damages at all stages are accumulated. They irreversibly limit the amount and quality of production independently on the next increase in soil moisture, which is caused by watering or precipitation (Fig. 3).

4. The irreversible physiological defeat depends on the energy condition of moisture in soil. This condition corresponds to different values of moisture in various soil textures.

2.2. Ecological requirements. In managing the agroecosystems, the ecological requirements are the following.

A. Agricultural activities must be implemented in ecologically-accepted form, protecting the environment (underground water, surface reservoirs, soil and atmosphere) from pollution.

B. Precise current estimation of the net norm of watering must takes into account the moment values of: depth of root layer of soil, water deficit in this layer, and water-retention capacity of each genetic horizon of soil, which on the day of watering is in the frame of the root zone.

These requirements can be introduced after putting into irrigation practices the top attainments aggregated in the new ecological technology. This will significantly precise the calculation of net

norm of watering. It will reduce or remove the amount of water, which causes the pollution by bearing pollutants (soluble nutrients for plants) to near underground water layers and to surface reservoirs located near the irrigated fields.

C. Appropriate watering technique, preventing the destroying and taking out of the soil by irrigation water through must be applied. The physical properties of soil and relief must be taken into account when controlling the watering process.

D. When applying the precisely determined watering norm, we must form the new water supply only in root layer on the determined day of watering. The watering norm must compensate only the moisture deficit in root layer under minimized loss of water.

E. Decreasing the losses of irrigation water, energy (electrical and from fuels), plant nutrients and human labour is possible to be reached implementing the irrigation schedule currently established through the offered technology.

3. Results and discussion/Результаты и обсуждение

Applying the technology under the extremely changing meteorological conditions over many years, we established the dependence of the amount of maize (H-708) yield on the soil water status estimated by us through the new biophysical index *L* of energy levels of soil moisture. The data on yield obtained under irrigation and non-irrigation are described through the equation:

(1) $Y = 19.45 - 0.55L$

or in general form

(2) $Y = A - B\,L$,

where: *Y* is the mass of grain yield (t/ha); *L* – the biophysical index ($J^{1/2}/kg^{1/2}$) of water status in root zone; A and B – the coefficients specifying the crop. The established correlation coefficient is equal to R = –0.980.

4. Conclusion/Заключение

The ecotechnology for current decisions during the growing season applies new estimation index of soil water status for the first time in agricultural sciences and practice. It is based on physical laws and biological regularities. No simulation models are used in the technology. It applies the complete set of current meteorological data for the current growing season.

The technology replaces the periodic measuring of soil moisture applying local (point) methods, which are not ensuring good representative data on soil moisture for the large field in agriculture. The application of point methods are consuming much human labour and time, and can not be successfully used for the enormous number of rural fields. The ecologically based agriculture is perspective only under conditions of applying this innovative technology. Its application will help to create and keep appropriate energy level of soil moisture for the first time in many large crop fields under different meteorological conditions.

This technology is energy-saving, water-saving and ensures ecologically accepted management of soil water status. Its applying ensures the planned amount of yield and the determination of needed nutrients.

Its wide application helps to protect the environment and develop sustainable agriculture. It ensures effective control on the pollution of lakes, rivers, dams and underground water, which is caused by the applied traditional agricultural activities.

Application of the ecotechnology created the possibility to obtain each year **12 t/ha maize grain** (hybrid H-708) under the conditions of Calcareous Chernozem soil (near Lom, Bulgaria) during the period of 8 years (1981-1988), under extremely different meteorological conditions, saving **on average 30 % of the irrigation norm** compared to that recommended by the project schedule of irrigation for this crop in the region. The ecotechnology represents a great interest for buying by the farmers in the European Union and abroad, after transforming it in friendly for farmers and specialists **universal market system for managing.**

5. Literature/Литература

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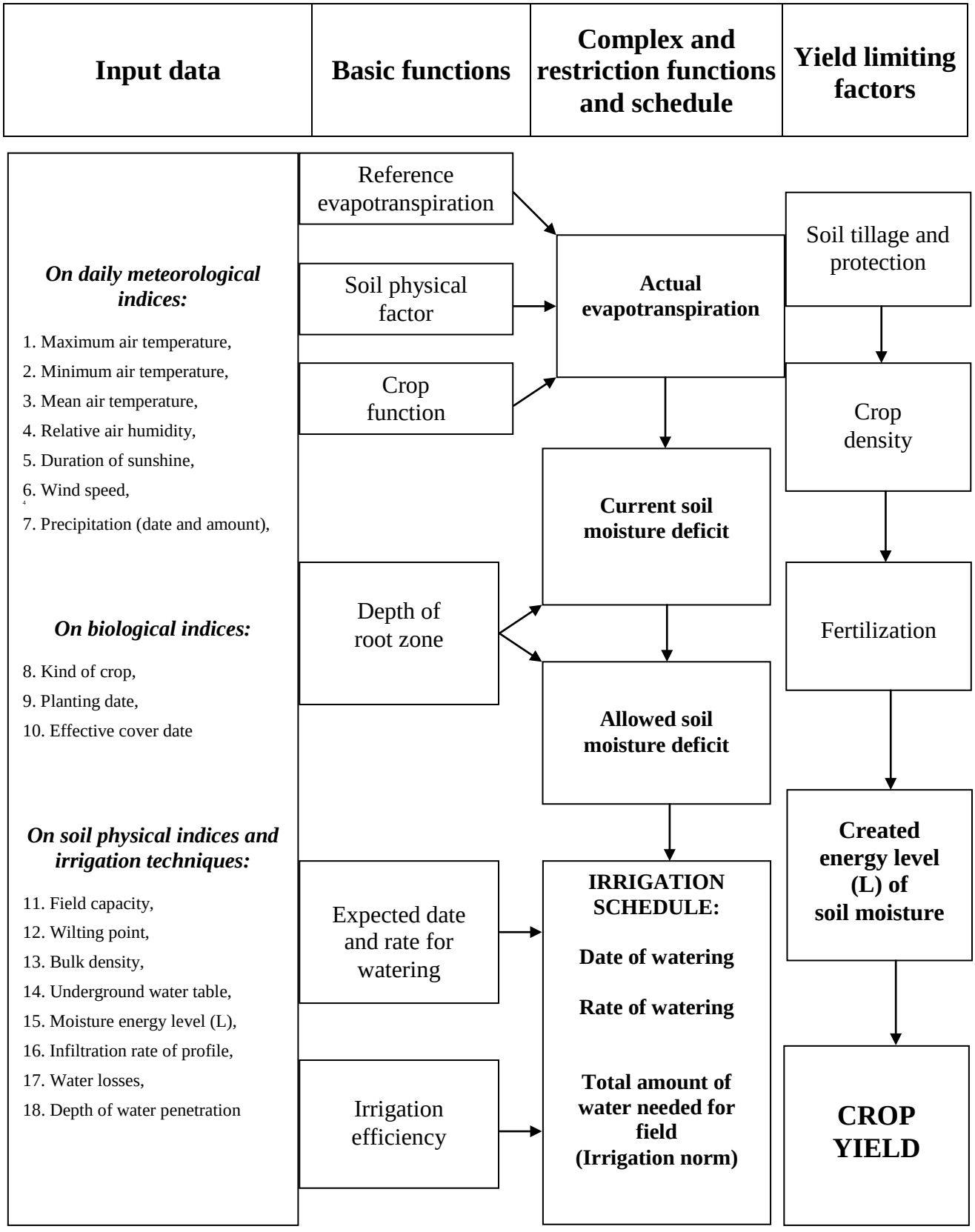

Fig. 1. Scheme of the Decision support system (DSS) for agroecosystem water status management

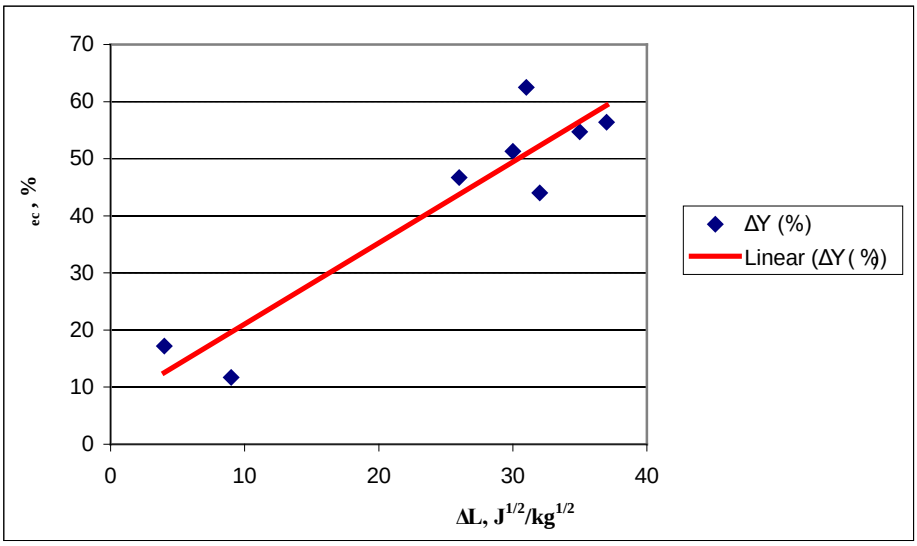

Fig. 2. Dependence of the losses, ΔY_{ec} (%), of maize grain yield on the drop, ΔL_{ec} ($J^{1/2}/kg^{1/2}$), of energy level of soil moisture under field conditions at extreme-critical stage of ontogenesis only (correlation coefficient is R = 0.95; equation is $\mathbf{\Delta Y_{ec}} = 2.217 + 1.567\ \mathbf{\Delta L}$

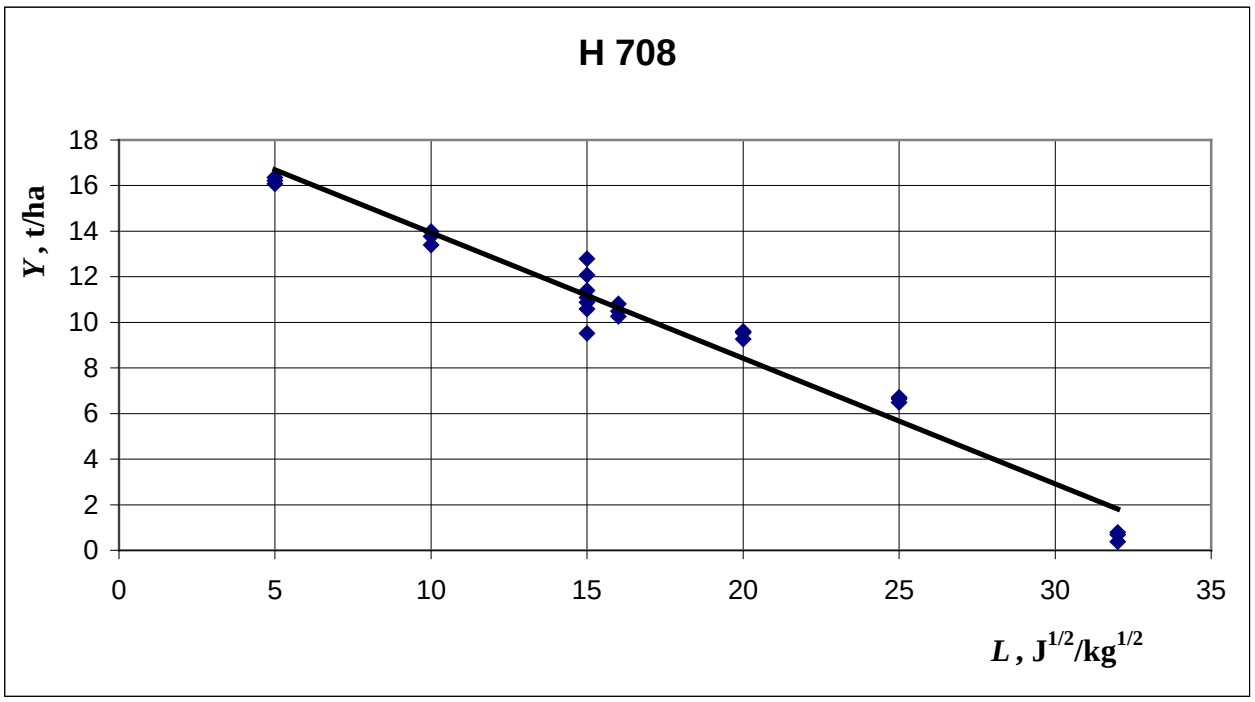

Fig. 3. Dependence of yield ***Y***, t/ha, of maize grain (obtained at appropriate ***N, P*** and ***K*** nutrient rates determined through the DSS) on the integral index ***L,*** $\mathbf{J^{0.5}/kg^{0.5}}$ (correlation coefficient R = 0.98; equation is Y = –0.55L + 19.45)