The influence of the work system on the maintenance of moisture in the soil - a review

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Abstract. Soil works are technological processes of general character in agriculture that are made in order to create the right environment for the development of plants by soil loosening, enrichment in water, air, heat and nutrients, regenerating their production capacity. The amount of water existing in the soil, in the layer in which the root system of plants is developed, can ensure higher or lower harvests depending on several factors and first of all by the applied crop technology. Ground water ensures that all biological, physical and chemical processes are carried out. The accumulation, conservation and storage of water in the soil is the most important task of the users of agricultural land. The correct management of the water resources of the soil is a problem that needs to be solved with the following consideration: of the concrete climatic situation of one or another agricultural territory; of the hydro-physical properties of the soils used in agriculture; the water requirements of sown agricultural crops; of the real possibility of partially regulating the water regime in the soil through agro-technical measures and irrigation etc. Soil moisture is also related to its physical, physical-mechanical, chemical and biological properties. The soil supplies the plants with nutrients, but for the plants to be able to use the nutrition from the soil, it must necessarily be dissolved in water. An eastern proverb says that "where there is water, there is life". The loss of moisture from the soil occurs due to the increase of evaporation under the influence of the passage of agricultural equipment during soil work. This loss of soil moisture is unfavorable for plants and therefore for agricultural production.

Key Words: system of works, humidity, water regime, hydro physical indices.

Introduction. Successful cultivation of agricultural plants is possible only within an agricultural system that ensures efficient use of soil water reserves. The problem of accumulating and maintaining water in the soil depends on a number of its features (https://www.gwp.org):

1. Texture: in the case of sandy, clay and loamy sandy soils, the volume of useful and easily accessible water for plants at the appropriate humidity is lower than in the case of clayey and clayey soils;
2. Apparent density and structure: the volume of useful and easily accessible water for plants is higher in loose soils and small in compact unstructured soils;
3. Organic substance content: in soils rich in organic matter, the water content accessible to plants is higher than in soils with low content of organic substance.

In order for the volume of water accessible in the soil to be large, the soil needs to be medium-textured, structured, relaxed and have an optimal content of organic substance. The process of water penetration into the soil depends on several factors: soil porosity, initial soil water content, soil permeability (Blaga et al 1996).

Humidity as a physical factor can quite significantly change the mechanical properties of the soil: one and the same soil, depending on the water content can be strong or soft (Mihalache 2010). The soil moisture is characterized by the water content (q_a) in each unit of dry matter (q_{su}) and is determined by the relation:

$$W = \frac{q_a}{q_{su}} \cdot 100\ [\%] \qquad [1]$$

The amount of water retained in the soil until complete saturation is called *total water capacity.* The property of the soil to ripen under the best conditions is related to certain humidity; according to some data optimal conditions for shredding are obtained in the case of a humidity that represents 40% of the total water capacity of the soil. Soil water is of particular importance both in the genesis of the soil and in the growth and development of plants. The amount of water in the soil at one point is known as „soil moisture" or „current moisture" (Canarache 1990).

The variation in soil moisture over time plays a particularly important role in plant growth and agricultural work. The moisture index (Chiriță 1984) is the element used in research on the water regime of the soil (Table 1).

Table 1

Humidity index value classes (Chiriță 1984)

Symbol	*Name*	*Values [%]*
I	Inaccessible humidity	< 1
A_1	Humidity very difficult to access	1 - 20
A_2	Moderate humidity hardly accessible	21 - 50
A_3	Easily accessible humidity	51 - 90
A_{3+}	Very easily accessible humidity	91 - 100
E	Excessive humidity	> 100

The variation of humidity in the soil layer worked and especially in the upper part of the germinal bed, is characterized by a very accentuated dynamics, important changes occurring only in a few days. Such changes occur due to climate change but can also be favored by the inadequate physical state of the soil or by the agricultural works executed irrationally (Cârciu et al 2008). The quality of the soil works, the possibilities of reducing their number, the accumulation and storage of water in the soil have always been priority research topics. The water regime has a great influence on the porosity and other properties of the soil . The technological processes that occur through the soil works indirectly cause major changes in the water regime. The absorption and maintenance of water in the soil is influenced by the total porosity and distribution of the aggregates. Because soil works influence these factors, there are also changes in the process of maintaining water in the soil (Lavrenko et al 2019). If the apparent density decreases, the total porosity increases, and in the case of fine textured soils the water content retained at high potentials increases and the one retained at low potentials decreases. If the natural structure is disturbed, the water absorption decreases in the coarse textured soils and increases in the fine textured ones (https://fermierul.ro).

The non-capillary porosity in a too large proportion favors excessive soil aeration and loss of water supply from the deep layers. The water loss curve has two peaks: when the non-capillary porosity has values over 40% of the total porosity (excessive ventilation) and when the capillary porosity has values over 70% (loss by capillary ascension). Increased capillary porosity increases the water storage capacity, a phenomenon particularly important for areas with moisture deficiency (Moraru & Rusu 2010).

The specialized literature does not doubt the special importance of the primary work of the soil (plowing) in the process of accumulation and storage of water in the soil, an essential condition for obtaining high agricultural production. However, generally, soil works that expose the wet layer to the surface increase evaporation (Chebil et al 2019). All the works by which a level surface is created, determines the interruption of the upstream capillary water flow and therefore decreases the water losses by evaporation (Ungureanu & Prisacari 2004).

The variation of the amount of water lost by evaporation can also be appreciated according to the values of the apparent density. It has been established that for a medium soil, the smallest water losses are recorded when in the soil layer of 5-10 cm, the apparent density is between 1.15 and 1.28 g/cm^3. Evaporation increases greatly at values below 1 g/cm^3 and at a non-capillary porosity of over 40-50% of the total. If by plowing a layer of soil with a better structure is brought to the surface, the speed of infiltration of the water increases and the losses by evaporation are reduced. In the case of an unstable structure, the aggregates disperse quickly and as a result the soil is priced and the water infiltration decreases sharply (https://www.lumeasatului.ro).

The purpose of this paper is to review the practices of sustainable management of soil moisture resources based on research in the field. Based on these studies, activities and especially soil works can be planned to reduce the negative impact of decreasing the amount of water in the soil in the social-economic context of the rural area.

Material and Method. In order to reduce the water loss in such situations, it is recommended to make an insulating layer (by works with the roller) on the surface of the soil to prevent capillary ascension. Although in such situations the soil density increased and the permeability decreased, the production increases evidenced the need for an optimal state of compactness for plant growth and development (http://movca.md).

Ground water can be found in the following forms (https://www.gwp.org):

A. Hygroscopicity water (very strongly bound): it is water represented by layers of water molecules held in close proximity to the surface of soil particles and it is not accessible to plants;

B. Water film (weakly bound): it is water that moves only around the soil molecules and can only be used a little bit by plants;

C. Capillary water: it is water retained in the soil due to capillary forces and is easily accessible to plants;

D. Gravitational water. It is the water that flows into the depths under the influence of gravity. The water content of the soil or the gravimetric humidity is expressed as a percentage of the dry soil mass with the relation:

$$W\ \%\ g/g = (a : m) \cdot 100 \quad [2]$$

where: w % g/g - moisture in gravimetric percent [% g/g];
a - the quantity of water in the soil sample analyzed [g];
m - the amount of dry soil from the sample analyzed [g].

The volumetric moisture of the soil represents the water content of the soil expressed as a percentage of the volume of the soil and is determined by the relation:

$$W\ \%\ v/v = W\ \%\ g/g \cdot DA[\ g/cm^3] \quad [3]$$

where: W % v/v - volumetric soil moisture [% v/v];
DA - apparent density [g/cm^3].

Humidity values expressed as percentages with major changes in water accessibility for plants are called hydro physical indices. The most important are (https: //fermierul.ro; Canarache 1990):

CT - total capacity;
CC - field capacity;
URC - humidity breaking the continuity of water in capillaries;
CO - weaning coefficient;
CU - useful water coefficient (CU = CC - CO);
CH - hygroscopicity coefficient(CH = CO / 1.5);

Results and Discussion. Water useful for plants is found in the soil in the following forms:

1. Very easily accessible water - it is in the humidity range from CT to DC. The excess of gravitational water decreases the aeration of the soil and negatively influences the crop culture;
2. Easy and moderately accessible water - it is in the range from CC to URC;
3. Hard to reach water - it is in the humidity range from URC to CO.

During the growing period of the plants it is necessary that the soil moisture is kept within the CC limits until the URC. The useful water supply in this range provides the moisture needed for plant development. These reserves of useful water easily accessible to plants depend on the texture of the soil and its apparent density, which is influenced to a great extent by the agricultural works that are carried out (https://www.gwp.org).

The interdependence between the apparent density of the soil and the values of useful water in the soil easily accessible for plants is presented in the Table 2.

Table 2

Average values regarding the dependence between the values of the apparent density and the different humidity categories in the loam and clay soils (Cerbari 2007; https://www.gwp.org)

Apparent density [g/cm^{3}]	*Field capacity (CC) [% g/g]*		*Moisture breaking water continuity in soil capillaries (URC) [% g/g]*		*Easily accessible water capacity (CC – URC) [% g/g]*	
	Ground clayey	*Ground loamy*	*Ground clayey*	*Ground loamy*	*Ground clayey*	*Ground loamy*
1.20	28.0	30.0	19.7	24.0	83	6.0
1.25	27.0	29.0	19.6	239	7.4	5.1
1.30	25.9	28.0	19.5	23.8	6.4	4.2
1.35	24.8	26.8	19.2	23.0	5.6	3.8
1.40	23.4	25.8	18.7	22.2	5.0	3.6
1.45	22.7	24.5	18.3	21.2	4.4	3.3
1.50	21.6	23.4	17.9	20.9	3.7	2.9
1.55	20.4	22.3	17.5	19.6	2.9	2.7
1.60	19.6	21.0	17.1	18.7	2.5	2.4
1.65	18.8	19.0	16.8	17.8	1.5	1.2
1.70	17.4	17.8	16.4	17.0	1.0	0.8

Execution of agricultural works that achieve a relaxed layer of optimum thickness ensures a greater storage of water in the soil. The system of soil works, through the effects on the structure and porosity, modifies the hydro physical indices of the soil, the permeability and the forces acting on the water in the soil, the evaporation and the total water supply. Soil loosening leads to increased water permeability (http://network.app4inno.eu). On the tiled soil an amount of water can be accumulated by 25-30% higher than on the unpowered soil, but at the same time, a too high porosity value favors excessive soil aeration and loss of water supply. Through the works applied to the soil, the leakage from the soil surface and the evaporation losses must be minimized so that most of the fallen water is stored in the soil. Research in this area shows that 64.4% of the rainfall is infiltrated in the plowed land, while in the unpaved land, only 9.2%. An important role in the storage of water in the soil has also the presence of a vegetal layer on the surface of the soil, in which situation accumulates 97% of the water dropped from precipitation, while on the ground discovered only 41%.

The use of manure also ensures the structure of the soil and maintains it in a state of optimal relaxation for plant growth and favorable for storage and storage of water in the soil. The highest values in % g/g of easily accessible water for plants are characteristic for values of the apparent soil density between 1.2-1.3 g/cm^3 for both loam and clay soils. Hydro physical indicators for the same apparent density values are higher for loam soils compared to clay soils. However, clay soils are more resistant to drought than the loamy ones. Clay arable soils have easily accessible water capacity for plants at density values between 1.2-1.3 g/cm^3. For soils with apparent density values between the limits of 1.3-1.4 g/cm^3, the easily accessible water capacity is medium. Important are not only the measures of water accumulation but also the ways in which water losses can be reduced. The land must be kept well leveled (Nicola et al 2020). Water losses increase by approximately 30% on uneven terrain, depending on the surface exposed to the sun and wind. In the spring, the soil should not be loosened with the disc harrow when the water losses can reach 28-29% and be sown directly, in the field prepared in autumn, especially the crops of emergency I. When necessary, the preparation of the germinal bed is carried out only with the combiner, well regulated and by a single passage, up to the depth of incorporation of the seed, in which case the water losses are below 5-6% (https://www.gwp.org).

Conclusions. The system of works applied to the soil increases the porosity and permeability by removing the impermeable layers. When on the layer of 0-30 cm has been formed the hardpan (plow sole) someone will work with the plow provided with screwdrivers that loosen the soil 5-10 cm deep, under the bottom of the furrow. When the waterproof layer is located at 30-40 cm it will work with the chisel on this depth, and if it is 50-70 cm, someone will work with the ripper. This ensures conditions for the accumulation of large quantities of water in the soil up to a depth of up to 100-150 cm which can be exploited by the roots. The optimum water supply of the soil on 0-100 cm is 1.200-1.500 m^3/ha when it can withstand, without significant losses, 1-2 months of drought.

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