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PECULIARITIES AND SELECTION OF TECHNOLOGY OF MINIMUM SOIL TILLAGE ACCORDING TO ZONING

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Abstract

The article analyzes the peculiarities of land cultivation technologies to identify the factors affecting the energy efficiency of land cultivation, costs, as well as searching for solutions to reduce negative factors and to substantiate the advantages of the technology of minimum soil cultivation.

By using energy-saving machines with minimum tillage and increasing soil fertility and productivity, costs are reduced by about 2-6 times.

Key words: minimum processing, fertility, erosion, energy saving, energy costs.

Introduction

Land cultivation technologies have been practiced since the 18th century. This type of intensive scientific research has been noted among European farmers. Europe has made significant progress through the use of organic fertilizers, pasture and plowing poor soils.

With the advent of tractor power, deep cultivation with careful processing of the next surface layer was widespread which ensured high fertility in conditions of sufficient moisture, excessive use of manure and weeds.

The “blind” introduction of this tillage technology in Eastern Europe, Siberia and other places where there was an acute shortage of moisture, especially in the steppe regions, agriculture went bankrupt, weeding was unjustified and organic fertilizers became less effective. Farmers in the USA and Canada found themselves in the same tragic situation when aeration increased due to constant

deep subsidence of the soil which led to accelerated decomposition of humus, loss of soil structure water and wind erosion.

Due to the improper implementation of land cultivation technology in 1934, a dust storm swept over 40 million large areas of the United States and carried 300 million tons of fertile land into the ocean [11].

This tragedy of agriculture has mobilized the scientists of the advanced states to decide how to find a solution to the problem. In 1943 Faulkner's book, «The Plowman's Madness» gained widespread acceptance among farmers. Faulkner strongly criticizes tillage and suggests using the topsoil 7-7.5cm deep to mix fertilizer with the topsoil.

The mechanical transfer of soil cultivation techniques to agriculture under different conditions was sharply criticized by the Russian scientist V.V. Dokucha and D.I. Mendeleeva [8]

T.S. Maltz proposed to plow the land every 3-5 years, the rest of the time it was proposed to cultivate soil with suitable tools in 1953 [1].

After Faulkner's critical analysis, serious work began on soil cultivation technology and it was proposed to revise the foundations of scientific agriculture. A characteristic feature of this scientific process was a single recipe for cultivating the land. Moving from ordinary schemes to creative ones based on scientific advances and best practices, taking into account local conditions.

According to G. Kant about the minimum tillage, we read: “As much as needed, but as little as possible”. First the method of minimum cultivation was tested in 1945 in the United States. Currently, 50% of the southern United States is cultivated using minimum and zero technology. In 2013, it is planned to cultivate the entire sown area using this technology [4]. It has been established that the soil intended for sowing cereals should have a density of 1.1-1.3 g / cm 3, for potato-sunflower - 1-1.2 g / cm 3, for sugar beets 1.1-1.5 g / cm 3 [9]. This means that if the density of the soil is lower than the specified one, it should be rolled and at high density - shallow cultivation must be applied.

In this regard, I. B. Revut stated «The deviation of soil density from the optimal 0.1-0.3 g / cm^3 leads to a loss of yield by 20-40%” [6].

It is known that agricultural land is distinguished by a great variety which is expressed by the type of soil, physical and mechanical properties, climatic conditions, position, area of use etc. Thus, the problem lies in the minimum tillage technology for the most efficient use of different types of land in different areas applying various working aggregates or machine-tractor units.

Material and method

Until the 1990s, in agricultural production in the United States and today in the Republic of Armenia [7], minimal soil cultivation is combined with preservatives, that is, crop residues remain in the process of soil cultivation, which not only increases the yield, but also prevents its erosion. In this case, it is necessary to combine this technology with protection against plant diseases, pests and weeds. The presence of crop residues on the soil surface improves moisture penetration, reduces evaporation, but requires a large amount of nitrogen fertilizers, since crop residue nitrogen does not enter the soil, it decomposes uselessly.

Minimum tillage technology is considered the most important result of the scientific and technological revolution in agriculture.

Results and analysis

Numerous theoretical and experimental studies were carried out in order to identify factors affecting the energy efficiency of land cultivation, as well as their reduction, taking into account the following main aspects:

Agronomic point of view - studies have shown that after deep seeding (20-25 cm) in the next two years, the soil can be cultivated face down (15-18 cm) without compromising fertility. Decreasing the depth by 1 cm reduces fuel consumption by 0.4-0.6 kg / ha and cash costs by 0.43-0.52 US dollars / ha. Preparation of the land during cultivation with aggregates in combination with sowing wheat yielded more yield than with double cultivation, and the costs decreased almost twice, the fuel economy was 3.5-4 kg / ha [2].

Energy aspect - in the case of soil cultivation with passively acting organs, the expended energy is determined by resistance [5, 7].

$$E_m = K_1 = k_1 +_1 \cdot v^2, \quad (1)$$

E_m - specific energy intensity of the earth N/m^2

K_1 - specific traction resistance of the car, N/m

$_1$ - dynamic resistance coefficient, Ns^2/m^3

V - the working speed of the car m/s

The specific fuel consumption required for tillage is determined by the following formula: [13]

$$Q_0 = 2.778 \cdot 10^{-6} g_e \eta_{V\max} (k_1 + \varepsilon_1 V^2) e^{c(V_0 - V)^2}, \quad (2)$$

Q_0 - specific fuel consumption , kg / ha

g_e - specific fuel consumption of the tractor engine, g / kWh

$\eta_{V\max}$ - maximum value of the tractor power factor

$e = 2.718$, the basis of the natural logarithm

V_0 – the speed corresponding to the maximum traction power, m / s,

c-coefficient that takes into account the physical and mechanical properties of the soil and the operating conditions of the tractor.

For wheeled tractors $c \approx 0.15 \pm 0.05$ - for compacted soils; $c \approx 0.3 \pm 0.05$ - for cultivated soils.

The above formula (2) shows that the specific fuel consumption for tillage is determined by the energy intensity of the technological process, the energy characteristics of the tractor as well as their changes [2, 12, 13] (Tab.).

Table

Energy characteristics of tillage machines in the range of speed- 1.5 - 3 m / s (5-11 km / h)

Process type/ used machine	Static resistance, k_1', N/m	Dynamic resistance coefficient, ε, Ns^2/m^3
Planting at a depth of 20-21 cm		
- with corpus of attaching plow	7000-18000	400-700
- with corpus of hanging plow	6000-15000	400-700
- spiral corpus of hanging plow	5000-12000	250-450
surface sowing	1500-2300	100-400
Cultivation at a depth of 8-12 cm		
- with T-shaped cultivators	1300-3500	80-400
- with crusher	2000-3600	60-400
- combined high-speed machines	4000-5500	200-550
double cultivation 8-12cm		
- with T-shaped cultivators	800-1000	50-100
Deep loosening of soil (15-20 cm) with combined machines	2000-5300	150-500

The data in the table shows that downstream processes are considered to be more energy intensive than other processes. In addition, pre-sowing cultivation of arable land is associated with additional energy costs. Therefore, in order to reduce energy costs, it is advisable to replace the bottom with other tillage methods.

The technical point of view is the introduction of more efficient machines and the use of combined machine units.

One of the main indicators that determine fuel consumption is the specific traction resistance of the vehicle, which is characterized by static resistance (k_1') and coefficient of dynamic resistance (ε_1). Their size depends on the physical and mechanical properties of the soil, the design of the machine, working bodies, as well as on their suitability for work in specific conditions [12, 13]. The lower these indicators, the less fuel is required, the higher is the productivity and the cheaper is the work.

Greater fuel savings can be achieved by combining technological processes. It is advisable to use combined machines to combine the following processes:

- main soil cultivation with simultaneous additional cultivation,
- pre-sowing treatment by integration of herbicides and fertilizers,
- sowing grain and other crops by applying herbicides and fertilizers.

In the case the fuel economy is 15-30%.

From an economic point of view, with intensive cultivation of the land, the cost of labor, fuel and other resources is 1.5 times higher than when traditional technology is used. By simplifying the processing technology, it will be possible to reduce costs by 30% with the use of the minimum processing technology - 2 times, with zero - 6 times [12].

Environmental point of view - minimal tillage is considered environmentally friendly. This reduces the number of machines used, reduces unwanted soil compaction and reduces the amount of toxic gases released into the atmosphere.

Research confirms that for better soil cultivation in mining agriculture in the Republic of Armenia, it is necessary to develop a minimum soil cultivation technology and apply various machines or machine-tractor units. And in general, if we take into account that the choice of the technology for its cultivation is conditioned by the physical and mechanical properties of the soil, then the choice of the type of tractor, tractor shape or traction becomes a decisive factor.

Conclusion

1. One of the most effective ways to reduce the cost of land and energy processing is the use of minimum processing technology, which is considered agriculturally acceptable, economical and environmentally friendly. When using the technology of minimum tillage, costs are reduced by about 2-6 times.
2. The use of energy-saving machines (chisel cultivators, machines with active working units, machines with vibrating units, combined tillage machines) increases the efficiency of the soil cultivation process, soil fertility and productivity.
3. For the best tillage in the mining agriculture of the Republic of Armenia, it is necessary to develop a minimum tillage technology using machines of various shapes or machine-tractor units.

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ՀՈՂԻ ՆՎԱԶԱԳՈՒՅՆ ՄՇԱԿՄԱՆ ՏԵԽՆՈԼՈԳԻԱՅԻ ԱՌԱՆՁՆԱՀԱՏԿՈՒԹՅՈՒՆՆԵՐԸ ԵՎ ԸՆՏՐՈՒԹՅՈՒՆԸ ԳՈՏԻԱԿԱՆՈՒԹՅԱՆԸ ՀԱՄԱՊԱՏԱՍԽԱՆ

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Հոդվածում՝ հողի մշակման էներգատարության, ծախսերի վրա ազդող գործոնների բացահայտման, ինչպես նաև դրանց կրճատման լուծումների որոնման նպատակով կատարված է հողի մշակման տեխնոլոգիաների առանձնահատկությունների վերլուծություն և նվազագույն մշակման տեխնոլոգիայի առավելությունների հիմնավորում:

Էներգախնայող մեքենաների կիրառմամբ հողի նվազագույն մշակման դեպքում բարձրացնում է հողի բերրիությունը և մշակաբույսերի բերքատվությունը, ծախսումները կրճատվում է մոտ 2 - 6 անգամ:

Բանալի բառեր. նվազագույն մշակում, բերրիություն, էրոզիա, էներգախնայող, էներգածախսեր:

ОСОБЕННОСТИ ТЕХНОЛОГИИ МИНИМАЛЬНОЙ ОБРАБОТКИ ПОЧВЫ И ВЫБОР В СООТВЕТСТВИИ С ЗОНАЛЬНОСТЬЮ

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В статье проанализированы особенности технологий обработки почвы с целью выявления факторов, влияющих на энергоемкость и стоимость обработки почвы, а также поиска решений по их снижению, и обоснованы преимущества технологии минимальной обработки почвы.

При минимальной обработке почвы с применением энергосберегающих машин повышается плодородие почвы и урожайность культур, затраты сокращаются примерно в 2-6 раз.

Ключевые слова: минимальная обработка, плодородие, эрозия, энергосбережение, энергозатраты.

- Հետազոտությունն իրականացվել է ՀՀ գիտության կոմիտեի ֆինանսական աջակցությամբ՝ 21T - 4B008 ծածկագրով գիտական թեմայի շրջանակներում:

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