UDC - 631.316.031

THE STUDY OF INTERACTION OF WORKING ORGAN OF SOIL CULTIVATING MACHINE WORKING ON SLOPE AND THE SOIL

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The field cultivation processes in the mountain farming of the RA and AR are mainly carried out by such machines and mechanisms designed for lowland conditions without taking into account the specificities of mountain farming. As a result, the slope soil is subjected to erosion. Taking into account this factor, the interaction between the soil and working organ of soil cultivating machine working on slopes was theoretically studied and the relative motion of the soil on the working surface of the working organ was determined. The resulting statements will help to identify the mechanism of soil erosion during slope soil cultivation and to develop preventive measures.

Key words: slope, working organ, furrow, soil erosion, trajectory, wedge, motion.

Introduction

The current level of mechanization of the mountain agriculture of the Republic of Armenia is quite low, it does not exceed 15% on average and some of the existing machines carry out technological processes with incomplete, low productivity and insufficient quality. Therefore, the mechanization of cultivation processes in mountain conditions is carried out by such methods and machines which are designed for lowland conditions without taking into account the specificities of mountain farming. As a result, slope lands are subjected to intensive erosion and if appropriate measures are not taken, these lands can become non arable causing significant economic harm to agriculture.

For the best cultivation of slope soil as well as for increasing the efficiency of agricultural machinery operation we need a multifaceted study and justification of the interaction between the soil cultivating aggregates and their working organs and between the working organ and soil as well based on modern agro-technical requirements.

Conflict setting

In slopes due to lateral forces, the working organs of the soil cultivating machine deviate from the set direction which also changes the trajectory of relative movement of the soil over the working surface of the working organ [1,2,3,4,5,6,7].

During the process of slope soil cultivation normal pressure force N, impact lateral force Q directed to down slope and contact force F (Fig. 1) [3,4,8,9,10] influence on the furrow cut by working organ. During slope cultivation the soil particles begin to move in the direction of the equilibrium forces. The contact force of these forces does not affect the relative motion of the soil. It is therefore necessary to determine the trajectory of relative motion of slope soil due to the normal pressure N and lateral Q forces.

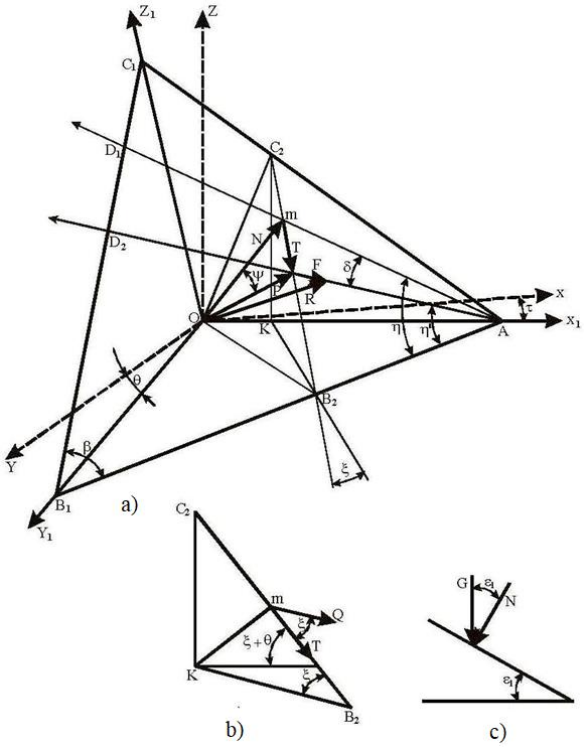

Fig. 1 The scheme of determining the deviation angle of the trajectory of relative motion of slope soil (δ)

Research results

Lateral Q force is located on KB_2C_2 plane parallel to slope and the component is in ABC plane (Fig.1,a).

$$T = Q\cos\xi = G\sin\theta\cos\xi, \tag{1}$$

where ξ- is the angle of B_2C_2 line and AOB_1 plane down the wedge on the working surface of trihedral wedge. It is dependent both on wedge parameters and motion direction of machine-tractor aggregates (MTA) to horizontal (τ) (Fig.2).

Considering that T component of Q force is directed to CE we will get the following according to Fig. 2

$$tg\xi = \frac{OC}{OE} = \frac{OC}{OD}\cos(\gamma - \tau) = tg\varepsilon\cos(\gamma - \tau) \tag{2}$$

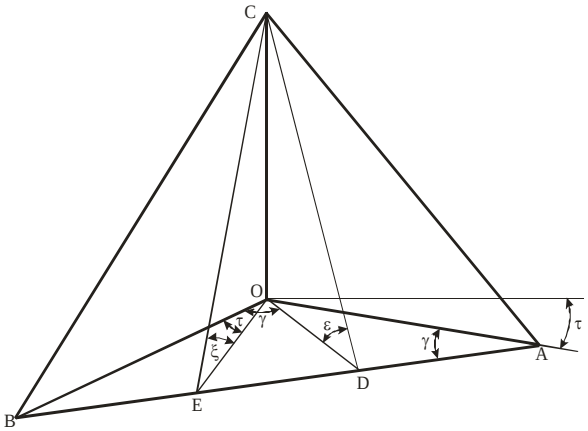

Fig. 2 Determining scheme of ξ angle formed by AOB plane down the wedge and EC line stretching down the slope

From the analysis of obtained (2) expression and $\xi = f(\tau)$ graph (Fig. 3) we see that

1. when soil cultivating MTA moves towards the field horizontals ($\tau = 0$), then

$$tg\xi = tg\varepsilon \cos\gamma = tg\beta \ , \tag{3}$$

i.e. here $\xi = \beta$,

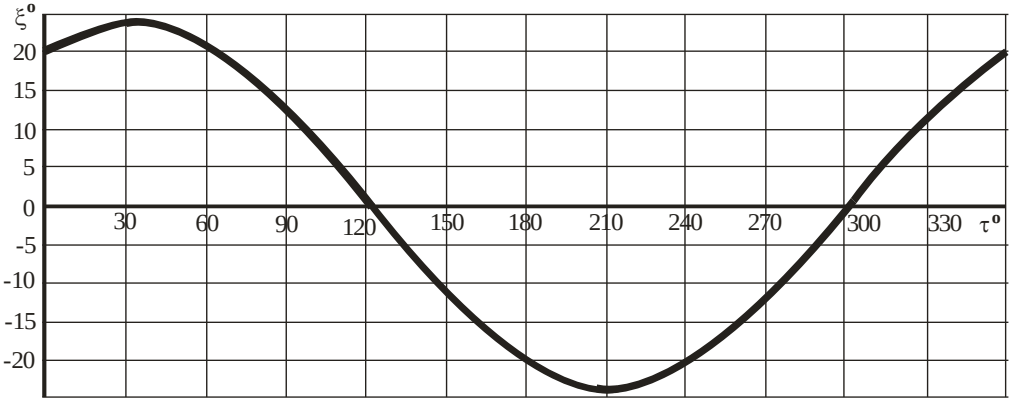

Fig. 3 The graph of change of the ξ angle by EC line stretching down the slope and AOB plane down the wedge depending on direction of MTA motion $\gamma = 32°, \varepsilon = 23,5°$

2. when MTA moves down the slope ($\tau = 90°$), then

$$tg\xi = tg\varepsilon \cos(\gamma - 90°) = tg\varepsilon\gamma\sin = \text{tg}\alpha, \tag{4}$$

i.e. $\xi = \alpha$,

3. when $\tau = \gamma$, $tg\xi = tg\varepsilon$, (5)

i.e. $\xi = \varepsilon$

for arrow paw breast up the slop ξ angle will be

$$tg\xi = tg\varepsilon \cos(\gamma + \tau) \tag{6}$$

According to (2) and (6) expressions the formula for determining ξ angle will generally have the following form

$$tg\xi = tg\varepsilon \cos(\gamma \pm \tau) \ , \tag{7}$$

where + corresponds to breast of arrow paw to upper slope, - to the breast of down the slope.

T component of lateral Q force, normal pressure N force and their equilibrium P force are in OB_2C_2 plane (Fig.1, a). The angle ψ by N and P forces will be determined from the following expression

$$tg\psi = \frac{T}{N} \tag{8}$$

Normal pressure N force is determined by Fig.1, c- $N = G\cos\varepsilon_1$,

where ε_1 is the angle of working surface with horizontal plane

consequently,

$$tg\psi = \frac{G\sin\theta\cos\xi}{G\cos\varepsilon_1} = \frac{\sin\theta\cos\xi}{\cos\varepsilon_1} \tag{9}$$

Influenced by T component of lateral force the trajectory of the relative movemet of soil over working surface of wedge deviates by δ angle forming η' angle to cutting edge (Fig. 1, a)

$$\eta' = \eta \pm \delta, \tag{10}$$

where η is the angle by the trajectory of relative motion of the soil over the working surface of wedge to the cutting edge working in horizontal plane. + corresponds to breast of arrow paw to upper slope, - to the breast of down the slope.

In Fig. 4 we see the boundary positions AD_2' and AD_2'' of trajectory of relative movement of furrow and AD_1 trajectory corresponds to the case when lateral forces are absent (plane).

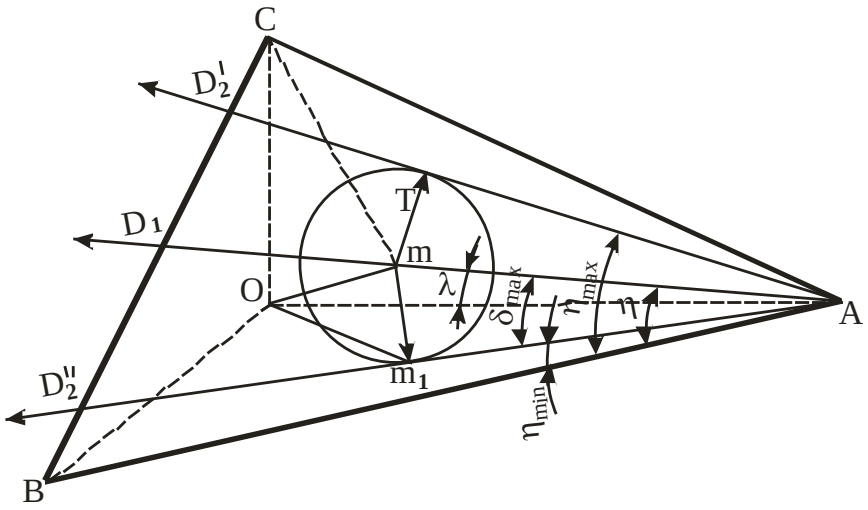

Fig. 4 Scheme of determining the dimension of deviation of trajectory of relative motion of soil over the working surface of working organ

The deviation of the trajectory of relative motion of the furrow on the same slopes (δ) is dependent on the direction of MTA movement. When the slope coincides with mm_1 line, the trajectory of relative movement of furrow will be AD_2' having the maximum deviation. In this case the working organ will be deviated towards horizontal by $\theta = \eta_r$ angle. i.e. the projection of AD_1 trajectory on the horizontal plane and the direction of movement of MTA coincide. We can observe Omm_1 and Amm_1 rectangular triangles for this case which have the same mm_1 leg (Fig. 4). According to these triangles we can write

$$Om\, tg\psi = Am\, sin\delta_{max}, \quad \text{where}$$

$$sin\delta_{max} = \frac{Om}{Am} tg\psi = tg\lambda\, tg\psi, \tag{11}$$

where λ is the angle of the direction of movement of MTA and AD_1 trajectory.

Taking into account that the trajectory of relative movement of soil over working surface of wedge is proposed by the η angle with cutting edge of plough and, according to L. V. Gyachev [3], it satisfies the following condition $tg\eta = tg\gamma \cos\varepsilon$,

$\cos\lambda \cos\eta = \cos\gamma, \quad \sin\gamma \sin\varepsilon = \sin\lambda,$

where γ is the angle to the direction of movement and cutting edge of the wedge.

From the last expressions we can write

$$tg\lambda = \frac{sin\gamma sin\varepsilon cos\eta}{cos\gamma}, \quad \text{or}$$

$$tg\lambda = tg\gamma sin\varepsilon cos\eta \tag{12}$$

Considering (9) and (12), (11) will have the following form

$$sin\delta_{max} = \frac{tg\gamma sin\varepsilon cos\eta sin\theta cos\xi}{cos\varepsilon_1} \quad (13)$$

Current values of δ angle will be determined by multiplying the obtained expression with $\cos(\theta \pm \eta_r)$

$$sin\delta = \frac{tg\gamma sin\varepsilon cos\eta sin\theta\ cos\xi \cos(\theta \pm \eta_r)}{cos\varepsilon_1} \quad (14)$$

where η_r angle by horizontal projection of the direction of furrow movement and movement is determined by the following expression [11]

$$tg\,\eta_r = \frac{tg\gamma - cos\varepsilon \cdot tg\eta}{1 + tg\gamma \cdot tg\eta \cdot cos\varepsilon} \quad (15)$$

Inserting the calculated value of δ in (10) expression the trajectory of relative movement of furrow over working surface of working organ on slope depending on the impact of lateral forces is determined.

Conclusion

1. As a result of study of interaction of soil and working organs of soil cultivators on the slopes the expressions were obtained determining the trajectory of relative movement of furrow over the working surface of working organ depending on the impact of lateral forces and the change of technological parameters of working organ.
2. The obtained expressions will allow to reveal the soil erosion mechanism during slope soil cultivation and to develop preventive actions.

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ՀՏԴ - 631.316.031

ԼԱՆՋՈՎ ԱՇԽԱՏՈՂ ՀՈՂԱՄՇԱԿ ՄԵՔԵՆԱՅԻ ԲԱՆՈՂ ՕՐԳԱՆԻ ԵՎ ՀՈՂԻ ՓՈԽԱԶԴԵՑՈՒԹՅԱՆ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆԸ

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ՀՀ և ԱՀ լեռնային երկրագործությունում դաշտավարության գործընթացներն հիմնականում իրականացվում են այնպիսի մեքենաներով և մեխանիզմներով, որոնք նախատեսված են հարթավայրային պայմանների համար՝ հաշվի չառնելով լեռնային երկրագործության առանձնահատկությունները: Արդյունքում լանջերի հողը ենթարկվում է հողատարման: Հաշվի առնելով այդ հանգամանքը տեսականորեն ուսումնասիրվել է լանջերում հողամշակ մեքենայի բանող օրգանի և հողի փոխազդեցությունը, որոշվել բանող օրգանի աշխատանքային մակերևույթով հողի հարաբերական շարժման հետագիծը: Ստացված արտահայտությունները

թույլ կտան բացահայտելու լանջերի հողերի մշակման ժամանակ հողատարման մեխանիզմը և մշակել կանխարգելիչ միջոցառումներ:

Բանալի բառեր. լանջ, բանող օրգան, առ, հողատարում, հետագիծ, սեպ, տեղաշարժ:

УДК - 631.316.031

ИССЛЕДОВАНИЕ ВЗАИМОДЕЙСТВИЯ РАБОЧЕГО ОРГАНА ПОЧВООБРАБАТЫВАЮЩЕЙ МАШИНЫ, РАБОТАЮЩЕЙ ПО СКЛОНУ, С ПОЧВОЙ

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В горном земледелии РА и Республики Арцах процессы полеводства в основном осуществляются машинами и механизмами, предназначенными для равнинных условий, без учета особенностей горного земледелия. В результате почвы на склонах подвергаются эрозии. Учитывая это обстоятельство, теоретически было изучено взаимодействие рабочего органа почвообрабатывающей машины с почвой на склонах, определена относительная траектория движения почвы по рабочей поверхности рабочего органа. Полученные утверждения позволят выявить механизм эрозии при обработке земель склонов и разработать профилактические мероприятия.

Ключевые слова: склон, рабочий орган, пласт земли, эрозия почвы, траектория, клин, перемещение.

Ներկայացվել է՝ 24.02.2020թ.
Գրախոսման է ուղարկվել՝ 25.02.2020թ.
Երաշխավորվել է տպագրության՝ 02.04.2020թ.