ARTICLE IN PRESS

Annals of Agrarian Science xxx (2016) 1–5

Contents lists available at ScienceDirect

Annals of Agrarian Science

journal homepage: http://www.journals.elsevier.com/annals-of-agrarian-science

Development and substantiation of the universal working organs parameters of sloped processing with minimal technologies

A.P. Tarverdyan*, P.A. Tonapetyan

National Agrarian University of Armenia, 74 Teryan Str., Yerevan, 0009, Armenia

ARTICLE INFO

Article history:
Received 25 August 2016
Accepted 28 September 2016
Available online xxx

Keywords:
Working organs
Minimum tillage
Installation
Disk
Aggregate

ABSTRACT

The article considers the problem of reducing energy consumption in the mountainous arable farming and approved that one of the effective ways to solve this problem is minimal technology of tillage machines with disk working organs, using cultivators and harrows.

Is proposed for universal working organ of minimum tillage, which is a spherical disc welded with segmented toothed flat disk. When machining of soil with the elaborated spherical working body the value of overlap groove decreases, provided loosening of the ridges formed between the grooves, which provide high technological quality of soil processing and stability of aggregate motion. That organ wich we are presenting makes it possible to reduce the number of disks in the battery and reduce the traction resistance of aggregate at identical working width.

1. Introduction

One of the effective ways to improve the productivity of production processes in mountain farming is the reduction in energy consumption. So, finding of the ways to reduce the energy consumption of the basic processes of tillage continues to be the main problem in mountain farming.

Research has established that one of the effective ways to solve this problem is minimal technology of tillage machines with disk working organs, using cultivators and harrows.

If a tillage on the plains by existing tillage machines basically provides sufficient technological quality, so the agronomical requirements for a minimum tillage during processing of slopes with them, are not satisfied, which reduces a fertility, increases the risk of soil erosion.

The processing of the slopes by disk implements is accompanied by instability dynamic and technological parameters of the unit. The main reason of this instability is the redistribution of the unit's weight working on the slope.

2. Objectives and methods

The forces acting on the disc implement, which works on a slope, are shown in Fig. 1. Here reactive soil resistance, acting on the spherical disks, cannot be given to the single resultant, so they are presented by the forces R_1 and R_2, acting parallel to the disk's rotation axis and attached in the center of gravity of disks' segments embedded in the ground, F is a force, applied at the centre of gravity and acting in the opposite direction of the absolute velocity of the, T is a lateral force applied at the centre of gravity of the implement and directed down the slope, P_{XY} is a drawing force (Fig. 1a).

The implement aspire to revolve around the instantaneous centre (π) under the effect of lateral forces T and deviates from a predetermined driving directions for some angle φ. Then the angle of the battery disks, located on the upper side of the slope, increases and makes $\theta + \varphi$, and the batteries, located on the lower side of the slope, vice versa, will decrease and make θ-φ (Fig. 1a).

It is known that the resistance of disk implements, hence the forces R_1 and R_2, acting along the disks' rotation axis depend on many factors, one of which is the angle of disks' attack [1,2]. The uneven penetration drives and change of the width of the implement's capture also affect the value of the forces R_1 and R_2.

Discs moving on lower side of the slope are buried more as a result of redistribution of tools' weight. Change of attack angle of the disks also significantly influences on irregularity of disks' motion. Discs aspire to tend deepened and increase the tillage depth

* Corresponding author.
E-mail address: rector@anau.am (A.P. Tarverdyan).
Peer review under responsibility of Journal Annals of Agrarian Science.

http://dx.doi.org/10.1016/j.aasci.2016.09.014
1512-1887/

Please cite this article in press as: A.P. Tarverdyan, P.A. Tonapetyan, Development and substantiation of the universal working organs parameters of sloped processing with minimal technologies, Annals of Agrarian Science (2016), http://dx.doi.org/10.1016/j.aasci.2016.09.014

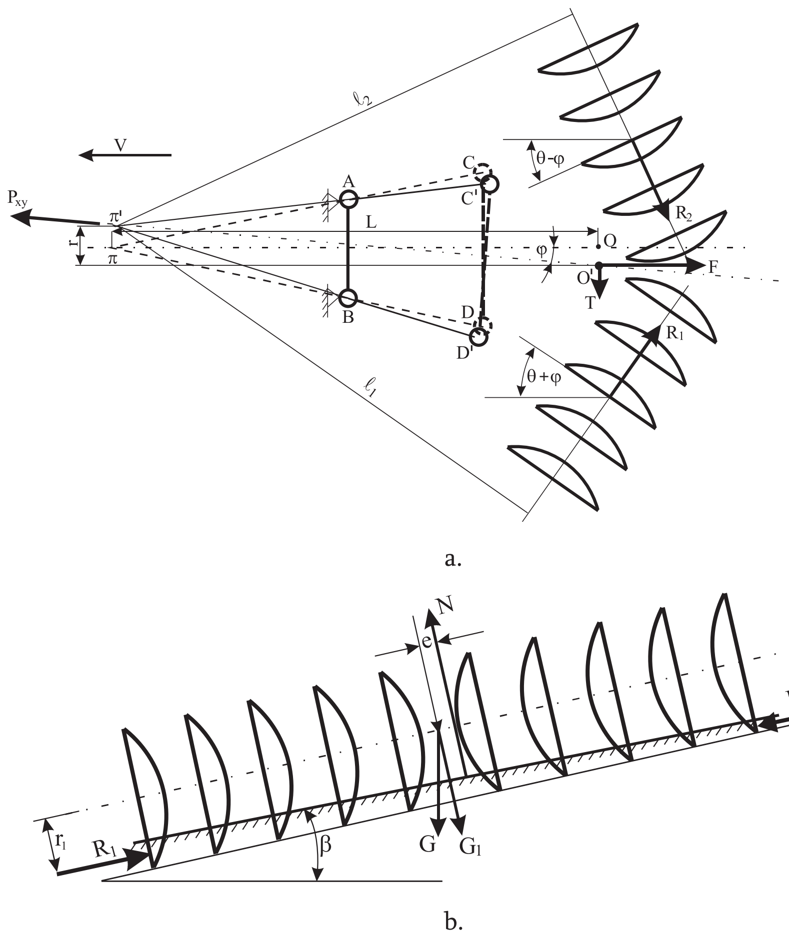

Fig. 1. Moving the disk aggregate operating on a slope: a-in a plane of parallel to the field surface, b-in a plane perpendicular to the field surface.

with increasing of attack's angle up to certain limits [1,2].

All this leads to the fact that force R_1 is considerably larger R_2 when working in cross slope.

The moment of all forces about the instantaneous center of rotation (π) should be zero for implements' balance in plane of parallel to a surface of the field.

$$\frac{\partial^2 \phi}{\partial t^2}\left(ML^2+I\right)+F\cdot r-T\cdot L\cos\phi+R_1 l_1-R_2 l_2=0, \quad (1)$$

where M-weight of the implement, I- implement's moment of inertia about the axis normal to the surface of the field and passing through the center of gravity, T-lateral force, can be taken, $T = G\sin\beta$, β-tilt angle, L-distance of implement's center of gravity from the instantaneous center of rotation(π), l_1, l_2 and r-shoulder of forces R_1, R_2 and F respectively.

For the study of disc's equilibrium of tillage equipment in the perpendicular to the surface of the field plane, assume that the disks' angle of attack is zero and equipment does not have a skew. Then the batteries, located in the upper and lower side of the slope, will be on one line (Fig. 1b): Conventionally, assume that the axial forces R_1 and R_2 continue to apply on equipment. Besides them in the equipment's center of gravity, perpendicular to the surface of the field, the component of gravity $G_1 = G\cos\beta$ and the reaction force N of the furrow's bottom act. Reaction force is rejected by an amount e due to non-uniformity of processing (Fig. 1b).

The equation of equipment's equilibrium in the vertical plane of the field on Fig. 1b will:

$$R_2\cdot r_2+N\cdot e=R_1\cdot r_1. \quad (2)$$

When $\theta \neq 0$, the forces R_1 and R_2 will not be in the same working plane, and moments $R_2\cdot r_2$ and $R_1\cdot r_1$ separately will contribute more burying of front discs. This burying increases with increasing angle of attack disks.

3. Results and analysis

To correct these deficiencies have developed a universal working organ of minimum tillage, which is a spherical disc [1] welded with segmented toothed flat disk [2] (Fig. 2). When machining of soil with the elaborated spherical working body the value of overlap groove decreases, provided loosening of the ridges formed between the grooves, which provide high technological quality of soil processing and stability of aggregate motion. Presenting working organ makes it possible to reduce the number of disks in the battery and reduce the traction resistance of aggregate at identical working width.

Fig. 3 shows the disc as circle of radius r, perpendicular to the fields of the plane, which in direction of aggregate movement amounts to an angle Θ equal to disc's angle of attack.

Let us take an arbitrary point M of the circle, then M_X - its projection on the X-axis, and M_X-the projection of M_X on the axis x' (Fig. 3).

We write the equation of the circle in parametric form:

Please cite this article in press as: A.P. Tarverdyan, P.A. Tonapetyan, Development and substantiation of the universal working organs parameters of sloped processing with minimal technologies, Annals of Agrarian Science (2016), http://dx.doi.org/10.1016/j.aasci.2016.09.014