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Improve the Design of the Apparatus of Cotton Harvesting Machine

Omonov Nabijon Normamatovich

Senior teacher, Tashkent state technical university, Tashkent, Uzbekistan

ABSTRACT. In article is considered this issue of increasing to capacity and improvement produced at present cotton picker machines, scientific research developments, conducted in this direction. The main factors, which are affecting on technological process, are feature and criteria for estimation the adaptation various sorts of cotton plant to machine harvesting are presented the problems for elaboration of new design of the harvesting apparatus, the analysis of researches, which are installed in this direction, the structure of bush and physical - mechanical characteristics of regional and perspective sorts of the cotton plant, the criteria of the estimation adaptation cotton plants to machine harvesting with vertical spindle harvesting apparatuses: by wide of the cotton plant's bush; by height of location of the lower boll of cotton and by dimension of feature of green and opened boll. Are given the diagrams and coeffitcients of adaptation the various sorts of cotton plant to serial vertical spindle cotton picking machine by criteria of opened and closed bolls' diameters and also criterials of height and wide of the bush.

KEY WORDS: adaptation, machine harvesting, cotton plant, bushes and bolls, cotton picking machine, criterion, dart of the sagging, diameters of boll.

I. INTRODUCTION

Actuality of topic harvesting apparatus of serial cotton picking machine (CPM) of vertical spindle (VS) is placed in two ranges in "Tandem" scheme [1]. The reason is facilitation of maintenance of apparatus, namely creation possibility to reapers dividers and doors. But when harvesting apparatus are placed in "Tandem" scheme machine base (the distance between front moving wheels and back guiding wheels) is lengthen, in consequence of this the mass of CPM increases sharply. This resulted increases of expenses of material more pressing a soil by CPM's wheels and worsening of soil structure, emergence of very small less than 1 mm, unproductive soil. Besides this the lengthen of the CPM base lead to increase the width of return area to the row at the brink of the field. As the of turning increased, the cotton plant harvest in this a red will be wasted. Therefore for the solve a problem it is necessary a shortages to create the harvesting apparatus of renew construction.

II. SIGNIFICANCE OF THE SYSTEM

In article is considered this issue of increasing to capacity and improvement produced at present cotton picker machines, scientific research developments, conducted in this direction. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. LITERATURE SURVEY

Dimensional and physic mechanical properties of objects of processing – bushes and boxes of a cotton at machine collecting by spindle harvest devices are a basis for the choice of their design and process parameters.

On the basis of studying of earlier performed works [1,2,3] devoted to a research of dimensional and physic mechanical properties of a cotton it is established that so far criteria are not developed according to fitness of a cotton to machine harvesting. The available separate works on studying of properties of grades are devoted to studying only of some private questions and do not cover all complex of the properties characterizing fitness to machine harvesting [1,2,3].

For comparison of fitness to machine harvesting of various biological grades of a cotton a relevant task is development of criteria of quantitative assessment of the specified indicator.

The fitness of grades of a cotton to machine harvesting is defined by its structural and dimensional characteristics and physic mechanical properties and also terms and intensity of maturing (disclosure) of cotton boxes.

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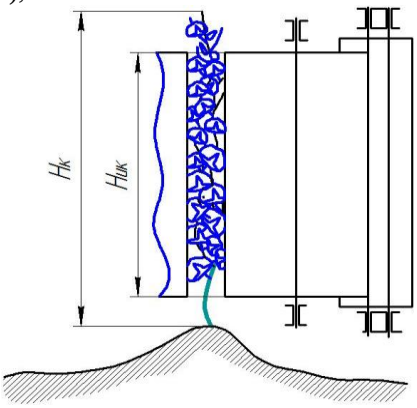
IV. METHODOLOGY

At increasing completeness of harvesting by CPM with VS and gain quality indexex of harvesting cotton yield it should be reconsidered all factors such as disposition of spindles, width of working chamber, action and state of cotton balls in process of harvest, meeting cotton balls with spindle and time and state of collecting cotton of opened balls by spindle, dimensions of cotton bush and cotton balls in the working chamber, as well as physical and mechanical properties of cotton balls, generally each of all factors which participate in the technological process of CPM. At fulfillment of such difficult multiplex and factor task we used method of system approach [2]. Thus item outputs estimating conformity to CPM ($q_1,...,q_к$) – are criterions. They may be of different quantitative and qualitative indexes depending on type of CPM, most of them have one side limitation.

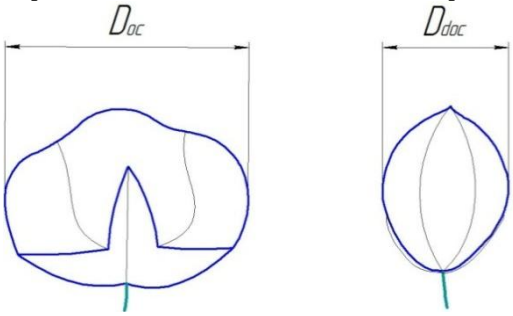
Item output of the model ($q_1,...,q_к$) criterions – estimating conformity to harvesting of CPM of sort are as follows:

- ***q_1 –height of cottonplant $H_к$, on width (breadth) $B_г$ and on form*** - cotton plant must be taller from working chamber of CPM at least to 200...250mm, i.e. $\frac{H_к}{H_{ик}} \le 1{,}2...1{,}3$, if it will increased this height, cotton plant will enter to the working chamber with big bend and will cause detrimental effect to agronomic indexes. For harvesting the cotton by spindles to the maximum it will be purposeful that cotton plant will be near the cylinder form (picture 1);
- ***q_2 - $H_{пк}$ – location of cotton balls in cotton plant***– height of the lowest ball on the cotton plant from surface of cultivation furrow should not be less than $H_{lb} \ge 80$ mmand it is purposeful that location of balls be along the height of cotton plant distributed equally (picture 1);



Picture 1. Diagram of location the cotton plant and cotton balls refer to harvesting apparatus

- ***q_3 - $t_{ко}$ – ball's quickness of opening*** - opening of almost all balls of cotton plant in short term ($t_{qo} \le 10$ day) opening is one of the criterions of estimation of conformity for machine harvesting;
- ***q_4 – O_{bok} – ratio coefficient ball's of opening*** – it is purposeful that the ratio of diameter of opened ball's to not opened ball diameter to be $\frac{D_{ob}}{D_{gb}} \ge 1{,}6$, depending on the most higher degree of this ratio the possibility of meeting the spindles with opened balls will raise, the damage of green balls will bedecreased, this criterion also is valuable for CPM with HS (if it will operate in the field where balls did not opened to 100%) (picture 2);



Picture 2. Diagram of dimensions of opened and don't opened (green) cotton balls

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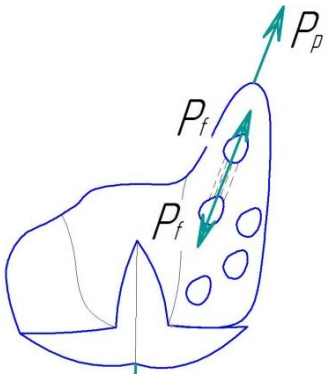
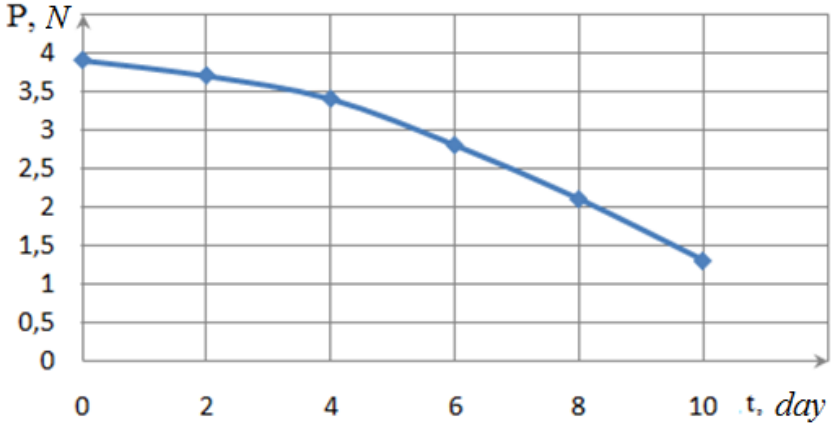


Picture 3. Diagram of forth of connection between cotton-seeds in balls and cotton plate

• ***q_5 – P_f – mutual connection forth of cotton-seeds and of piece of cotton in balls and in cotton plate*** – forth of connection between the cotton-seeds in cotton balls $P_f$and forth of connection of cotton plate with cotton ball must be 1,3...1,4 times bigger re P_p ($\frac{P_f}{P_p} \geq 1{,}3$), if this condition will be fulfilled the cotton will be taken out from cotton balls without tear it off (picture 3).

• ***q_6 - P_p – stability of forth of connection of seed with cotton plate*** (speed of decreasing) – decreasing this force during 10 days must not exceed to 3 times re the day of cotton opening, otherwise natural falling out of cotton plate in the piece of ball will happen (picture 4);



Picture 4. Diagram of time dependence of the dependenceforth of cotton plate with cotton ball(speed of decreasing)

• ***q_7 –$S_{p.c.}$– degree of closing of opened balls with petals*** – aggregate ofpetals total surface re total surface of opened cotton must be ($\frac{S_{p.c}}{S_{oc}} \leq 30\%$) less to 30%, thus the less this percent will be, the possibility of meeting spindle with opened balls will be increased, if otherwise the degree of closing of balls by petals is high, spindles will grasp petals together with cotton in balls and dirtiness of harvested cotton will increased (picture 5).

• ***q_8 -$B_{г.ш.}$ – lateral development of cotton plant (monopodial or sympodial)*** – if the amount of side boughs grown from the main plant of cotton (monopodia) is less or cotton balls are grown out of the main bines (symposia), the crop of this sort shall meet qualitative effective harvesting with BS of CPM (at a ATT degree) (picture 6).

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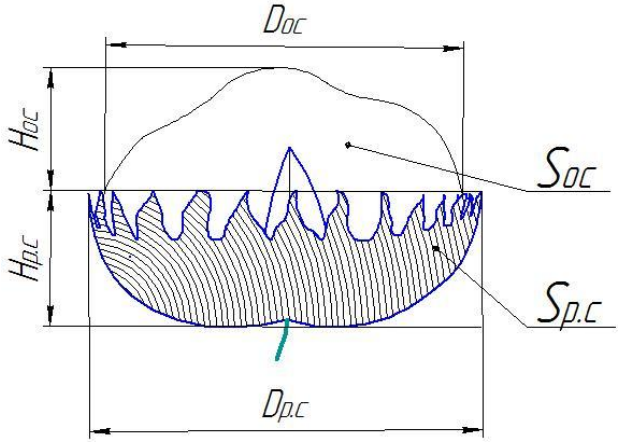
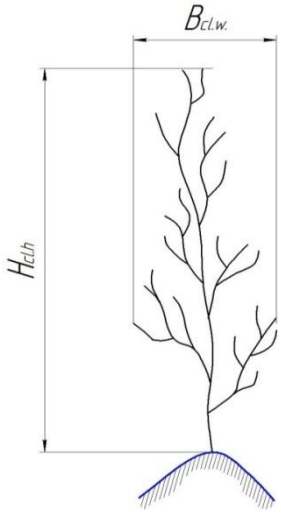


Picture 5. Diagram of definition of closing ratio of opened balls by petals



Picture 6. Diagram of lateral development of cotton plant (monopodial or sympodial)

Theoretical research was made out of the above given criterion on estimation of conformity of different sorts of cotton to harvesting by machines on criterion of difference of dimensions and forms of cotton plant, height of the lowest cotton ball from the surface of a furrow, diameters of disclosed or closed balls [2].

V. EXPERIMENTAL RESULTS

Diameters of disclosed and closed green balls of recognized variety and perspective sorts of cotton were measured in the cotton field, criterion of conformity was revealed on theoretically reasonable criterion for CPM of batch manufacturing (picture 7).

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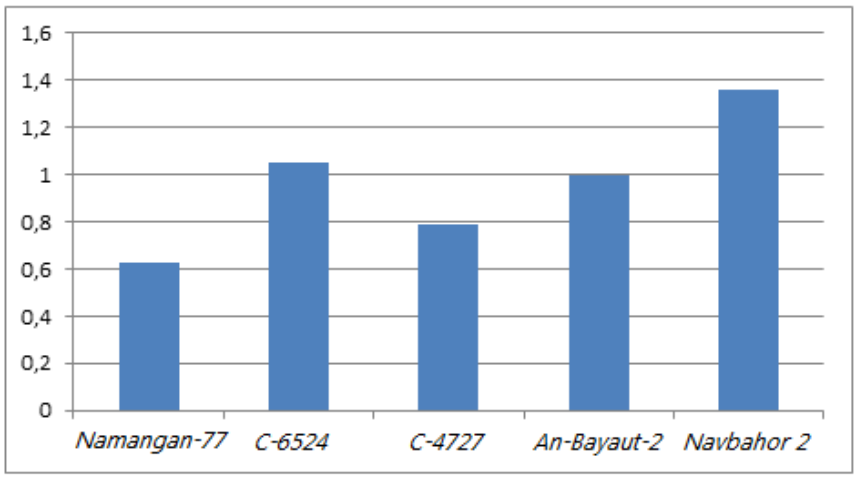


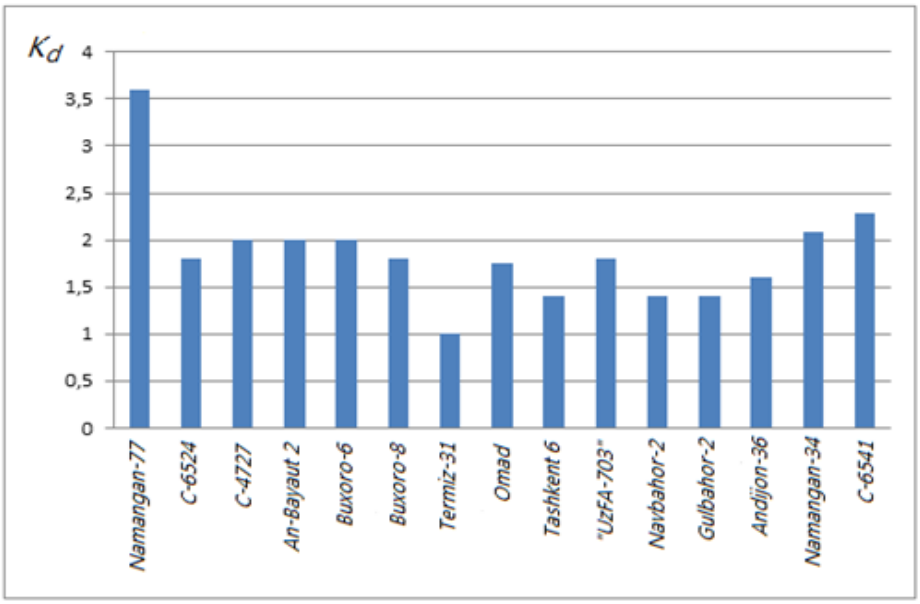
Picture 7. Conformity ratio on criterion of diameters of disclosed and closedgreen cotton balls, K_d

Conformity ratio of 5 sorts were revealed for CPM of batch manufacturing on criterion of diameters of disclosed and closedgreen cotton ball's in picture 7. Thus 0,62 in sort of Namangan-77, 0,78 in sort of C-4727 which have small value made re other sorts.

Coefficients K_d of conformity ratio criterion of width of cotton bush $B_{b.g}$ to different 15 sorts of cotton for CPM of batch manufacturing were revealed are present in the picture 8. Thus coefficients $K_d$in sort of Termiz-31 is 1,0, in Tashkent 6, Navbakhar-2, Andijan-36 sorts, Coefficients K_{ad} compose nearly 1.4.

It was revealed that flection of cotton plant in the process of entering it to harvesting zone and pass through it renders negative effect to the indexes of operation quality of machine. For purpose minimization of flection's of cotton plant to moving direction of harvesting machine it is necessary to exclude entering moving the spindle in harvest chamber of CPM, but together with this spindle in harvest chamber must be enough time for supply full harvest from cotton ball's and agricultural background (width of cotton ball), methodology of calculation of dimensions of harvest chamber and diameter of spindle drum was developed.

The picture 9 are presented the coefficient of conformity ratio of 15 sort's cotton bush's for CPM's of batch manufacturing. Thus the coefficients are 1,15 in Omad sorts, 1,3 in An-Bayaut 2 and Bukhara-6; nearly -1,5was made in Bukhara-8, C-4727, Tashkent 6andAndijan-36 sorts.



Picture 8. Coefficients K_d of conformity ratio on width of cotton bush for different sorts of cotton ($B_{b.g}$)

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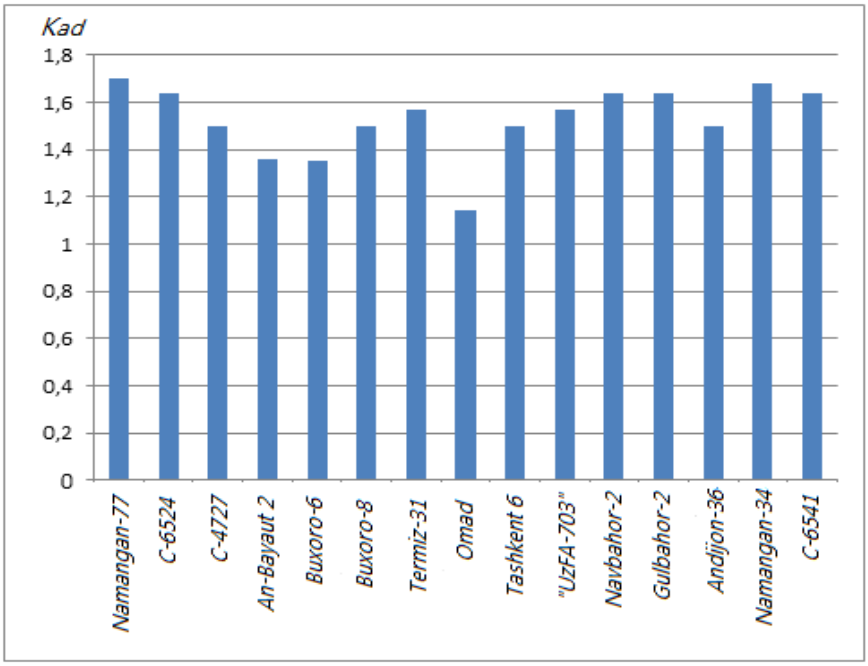

Picture 9. Conformity ratio on height of cotton bush, K_{ad}

For example: let's reveal radius of apparatus drum for Navbakhar-2 sort. Thusaverage width of cotton bush is B_{yp}=125 mm, width of working chink of apparatus is - C=22…36 mm.

$$R_{\delta} = \frac{(B_{yp} - C)K}{2(K-1)} = \frac{(125-30)1,5}{2(1,5-1)} = 142,5мм$$

here: B_{yp} – average width of cotton bush, mm.

K- advance ratio coefficient, 1,3…1,5.
C – width of working chamber, mm, C=22…36 mm;
Scheme of determine radius of drum for biologic sorts Navbakhar-2, C-6524 and Namangan 77 we gave in the picture 10.
Over recent years cotton of nil type sorts are harvest in harvesting machine of MX-1,8 brand which is manufacturing in the Republic harvest cotton of nil type sorts. CPM operates on areas where distance between rig of plants makes 900 mm, diameter of spindle drum is 292 mm, number of spindles are 12.

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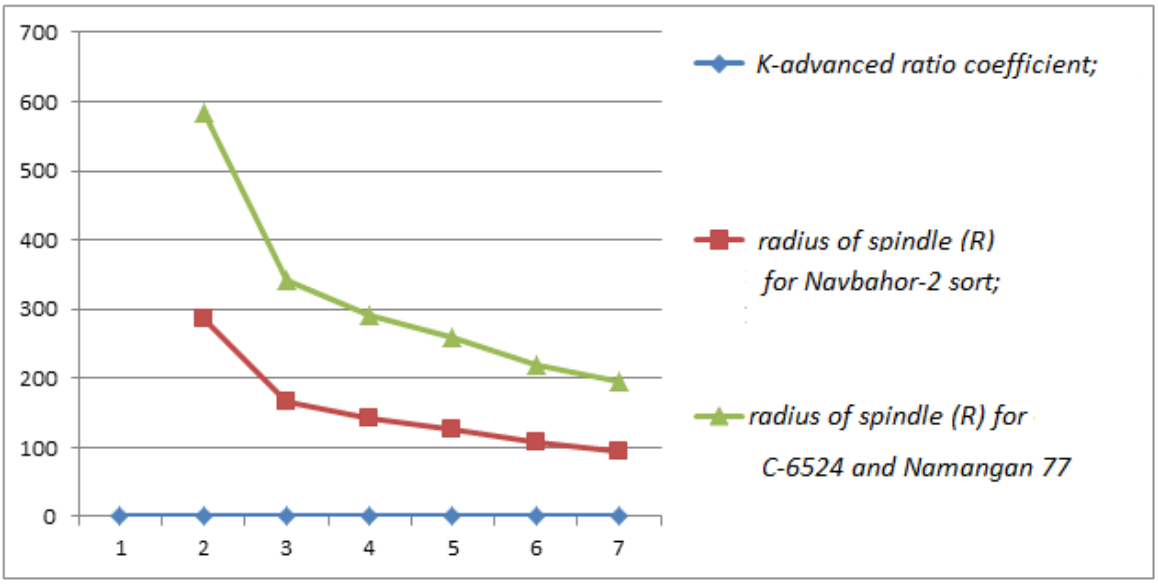

Picture 10. Scheme of dependence of advance ratio and radius of spindle drum

Lets determine steps $\Delta L_б$of spinddles in drum of VS of CPM in speed of 3…4 km/h at harvesting cotton crop and according to linkage parameter and structure of spindle drum:

$$\Delta L_d = \frac{2 \cdot \pi \cdot D_d}{n_s} = \frac{2 \cdot 3{,}14 \cdot 292}{12} = 76{,}4 \text{ mm}$$

here: n_s– number of spindles n_s= 12;

D_d – diameter of drum isD_d =292mm.

According to scheme in picture 11, for spindle drum for cotton of nil type store cotton (for example: Navbakhar-2, Gulbakhar, Navruz, Baraka) we took a drum with diameter 270 mm.

Lets determine circle length L_d of diameter from center of drum to axes of spindles and number of spindlesn_s:

L_d =2π·135=847,8 mm;

$$n_s = \frac{L_d}{\Delta L_d} = \frac{847{,}8}{76{,}4} = 11{,}09.$$

For the drum of VS CPM with 135 mm radius. We shall take 10 spindles as there is possibility of choose double spindles.

VI. CONCLUSION AND FUTURE WORK

With a view to make away with the above stated shortages we may harvest cotton sorts of "nil" type lace frontal the apparatus in CPM produce construction of drum with diameter 270 mm, and 10 thing of spindles in a drum. It gives opportunity to reduce waste of materials. Besides this as the base of CPM is reduced, the width of return space to the edge of the field reduced and the waste of cotton harvest on each area will reduce too.

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