Determination of the content and quality agricultural techniques required for thousand hectares of cotton area

Aziz.Abduvasikov [1], *Fazliddin* Namozov [1*], and *Shavkat* Umidov [1]

[1]Tashkent State Agrarian University, 2 University street, Tashkent, Uzbekistan

Abstract. The article presents a normative method for substantiating the composition and quantity of tractors and agricultural machinery required for 1000 hectares of cotton in the soil and climatic conditions of the Republic of Uzbekistan. For the substantiation of the composition of machines (plough, disc harrow, seeder, cultivator, cotton harvester, etc.), modern equipments were selected to perform the agro-technical measures (ploughing, leveling, sowing, harvesting, etc.) identified in the technological map of cotton cultivation. In substantiating the required number of specific machine required for performing specific agricultural measure or practice per 1000 hectares, its productivity of one shift determined during testing, the duration of the shift, the number of shifts, the daily productivity, the duration of the agricultural measures and practices, the volume of seasonal work were used as arguments.

1 Introduction

In Uzbekistan, raw materials from cotton are mainly produced in cotton and textile clusters, and the processing of the harvested crop into finished products is expanding. To increase the potential and quality of the yield, the clusters should have agricultural machinery loop that performs all the operations listed in the technological map of cotton cultivation. If the types and numbers of machines do not meet the standards, some technological operations are not performed or not completed in the optimal time. When the number of machines exceeds the norm, their annual utilization coefficients (levels) decrease and storage costs increase. Therefore, the development of normative methods to substantiate the rational composition and quantity of the machine fleet, which should be on the balance of cotton and textile clusters, is an urgent scientific and practical issue.

The aim of research – is to develop a normative method for substantiating the rational composition and quantity of the machine fleet, which performs technological operations in cotton growing in optimal time in 1000 hectares of land of cotton-textile clusters in the soil-climatic conditions of Uzbekistan.

2 Material and method

The main mechanized technologies used in the cultivation of cotton in the soil and climatic conditions of Uzbekistan are as follows: land fertilization, ploughing, deep loosening, leveling, preparation for sowing, seeding, loosening the soil between the rows of cotton, chemical treatment against diseases and pests of cotton plants, defoliation of cotton before the cotton harvest, mechanical harvesting of cotton, delivery of harvested raw cotton to processing enterprises. These agricultural technologies are implemented using machine-tractor units (MTU) consisting of universal-mowing and mowing tractors, as well as of fertilizer machine, ploughs, loosening machine, levelers, harrows, mouldboard, drills, cultivators, sprayers, cotton harvester, tractor trailers. Based on the results of many years of experience in testing and operation of various cotton machines in the field, we recommend the following procedure for determining the composition and quantity of tractors and agricultural machinery required for 1000 hectares of field area [1, 2]:

1) w_c value of the productivity of a tractor or machine of a specific model in 1 shift is obtained (in ha / h) from the protocols of the Center for Certification and Testing of Agricultural Machinery and Technologies;

2) according to the operative references received from the regional agricultural departments, a set of relevant numbers is compiled for the duration of 1 shift on 'T_c' (in hours) and the number of shifts used per day on 'n_c' in the implementation of appropriate agro-technical measures using a specific type of machine (MTU) by regions. By statistical processing of numbers their arithmetic mean values throughout the republic are determined;

3) machine productivity per day (in hectares) is calculated by this formulae:

$$w_1 = w_c T_c n_c \quad (1)$$

4) the duration of specific agricultural measure season on '$T_м$' is not defined by calendar time from the beginning of the season to its end, but from the busy, i.e stabilized and intensive time of the season. Because in busy and peak time of the season, all the machines of specific

*Correspondence author: namozovfazliddin82@gmail.com

models in the balance sheet of clusters, farms, alternative and district "Agroservis MTP" and needed for this season practices, are fully involved in the work, their sudden breakdowns decrease and they begin to function stably. The values of w_c, T_c and n_c parameters, i.e. the value of w_1, are also timed and calculated by examiner-engineers in the same period.;

5) while-season ($T_м$) work productivity of machine with w_1 daily productivity is calculated by this formulae:

$$w_м = w_1 T_м \ (ha) \quad (2)$$

6) The total number of specific model machines required to implement a specific type of agro-technical measure in 1000 hectares of cotton is determined as follows:

$$M_T = 1000 : w_м . \quad (3)$$

The rules of operating machine-tractor fleet science were used to determine the number of machinery required for 1000 hectares of cotton fields.

3 Results and discussion

Calculating number of wheel-type utility tractors. Wheel-type utility tractors include to the group of tractors designed for operating general practices. They are used to plough the land, deep loosening, harrowing, chiseling and other soil tilling practices [3]. The peak period of autumn plowing in the republic makes $T_м$ = 25 days. If the duration of the season exceeds this period, the snowy and rainy days begin and the quality of the tillage deteriorates, it is even necessary to stop and leave it in the spring [4].

Magnum 8940 (240 h.p.), MX-255 (255 h.p.), MX-240 (282 h.p.) and K-701K (300 h.p.) model utility tractors with 240-300 horse power are considered as group-1 tractors. When these tractors are aggregated with “EuroOpal 5 4+1 N100”, “Standart 7 plus 3+1”, ПД-4-45, ПНЯ-4+1-45 two-tiered and LD-100, O’P-4/5-40 ploughs for general practices, their daily work productivity in the republic was equal to w_1 =14. According to such aggregate (2), $w_м$ =14 · 25 = 350 ha land is ploughed during the season.

Using the formula (3) we determine the number of wheel-type utility tractors required for 1000 hectares of land: M_T =1000: 350 = 2,857 pieces.

“ARION 630C” (150 h.p.), ХТЗ-17221 (165 h.p.), T-150K (165 h.p.), “John Deere 6175M” (175 h.p.), “T-7060 NewHolland” (213 h.p.) and chained ВТ-150Д (150 h.p.), T-402.01 (150 h.p.), ХТЗ-181 (180 h.p.) wheel-type utility tractors with 150 ≤ N < 220 h.p.engine power are included to group- 2. Daily work productivity of aggregates made from these tractors and “EurOpal5 3+1 N100”, ПЯ-3-35-2, ПЛН-4-35, ПЛН-5-35, “EurOpal5 2+1 N100” ploughs is found to be equal to the half of productivity of group-1 utility aggregates, that is, w_1=7 (14:2). In this case, seasonal productivity of the aggregate is equal to $w_м$ =7 · 25 = 175 ha, number of tractors required for operating in 1000 hectares equal to M_T =5,714 pieces (1000:175).

With horse power between 100 ≤ N < 150 h.p. and with fixed engines, chained T-4A.01 (130 h.p.), ВТ-100 (130 h.p.), ДТ-75, ДТ-75М (95 h.p.) and and wheel-type utility tractors “NewHolland TD 5.110” (110 h.p.), “John Deere 6110B” (110 h.p.), “John Deere 6135B” (135 h.p.), “T-6072 NewHolland” (140 h.p.), “Belarus 1523” (148 h.p.), “ARION 630C” (150 h.p.) “Belarus” 1221.2 (130 h.p.), “AXOS 340C” (100 h.p.), MX-135 (140 h.p.), MX-140 (142 h.p.) are included to the 3rd group of tractors. When these tractors are aggregated with ПНО-3-35, ПН-3-30, ПНЯ-3-35, ПЯ-3-35, ПД-3-35 type ploughs, their daily work productivity was found to be 1/3 part of work productivity of the 1st group utility tractor aggregate, i.e equal to w_1=4,666 ha (14:3). Seasonal work productivity of this propellent unit: $w_м$ =116,65 ha (25·4,666). The number of such tractors needed for 1000 ha crop field: M_T =8,572 (1000:116,65).

Calculating number of row crop tractors. Row crop tractors such as ТТЗ-811, ТТЗ-100НС, “AXOS 340C”, МТЗ-80Х, ТТЗ-80.11, ТТЗ-60.11 and ТТЗ-100К11 are designed for all mechanized farm activities in cotton cultivation, harvesting, as well as, cultivation and caring for other agricultural intercrops and their harvesting practices [3]. The number of row crop tractors is determined by the number of cultivators used for processing interrows of cotton plants: in the fields where the width of inter-rows is 90 cm, an average seasonal work productivity of cultivator was found to be $w_м$ =75 ha from the first processing to the fifth processing. Thus, M_T =13,3 pieces of cultivator and the same number of row crop tractors are required for cotton interrow processing in 1000 hectares; when inter-row spacing is 60 and 70 cm, then: $w_м$ = 50 ha, M_T = 20 pieces.

Defoliation in cotton fields and pest control measures are performed with the help of sprayers mounted on row crop tractors. Seasonal work productivity of one preparation sprayer is equal to $w_м$ = 250 ha. The number of needed tractors for this is M_T = 4 pieces.

To perform loading-unloading practices, it was proven in practice that three row crop tractors are required for 1000 hectares of cotton crop [1].

Calculating number of tractor trailers. Tractor trailers such as 2ПТС-4-793А (modifications 2ПТС-4-793А-01, 2ПТС-793А-03), 2ПТС-4-887 models are chosen by two pieces for universal row crop tractors ТТЗ-60.10, ТТЗ-80.10, ТТЗ-100К10, МТЗ-80, МТЗ-82. Required number of such tractors for 1000 hectares is 12 pieces (the 3rd line of table). Accordingly, required number of tractor trailers equal to M_T = 24 pieces.

Calculating number of disc harrow. Average shift productivity of disc harrows such as “Rubin 9/3001”, “KD-3000”, БДТ-3,0 and ТДБ-3/5 models is: w_c = (1,7+2,6) : 2 = 2,15 ha/hour. Daily work productivity: w_1=w_c·10=2,15·10=21,5 ha. Seasonal land tilling duration with disc harrow is: $T_м$ = 10 days. Thus, $w_м$ = $T_м$ w_1 = 10·21,5 = 215 ha and $T_м$ = 1000:215 = 4,651 pieces.

Calculating number of seed drills. In the balance sheet of clusters, farms, “Agroservice MTP” and alternative MTPs, there are 4-row mechanic seed drills СТХ-4 (M = 60 cm inter-row), СЧХ-4А, СЧХ-4Б, SChX-4B (M = 90 cm), СХУ-4 (M = 60, 70, 90 cm), СМХ-4 (M = 60, 90

cm) to sow fuzzy seeds and 4-and 8-row pneumatic seed drills “Planter-3M”, “Planter-4M”, “Planter-D4”, “Case-1200” (M = 60, 76, 90 см) to plant naked seeds [5]. The duration of seed sowing period in our republic makes $T_м$ = 10 days. Seasonal work productivity $w_м$ of seeders are: in 8-row pneumatic seed drill “Case-1200” for 60, 76 and 90 cm inter-row work is – 350 ha; in 4-row mechanic seed drill for 60 cm inter-row work – 90 ha, for 90 cm inter-row work – 120 ha. Number of specific model seed drills required for 1000 hectares is M_T = 2,857 (1000:350), 8,333 (1000:120) and 11,111 (1000:90) pieces.

Calculating number of cotton topping device. For cutting the growing shoot tips of cotton plant, the farmers are using available ЧХУ-4А devices and РСhМ-4Б model devices produced by “Aggregate” plant [6]. These devices are mounted on front frame of cotton cultivator. This means that the more cotton cultivators there are in the cluster, the more topping devices there should be. For 1000 hectares of 90 cm inter-rows 13,3 pieces of topping device is required, for 60 cm inter-rows – 20 pieces. Topping device mounted cultivators are recommended to be aggregated with ТТЗ 100К.11 or ТТЗ 80.11 tractors.

Calculating number of sprayers. Fan sprayers VP-1, VP-11B, ОВХ-600, ОВХ-28А are used for feeding cotton and grain crops from the leaves (suspension spraying), disease and pest control, defoliation of cotton fields, chemical treatment of orchards and vineyards. Boom sprayers ОШУ-1-200, ОШУ-50, ОПШХ-12/15 are used for spraying suspensions on row crops, chemicals against their diseases and pests, and defoliating cotton plants [7].

Annual work productivity of ОВХ-600 fan sprayer, when calculated considering all aforementioned agro-techical practices, made 250 ha as proven in practice. This means, if W_M = 250, then M_T = 1000: 250 = 4 pieces.

Calculating number of cotton harvesters. At present, double-row vertical-spindle MX-1.8 cotton harvesters are being produced in the country, designed to pick cotton grown in areas with a row spacing of 90 cm by semi-aggregated with TTZ-811 tractor [8].

In recent years, in all cotton fields of the country, harvesting is carried out after the defoliation of cotton when at least 90% of the bolls are opened. At the peak of the harvest, the opening rate of cotton bolls reaches 95-98%. The cotton harvest season in the country is coming to an end in just 15 days. Therefore, we also assume that harvest season duration is TM = 15 days.

The results of many years of experience in the field operation and testing of two-row vertical-spindle cotton pickers have shown that their daily work productivity is around 4-6 hectares [9]. For now, we consider that it is expedient to take the daily productivity of the machine equal to w_1 = 4 ha.

Then the seasonal work productivity of machine makes $w_M = T_M\ w_1$=15·4 = 60 ha. In order to pick the cotton of 1000 ha area within 15 days, 16,66 pieces (1000:60) machines are required.

In cotton harvesting period of 2020, the average seasonal productivity of CE-220 double-row horizontal spindle cotton harvesters per hectare was 100 hectares. Their number for 1000 hectares is M_T = 10 pieces (1000:100).

The numbers of universal row crop tractors, levelers, deep cultivators, fertilizer spreaders, ploughs, tooth harrows, chisel cultivators and cotton cultivators were calculated in the same order and included in Table 1.

Table 1. Calculation norms of machines required for 1000 hectares of cotton fields **.**

№	Machines	Duration of season T_M, day	Daily productivity of machine w_1, ha	Seasonal productivity of machine $w_м$, ha	Number required for 1000 hectares M_T, pieces
1.	Utility wheel-type tractors:				
1.1.	Magnum 8940, MX-255, MX-240, К-701К type	25	14	350	2,857
1.2.	“ARION 630C”, “John Deere 6175M”, “T-7060 New Holland”, ВТ-150Д, Т-402.01, Т-150К, ХТЗ-17221, ХТЗ-181 type	25	7	175	5,714
1.3.	ДТ-75, ДТ-75М, AXOS 340, Belarus 1221.2, Т-4А.01, ВТ-100, MX-135, MX-140, “New Holland TD5.110”, “John Deere 6110B”, “ARION 630C”, “AXOS 340C” type	25	4,666	116,65	8,572
2.	Row crop tractors with 3 wheels for inter-row processing: ТТЗ-811, ТТЗ-100НС, “AXOS 340C”, МТЗ-80Х, ТТЗ-80.11, ТТЗ-60.11, ТТЗ-100К11				
2.1.	For 90 cm row spacing			75	13,3
2.2.	For 60, 70, 76 cm row spacing			50	20
2.3.	For defoliation and pest control				4
2.4.	For loading-unloading practices			250	3
3.	Universal row crop tractors: LS “U62”, ТТЗ-812, “New Holland TD5.110”, “John Deere 6110B”, МТЗ-82, ТТЗ-60.10, ТТЗ-80.10, ТТЗ-100К10, МТЗ-80				12
4.	Long base levelers: ПА-3, П-4А, П-2,8А	20	12	240	4,166

5.	Deep loosening cultivators: ГР-270, ГР-370, ГРХ-2-50, ГРП-3/5, ГНУ-1МС	25	14	350	2,857
6.	Mineral fertilizer spreading machines: GS2-600, НРУ-0,5, РМУ-0,5М, РМУ-0,75, МВУ-0,5А, 1РМГ-4, 1РМГ-4Б	20	13	260	3,846
7.	Local fertilizer spreading machines: РОУ-6, РТП-5	20	5	100	10
8.	Tractor trailers: 2ПТС-4-793А, 2ПТС-4-793А-01, 2ПТС-793А-03, 2ПТС-4-887				24 (2 pieces for one universal row crop tractor)
9. 9.1.	Ploughs: For tractors of Magnum 8940, МХ-255, МХ-240, К-701К type: “EuroOpal5 4+1 N100”, “Standart 7plus 3+1”, ПНЯ-4+1-45, ПД-4-45, О’Р-4/5-40	25	14	350	2,857
9.2.	ВТ-150Д, Т-402.01, Т-150К, For tractors of ХТЗ-17221, ХТЗ-181 type: “EurOpal5 3+1 N100”, LD-100, ПН-4-35, ПЛН-5-35,	25	7	175	5,714
9.3.	For tractors of “Т-6072 New Holland”, “ARION 630C”, “AXOS 340C”, ДТ-75, ДТ-75М, AXOS 340, Belarus 1221.2, Т-4А.01, ВТ-150, МХ-135, МХ-140 type: ПНЯ-3-35 ПЯ-3-35, ПЛН-4-35, ПН-3-35, ПН-2-35	25	4,666	116,65	8,572
10.	Tooth harrows: БЗСС-1,0; БЗТС-1,0; БЗТХ-1,0	10	100	1000	1,0 (a set of harrows consisting of 14 units)
11.	Disc harrows: “Rubin 9/3001”, “KD-3000”, БДТ-3,0; ТДБ-3/5	10	21,5	215	4,651
12.	Chisel-cultivator: “Karat 9/300”, ЧКУ-4А type	10	20	200	5
13. 13.1.	Seed drills: 4-row mechanic seed drills: For 60 cm row spacing: СТХ-4, СХУ-4, СМХ-4	10	9	90	11,111
13.2.	For 90 cm row spacing: СЧХ-4А, СЧХ-4Б, СХУ-4, СМХ-4 8-row pneumatic seed drills: “Case-1200” type	10 10	12 35	120 350	8,333 2,857
14. 14.1.	Cotton cultivators: For 90 cm row spacing: КХУ-4, КРТ-4, КРХ-3,6			75	13,3
14.2.	For 60, 70, 76 cm row spacing: КХУ-4, КРХ-4			50	20
15. 15.1. 15.2.	Cotton topping machines: РСhМ-4Б For 90 cm row spacing For 60 cm row spacing				13,3 20
16.	Sprayers: VP-1, ОВХ-600, ОШУ-50, ОПШХ-12/15, ОШУ-1-200			250	4
17. 17.1.	Double-row spindle cotton harvesters: picking device with series and spindle in component is mounted on МХ-1,8 type machine: On hectares On tons	15 15	4 10,88	60 163,2	16,66
17.2.	Boll intensive treating picking device equipped with spindle in component is mounted on machine: On hectares On tons	15 15	4 11,62	60 174,4	16,66
17.3.	Double-row horizontal spindle СЕ-220 cotton harvester: On hectares On tons	15 15	6,66 20	100 300	10

4 Conclusion

By using the criteria given in the table, it is possible to determine the composition and amount of equipments required for the production of any agro-cluster and farm. For example, calculation norms of "Bukhara AgroKlaster" LLC technical park with cotton fields of 47264 ha: for 1.1-row 135 pcs, for 1.2-row 270 pcs, 1.3-row 405 pcs, 2.1-row 629 pcs, 2.2-row 945 pcs, 2.3-row 189 pcs, 2.4-row 142 pcs, 3-row 567 pcs, 4-row 197 pcs, 5-row 135 pcs, 6-row 181 pcs, 7-row 473 pcs, 8-row 1134 pcs, 9.1-row 135 pcs, 9.2-row 270 pcs, 9.3-row 405 pcs, 10-row 47 pcs, 11-row 220 pcs, 12-row 236 pcs, 13.1-row 525 pcs and 394 pcs, 13.2-row 135 pcs, 14.1-row 629 pcs, 14.2-row 945 pcs, 15.1-row 629 pcs, 15.2-row 945 pcs, 16-row 189 pcs, 17.1 and 17.2-rows 787 pcs, 17.3-row 473 pcs.

The problem of calculating the demand of agricultural clusters for agricultural machinery is to determine the composition of the machine-tractor fleet in such a way as to ensure the quality and high productivity of mechanized agricultural practices, minimal labor and operating costs per unit of work.

References

1. M. Toshboltaev, Sh. Azizov, Fan va tehnologiya, 185 (2014)
2. M. Toshboltaev, Sh. Azizov, *Determining the land area of the model farms specializing in cotton growing, the composition and quantity of the necessary equipments by the criteria of seasonal productivity of the cotton harvesting machine // Creating resource-saving agricultural machinery and increasing the efficiency of their use: Collection of scientific articles of the Republican scientific-practical conference,* Gulbahor: AMERI, pp. 337-342 (2014)
3. I. Tulanov, B. Kambarov, R. Mirsaidov R, Fan va tehnologiya, pp. 309-334 (2016)
4. F. Hasanova, Fan va tehnologiya, pp. 223-225 (2016)
5. A. Korakhonov, Fan va tehnologiya, pp. 375-391 (2016)
6. A. Korakhonov, Fan va tehnologiya, pp. 391-408 (2016)
7. M. Toshboltaev, Fan va tehnologiya, pp. 418-425 (2016)
8. M. Toshboltaev, Fan va texnologiya pp. 425-446 (2016)
9. Maintenance and efficient operation of cotton and grain machines: Manual (amended, completed 2nd edition) / editor-in-chief M. Toshboltaev. – Tashkent: Fan, pp. 121-122 (2012)
10. K.D. Astanakulov, F.Q. Qurbonov, F.J. Isakova, *Investigation of the rotation number of a fish feed distribution device disc apparatus*. International Scientific and Practical Conference, Development and Modern Problems of Aquaculture (Aquaculture 2022) E3S Web of Conf. 2023, **381**, p-1-5 (2023)