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Determining the Optimal Sowing Frequency and Sowing Norm of Cereal Crops

Natroshvili D.*[a], Lomishvili M.[b]

[a]*Dimitri natroshvili - Professor, Doctor of Technical Sciences, Department of Agro-Engineering, Georgian Technical University, Georgia, 0192, Tbilisi, 17 D. Guramishvili Street*

[b]*Maia Lomishvili - PhD, Department of Agro-Engineering, Georgian Technical University, Georgia, 0192, Tbilisi, 17 D. Guramishvili Street*

[a]*Email: d.natroshvili@agruni.edu.ge*

[b]*Email: makomako429@mail.ru*

Abstract

Anyone interested in growing crops ¬ knows that all crops need favorable conditions to get a good crop. In particular, the yield of cereal crops depends on many random factors, the complex consideration of which is associated with great difficulties.

Optimal plant distribution and grain crop nutrition conditions can only be achieved during sowing. The main calculation values of sowing of cereal crops are the determination of the optimal sowing frequency and the sowing norm per hectare. Through the nomogram given in the paper it is possible to determine the required number of plants in the open sowing trail depending on the distance between the given rows and the optimal plant frequency. There is also a nomogram defining the sowing norm, through which it is possible to determine the sowing norm of the desired crop by considering the absolute mass of the grain and its ability to emerge.

Keywords: Optimal frequency; The sowing norm; Distance between rows; Productivity**.**

1. Introduction

The basis for sowing crops is to achieve the optimal sowing frequency. The sowing rate of the plant should be higher than the calculated one due to the not so high rate of field crop emergence and the negative impact of weeds and pests.

Figure 1. shows the effect of plant frequency on corn yield [1,2].

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* Corresponding author.

2. Materials and methods.

Depending on soil and natural-climatic conditions, the optimum frequency of maize sowing varies within the limits of $\mathbf{25 \cdot 10^3}$ .....$\mathbf{42 \cdot 10^3}$ pieces/ ha., and for sunflower $\mathbf{28 \cdot 10^3}$ ....$\mathbf{55 \cdot 10^3}$pieces / ha.

Here Table 1: shows the number of plants during the sowing of corn and sunflower in the open sowing trace in different soil conditions depending on the sowing scheme.

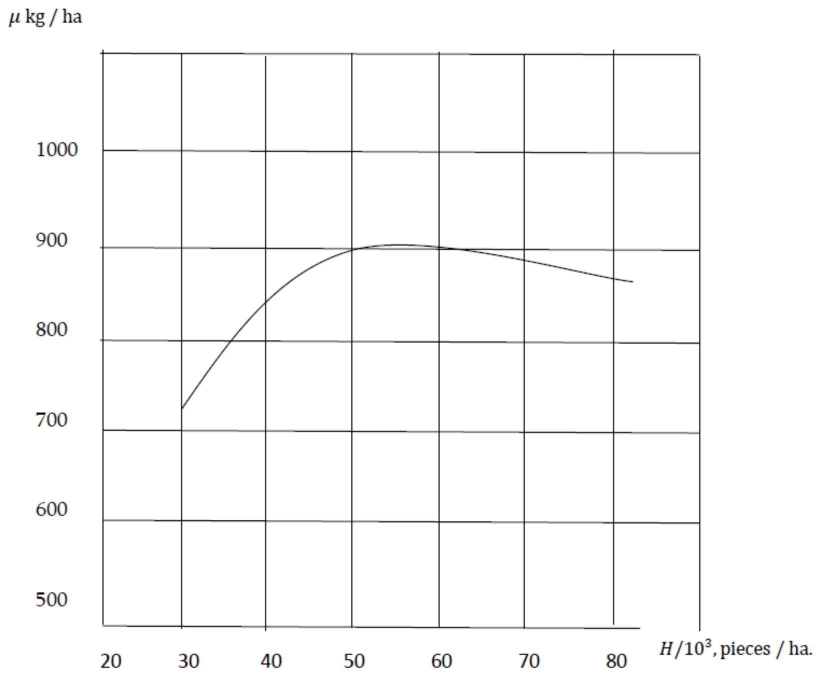

Figure 1: Plant frequency (H) Impact of maize on plant frequency Yield (Q kg / ha) according to the sowing Figur**.**

According to the given sowing scheme, it is necessary to determine the number of grains sown in the open sowing trace, so that the number of missed (not emerged) sown sowing traces does not exceed the permissible deviation from the normal value of plant frequency and also the locate optimal number of plants in the open sowing trace **[3].**

The number of opened sowing traces (z, thousand pieces / ha) considering the distance between the plants in the rows and the distances between rows themselves is determined by the following formula:

$$z = \frac{10^4}{ab} \qquad (1)$$

Where $\boldsymbol{a}$ is the distance between rows, (m);

$\boldsymbol{b}$ - Distance between opened sowing tracks in a row, m;

Table 1: Number of plants in the opened sowing trace during the sowing of corn and sunflowers depending on the sowing scheme

Agricultural Culture	Zone	Number of plants pieces / ha	Distance between rows m.	Sowing scheme m.	Number of plants	
					In the footsteps of an open sower	On the longitudinal meter
2	3	4	5	6	7	8
Cor n as grain and silage	Moist	40...42	0,7 0,9	0.7x0.7 0.9x0.9	2 2...3	2.8 3.7
	Less moist	28...32	0.9	0.9x0.9	2...3	2.7
	Dry	25...28	0.9	0.9x0.9	2	2.4
sunflower	Moist	50...55	0.7	0.7x0.7	2...3	3.7
	Less moist	38...40	0.7 0.9	0.7x0.7 0.9x0.7	2...3 2...3	3.5 2.6
	Dry	28...30	0.9	0.9x0.9	2...3	2.6

The number of plants in the open sowing track depending on the frequency is determined by the formula:

$$k = \frac{10^4}{Hab} \qquad (2)$$

Where ***H*** is the plant frequency (thousand pieces / ha);

The values of the distances between the rows, quantity of the opened sowing tracks, quantity of the plants in the opened sowing tracks during different frequencies is given in the chart 2 and were defined by formulas (1) and (2) With the nomogram in **figure 2**, it is possible to determine the number of plants required for open sowing traces depending on the distance between rows and the optimum plant frequency [4].

Determine the required number of sowing grains that are needed to achieve a given number of plants. In order to solve this task, the ability of the seed material to emerge from the field, pests, diseases and other factors that hinder the growth and development of plants during the vegetation period must be taken into account.Taking into account the ability of the seed emergence in the field try to solve the task using the probability theory, namely by the binominal law of the distribution, which for this particular case can be defined as follows. At the time of sowing, it is possible to emerge seeds with probability P at each sowing track, The probability of any number of occurrences corresponds to the degree of members of the Newton binomial decay, Which is equal to the number of seeds sown in the sowing track:

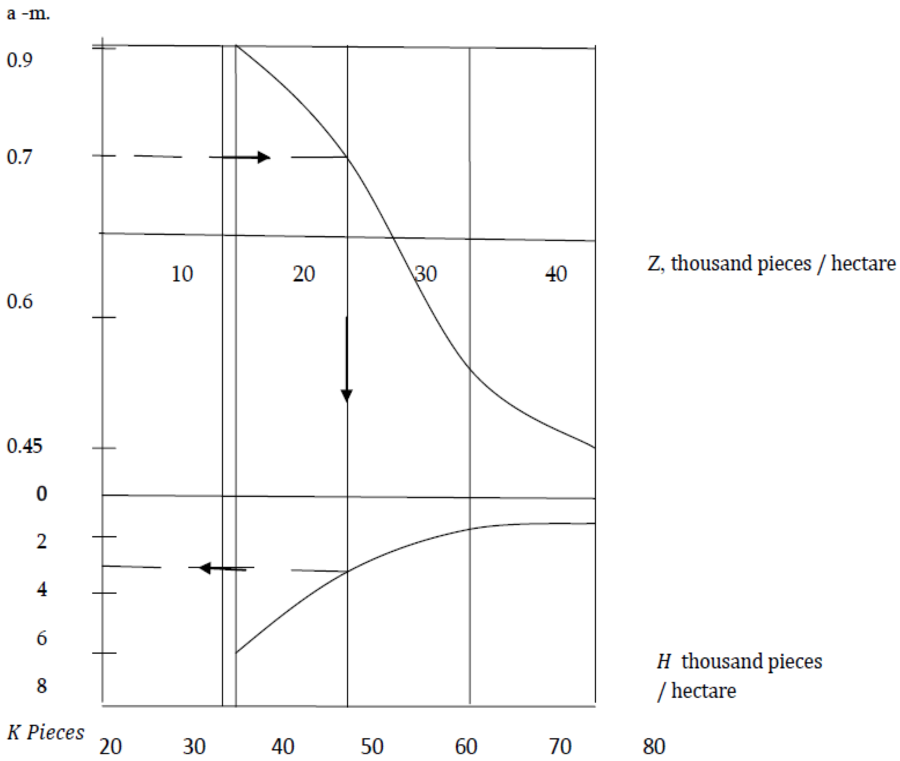

Figure 2: Nomogram for defining sowing as studies.

$$(p+q)^n = p^n + C_n^1 p^{n-1} q + C_n^2 p^{n-2} q^2 + \ldots + c_n^m p^{n-m} q^m + \cdots + q^m \qquad (3)$$

Where **P** is the seed grow up probability;

q - non-Probability of grow up of seeds;

$\boldsymbol{C_n^m}$**-n** The number of samples selected from the $\boldsymbol{m}$ seeds and grow up of plants;

The probability of the grow up of ,,m" number from ,,n" number of seeds is determined by the Bernoulli equation:

$$p_n^{(m)} = C_n^m \cdot p^m \cdot q^{n-m} \qquad (4)$$

where $C_n^m = \frac{n!}{m!(n-m)!}$

3. Results

(4) Using the formula, the probability of sowing tracks creation according to the number of the grains (N=3) and their B dependent field emergence ability was defined, according to which the nomogram was **Figure** (**Fig.** 3). This monogram determines the number of plants emerging in the footsteps of trace $\boldsymbol{M}$, % the field emergence capacity for a specific value of $\boldsymbol{B}$.

The nomogram in **Figure 3** gives a complete picture of the distribution of grains in the sowing trail, using it it is possible to select the required number of grains in the sowing trail, in our case $\boldsymbol{n} = \mathbf{3}$ is selected for the corn crop when its field emergence capacity is $\boldsymbol{B} = \mathbf{90}\%$. For a particular case according to the nomogram (Chart 3.) we will have: number of sowing tracks without plants -2.4%, with one plant -8.6%, with two plants -13.5% and with three plants -75.5%.

When sowing arable crops, we know the distance between rows (0.7) according to the graph given in Figure 2, we determine the number of sowing traces per -20 000 1 hectare. In case of sowing three grains during sowing per trace and field emergence, considering field emergence ability (B) we get 54 000 plants per 1 hectare. From which we will have sowing traces without plants - 1296, with one plant - 4 644 sowing traces, with two plants - 7 290 sowing traces, and with three plants - 40 770.

The assumptions obtained in determining the optimal sowing frequency incompletely reflect the distribution of seeds and germination during sowing, so that modern sowing machines and compaction devices give a significant deviation and in many cases the sowing scheme is infringed. Therefore, to achieve optimal plant distribution, we need to have real data on grain distribution in the row [5].

Optimal plant distribution and grain nutrition is possible only during sowing, so the main calculation value of sowing of grain crops is the sowing norm per hectare, the main determinants of which are the following indicators. plant variety, natural-climatic conditions, soil condition, soil quality, soil Type of sowing, depth of sowing of grain in the soil, agro-terms of sowing. Plant feeding and weeding the plot [4].

Agronomic science and practice under these conditions gives the sowing norm for all zones of the country.

In order to increase the yield of agricultural crops, it is necessary to carry out soil improvement works, as well as to maintain the optimal distribution of grains in the soil in both horizontal and vertical planes. Under such conditions the sowing rate can be significantly reduced.

Improving the sowing technology of grain crops requires strict adherence to the defined sowing norm.

The sowing norm can be defined by the following formula:

$$X = \frac{Q \cdot A}{\Pi \cdot 10^4} \qquad (5)$$

Where $\boldsymbol{Q}$ is the number of grains per hectare, pieces / hectare;

A - absolute mass of grains, grams;

П - ability to germinate grains,%;

(5) The values in the formula are defined as follows:

Q - refers to the number of grains per hectare, the variability limits of which are given below.

A - To determine the absolute mass of a grain we must understand the mass of 1 000 grains, it will be the absolutely dry substance in the grain with its own hygroscopic water.

The absolute mass of a grain is called the mass of an absolutely dry substance of 1,000 grains, and the percentage of moisture in the grain must also be taken into account during the study, as it can affect the mass of 1,000 grains [3, 4, 6].

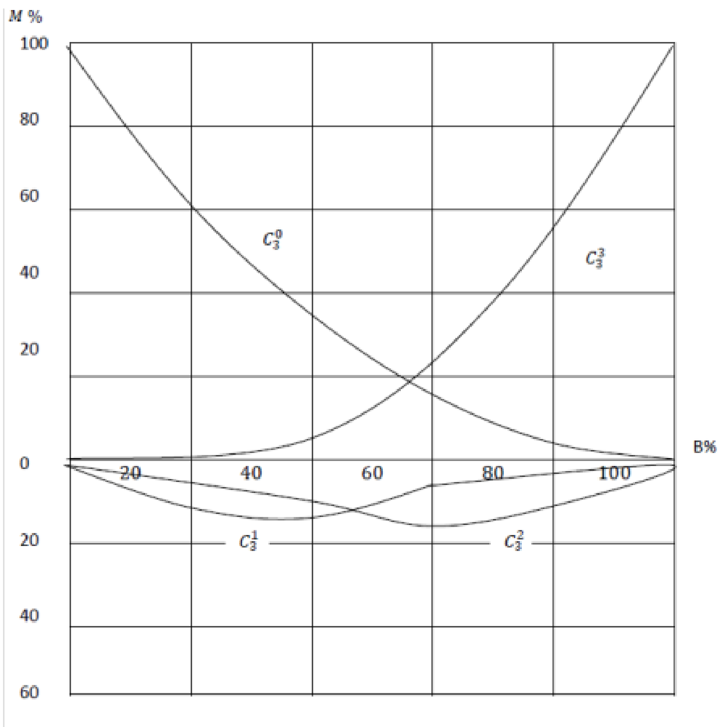

Figure 3: Determining the number of plants in the sowing Trace Nogram (n = 3).

The absolute mass should always be expressed according to the dried grain. It is calculated by the formula:

$$A = \frac{(100 - c) \cdot a}{100} \; gr. \qquad (6)$$

Where **C** is the grain moisture content in%.

a - air dry mass of 1 000 grains.

In order to determine the ability of grain to germinate *П* it is necessary to take the seeds of the "main crop".

The grain sowing rate is best determined by nomographic means, which can be constructed using formula (5).

To construct the sowing norm nomogram, we need to obtain the following limits for the values $\boldsymbol{Q}$, and **П**:

$$3 \cdot 10^6 < \mathrm{Q} < 8 \cdot 10^6$$

$$0.01 < \mathrm{A} < 0.06$$

$$60 < \Pi < 85$$

If we calculate formula (5) we get the following image:

$$lgX - lgA + lgQ - lg\Pi \cdot 10^4$$

Or

$$lgX - lgA = lgQ - lg\Pi \cdot 10^4 \qquad (7)$$

This image is suitable for calculating the proportional nomogram:

$$f_1(u) - f_2(v) = f_3(\omega) - f_4(t) \qquad (8)$$

To get the nomogram, we need to construct the scale of the function in Chart (8) with the following equations:

$$x = \lambda_1 f_1(u); \quad y = \lambda_2 f_2(v);$$

$$z = \lambda_3 f_3(\omega); \quad \mu = \lambda_4 f_4(t)$$

Or

$$x = \lambda_1 (lgX_{max} - \mathrm{lg}X_{min.}); \qquad y = \lambda_2 (lgA_{max} - lgA_{min}); \qquad (9)$$

$$z = \lambda_3 (lgQ_{max.} - lgQ_{min.}); \quad \mu = \lambda_4 (lg\Pi_{max.} \cdot 10^4 - lg\Pi_{min} \cdot 10^4;$$

Where $\boldsymbol{\lambda_1}$, $\boldsymbol{\lambda_2}$, $\boldsymbol{\lambda_3}$, $\boldsymbol{\lambda_4}$ are the values that determine the length of the corresponding function scale on the nomogram.

Determine the sowing norm - X (kg / ha) according to the formula for the absolute grain mass A, the grain germination capacity P and the specific value Q for the number of grains per hectare (5).

We know that $5 < \mathrm{X} < 565$

Let's get it $\lambda_1 = 120\ \partial\partial., \quad \lambda_2 = 250\ \partial\partial.$

Let the distance between the scales x (X) and y (A) be $h_1 = 50$ mm, and let the distance between the scales z (Q) and μ (Π) be h_2, the value of which can be determined from the following dependencies:

$$\frac{h_1}{h_2} = \frac{\lambda_2}{\lambda_1}$$

from where $\lambda_2 = h_1 \frac{\lambda_2}{\lambda_1} = \frac{50 \cdot 260}{120} = 108\ \partial\partial.$

The values of $\boldsymbol{x}, \boldsymbol{y}, \boldsymbol{z}$ and μ scales can be determined using formula (9):

$L_x = 120(lg565 - lg50) = 123.9\ \partial\partial.$

$L_y = 120(lg0.06 - lg0.01) = 93.4\ \partial\partial.$

$L_z = 260(lg8 \cdot 10^6 - lg3 \cdot 10^6) = 110.7\ \partial\partial.$

$L_\mu = 120(lg85 - lg60) = 39.2\partial\partial.$

Construct a scale of function $\boldsymbol{y}$ when A changes in the limits $A_1 = 10$ grams from $A = 60$ grams.

Q varies from $Q_1 = 3 \cdot 10^6$ to $Q_2 = 8 \cdot 10^6$ per/ hectar;

Π varies - $\Pi_1 = 60$ from Π_2=85%.

X varies - $X_1 = 50$ to $X_2 = 500$ kg / ha.

It is then possible to construct scales of values $\boldsymbol{X},, \boldsymbol{A}, \boldsymbol{\Pi}$ and $\boldsymbol{Q}$, followed by a nomogram on which the scales $\boldsymbol{X}$ and $\boldsymbol{A}$ are parallel to each other, and also the scales $\boldsymbol{\Pi}$ and **Q** are parallel to each other (Chart. 4).

4. Conclusion.

The nomogram given in **Chart - 4** makes it possible to determine the grain sowing rate per hectare for the specific conditions mentioned above:

Suppose we have the following values [4]:

$Q = 4 \cdot 10^6$ pieces / hectare; $\Pi = 70\%$; $A = 50$ gr.

We connect the points $\boldsymbol{Q}$ and $\boldsymbol{\Pi}$ on the scale accordingly. On the $\boldsymbol{A}$ scale we will find the corresponding point of 30 gr and from this point we will let it run on the $\boldsymbol{ab}$ line until it crosses the X scale. The crossing point on theX scale indicates the sowing norm $\mathbf{X} = 200\ kg/he.$

This nomogram can be used to determine the sowing rate of a desired crop, taking into account the absolute mass of the grain and its germination capacity.

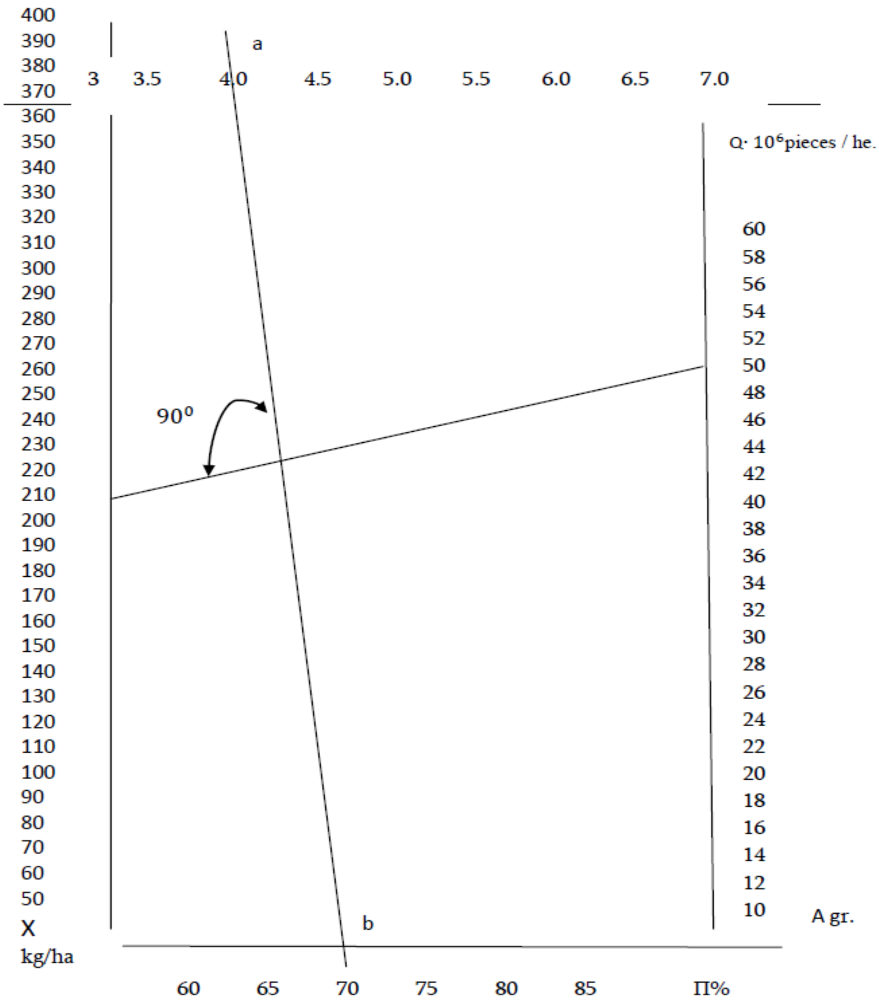

Figure 4: Determination of sowing rate of cereal crops by nomogram.

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