Якість, стандартизація, безпека, екологічність та ергономічність машин і технологій
Quality, standardization, safety, environmental and ergonomic properties of machines and techniques

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Improving the quality control of agricultural products as a component of its quality management

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The article discusses the issues of improving the quality of agricultural products to increase their competitiveness in the international market in the conditions of the market economy of Ukraine. The quality management system of the company's products provides for the conduct of control operations in accordance with regulatory requirements.

The quality of agricultural products depends on their organization at all stages of production, storage, transportation in accordance with the requirements of the consumer. As a result of the professional organization of the entire process, the company receives a high profit and indicators of competitiveness in the market.

The results of using the consistent numerical quality of agricultural products in order to increase their competitiveness are presented. The concept of sequential control describes multi-stage control, an example of which is the chain: technological control - control of the control department of the enterprise - state control - incoming control of the consumer.

The primary tasks in the construction of a statistical model of measuring control are analyzed, a typical control system, the structure of sequential control and its characteristics are presented.

The proposed type of control significantly reduces the proportion of rejects in the total mass of products. The results of analytical dependences are obtained, which are convenient for engineering calculations of other types of numerical control.

The obtained general results of analytical dependencies in the organization of sequential control can be used more widely, not only specifically for a given type of product, but also for other types of products and control operations.

Keywords: *agriculture, products, serial numerical control, quality, competitiveness*

Introduction. The problem of quality and marketability of production is relevant at all times. It acquires particular significance, especially at present, in the conditions of formation and development of market relations and Ukraine's entry into the international market of agricultural production. To establish, stabilize and increase production, the enterprise should be competitive. The guarantee and confirmation of its competitiveness is the availability of a quality management system at the enterprise. The general requirements for such a system are set out in international standards [1].

These requirements include a scope of quality management measures which an enterprise ought to carry out in all areas of its production activities - from planning, production output to production distribution [2,3]. These functions also provide for a scope of measures, the development of methods and tools seeking to preserve the quality of agricultural products in the period of storage and transportation in accordance with the requirements of the consumer. The program should consist of normative and technical documents that ensure the requirements of international standards for storage, transportation and sales of products, technological maintenance of storage facilities and vehicles; methods and means of control as well as serve the conditions of storage, transportation and sale.

The competitiveness of agricultural enterprises in the international market directly depends on the professional and timely implementation of this program.

Analysis of recent research and publications. Control of agricultural products at all stages of manufacturing and marketing has a number of features and difficulties. This marketable product is respondent to many factors, which reduce finally its quality and cost during storage, transportation and sale. These are the time limitations of the above operations, the impact of physical, chemical and biological factors. Therefore, metrological assurance of product quality includes the whole range of activities seeking to improve the level of work quality and products at all stages of the production cycle by determining and fixing the optimal number of controlled parameters, metrological support of measuring the quality of work and products, and the parameters of technological processes.

The program determines the problems concerning the ascertainment the optimal volume and range of measurable quality indicators; method preparation and selection of measurement instrumentation that ensure the adequate accuracy. When controlling agricultural products, those methods and means were often used which were employed in industry, but only partially represent the specific character of metrological support of quality control [4-6]. The determining part in the described requirements is assigned to the technological process of manufacturing products, so – to all its distinctive types of control (input, operating, output, etc.). This stimulates enterprises, which are concerned about their image and development prospects, to look for new, more advanced forms of their conduct. This article describes one of these forms.

Identification of research object and problem

Control is an experimental procedure that establishes whether the object of control conforms to the quality declared by the manufacturer, whether the object is suitable or not suitable for its intended use. However, real control does not give a hundred percent guarantee of the fidelity of their outcomes. An object which was recognized as unfit by it can in fact be suitable (control error of first kind) and, conversely, an object which was recognized as valid may prove to be unfit (error of second kind).

Nevertheless, properly organized control significantly reduces the initial share of waste in the total mass of finished products and ultimately increases its competitiveness. It is natural that the control developer tends to build it so (within the range of the available resources) that this decline was as weighty as possible. In search of effective methods of such control, specialists use different structural constructions of its procedure. In this sense components of control procedure, the elements of which are control procedures, are of interest. In production practice, the concept of repetitive control is well known and has been developed recently. It consists in the object under control, that has been identified as suitable, is subjected to successive repeated verifications. The scope of such checks will be called conventionally sequential control. Particularly, the so-called multi-stage control dovetails into the concept of sequential control. An example of it is the chain shown in [7]: technological control - control of the QC department - state formal acceptance - consumer incoming control. For example, in the case of grain product control: on-the-spot production check - storage control at the elevator - customer control (when buying) - control when (on) transportation - the consumer incoming control.

This chain consists of several independent, time-separated and space-based procedures. However, a combination of checks with sequential control can be organized as an undivided procedure which is conducted at one "workplace" (in the absence of additional technical means) and on one check-out equipment.

Despite widespread industrial implementation of sequential control, its theoretical evidence has not been consummated to an acceptable results for the practice. In particular, the influential parameters of its substantial carrier (the controlling system) have not been established, as well as the methods of their engineering calculation has not been proposed. The materials in this article make it possible to fill in this gap. The proposed solutions are based on the results obtained by the executors on the basis of processed preliminary statistical data.

Major part of the study

1. Statistical model of sequential control. The primary task of the analysis

Theoretical development of complex control structures (including those considered in this paper) is conveniently carried out on basis of a general statistical control model that is close to real production conditions. In this model, the center of gravity of research is transferred from the personally control to the monitoring system (MS) - the materialized carrier of its functions [8]. The MS itself is considered as a certain converter connected with the external environment by one input and two output channels. We shall call them also its materialized inputs and outputs.

The finite flow (set) of controlled objects enters the MS input. From the MS output two flows are put out. Only those that are recognized as fit by MS are sent to one of these flows. And in the other, only objects which are recognized as unfit. Due to the non-ideality of the MS, both output flows turn out loaded by the objects of the opposite quality. The scope and extent of clogging each of these flows exhaustively describe it. Such pairs of parameters, called informative [8], can be made up several. One of them (the number of truly fit ones and the number of truly unfit objects in the flow) is suggested to be considered as a pair of MS variables [8, 9]. Knowing this pair makes it easy to calculate any other informative flow parameters.

In order to assess the effectiveness of any control, it is necessary to be able to calculate the informative parameters of the MS output flows by the informative parameters of its input flow. Such a calculation assumes knowledge of the comprehensive characteristics of the MS itself. The primary task of analyzing a complex MS, including MS of a sequential control, - is to determine these characteristics.

General problem statement. The structure of a complex MS is known (its constituent elements and their interconnection with each other and with the external environment). The exhaustive characteristics of all its elements are given. It is required to determine the exhaustive characteristics of the MS S itself.

To date, no rigorous solutions to this problem have been obtained for any of the known complex control structures (at least, the authors did not meet them). In this article, the task is solved for sequential control. The exact analytical correlations which connect the characteristics of the MS with the characteristics of its constituent elements are founded.

Let us first consider some general principles on which the proposed solutions are based.

2. Typical MS as a structural unit of sequential control.

The simplest form of measurement control organization (algorithm) is reduced to a typical sequence of operations: measuring the components of the object's parameter under control, comparing the components values which had been measured with their proper upper and lower tolerance limits, generation of control outcomes - "1" or "0". The value "1" (feature of suitability) is ascribed to the object when all the results of component measurements fall within the boundaries, the value "0" (the feature of reject) – in the case if not one of them falls inside the boundaries.

The described control algorithm is implemented by a typical structural diagram, shown in Fig. 1. The components of the monitored parameter $\bar{X} = (X_1, X_2, \ldots, X_n)$ of the unit under test (UT) are measured by a measuring device (MD).

The results of the measurements are compared by the compare facility (CF) with the specified tolerances and the tolerances in its memory. The CF draw a conclusion about the suitability of the object - "1", if all the results are in the appropriate tolerances, and about worthless of the object - "0", if at least one of the results is out of its tolerance.

Following the established terminology, the set of MD and CF, acting as a materialized carrier of measurement control functions, will be called a measuring typical monitoring system (measuring TMS). Because of its non- singularity (the presence of methodological and instrumental errors in measurement and comparison), control errors occur.

The scheme in Fig. 1 represents the most common, but particular variant of TMS and it is given only as a possible example. In general, the control which is implemented by the TMS may not be measurable, it can have a simpler or more complex algorithmic structure. The essence of the studies carried out below and the obtained solutions does not change from this.

When analyzing a complex MS, we are not interested in either the internal structure of the TMS, the type of the monitored parameter (scalar, vector), or the algorithm of the TMS functioning. The recent is considered as some integration, as a structural unit of the MS, which has three material channels of communication with the external environment (one input and two output) and represented by two independent indicators.

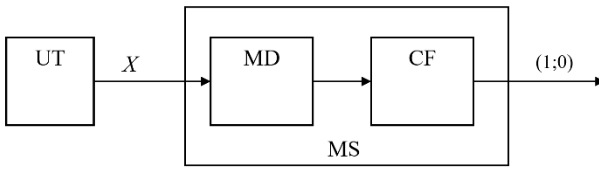

Fig. 1. Structure of measuring control
UT - control object, MD - measuring device;
CF - comparator, MS - control system;
$\vec{X}$ - controlled parameter (vector value)

One of them $p_1^{/}$ (a priori conditional producer risk) characterizes the functioning of the system with a view of a knowingly available object and is described by the probability of its rejection. Another $p_2^{/}$ (ta priori conditional risk of the customer) characterizes with a view of a knowingly faulty object and it is described by the probability of its acceptance.

Such model is showed in fig. 2.

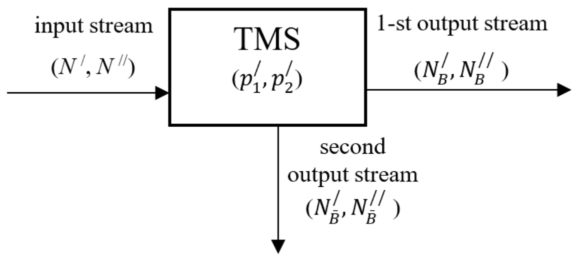

Fig. 2. Typical MS
TMS – typical monitoring system,
$p_1^{/}, p_2^{/}$ - indicators of its functioning,$(N^{/}, N^{//})$ и $(N_B^{/}, N_B^{//}), (N_{\bar{B}}^{/}, N_{\bar{B}}^{//})$ - characteristic parameters of input and output streams of TMS.

Here (N'и N'') are input variables of TMS (the number of really available and really useless objects of its input stream); and - output variables of TCS (the number of truly usable and truly faulty objects,

respectively, of its first and second output streams);
- indicators of TMS functioning (a priori conditional risks of the manufacturer and the customer).

3. Sequential control structure

The relevant monitoring system will be called as a sequential MS. It is a series-parallel connection of two, three or more TMSs. They turn out consistently connected on their inputs and first outputs. This is the main channel for the flow of objects. Exactly this channel is of the greatest production interest. The second outputs of the TMS are connected in parallel.

Fig. 3 illustrates the structure of the sequential MS. It consists of several typical control systems $TMS, i = 1,2,\ldots,n$.

The first output (output stream) of each previous TMS is the input (input stream) of the subsequent one. The initial input stream (test lot) enter the input of the first TMS. The first output of the last TMS serves as the first output of the MS integrally.

The second outputs (output streams) of all TMSs are combined into one common second connection output.

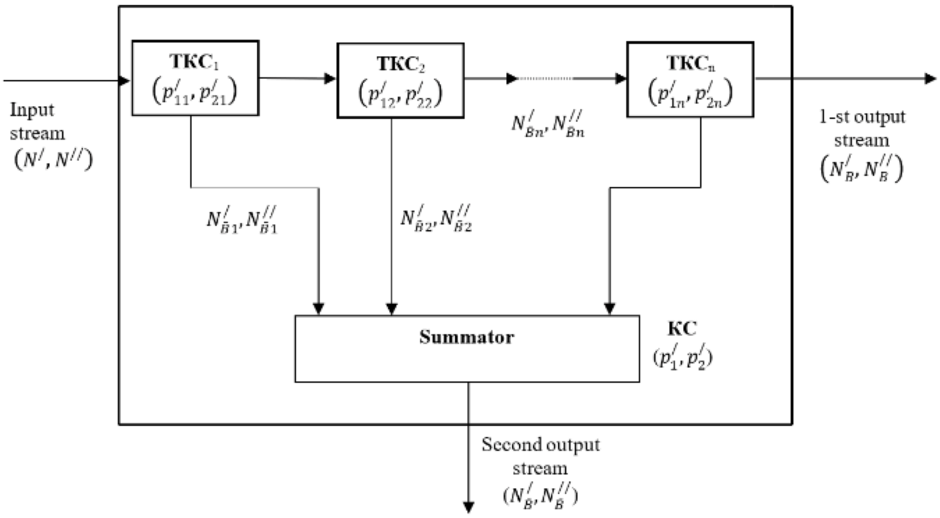

Fig. 3. The structure of the sequential MS.
MS – monitoring system (composite), ТКC_i, $p'_{1i}, p'_{2i}, i = 1,2,\ldots,n$ - typical MS and its parameters

4. Reference regulations and relations

There some general laws of numerical control are induced in the article [10] We take these laws as reference statements of research. Let's remind them.

Any MS can be considered as a linear static converter of the input stream of objects under control into two output streams

For an exhaustive description of the MS functioning, it is enough to dispose of two probability rates: the a priori conditional risk of the producer and the a priori conditional risk of the customer.

Each of the informative parameters of the MS output streams, which was chosen as its variable, depends only on one - the similar informative parameter of the input MS flow and it is related to it by the proportionality. A priori conditional risks or their complements up to unity act as the proportionality coefficients.

We use the standard symbolism during the mathematical expansion of these dispositions [10]. We designate by way of N, N_B and $N_{\bar{B}}$ accordingly, the volumes of the input, the first output, and the second output stream. We label the same symbols with a stroke on top to quantities of fit, and with two strokes to the number of objects that are not fit in the proper flows. The a priori conditional risks of the producer and the customer will be designated by the symbols p'_1 and p'_2, and their augmenters up to unity by the symbols $\bar{p}'_1$ and $\bar{p}'_2$

$$\bar{p}'_1 = 1 - p'_1; \bar{p}'_2 = 1 - p'_2. \quad (1)$$

Using these symbols, the dependencies indicated in position 3 appear in the following form

$$N'_B = \bar{p}'_1 N'; N''_B = p'_2 N''; \quad (2)$$

$$N'_{\bar{B}} = p'_1 N'; N''_{\bar{B}} = \bar{p}'_2 N''. \quad (3)$$

It follows from them that the indicators $\bar{p}'_1$ and p'_2 act as the coefficients for the transfer of the quantities of fit and unfit objects respectively at the first output of the MS, $\bar{p}'_2$ and p'_1- at its second output. We also note that only two of these four indicators (in any combination with different lower indices) are independent. Here we will be mainly interested in the indicators p'_1 and p'_2. The other two indicators are used only to simplify the computations.

Since the sum of the quantities of fit and unfit objects of the flow gives its volume, then

$$N = N' + N''; N_B = N_B^{/} + N_B^{//}; N_{\bar{B}} = N_{\bar{B}}^{/} + N_{\bar{B}}^{//}. \quad (4)$$

For a sufficiently large volume of the input flow N (in the limit tending to infinity) the next propositions are valid:

$$N^{/} = pN; N^{//} = \bar{p}N = (1-p)N, \quad (5)$$

where pN $\bar{p}N$ – a priori probabilities, respectively, of the fitness and unfitness of an arbitrarily taken object of the flow (test lot).

5. Characteristics of the sequential MS

Let turn our attention to the dependence (2). It is valid for any MS, including for TMS. Let us single out the first of these dependencies

$$N_B^{/} = N^{/}\bar{p}_1^{/} \quad (6)$$

Consistently applying it with respect to each TMS_i, (see Fig. 3), we will obtain:

$$N_{B1}^{/} = N^{/}\bar{p}_{11}^{/}, N_{B2}^{/} = N_{B1}^{/}\bar{p}_{12}^{/} = N^{/}\bar{p}_{11}^{/}\bar{p}_{12}^{/},$$
$$N_{B3}^{/} = N_{B2}^{/}\bar{p}_{13}^{/} = N^{/}\bar{p}_{11}^{/}\bar{p}_{12}^{/}\bar{p}_{13}^{/} \quad (7)$$
$$N_B^{/} = N_{Bn}^{/} = N_{B,n-1}^{/}\bar{p}_{1n}^{/} = N^{/}\bar{p}_{11}^{/}\bar{p}_{12}^{/} \cdots \bar{p}_{1,n-1}^{/}\bar{p}_{1n}^{/}.$$

On the other hand, the dependence (5.6) is valid for a sequential MS as a whole, where $\bar{p}_1^{/}$ - one of its indicators (the addition of an a priori conditional risk to unity). Comparing (6) with the last row (7), we have

$$\bar{p}_1^{/} = \prod_{i=1}^{n} \bar{p}_{1i}^{/},$$

that for transition to the a priori-conditional risks of the producer (see (1)) gives

$$p_1^{/} = 1 - \prod(1 - p_{1i}^{/}). \quad (8)$$

To find the second index of the sequential MS, we write out the second dependence (2)

$$N_B^{//} = N^{//}p_2^{/}.$$

Analogously to the previous case, applying it consistently to each model MS, we finally find

$$N_B^{//} = N_{Bn}^{//} = N^{//}p_{21}^{/}p_{22}^{/}p_{23}^{/} \cdots p_{2n}^{/},$$

from which (compare with the previous notation) the desired result follows

$$p_2^{/} = \prod_{i=1}^{n} p_{2i}^{/} \quad (9)$$

Thus, with a series-parallel connection of two or more typical monitoring systems (which, in particular, occurs in a sequential MS), their a priori-conditional customer risks and additions to the unit of a priori-conditional risks of the producer are multiplied and making corresponding indicators (a priori conditional risk of the customer and the addition of the producer's a priori conditional risk) of the connection as a whole.

Relations (8) and (9) are precise analytical representations of the a priori conditional risks of the producer and the customer, which exhaustively describe the functioning of the serial MS. They are simple, physical, obvious, convenient to use in engineering practice. Knowing them, it is not difficult to calculate all the parameters of the output flows of the compressor station (their volumes, the degree of contamination by objects of the opposite quality, etc.), and also to assess the effectiveness of the sequential control as a whole.

Conclusions. One of the practical ways to increase the effectiveness of control is to construct it in a repeating system, when an object that is recognized as fit is subject to repeated check. In this section, such control is called sequential control. Despite its widespread industrial introduction, theoretical developments are keep abreast of the practice needs. In particular, its defining characteristics have not been established, methods for their calculation have not been proposed.

Studies proposed in this article, according to the authors opinion, eliminate this gap. The decisions are based on the general laws of numerical control which were established earlier in the article [10]:

- any monitoring system (MS) is exhaustively described by the a priori conditional risks of the producer and the customer;
- each output variable of the MS is related to the input variables of the same name by the proportionality.

Precise analytical relations are deduced that relate the exhaustive characteristics of the coprocessor to the corresponding characteristics of its rectangular structural elements. They are reduced to an extremely simple rule: in order to find the a priori conditional risk of the customer and the addition to the unit of a priori conditional risk of the producer of the sequential MS as a whole, it is necessary to multiply the corresponding indices (the a priori conditional risks of the customer and the a priori conditional producer's risks) of all its rectangular elements (TCS). The consistency of this result is shown.

The obtained result is invariant with respect to different types of numerical control (measuring - not measuring, one-parameter - multi-parametric, direct-indirect, etc.). The analytical dependencies arising from it are convenient in engineering calculations and can serve as reference relations in evaluating the effectiveness of sequential and other complex structures of control.

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Анотація

Підвищення якості контролю сільськогосподарської продукції як складова управління її якістю

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У статті розглядаються питання підвищення якості сільськогосподарської продукції для підвищення її конкурентоспроможності на міжнародному ринку в умовах ринкової економіки України. Система менеджменту якості продукції підприємства передбачає за нормативними вимогами проведення контролюючих операцій. Від їх організації на всіх етапах виробництва, збереження, транспортування згідно вимог споживача залежить якість сільськогосподарської продукції. Як результат професійної організації усього процесу підприємство отримує високі прибутки та показники конкурентоспроможності на ринку.

У статті наведені результати використання послідовного чисельного контролю якості сільськогосподарської продукції з метою підвищення її конкурентоспроможності. Концепція послідовного контролю описує багатоступеневий контроль, прикладом якого є ланцюжок: технологічний контроль – контроль відділу контролю підприємства – державний контроль – вхідний контроль споживача. Представлена структура вимірювального контролю, типова контролююча система. При розгляді вхідних та вихідних параметрів системи контролю враховані ризики виробника та споживача. У таблиці наведені параметри вхідного та вихідного потоків системи контролю.

Проаналізовані першочергові задачі при побудові статистичної моделі вимірювального контролю, представлена типова контролююча система, структура послідовного контролю та надані її характеристики. Запропонований вид контролю суттєво знижує долю браку в загальній масі продукції. Представлені результати аналітичних залежностей зручні при інженерних розрахунках інших видів чисельного контролю. Отримані загальні результати аналітичних залежностей при організації послідовного контролю можливо використовувати більш широко не тільки специфічно для даного виду продукції, але і для інших видів продукції та контролюючих операцій.

Ключові слова: *сільське господарств, продукція, послідовний чисельний контроль, якість, конкурентоспроможність*

Аннотация

Повышение качества контроля сельскохозяйственной продукции как составляющая управления ее качеством

Н.А. Любимова, В.К. Пузик, Л.М. Пузик, А. Любимова

В статье рассматриваются вопросы повышения качества сельскохозяйственной продукции для повышения ее конкурентоспособности на международном рынке в условиях рыночной экономики Украины. Система менеджмента качества продукции предприятия предусматривает в соответствии с нормативными требованиями проведение контрольних операций. От их организации на всех етапах производства, хранения, транспортировки в соответствии с требованиями потребителя зависит качество сельскохозяйственной продукции. Как результат профессиональной организации всего процесса предприятие получает высокую прибыль и показатели конкурентоспособности на рынке.

В статье приведены результаты использования последовательного числового контроля качества сельскохозяйственной продукции с целью повышения ее конкурентоспособности. Концепция последовательного контроля описывает многоступенчатый контроль, примером которого является цепочка: технологический контроль - контроль отдела контроля предприятия – государственный контроль – входной контроль потребителя.

Представлена структура измерительного контроля, типовая контролирующая система. При рассмотрении входных и выходных потоков системы контроля учтены риски производителя и потребителя. В таблице приведены параметры входного и выходного потока системы контроля. Проанализированы первоочередные задачи при построении статистической модели измерительного контроля, представлена типовая контролирующая система, структура последовательного контроля и ее характеристики. Предложенный вид контроля существенно снижает долю брака в общей массе продукции. Получены результаты аналитических зависимостей удобные при инженерных расчетов других видов числового контроля.

Полученные общие результаты аналитических зависимостей при организации последовательного контроля возможно использовать более широко не только специфично для данного вида продукции, но и для других видов продукции и контрольных операций.

Ключевые слова: *сельское хозяйство, продукция, последовательный чис-ловой контроль, качество, конкурентоспособность.*

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