Modeling the technological process of cultivation of crop products

N Zh Shkaruba¹, O A Leonov and Yu G Vergazova

Department of Metrology, Standardization and quality management, Russian State Agrarian University – Moscow Timiryazev Agricultural Academy, 49 Timiryazevskaya, Moscow, 27550, Russia

¹E-mail: metr@rgau-msha.ru

Abstract. The article has devoted to a topical topic, includes the modeling of technological processes for the cultivation of crop products. As an object of research, the process of cultivation of fodder lupine had chosen. The analysis of the process of cultivation of crop products from the point of view of the Deming cycle has carried out. The production of feed lupine has presented as a system of interrelated processes. A passport of the process «Production of fodder lupine» has been developed, which contains brief information about the projected process: inputs, outputs, resources, control mechanisms, etc. The top-level model «Production of fodder lupine» in IDF0 notation has developed. The developed model can be used as the basis for building a quality management system for lupine cultivation. The proposed approach will allow to achieve the quality of the crop and achieve the set goals.

1. Introduction

The most effective method in quality management is the development and implementation of quality management systems at enterprises and organizations [1]. World experience has proven that enterprises and organizations implementing a quality management system have more efficient production and the highest economic indicators. Modern quality systems are aimed not only at achieving the required level of quality, but are an effective tool for managing risks [2] associated with a possible loss of quality.

The ISO 9000 series standards regulating the development and operation of quality management systems are universal and can be used in various sectors of the national economy [3]. Despite this, the application of this approach is still not widely used in agriculture.

One of the stages of building quality management systems is process modeling [4]. Processes in the quality management system can be of different levels, and depending on this, different notations can be used in modeling: IDF0, EPS, BPM, etc. This stage allows you to visualize individual elements of the process and then move on to digitalization and automation of the process [5]. In addition, the modeling of business processes is a component of reengineering, and also allows you to carry out a functional cost analysis of the process and find its optimal configuration [6, 7].

We have chosen a fodder plant – lupine as the object of research. Three annual types of lupine are cultivated: yellow, white and narrow-leaved for green mass and seeds. In small areas, one perennial species is grown – perennial lupine. The cultivation of lupine allows you to increase the production of high-quality protein and obtain cheap vegetable protein without the cost of expensive nitrogen fertilizers.
The purpose of the research is to develop a model of the cultivation process of fodder lupine in IDF0 notation. To achieve this goal, it is necessary to solve the following tasks:

- to analyze the process of cultivation of crop products from the point of view of the Deming cycle;
- collect initial data to describe the process: inputs, outputs, resources, control mechanisms, etc., develop a process passport;
- to simulate the process of cultivation of fodder lupine.

2. Research results

The Deming cycle has been used as a tool for analyzing the process of lupine cultivation. The Deming cycle is a simple algorithm for managing and achieving its goals [8]. It starts with planning work to achieve certain goals. Next comes the execution of the planned work. Then checking the result obtained, identifying and analyzing deviations, establishing deviations. Ultimately, measures are taken to eliminate deviations from the planned result.

The Deming cycle can be applied to absolutely any procedure. With regard to the technology of lupine cultivation, the planning of the process will be – preparation of seeds and fields. Further, sowing seeds, caring for the harvest, harvesting and storing – this is the implementation of the planned work.

The Deming cycle in relation to the process of cultivation of crop products is shown schematically in figure 1.

![Figure 1. The Deming cycle in relation to the crop production process.](image-url)

For effective management of the technological cycle, it is necessary to combine it with the Deming cycle and present it as a system of interrelated processes. The technological cycle of crop production includes the following stages: preparation of seeds and fields; sowing seeds; care of the harvest; harvest; storage and sales.

In addition, considering the life cycle of crop products from the standpoint of the quality management system, one must take into account that this process must comply with the requirements of GOST R ISO 9001-2015 in clause 8.5. General information about the process can be specified in the documents of the upper level of the QMS and includes the following information: process goal, process owner, process manager, process consumers, process inputs and outputs, process suppliers, resources, process steps,
measurable and controlled process characteristics, methods of measuring process parameters, indicators of the effectiveness of the process.

Also, the description of the process is also called the specification or the passport of the process. The developed passport of the process «Production of crop products» has presented in table 1.

**Table 1. Description of the process «Production of feed lupine».**

| Process code | Clause of ISO 9001 | Process name |
|--------------|--------------------|--------------|
| 3.6          | 8.5                | Production of feed lupine |

**Process definition**

| Purpose of the process |
|------------------------|
| Receiving a profit |

**Process owner**

| Chief agronomist |
|------------------|
| General director of the enterprise |

**Process consumers**

| Potential clients |
|-------------------|
| Harvest of fodder lupine |
| Progress report |
| Profit |

**Process providers**

| Consumer inquiries |
|--------------------|
| Consumer requirements |
| Fuel and lubricant |
| Fertilizers and herbicides |
| Seed material of fodder lupine |

**Process steps**

| Personnel, fertilizers, agricultural machinery, herbicides, fields, warehouses and staff quarters |
|------------------------------------------------------------------------------------------------|
| Preparation of seeds and fields, sowing seeds, care of the harvest, harvesting, storage and subsequent sale |

**Process performance indicators**

| Compliance with GOSTs and accompanying documentation in the production of lupine, the degree of implementation of the production plan, the number of identified inconsistencies between the production process and finished products |

Let us consider in detail the description of the process «Production of fodder lupine» presented in table 1 in relation to the cultivation of lupine.

The owner of the process and empowered with respect to this process in our case is the chief agronomist. The chief agronomist is responsible not only for the result, that is, the lupine harvest, but also for its progress and customer satisfaction.

The head of this process is the general director. He is personally responsible for ensuring the effectiveness of the process he leads in all aspects: timeliness, efficiency, quality, satisfaction of his internal and external consumers.

The consumers of this process are the clients of crop products. Basically, these are factories that produce compound feed for animal husbandry.

The output of the process «Production of fodder lupine» will be: finished harvest, analysis of lupine yield and analysis of the quality of lupine. Outputs Analysis of lupine yield and analysis of lupine quality helps to analyze the work done and make corrective actions if necessary.
Process suppliers provide resources for the Feed Lupine Production process. In our case, the suppliers are: consumer requests; suppliers of fuel and lubricants for the machine and tractor fleet; suppliers of fertilizers and herbicides.

At the input of our process «Production of fodder lupine» will be: the seed of fodder lupine, fuel and lubricants, consumer requirements. These inputs allow you to meet all requirements regarding the production, quality and yield of lupine.

Requirements for inputs include requirements for the quality of fodder lupine seed, timely delivery of fuel and lubricant and positive results during its acceptance, keeping consumer requirements up to date.

Output requirements include up-to-date and constructive consumer feedback on the finished crop of fodder lupine, timely reporting on the results of fodder lupine production, profit information and analysis of its amount by comparing profits with previous years.

The process also has resources without help, which the process will not function. In our case, these are: personnel, fertilizers, agricultural machinery, storage facilities and premises for personnel.

The performance indicators have been determined, with the help of which it is possible to assess the quality of the crop and its yield. For the process «Production of fodder lupine», the following performance indicators have been determined: the amount of profit obtained as a result of the production of fodder lupine, the degree of fulfillment of the production plan, the number of identified inconsistencies between the production process and the grown crop.

In practice, the design of business processes, there are many different notations, at the top level of design it is most appropriate to use the notation IDF0 [8]. For the object under study, a model has been developed and the main inputs, outputs, resources and mechanisms necessary for the functioning of the processes included in the developed model, presented in figure 2, have been determined.

![Figure 2. Model of the process «Production of fodder lupine» in IDF0 notation.](image-url)
3. Conclusions

Thus, the analysis of the process of cultivation of crop products from the point of view of the Deming cycle is carried out. The production of feed lupine is presented as a system of interrelated processes.

A passport of the process «Production of fodder lupine» has developed, which contains brief information about the projected process: inputs, outputs, resources, control mechanisms, etc.

The model of the top-level process «Production of fodder lupine» in IDF0 notation has developed. The developed model can be used as the basis for building a quality management system for lupine cultivation. The proposed approach will allow you to effectively manage the quality of the crop and achieve the set goals.

References

[1] Antonova AA, Kublin IM and Makhmetova AE 2015 Quality management system as a factor in increasing the competitiveness of an enterprise Izvestia Volgograd State Technical University 3(158) 77-83
[2] Leonov O A, Temasova G N, Shkaruba N Zh and Vergazova Yu G 2020 Methodology for calculating the effectiveness of the quality management system Competence 3 26-31
[3] G I Bondareva et al. 2021 IOP Conf. Ser.: Earth Environ. Sci. 677 042117
[4] Karpuzov V V 2010 A systematic approach to quality management at agricultural enterprises Vestnik FGOU VPO MGAU 2(41) 124-7
[5] Cherkasova E I et al. 2018 Analysis and Synthesis of Quality Assurance Processes (Moscow: Publishing house of RSAU-Moscow Agricultural Academy) p 174
[6] Lepeiko T I 2015 Methodological foundations for modeling business processes as a component of their reengineering in the activities of industrial enterprises Mechanism of regulation of the economy 1 31-7
[7] Zhigulina EP and Kasho D Yu 2017 Process modeling in the issue of quality management of the functioning of industrial enterprises Economy and entrepreneurship 3-2(80) 756-9
[8] Leonov O A et al. 2018 Quality management of production processes and systems (Moscow: Publishing house of RSAU-Moscow Agricultural Academy) p 182