Technology basis of digital business-model with land assessment function

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Abstract. The chief purpose of the investigation was the creation and theoretical foundation of the main features of the technology basis of digital agrarian business-model, which allows to estimate the value of the useable land. Methodological information was theories of constant accounting, technological theories of scientific revolutions, and theories of stages of economic growth. We applied abstract-logical technique of research, modeling methods, formalization procedure and another approaches. The database included tables of annual accounting reports of agricultural organizations and technological maps of crop cultivation. We suggest the term "Technology basis of the digital agrarian business-model," which constitute a combination of three factors of agricultural production, which are closely related. These factors are soil fertility and technological attributes of lands; climate indicators; innovative technologies which use geographic information systems. The most important part of the technology basis of the agrarian business-model is the process maps of crop cultivation, which used as digital twins of real production processes. However, the basis also includes the annual accounting report of agricultural organizations using the software products of the 1C platform after their adaptation. Adaptation of 1C-accounting platform applications means the separation agricultural procedures and production costs between their variable and constant costs (this step is necessary to calculate the efficiency of applied technologies and economic assessment of used land), the creation of a cluster for technological monitoring and forecast of crop yield, as well as the introduction of a managing cluster in application . This last one is capable of evaluating the effectiveness of various innovative products, optimizing the use of available resources, combining the technological module with the geographic information environment. The main function of technology basis is to estimate the value of the used land based on balance between the correlation of natural to artificial fertility of soils and the correlation of constant to variable costs.

1. Introduction

Agro economics needs to create digital business-model of agricultural organization for several reasons. First, the digital world is developing regardless of the willingness of enterprises to digitalize. This is not a problem of increasing competitiveness of enterprises in market conditions, it is a problem of possibility of "survival" of enterprises in the economic world. Second, the digital business-model can be extremely useful for improving the quality and efficiency of agricultural production management by quickly introducing innovative products and attracting investors. The long production cycle, exposure to natural risks, high crop losses during harvesting and storage require highly accurate
local weather forecasts, knowledge about agrochemical soil data, having aerospace information, introduction of precision farming technologies, process tracking and monitoring of machinery and animal movements, etc.

The aim of the study is to develop the technology basis of a digital business-model of an agricultural organization. We consider the basis as a digital twin, representing all the processes taking place in the model, the emerging ties and relations with external counterparties and internal management objects, ensuring increased productivity and maximization of profits.

2. Materials and methods
In our research we used a big push theory, theories of technological, scientific revolutions by T.Kun, the theory of innovative development by Schumpeter in foundation the possibilities of agriculture transition from current indicators to a new state, we used economic-mathematical modeling technique, formalization procedures, methodological mechanisms of accounting and official statistics, and geographic information systems and technologies.

3. Research results
The economic logic of an agrarian business company is based on its spatially distributed sphere of activity, the production cycles lifetime and the great dependence of production results on weather fluctuations. This gives priority to development in the direction of improving production technologies operating in the geographic information environment.

In this regard, the digital agrarian business-model, as a "digital representation of the way of organization" or "digital twin" [1, 15, 17] of the production process, should have a technological basis combining soil fertility and technological properties of land plots; climate indicators; innovative production technologies using geographic information systems. However, soil fertility, land technological properties and climate indicators are more an independent given from the entrepreneur. Therefore the most important component of technology basis of a digital business-model are process maps as "digital doubles" of real technologies. But if we want to this maps to be useful in the digital business-model, the calculations should be automated, the possibility to manage the calculations existed, and the format and indicators were as much as possible adapted to the tables of the production and financial plan of the organization, accounting and annual reporting.

Moving information from process maps to a production and financial plan does not represent complexity, but there must be reliable communication between them. However, we want to pay attention, process maps must be adapted for accounting and reporting. Process mapping should become a tool by which one constant accounting theory [2] can be implemented, accounting should set targets according to this tool. Process maps should become something that the actual data are constantly compared with, and adjustments are made to both the plan and the production process if necessary.

In this way, the digital business-model of an agricultural organization can be a set of three most important components: a technological basis, a production and financial plan and an annual accounting report (in any sequence). Naturally, this unity should be ensured by reliable and stable channels of internal and external communication with production structures, infrastructure facilities, logistics, transport units, external technological and cloud platforms, Internet network, etc.

Electronic (digital) process maps (as a module of the technological basis of crop cultivation) is not unusual for agriculture, but is not always used as a management tool. The module accounting report of the organization can be implemented with the help of applications of the 1С platform, which has a reliable system of automation (digitalization) of accounting and reporting operations, formation and set of annual accounting reports in the product "1С - Accounting" [3]. By the way, for several years we have been using the results of this development - a set of annual reports of agricultural organizations of the region as a database for multi-factor full-scale (matrix) analysis, evaluation of reproduction processes and forecasting of the results of economic activity. We assume that all three
essential components of the digital business-model in the agrarian sphere can be formed on the basis of this platform.

An important task of technology basis is to estimate the value of agricultural land that is needed to determine cadastral and market value, rent and land tax. This, firstly, uses the division of costs into constant and variable, secondly, uses the availability of agrochemical survey data and, thirdly, uses geo-information systems. The agrochemical survey data make it possible to compare two types of soil fertility: natural (characterized by the content of plant mineral elements) and artificial (represented by the number of fertilizers applied. At the same time we assume that the total land rent (the rent I + absolute) if land tax is not included in structure of prime cost, is equal to a part of the net income falling on conditionally constant expenses at its distribution on elements of costs of production. Differential rent II, as the effect of artificial fertility, is defined as part of the profit variable costs. The value of land as capitalized aggregate land rent is calculated as the ratio of land rent to capitalization rate [14, 16].

4. Discussion

In order to develop a digital business-model of an agricultural organization, we must combine three mentored earlier components, taking into a theoretical foundation of their applicability, and according to adaptation to specific conditions of agricultural production and addition of missing elements.

First of all, we need to significantly adapt the mechanism of development and use of process map. The first element, needs to be adapt, is the division of crop cultivation costs into variable and constant components in process mapping. This is essential to model different variants for technological operations, marginal analysis and estimates of efficiency of technologies, and it is necessary to distribute the final economic result between the tenant and the owner of the land plot (lessor) in determining the amount of land rent, including in assessing the cadastral and market value of the land. This method was not used earlier and 1C-Accounting developers failed to give an objective assessment of the technology on different land plots (fields). In the "Cost Effectiveness Analysis" table [3], they use direct costs for 1 cwt of production and 1 ha of sowing as performance indicators, although we believe it is easy to calculate variable cost constants for 1cwt (V) and constant costs for 1 ha (C) and then calculate margin effects.

The second very important element, needs to be adapted, is the creation of a cluster of technological monitoring and prediction of crop yields. This one consists of four subclusters, three of which are private estimates of technological operations by timing, duration and quality, and the fourth subcluster makes calculations and forecasts [4].

The third element is the managing cluster, with which it is possible to work out various options for changing any parameters used in the development of job instructions. We are talking about the sowing rate and cost of seeds, the dose and price of mineral fertilizers and plant protection products, the price of diesel fuel, etc. [5]. Since the information from the process map is directly transferred to the appropriate forms of the production and financial plan and accounting of the enterprise, it is possible to evaluate various innovative products according to the final results of the agricultural organization.

The technological module acquires a completely different quality when it is placed in the geographic information environment (GIS). In particular, this module in the author’s version is connected to GIS Mapinfo [6, 7]. The sources of geoinformation (information on land, except for geographically large-scale maps) are maps of internal land administration, soil, agrochemical and others [8]. Agrochemical survey materials, which agrochemical service stations develop, as well as materials of internal cadastral assessment of land, in which we have a description of all used land (fields of crop rotation and separate land plots) are used. Developers of the 1C "Enterprise 8 ERP Agro-industrial Complex" offer to use for the purpose of displaying spatial data the functionality of cartography, which allows: to display the fields of the company (farm) on an interactive map; designate and edit field contours; display tracks of agricultural machinery and motor vehicles; generate accurate spatial position of areas using GPS and GLONASS [3]. We think it is useful, but other tools need to be involved too. In particular, the Unified Federal Information System on Agricultural Lands created by
the Ministry of Agriculture of the Russian Federation can become an important source of geo-information as well as other developments in this field.

During the formation of the digital business-model of the agricultural organization we attach great importance to the fluctuations of the main climate indicators, existing in the area, such as the amount of atmospheric precipitation and the average daily air temperature. In this regard, the unique and sufficiently reliable information by Federal State Government-Funded Scientific Institution Agricultural Research Institute of the South-East Region deserves attention. There was information for the period from 1976 to 2003 years (27 years, and subsequently supplemented by data for the period from 2004 to 2010 years) on stationary experiments on grain crops cultivation with simultaneous year-round weather observations of sub-stage values of the main indicators: atmospheric precipitation, temperature and humidity, the number of days with air humidity below 30% (dry days), etc. In this regard, there was a yield of winter and spring wheat placed on maize, the second crop after maize, as well as in permanent crops. Variants with and without fertilizers were compared. The researchers received rich material, the results were repeatedly published [9]. On the basis of these data, we have developed a mechanism to identify risks and threats to the sustainability of grain production in the conditions of the Saratov region, which are the result of fluctuations in weather conditions [10], as well as a mechanism for climatic monitoring and forecasting of crop crops.

In the context of the digitalization of the Russian economy and the digital transformation of agriculture, these developments can be adapted with a focus on the sufficiently high accuracy of hydrometeorological forecasts and forecasts of the local enterprises own weather stations.

In this way, the technological basis of the digital agrarian business-model consists of a technology module, a crop monitoring and forecasting cluster, and a control unit including GIS. The technological basis is an organizational and economic mechanism of process control, which allows: to plan of agricultural and other operations; to organize realization of operations; to monitor the progress and quality of execution; to regulate the use of necessary (required) and available technical, material and workforce; to optimize technology intensity and maximize economic results.

As a methodological example, (no claim for accuracy of arable land valuation performed) we can demonstrate the previous procedure of calculations on irrelevant information about experimental production farm (eif) "Solyanskoe" of Pugachevsky district of the Saratov region, in which a few years ago the agrochemical survey of arab land by the station of agrochemical service "Ershovskaya" was carried out [12]. At the same time, it should be noted that Pugachevsky district according to the results of previous studies [11] received the status of model of the municipal district of the left bank of the Saratov region, and (eif) "Solanskoe" - model economy farm [4]. Based on the materials of the report of the station "Ershovskaya," the authors calculated the total coefficients of differentiation of the planned crop yield by the indicators of weighted average consumption of nitrogen, phosphorus and potassium (Figure. 1).

Indices (relative deviations for each element) are calculated as ratios of values of indicators of this field to weighted average values for farm. The crop adjustment factors were defined as the products of indices on the respective crop impact factors of an element. The total coefficient was determined as the sum of the products of the three partial coefficients divided by the corresponding weighting coefficients.
The content of phosphorus, the deviation from the average unit.

1.12 – 1.13 (4)
1.06 – 1.12 (2)
1 – 1.06 (6)
0.88 – 1 (2)
0.78 – 0.88 (5)

**Figure 1.** Differentiation of the main indicators of natural soil fertility by crop rotation fields (eif) "Solanskoe" (Map shows: field area (ha), indices of content: nitrogen, potassium). Calculated according to the data of the agrochemical service station "Ershovskaya".

The results of differentiation of the planned yield of sunflower seeds and estimation of the cost of 1 ha of sown area are shown in Table 1.

At the same doses of mineral fertilizers (artificial fertility), the potential yield can range from 6.95 to 9.73 cwt/ha with a fluctuation span of 1.4 times. Given the stability of a large part of the costs, including fertilizers and seeds, the profit fluctuations are significantly higher (3.94 times). In the same proportion are land rents and the value of 1 ha of land, as the share of land rents is equal to the share of constant costs in their total.

**Table 1.** Differentiation of the planned yield of sunflower seeds and estimation of the cost of 1 ha of sown area (fragment).

| Name of crop rotations | Field number | Area (ha) | The adjusting coefficient | Productivity ctw/ha | Valuation of 1 ha of area profit, rub/ha | land rent (rub/ha) | cost (th.rub/ha) |
|------------------------|--------------|-----------|---------------------------|-------------------|------------------------------------------|-------------------|-----------------|
| Coarse                 | 1к           | 460       | 1.06                      | 8.49              | 1306.9                                   | 866.0             | 28.87           |
|                        | 2к           | 470       | 0.99                      | 7.88              | 985.1                                    | 652.8             | 21.76           |
|                        | 3к           | 447       | 0.99                      | 7.88              | 985.9                                    | 653.4             | 21.78           |
|                        | 4к           | 410       | 0.90                      | 7.21              | 630.9                                    | 418.2             | 13.94           |
| **Total on a crop rotation** |             | **1787** | **0.98**                  | **7.82**          | **954.3**                                | **632.4**         | **21.08**       |

Continuation of table 1

| Field | Area (ha) | The adjusting coefficient | Productivity ctw/ha | Valuation of 1 ha of area profit, rub/ha | land rent (rub/ha) | cost (th.rub/ha) |
|-------|-----------|---------------------------|-------------------|------------------------------------------|-------------------|-----------------|
| 4-1   | 200       | 0.87                      | 6.95              | 496.9                                    | 329.4             | 10.98           |
| 4-2   | 612       | 0.95                      | 7.62              | 849.8                                    | 563.2             | 18.77           |
| 4-6   | 298       | 0.89                      | 7.12              | 584.5                                    | 387.5             | 12.91           |
| 5-1   | 304       | 1.22                      | 9.73              | 1959.9                                   | 1298.6            | 43.28           |
| 5-2   | 240       | 0.99                      | 7.91              | 998.7                                    | 661.8             | 22.06           |
| 5-3   | 418       | 0.95                      | 7.56              | 817.4                                    | 541.8             | 18.06           |
| **Total on a crop rotation** |             | **2072** | **0.97**                  | **7.78**          | **930.7**                                | **616.8**         | **20.56**       |
| Economic output |           | **9864** | **1.00**                  | **8.00**          | **1047.9**                               | **694.4**         | **23.15**       |
The situation is fundamentally changing in modern conditions, within the agrarian digital business-model. In the technological basis, estimates of the cost of any field and even some of its individual areas will be carried out, and in multiple ways, that it is, when cultivating a culture, their combination, when applying certain doses of fertilizers, etc. This one will allow owners and users of land to have not only their cadastral value, obtained from the results of the state assessment, but also the current market value. The possibility of turning agricultural land into full-fledged land assets [13] and conditions for the use of agricultural land in land and mortgage lending will be established.

5. Summary
As a result of the research we gave foundation the necessity and possibility to create a digital agrarian business-model with such a technological basis that this one has technical means and a set of tools for: transfer of analog information into digital; automation of accounting and reporting on the activities of all production units, ancillary and subsidiary services; has monitoring tools and way of control over production processes; has facilities for optimization of production and management structure. Technology basis makes it possible to plan productivity growth and production efficiency growth on the basis of: optimization of production structure; introductions of innovative products; creations the logistics of production information flows; improving management efficiency by using automated decision support systems; upgrading planning and forecasting methodology. An important function of technology basis is to estimate the value of agricultural land, which contributes to giving it the status of land assets, with all the consequences.

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