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# ЕКОЛОГІЯ ТА ЕКОНОМІКА ПРИРОДОКОРИСТУВАННЯ

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## EXPERIENCE IN USING STRATEGIC ANALYSIS TOOLS IN DETERMINING THE EFFICIENCY OF AGRICULTURAL LAND USE

Saranenko I.I.

Kherson State University  
Shevchenko str., 14, 76018, Ivano-Frankivsk  
i.i.saranenko@ukr.net

The efficiency of the use of agricultural land is understood as the economic result, which is characterized by the ratio of the obtained effect in natural and cost indicators and the area, taking into account the quality and remoteness of the land plot. There are 7 main types of soil in the territory of the Kherson region, including black soil and chestnut soil. In order to carry out state control over changes in indicators of the qualitative state of soils, agricultural enterprises timely implemented measures for their preservation, reproduction and increase in fertility. However, the maximum yields were not reached.

The following work offers the method of analysis of efficiency of agricultural land utilization by example of Fedorivka Village Area of Kahovskiy Region of Kherson Oblast, in order to determine the cause of over-plowing, fertility decrease, soil pollution and decline in crop capacity. The application of such instruments of strategical analysis as SWOT – & GAP – analysis showed, that the disadvantages of efficient land utilization were: outdated agricultural machinery, over- or undersupply of fertilizers, soil pollution and use of monocultures. Other threats include: short-term lease, decline in size of land plots, natural factor influence, and soil degradation. Assessment on 9-point scale established strategical difference between real and desired result as satisfactory – 7 points. Criteria of efficient land utilization are established: natural and anthropogenic factors, quality score, land plot area, soil quality balance, lease duration, meeting the demands of environmental legislation. Expediency of strategical analysis instruments application in determination of factors, that influence the efficiency of land utilization, is proven. *Key words*: ecological research, SWOT – & GAP – analysis, soil quality balance, trial plot, criteria.

### Досвід застосування інструментів стратегічного аналізу у визначенні ефективності використання сільськогосподарських земель. Сараненко І.І.

Під ефективністю використання сільськогосподарських земель розуміють економічний результат, що характеризується відношенням отриманого ефекту у натуральних та вартісних показниках і площі з урахуванням якості та віддаленості земельної ділянки. На території Херсонської області налічується 7 основних типів ґрунтів, у тому числі чорноземи і каштанові. З метою здійснення державного контролю за зміною показників якісного стану ґрунтів аграрні підприємства своєчасно проводили заходи щодо їх збереження, відтворення і підвищення родючості. Проте, максимальних врожаїв не досягали.

У даній роботі запропонований метод аналізу ефективності використання сільськогосподарських земель на прикладі Федорівської сільської ради Каховського району Херсонської області з метою виявлення причин високої розораності, зниження родючості, забруднення ґрунтів, зниження врожайності культур. Застосування таких інструментів стратегічного аналізу, як SWOT – & GAP – analysis, показало, що слабкими сторонами ефективного використання земель є: застаріла аграрна техніка та апаратура, надмірне або недостатнє надходження добрив; забруднення та засмічення ґрунтів, використання монокультур. Загрози створюють укладання короткострокових договорів оренди; подрібнення земельних ділянок; вплив природних чинників; деградація ґрунтів. Оцінювання за дев'ятибальною шкалою встановило стратегічне розходження між реальним і бажаним результатом як задовільне – 7 балів. Визначені критерії ефективності використання земель: природні та антропогенні чинники; бал бонітету; площа земельної ділянки; баланс властивостей ґрунтів; термін дії договору оренди; виконання вимог екологічного законодавства. Доведена доцільність застосування інструментів стратегічного аналізу у визначенні чинників, що впливають на ефективність використання земель. *Ключові слова*: екологічні дослідження, SWOT – & GAP – analysis, баланс властивостей ґрунтів, пробна ділянка, критерії.

**Problem statement.** In the time of existence of Fedorivka Village Area of Kherson Oblast, the percentage of ruined lands was constantly growing. The use of massive agricultural machinery, outdated equipment, excessive application of fertilizers led to the fact that the quality of the soil was constantly decreasing. Solving the problems of soil conservation and amendment is impos-

sible without objective evaluation of soil ecological condition.

**Relevance of research.** Land users also have a huge influence on soils. Taking into consideration the new format of management, emergence of local communities and agricultural land market functioning, new methods of assessing the efficiency of land utilization have to be

found. Europe uses a number of instruments that are widely used in economics, management and marketing. One of them is SWOT – & GAP – analysis. Its active use started since the beginning of the millennia.

#### **Analysis of recent research and publications.**

Researches conducted by Christopher J.V. McClure, Laury K. Estep and Jeffry E. Hill determined the efficiency using GAP analysis in urban and rural landscape in central-eastern Alabama (2012). They tested the ability of the method to prognose the inhabitation of areas by birds. Overall, GAP was the most accurate for the selected species [1]. In 2015 Kao Kana, Wanda Qin, Wan Hun Yan and Dai Lin determined, that overuse of fertilizers and pesticides leads to soil pollution and decrease in wild animal population, and cannot sustain land utilization. To help the development of agriculture on Jianshan farm with the use of SWOT analysis, its strength, weaknesses, opportunities and threats were determined [2]. In 2017 Zeynel Abidin Polat, Mekhmet Alkan Hikret, Gursoy Surmeneli determined legal, institutional and technical status of the existing land management system in Turkey with the SWOT matrix [3]. In 2020 Hanane Agasafari, Alireza Karbasi, Hossein Mohammadi, Roberto Calisti researched Iranian province Khorasan Razavi, where the quality of lands had declined. Using the analysis of strength, weakness, opportunities and threats, 28 factors that influence organical farming were discovered, and strategies of improving land fund were developed [4]. Iren Vukkali Atonis and A. Zorpas proved, that the correlation between urbanization tendencies and pressure on environment was caused by growing demand of resource consumption, waste generation, greenhouse gas emission, massive shortage of natural resources, life quality improvement and climate change, which point to necessity of emphasizing attention and considering the correlation between cities and environment a dynamic concept. The assessment of offered methods was done using the SWOT-analysis. The results show, that there is a need in renewal and application of method that will include a number of new key factors of efficiency [5]. Among Ukrainian scientists, weighty contribution in application of SWOT – & GAP – analysis in ecology was done by professor L.H. Rudenko, academician of National Academy of Sciences of Ukraine [6].

**Novelty.** The SWOT-analysis is widely used across local communities, including Kherson Oblast [7].

Vast over-plowing and low amounts of harvest demand new methodical approach and modern analytical matrix to discover their cause [8]. The goal of this paper is to determine new markers of land utilization efficiency on the example of Fedorivska Village Area, Kahovskiy Region, Kherson Oblast.

#### **Methodological or general scientific value.**

Selection of soil samples, their preparation for analysis [9], identification of Ph levels [10], mobile phosphorus and potassium compounds [11], salinity [12] were done in accordance with state standards. SWOT – & GAP – analysis is the baseline of strategical

analysis [13]. SWOT – analysis consists in dividing influencing factors into four categories: Strengths, Weaknesses, Opportunities and Threats. GAP-analysis studies strategical differences between real and desired results using 9-point scale assessment: 1 – exceptionally high quality, 2 – high quality, 3 – excellent, 4 – very good, 5 – good, 6 – relatively good, 7 – satisfactory, 8 – low quality, 9 – very low quality. Gathered SWOT and GAP-analysis data is generalized and recommendations are given [6].

Object of study is land resources of Fedorivska Village Area, Kahovskiy Region, Kherson Oblast.

Subject of study is application of SWOT – & GAP – analysis for determination of land resource utilization efficiency in Fedorivska Village Area, Kahovskiy Region, Kherson Oblast.

**Presenting main material.** The lands of Kherson Oblast consists mainly of 7 types of soils: southern black soil – 46,1%; dark chestnut soil – 31,7%; residual saline black soil – 7,3%; sod-sandy soil – 6%; chestnut soil – 5,3%; common black soil – 0,8%; solonetz soil – 0,8%. In Kahovskiy Region common are: low humus southern black soil – 3,7%; dark chestnut residual saline soil – 2,3%; and alkali soils of hearths and depressions – 2,1% (meadow-chernozem gleyed saline-alkali soils and saline-alkali and sod gley saline-alkali soils) [14].

The lands of Fedorivska Village Area are located in the southern part of Kahovskiy Region, where low humus southern black soil predominates – 1,8%. The relief is hilly, in north-eastern part – partly flat. Soil cover in the area is various. It is mainly land stock and lands of Fedorivka, Slynenko, Sokyryky villages and other land users that are granted with land plots for functional utilization. To reach the best conditions for constant growth of yield capacity and systematic growth of soil fertility farmyards, buildings, road network, size and configuration of fields, optimal homestead ratio are created in accordance with specialization; soil protection systems and crop rotation are being introduced, fertilizers are being used, soil cultivation is being minimized and positive soil balance is being maintained. For each homestead there is an assigned land plot with most suitable natural qualities for each crop rotation.

Regarding the score of quality arable land with estimated 54–58 points is allocated for field grain-row crop rotation, with lower (42–50) points for grain-grass soil protective crop rotation. Branches of TOV “Ahroprodukt” and TOV “TD-YUG” operated in the district, which were engaged in the cultivation of grain and technical crops, renting land from farmers. In order to implement state control over changes in soil quality indicators, agricultural enterprises took measures to preserve, reproduce and increase fertility in a timely manner. However, the maximum yield was not reached. One of the reasons being fires during summer that cause a big amount of humus to burn out.

Landowners who did not lease land were unable to take measures to preserve soil fertility. Therefore, the

number of lands deprived of measures to preserve soil fertility increased every year.

To accomplish set goals in Fedorivka, Slynenska and Sokyry villages there are land plots for observation and soil profiles (2017–2021 yy.): PT № 1 – where winter rape grows, PT № 2 – for winter wheat, PT № 3 – for sunflower. For comparison purposes a privatized plot PT № 4 was chosen that has been without any agricultural cultivation for 5 years.

As the result of conducted observation the following results are gathered (tab. 1).

In the period of land utilization on low humus southern black soil the following general trends are observed:

1. In the soils of agricultural lands:

- decrease in humus levels and contents;
- decrease in mobile phosphorus ( $P_2O_3$ ) and potassium ( $K_2O$ ) compounds;
- leaching of soils;
- accumulation of iron, copper and manganese.

In the soils of landowners:

- decrease of quality markers;
- leaching of soils;
- salinization;
- decrease in mobile phosphorus ( $P_2O_3$ ) and potassium ( $K_2O$ ) compounds;
- decrease in iron, copper and manganese concentration.

In the period of land utilization agricultural homesteads contributed to the improvement of soil quality by growing green crops; leaving nutrient residues and non-marketable parts of harvest with their

subsequent mulching; using biological plant protection products; stabilizing the structure of crop rotation with compulsory introduction of legumes and perennial grasses; introduction of contour ameliorative territory organization that provides ecological stability for agricultural landscapes (lowering intensity of erosion processes); development of minimum tillage systems; using new systems of fertilization that are based on activating soil microflora with the help of modern biofertilizers (Riverm, Humisol, Agrozyn etc.), biomodulators of growth, soil conditioners, soil absorbents, fungi and bacteria strains (EM-technologies) etc. that contributes to the growth in harvest capacity [15, 16] by 20–30%, causes a reduction in the deficit of organic matter and allows to stimulate the processes of humus accumulation in soil. It is worth noting that iron, copper and manganese are most accessible in low acidic and neutral environment; rapeseed, wheat and sunflower produce the best harvest at pH 6,0–6,7, therefore, ability to leach soils should be taken into consideration when using fertilizers, especially ones that include sulfur.

Despite researches determining the quality of soils being conducted, the reason of low utilization efficiency is still not found. For closer inspection of the situation we use SWOT – & GAP – analysis (tab. 2, 3) as projects for improving the functioning of eco systems or their separate elements and their management with detailed analysis of current situation with determining of issues, goals, and strategies of ecosystem development management, taking into consideration interests of different sides who often see it differently. Determining weaknesses and threats is the most important part of

Table 1

Analysis of low humus southern black soil efficiency utilization (2017–2021 yy.)

Land utilization markers	TOV “Agroprodukt”	TOV “TD-YUG”		Private landowner
Overall land utilization area, ha	6,916	925,1		2,5
Area of test site, ha	PT № 1	PT № 2	PT № 3	PT № 4
	2,5	2,5	2,5	2,5
Quality point	77,3	77,1	77,1	75,0
Purpose	Arable land	Arable land	Arable land	Hayfield
Duration of lease (usage), yy	5	5	5	5
Dynamic of soil quality markers in arable layer, $\Delta = \pm 0,05\%$ : thickness of the humus layer, cm	-1,0	-1,3	-1,0	-2,5
Humus content, %	-0,5	-0,7	-0,51	-0,23
Mobile phosphorus compound content ( $P_2O_3$ ), %	-1,73	-0,74	-1,04	2,1
Mobile potassium compound content ( $K_2O$ ), %	-1,26	-0,49	-0,84	1,9
pH	+1,5	+1,3	+1,3	+0,8
Salinity, %	+0,1	+1,1	+1,2	+2,0
Sodification, %	+0,14	+1,4	+0,89	+2,7
$Fe^{2+}$ , %	+4,0	+10,0	+0,5	-0,3
$Cu^{2+}$ , %	+8,0	+5,0	+0,7	-0,5
$Mn^{3+}$ , %	+5,4	+3,4	+0,45	-0,33

Table 2

**SWOT – analysis of soil ecological condition**

<b>Strengths</b>	<b>Weaknesses</b>
1. Advantageous physical and geographical location. 2. Well-developed road network. 3. Powerful agro-industrial complex. 4. Favorable soil quality.	1. Outdated agricultural machinery and appliances. 2. Over- or undersupply of fertilizers. 3. Soil pollution. 4. Use of monocultures.
<b>Opportunities</b>	<b>Threats</b>
1. Competitiveness of agricultural complex. 2. Functioning of the market of agricultural lands. 3. Decentralization and support of farmers. 4. Organic production.	1. Concluding short-term leases. 2. Shredding of land plots. 3. Influence of natural factors. 4. Soil degradation.

Table 3

**GAP – analysis of adhering to Article 35. LoU “On Land Preservation”**

<b>Law of Ukraine “On Land Preservation” Version from 19.11.2022 Chapter VI Article 35.</b>	<b>Adhering</b>	<b>Gaps</b>	<b>Point assessment</b>	<b>Recommendations</b>
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
antierosion	Violation of the optimal ratio of crops in crop rotations – monocultures	– tenants are not responsible for the quality of the soil upon completion of land use; – mostly extensive crops are grown on the leased area; – a significant part of the area is re-allocated for rapeseed, sunflower and winter wheat crops without proper observance of crop rotation time; – forced re-seeding of a significant part of the area of dead crops with sunflower due to adverse weather conditions.	7	– strict control over the observance of optimal crop rotation; – increasing the area of irrigated land in extreme climates; – establishment of certain volumes of state planned orders with fixed purchase prices; – introduction of zonal allowances for certain types of agricultural products; – expansion of animal husbandry.
agrotechnical	Deep loosening of the soil with heavy implements and burning of stubble.	– reduction of total and capillary porosity of the fertile layer; – reduction the level of viability of the microflora; – soil shredding; – soil over-compaction; – decrease of humus content.	8	– loosening the soil should be carried out in the presence of 80% stubble on the surface; – use of flat cutters, deep rippers to a depth of 30 cm; – perform shallow flat-cutting loosening with flat-cutter cultivators; – combine flat-cutting tillage with splitting and harrowing.
agrochemical	Modern state of lands. Land fragmentation.	– the number of landowners and land users has increased significantly; – loss of scientifically sound land use system, reduction of soil fertility; – low interest in agrochemical survey of lands.	7	– creation of a working group, intensification of work to check the presence of agrochemical passports of fields, land plots for landowners and land users; – resolving the issue of conducting agrochemical inspection of soils before concluding lease agreements and after their expiration.

Continuation of the table 3

1	2	3	4	5
	Insufficient and unbalanced application of mineral fertilizers	<ul style="list-style-type: none"> <li>– unstable pricing policy;</li> <li>– export orientation of chemical enterprises-producers, seasonality of consumption and demand of this product, complex logistics of fertilizer supply;</li> <li>– domestic fertilizers have a higher price position compared to similar resources of imported production, which reduces their competitiveness.</li> </ul>	6	<ul style="list-style-type: none"> <li>– development of programs for long-term provision of the agro-industrial complex with available mineral fertilizers of domestic production, by creating legal, financial and organizational conditions for fertilizer producers and agricultural producers;</li> <li>– reduce the cost of mineral fertilizers; increase their use;</li> <li>– reduction of nutrient deficiency;</li> <li>– restoration of natural soil fertility;</li> <li>– use of fertilizers based on plant and soil diagnostics.</li> </ul>
	Significant shortage and unbalanced application of organic fertilizers.	<ul style="list-style-type: none"> <li>– the actual application of mineral and organic fertilizers is not balanced and does not meet the optimal parameters, which are natural processes of soil self-renewal, which leads to increased chemical processes, which lead to increased dehumidification of the soil;</li> <li>– the practical lack of organic fertilizers is due to the rapid decline in cattle and pigs, due to a number of socio-economic realities of the last 10–15 years.</li> </ul>	6	<ul style="list-style-type: none"> <li>– optimization of the structure of crop rotations, which by increasing the overall productivity of crops, will increase the yield of non-marketable part of the crop and crop and root residues;</li> <li>– introduction of elements of biologization of agriculture, which provides a fundamentally new attitude to the methods of tillage and application of agrochemicals on the basis of modern scientific developments:               <ol style="list-style-type: none"> <li>1) cultivation of green manure crops;</li> <li>2) leaving crop residues and non-marketable part of the crop in the field with their subsequent mulching;</li> <li>3) use of biological plant protection products;</li> <li>4) stabilization of the structure of crop rotations, with the mandatory introduction of legumes and perennial grasses;</li> <li>5) introduction of contour-ameliorative organization of the territory, which ensures ecological stability of agro-landscapes;</li> <li>6) development of minimum tillage systems;</li> <li>7) use of fundamentally new fertilizer systems based on the activation of soil microflora through the use of the latest biofertilizers.</li> </ol> </li> </ul>



1	2	3	4	5
ameliorative	Insufficient volumes of chemical reclamation of saline soils.	– with an annual demand of 100 thousand hectares, in fact, plastering for the last five years was carried out on an area of 1.3-3.1 thousand hectares or 1.3-3.1% of demand. – reduction of reclaimed areas due to lack of funds for producers.	8	– introduction of targeted state programs of subsidies and support for agricultural producers to stimulate the productivity of saline soils.

analysis, because they are the baseline for taking further measures and forming problem field of situation as a the set of uncertainties in the system, their correlation with each other and inner and outer environment factors. The point of the procedure covers determining limits, analysis object, issues, researching causal relationships with the help of scheme that illustrates main problems and their influence in its upper half and their cause in the lower half. GAP-analysis is a simple yet effective method of strategical analysis. Its main goal is to find a gap between goal and possibilities – a strategical gap that is caused by present tendencies and desired marks in long-term perspective [13].

Water erosion deals considerable damage to agriculture in area of homestead placement [15, 17]. The processes of soil washing away and erosion are present throughout the whole area of land utilization. According to the materials of soil inspection 206,4 ha. out of 916,2 ha. (22,5%) of agricultural homesteads suffer from erosion. 206,4 ha. of them are slightly eroded soils. To increase the productivity of lands and to successfully fight water erosion, implementing an organizational agricultural complex of measures is anticipated.

To establish strategical gaps in effective land utilization, strengthen the weak spots and minimize threats let`s analyze abidance to the law of Ukraine of “On Land Preservation”, make a 9-point assessment, offer recommendations (Tab. 4). As a result of GAP analysis it is deduced that land users do not adhere to the requirements of Article 35. Of Law of Ukraine “On Land Preservation” or adhere partially. In case land users do not meet the requirements of the law, Article 55 about administrative offenses of Code of Ukraine states that these people bear administrative responsibility in the form of fine: for citizens – from 50 to 100 non-taxable minimum incomes, for the officials – from 300 to 500 non-taxable minimum incomes. Assessment in accordance with 9-point scale shows that strategical difference between real and desired result is satisfactory – 7 points. Meaning land users due to various reasons create problem field with low index of antierosion, agrotechnical, agrochemical, ameliorative measures, which leads to ineffective land utilization and worsens the properties of land.

In this paper, plot models with optimal soil indicators for each land user are developed. Let`s use polynomial trend line [18] and make a prognosis of quality balance.

Size of coefficient The value of the reliability factor is close to one on each model. The reference area has 93.5% efficiency and is proposed as a result that must be achieved for maximum efficiency.

On the example of SWOT – & GAP – analysis of land use of Fedorivska Village Area of Kakhovskyi Region of Kherson Oblast it is shown that in today`s conditions it is not enough to conduct research and statistically process data. New tools need to be used to analyze and deeply understand trends in soil degradation. The main polluters are land users who, due to non-compliance with legal requirements, careless treatment of fertile lands, excessive or insufficient application of fertilizers, contaminate and deplete soils and use them inefficiently. The proposed method of using the tools of strategic analysis, management and marketing in identifying deep problems of land use has proved its worth. The following criteria for land use efficiency are proposed for land users of the village area:

1) natural and anthropogenic factors. Fires, natural disasters and climatic conditions affect erosion and degradation processes and soil quality and require additional measures;

2) quality score, as an indicator of soil quality, determines the functional use of land and crops;

3) area of the land plot. This criterion necessitates the avoidance of land fragmentation, as this leads to a deterioration in its quality;

4) balance of soil properties. When using land, it is necessary to timely determine quality indicators and take into account their ratios to create a favorable soil environment. For example, micronutrients are most available to plants in slightly acidic and neutral environments;

5) the term of the lease agreement. For the landlord, the risk of providing land for long-term lease is lower, because short-term contracts do not ensure the responsibility of users for the quality of land, resulting in its value is reduced;

6) compliance with environmental legislation. Most land users do not comply with the requirements of the Law of Ukraine “On Land Preservation” or partially

comply with them, as a result of which the measures taken are ineffective.

Analytical tools have been applied to these criteria of land use efficiency:

1) environmental research is the basis for analysis and information source for assessing the criteria: natural and anthropogenic factors, quality rating, land area, balance of soil properties;

2) SWOT analysis is a tool for identifying the strengths and weaknesses of the internal environment, opportunities and threats of outer environment. It is advisable to analyze natural and anthropogenic factors, quality score, land area, the term of the lease agreement;

3) GAP – analysis identifies gaps between the desired result and the current state of affairs, identifies a problem area for the criteria: the balance of soil properties and compliance with environmental legislation;

4) forecasting using trend lines or other software tools is applied to the conclusions of hybrid analysis with simulation of the end result.

Upon completion of the analysis, recommendations are provided and ways to strengthen weaknesses, minimize threats, reduce gaps and achieve high land use efficiency are proposed.

### Conclusions

1. In the period of existence of the village area the percentage of plowed lands is constantly growing. The use of massive agricultural machinery, outdated equipment, excessive supply of fertilizers has led to the fact that the quality of soils is constantly declining. The humus content decreased to 0.7%.

2. The following strategic measures are used to preserve the soil cover in the Fedorivska Village Area of Kakhovskiy Region of Kherson Oblast: rational use of land by the most optimal justification of the location of farmyards, buildings, road network, size and configuration of fields, lands; creating the optimal ratio of agricultural land depending on the specialization of the economy; preservation of soil fertility through optimal selection of crops, introduction of soil protection system of agriculture, fertilizer application, introduction of crop rotation system, minimization of tillage, positive balance of humus. Despite the measures, the quality of soils is deteriorating.

3. SWOT – analysis showed that with such functioning and use of lands their ecological quality is endangered because short-term lease agreements are concluded, land plots are crushed, natural factors influence, soil degradation is observed. Weaknesses are the use of outdated agricultural machinery and equipment, excessive or insufficient supply of fertilizers, soil contamination and littering, the use of monocultures.

4. GAP – analysis revealed non-compliance with the requirements of Article 35 of the Law of Ukraine “On Land Preservation”. The nine-point score found a strategic difference between the actual and the desired result as satisfactory – 7 points. Meaning that land users for various reasons create a problem field with low rates of anti-erosion, agronomic, agrochemical, amelioration measures, which leads to inefficient land use, deterioration of their properties.

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