AN EFFECTIVENESS MODEL IN PROCESSING ACTIVITIES OF AGRICULTURAL RAW MATERIAL

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Abstract: *In this thesis, it is proposed an algorithm that can be definitely used, starting with the simplicity and efficiency of the examined case of agricultural foodstuff industry in the Republic of Moldova – by this is meant the necessity of reducing the export of the primary agricultural materials, and gaining new technologies in the processing industry.*

Keywords: *raw material, processing, optimal program, product, economic-mathematic model, function, profit, eficiency.*
JEL Classification*: Q13, Q18, Q16.*

1. Introduction

The contribution of agriculture, forestry and fishery, according to Moldova data in figures - 2018 is relatively far under potential level. In 2014-2017, the gross added value constitutes respectively 84.3; 84.8; 85.3; 84.1 %.

The share of agriculture makes only 13.0; 12.2; 12.1; 12.2%. The explanation is simple: the processing structures of the agricultural raw materials are underdeveloped in Moldova. Unfortunately Republic of Moldova is mostly specialized in the export of agricultural raw materials. As a result of it, the number of jobs is in reduction, the gross value added is not in increasing. In addition, technologies for processing agricultural raw material, for transforming raw material into finished products are not always optimally used. Sometimes these (technologies) are not completely used, and agricultural raw material is exported. The export of raw material, economically is equivalent to the export of job places, with an increase of the unemployment level in the Republic of Moldova. In order to provide food companies with processing activities for agricultural raw materials, (companies) must be provided with an algorithm model for effectiveness in processing of agricultural raw materials. For this purpose the problem is formulated for the general case; by an explicit example the algorithm interpreted for solving forthcoming issues.

2. Model in processing activities of agricultural raw material

NORD company for processing of agricultural products dispose of ***n*** technologies, capable of production ***m*** finished products.

The profit, gained by the NORD company for an unit of finished products *i*, i=1, 2,..., *m* realized by using technology *j*, j=1, 2, ..., *n* is equal to P_{ij}, i=1, 2, ..., *m*; j=1, 2, ..., *n*;

is the market demand for product *i*, i=1, 2, ..., *m* constitute$\boldsymbol{D_i}$, *i*=1, 2, ..., *m*;

is the NORD company offers – $\boldsymbol{S_j}$, j=1, 2,..., *n*. Proceeding out of these the issue arises: to what extent the NORD company must use the technologies *j*, j=1, 2, ..., *n*, in the production processes of the finished products to achieve a maximum profit. We note by $\boldsymbol{X_{ij}}$ - the intensity of technologies used by the NORD company *j*, j=1, 2, ..., *n* in the production processes of the output finished products *i*, i=1, 2, ..., *m*. The initial data set out above can be entered in a matrix form (Table 1). Summary offer for finished products $\sum_{j=1}^{n}(S_j)$, in this case it will not exceed the overall demand on the market $\sum_{i=1}^{m}(D_i)$. In this case, the issue is an open model and in the economic-mathematical language it has the following form:

determination of the maximum value of the function

$$f(x) = \sum_{i=1}^{m} \sum_{j=1}^{n} P_{ij} X_{ij}$$

Table 1. The initial data: general case; open model

Technologies / Finished product	1	2	...	j	...	n	Demand
1	P_{11} X_{11}	P_{12} X_{12}	...	P_{1j} X_{1j}	...	P_{1n} X_{1n}	$\leq D_1$
2	P_{21} X_{21}	P_{22} X_{22}	...	P_{2j} X_{2j}	...	P_{2n} X_{2n}	$\leq D_2$
...	...	...	...	...	...	...	...
i	P_{i1} X_{i1}	P_{i2} X_{i2}	...	P_{ij} X_{ij}	...	P_{in} X_{in}	$\leq D_i$
...	...	...	...	...	...	...	...
m	P_{m1} X_{m1}	P_{m2} X_{m2}	...	P_{mj} X_{mj}	...	P_{mn} X_{mn}	$\leq D_m$
Total Offer	S_1	S_2	...	S_j	...	S_n	$\sum_{j=1}^{n} S_j \leq \sum_{i=1}^{m} D_i$

$$\sum_{j=1}^{n} P_{ij} X_{ij} \leq D_i, \qquad \text{i=1, 2, ..., m}$$

Volume of products **i**, i=1, 2, ..., m, achieved by all technologies, will not exceed the demand $\boldsymbol{D_i}$, i =1, 2, ..., **m** in the market;

$$\sum_{i=1}^{m} P_{ij} X_{ij} \leq S_j, \qquad \text{j=1, 2, ..., n}$$

The agriculture food staff company NORD makes full use of technological capacities in processing of the agricultural raw material.

$X_{ij} \geq 0$, i=1, 2, ..., m; j=1, 2, ..., n

Intensity of using technologies ***j***, j=1, 2, ..., n

The optimal program can be identified, using the potential method [Maximilian S. "Modeling of economic processes", USM, 2009]. For this purpose the closed model in table 1 can be transformed into a balanced model, by introducing the fictitious variables $\mathbf{X_{i,\ n+1}}$, i=1, 2, ..., m (Table 2). Depending on the number of technologies used in processing the agricultural raw material and of the number of finished products, this (issue) can be solved manually by the potential method. To this end, here is an example.

Table 2. Initial data: general case; balanced model

Technologies / Final product	1	2	...	j	...	n	(n+1)	Demand
1	P_{11} X_{11}	P_{12} X_{12}	...	P_{1j} X_{1j}	...	P_{1n} X_{1n}	0 $X_{1,n+1}$	$=D_1$
2	P_{21} X_{21}	P_{22} X_{22}	...	P_{2j} X_{2j}	...	P_{2n} X_{2n}	0 $X_{2,n+1}$	$=D_2$
...	...	...	...	...	...	...	...	...
i	P_{i1} X_{i1}	P_{i2} X_{i2}	...	P_{ij} X_{ij}	...	P_{in} X_{in}	0 $X_{i,n+1}$	$=D_i$
...	...	...	...	...	...	...	...	...
m	P_{m1} X_{m1}	P_{m2} X_{m2}	...	P_{mj} X_{mj}	...	P_{mn} X_{mn}	0 $X_{m,n+1}$	$=D_m$
Total Offer	S_1	S_2	...	S_j	...	S_n		$\sum_{j=1}^{n} S_j \leq \sum_{i=1}^{m} D_i$

Example:

The agricultural food staff company NORD dispose of four technologies in processing agricultural raw materials in output of three finished products. Production capacities of the products 1; 2; 3 in the profit of the available technologies constitute: S_1 = 52 tons; S_2 = 60 tons; S_3 = 85 tons; S_4 = 200 tons. Market demand for products 1; 2; 3 constitutes: D_1 = 200 tones; D_2 = 100 tons; D_3 = 150 tons. The specific profit (per unit) realized after products marketing 1; 2; 3 in the profit of technologies in processing the agricultural raw material is known (Table 3). The issue to be set: to identify optimal use of technological capacities in processing of agricultural raw material for total profit realized by the NORD company, will be maximal one.

For this purpose by the variable $\boldsymbol{X_{ij}}$**,** i=1; 2; 3; j=1; 2; 3;4, it noted the intensity use of technologies for processing agricultural raw materials 1; 2; 3;4, for a profit of the finished products 1; 2; 3. The overall profit in this case will make:

$$P(x) = 2{,}5X_{11} + 2{,}2X_{12} + (-M)X_{13} + 2{,}8X_{14} + 1{,}6X_{21} + 1{,}0X_{22} + 1{,}9X_{23} + 1{,}2X_{2,4} + 0{,}8X_{31} + 1{,}0X_{32} + 0{,}6X_{33} + 0{,}9X_{34}$$

, when M > 0, i. e. it means technology 3 cannot output product 1 (profit is negative). The economic - mathematical model has the form:

$P(x) \Rightarrow$ maximum în the following conditions:

Table 3. Initial data: open mode

Technologies / Finished product	1	2	3	4	Need for finished products
1	2,5 X_{11}	2,2 X_{12}	-M X_{13}	2,8 X_{14}	≤200
2	1,6 X_{21}	1,0 X_{22}	1,9 X_{23}	1,2 X_{24}	≤100
3	0,8 X_{31}	1,0 X_{32}	0,6 X_{33}	0,9 X_{34}	≤150
Total	52	60	85	200	

$$\left.\begin{aligned} X_{11}+X_{12}+X_{14} &\leq 200 \\ X_{21}+X_{22}+X_{23}+X_{24} &\leq 100 \\ X_{31}+X_{32}+X_{33}+X_{34} &\leq 150 \end{aligned}\right\}$$

The volume of the finished products 1; 2; 3 will not exceed the market demand for finished products. respective.

$$\left.\begin{aligned} X_{11}+X_{21}+X_{31} &= 52 \\ X_{12}+X_{22}+X_{32} &= 60 \\ X_{23}+X_{33} &= 85 \\ X_{14}+X_{24}+X_{34} &= 200 \end{aligned}\right\}$$

Company NORD for processing of agricultural raw amterial use the production capacities to maximum. ximum...capacitățile de productiedisponibile.la

The problem can be solved by one of: MODI, FORD-Falcherson, POTENTIAL models. For this purpose, the initial data, the open model in the table 3, need to be transcribed in table 4, where technologies 1; 2; 3; 4 are supplemented with 5 - fictitious technology; variables X_{15}, X_{25}, X_{35} are introduced to transform inequalities into equalities. The initial data become balanced (Table 4).

Based on the data in table 4, the economic-mathematical model will have the form: To determine the maximum value of the a funcţion $P(x)$ in following conditions:

Table 4. The initial data: balanced model

Tehnologies / Finished products	1	2	3	4	5	Need for finished products
1	2,5 X_{11}	2,2 X_{12}	-M X_{13}	2,8 X_{14}	0 X_{15}	=200
2	1,6 X_{21}	1,0 X_{22}	1,9 X_{23}	1,2 X_{24}	0 X_{25}	=100
3	0,8 X_{31}	1,0 X_{32}	0,6 X_{33}	0,9 X_{34}	0 X_{35}	=150
Total	52	60	85	200	53	

$$X_{11}+X_{12}+X_{13}+X_{14}+X_{15}=200$$

$$X_{21} + X_{22} + X_{23} + X_{24} + X_{25} = 100$$

$$X_{31} + X_{32} + X_{33} + X_{34} + X_{35} = 150$$

$$X_{11} + X_{21} + X_{31} = 52$$

$$X_{12} + X_{22} + X_{32} = 60$$

$$X_{13} + X_{23} + X_{33} = 85$$

$$X_{14} + X_{24} + X_{34} = 200$$

$X_{15} + X_{25} + X_{35} = 53$ (The demand is 200+100+150=450; the offer constitues 52+60+85+200=397; 450-397=53)

The initial data are transcribed in table 5.1.

Table 5.1. The initial data

2,5	2,2	-M	2,8	0	200
1,6	1,0	1,9	1,2	0	100
0,8	1,0	0,6	0,9	0	150
52	60	85	200	53	450

Proceeding out of the table 5.1 it is was determined:
$\max\{2{,}5;\ 2{,}2;\ -M;\ 2{,}8;\ 0;\ 1{,}6;\ 1{,}0;\ 1{,}9;\ 1{,}2;\ 0\} = 2{,}8$

We fill in square (1; 4) with minimum $\{200; 200\} = 200$.

We set up table 5.2

Table 5.2. Iteration 1

2,5	2,2	-M	2,8 200	0	-
1,6	1	1,9	1,8	0	100
0,8	1	0,6	0,8	0	150
52	60	85	-	53	250

According to table 5.2 it is determined:
$\max\ \{2{,}2;\ -M;\ 0;\ 1{,}6;\ 1;\ 1{,}9;\ 1{,}8;\ 0;\ 0{,}8;\ 1;\ 0{,}6;\ 0{,}8;\ 0\} = 1{,}9$

fill in the square box (2;3) with min $\{100;\ 85\} = 85$.

It was designed table 5.3. where are performed iterations 1 şi 2.

Table 5.3. Iteration 2

2,5	2,2	-M	2,8 200	0	-
1,6	1,0	1,9 85	1,8	0	15
0,8	1,0	0,6	0,8	0	150
52	60	-	-	53	165

According to table 5.3 we determine:
max $\{1{,}6;\ 1;\ 0;\ 0{,}8;\ 1;\ 0\} = 1{,}6$. We fill in square box (2;1) with min$\{52;\ 15\} = 15$.

it was designed out table 5.4, where iterations 1; 2; 3 are performed.

Tablel 5.4. Iteration 3

2,5	2,2	-M	2,8 200	0	-
1,6 15	1	1,9 85	1,8	0	-
0,8	1	0,6	0,8	0	150
52-15=37	60	-	-	53	165

According to table 5.4 we determine:
max $\{0{,}8;\ 1;\ \ 0\} = 1$. We fill in the square (3;2) with minimum $\{60;\ 150\} = 60$.

It was worked out table 5.5, where iterations 1; 2; 3; 4. are performed.

Table 5.5. Iterations 4.

2,5	2,2	-M	2,8 200	0	-
1,6 15	1	1,9 85	1,8	0	-
0,8	1 60	0,6	0,8	0	90
37	-	-	-	53	90

According to table 5.5 we determine:
max$\{0{,}8;\ 0\} = 0{,}8$. Fill in the quare (3;1) with minimum $\{37;\ 90\} = 37$.

Table 5.6 was worked out, where all iterations have been performed.

Table 5.6. The optimum solution.

2,5	2,2	-M	2,8 200	0	-
1,6 15	1	1,9 85	1,8	0	-
0,8 37	1 60	0,6	0,8	0	53
-	-	-	-	53	53

In the Table 5.6 the obtained optimal solution is shown. In the agricultural food company NORD, technologies 2; 3; 4 will be used to output the products 3; 2; 1.

$$P^* = 2{,}8 \cdot 200 + 1{,}6 \cdot 15 + 1{,}9 \cdot 85 + 0{,}8 \cdot 37 + 1 \cdot 60 = 835{,}1\ (thousand. MDL)$$

Technology 1 will be used to output products 2 and 3. The total profit will be:

3. Conclusions

Application of economic-mathematical methods in the economic analyses and studies generates two effects: (1) - proposes well-reasoned theoretical and practical modalities in solving the problem under study; (2) – a concept is proposed, which must be based on the policies, economic development strategies, in the above examined case of the agriculture food industry in the Republic of Moldova. The algorithm proposed in this thesis may be easily used proceeding out from its simplicity and efficiency. One of the most important economic problems in the Republic of Moldova is the need to reduce the export of agricultural raw materials, to create the most diverse and original technologies for processing agricultural raw materials, and to obtain original finished products of no analogue out of the country. In this way the export of finished products can be increased. The quality, originality and the relatively low price of the products serve as basis of increasing demand for these products out of the Republic of Moldova.

The development of the industry of processing of agricultural raw material, can contribute indirectly to the increase of the demand for most diverse working professions, therefore to a higher quality of life.

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