AgroLife Scientific Journal - Volume 4, Number 1, 2015
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

MATHEMATICAL MODALITIES OF ECONOMIC RISK EXPOSING IN AGRICULTURAL ACTIVITY

Elena NIREAN

State Agrarian University of Moldova, 42 Mircesti Str., Sector Rascani, MD-2049, Chisinau, Republic of Moldova, Phone: +373 22 432387

Corresponding author email: ni-lena@mail.ru

Abstract

Each process, including economic, under certain conditions is conducted objectively. Manager, when it comes to economic processes can intervene to avert the processes, or to modify the conditions of their deployment. Economic processes, left to the discretion of supply and demand, generate a multitude of risks.
Risks (economic losses, misses, reduction of profit) in agricultural activities can be generated including due to insufficient implementation of programming methods. Currently, specialists in the application of economic and mathematical methods have developed a variety of methods and algorithms to reduce the risk coefficient in economic activities. A special importance for practitioners have presented mathematical methods accessible to specialists from other fields. Mathematical methods are based on the management of decisions (no the risks) and can contribute significantly to increasing productivity in agriculture and in other branches.

***Key words**: agricultural activity, optimal program, production cost, profit, risk coefficient.*

INTRODUCTION

Agricultural activity as a whole, being closely linked to the climatic conditions not controlled by humans, living organisms, strongly emphasized the economic interests of all parties involved, etc., is ranked as one of the highest risk level. Usually this assessment includes both natural risks and economic ones.
Economic processes, left to the discretion of supply and demand, generates a multitude of risks. The manager can intervene in economic processes that already take place, in economic processes that can potentially take place. Managerial intervention methods can be different depending on the specific nature, lag of the process. The processes generating by "comfort" or "risks" can be from different areas, fields organizational, economic, environmental, social, military, natural, political, national, ethnic, religious, linguistic, social structures, mentalities of society members, technological progress, innovation. For each of the economic sectors in economic theory, mathematics can be found various ways to reduce risky situations. For economic activities are available a large set of programming methods.

MATERIALS AND METHODS

To reveal the problem was used specialized literature and data obtained from research conducted by author. Based on accumulated data were performed calculations to determine the costs of agricultural producer and was elaborated optimal production program. For the interpretation of accumulated data and calculations was applied analytical method, tabular and graphical methods. In order to interpret the results analytical method was applied. In formulation of the conclusions the author focused on the method of induction and deduction.

RESULTS AND DISCUSSIONS

Mathematical methods with which the problem of selecting variants can be solved by the level of cost proposed in the mathematical programming bibliography involve manager's knowledge of applied mathematics. Problem solving and therefore reducing risk of potential losses becomes a reality, if at the disposal of manager will be the resolution methods less "sophisticated". The idea of elaboration an optimization method of agricultural activities may be exposed on the basis an economic problem solving. The enterprise S.A. "Nistru - Olăneşti" in Stefan Voda has an area of arable land (1) where can be cultivated three crops: 2; 3; 4 (tomatoes, cucumbers, peppers); the production obtained may be preserved in three assortments 5; 6; 7 (conserved tomatoes, cucumbers preserved; assorted tomatoes and cucumbers); the final product can be stored in the centers: 8; 9; can be exported by direction 10. Costs incurred by the economic agent related to cultivation, processing, storage and export are shown in schematic form in Figure 1. The issue is following: to determine the economic activities of the economic agent for which costs will be minimal.

The optimal program can be determined on the basis of R. Bellman optimization:

$$f_{n-l}(S_l) = \underset{U_{l+1}}{optimum} \{R_{l+1}(S_l, U_{l+1}) f_{n-(l+1)}(S_{l+1})\},\ l = 1,2,...(n-1)$$

Where $U_l = (U_l^{(1)}, U_l^{(2)} ..., U_l^{(m)})$ - solution to achieve the iteration l;

$S_l = (S_l^{(1)}, S_l^{(2)} ..., S_l^{(m)})$ - economic situation of agricultural activity by the iteration l;

R_e - effect achieved after the iteration l; b

f_{n-l} - optimal value of the effect achieved by (n-1) iterations;

n - number of iterations.

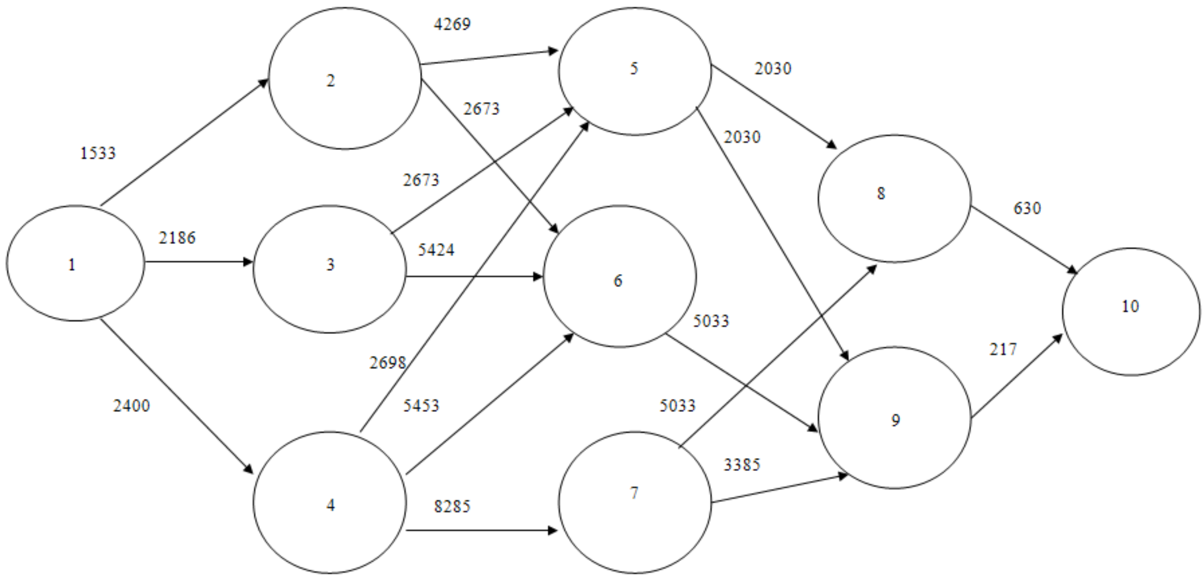

Figure 1. The scheme of possible costs flows of agricultural activities in S.A. „Nistru - Olăneşti"
Source: elaborated by author

Schemes of implementing the principle of R. Bellman for dynamic problem solving, in our view, include: a considerable training in mathematics; are not accessible to many managers. Under these conditions manager accepts intuitive a variant, that usually is not optimal, and thus creates conditions of losses, failures, reduction of profit possible. The following is proposed a way, in our view is simple, for determining the optimal variant of agricultural activity. For this purpose we develop a table - algorithm (Figure 2).

		Final product	Storing		Processing			Agricultural crops			Surface
		10	9	8	7	6	5	4	3	2	1
0	10	0									
Storing	9	4269*	4269								
	8	5033		5033							
Processing	7		3385	5033	min (7654; 10066)= 7654						
	6		630			4015					
	5		2030*	2030			min (2660; 7063)= 2660				
Agricultural crops	4				1533	5453	8285	min (9187; 9468;10945)=9187			
	3					5453	2673		min (9468; 5333)= 5333		
	2					7744	5808*			min (11759; 8468)=8468	
Surface	1							2400	2186	1533*	min (11587; 7519;10001)= 7519

Figure 2. Scheme - bloc, S.A. „Nistru - Olăneşti”
Source: elaborated by author

The initial data of Figure 1 are transcribed in table - algorithm, they occupy squares below the main diagonal. Algorithm of completing the data on the main diagonal of Figure 2: into the square 10×10 fill out the "o" (cost of agricultural activities before their starting); 4269+0= 4269 – pass it into the square 9×9; 5033 + 0= 5033 – pass it into the square 8×8;
min {3385+4269; 5033+5033} = 7654 – pass it into the square 7×7;
min {630+3385; 630+4269} = 4015 – pass it into the square 6×6;
min {2030+630; 2030+5033} = 2660 – pass it into the square 5×5;
min {1533+7654; 5453+4015; 8285+2660} = 9187– pass it into the square 4×4;
min {5453+4015; 2673+2660} = 5333 – pass it into the square 3×3;
min {7744+4015; 5808+2660} = 8468 – pass it into the square 2×2;
min {2400+9187; 2186+5333; 1533+8468} = 7519 – pass it into the square |x|.

We determine the optimal program starting the square |x|, take an arrow to the intersection with the main diagonal; from this intersection (square 2 × 2) take an arrow to the figure marked (5808*); from square occupied by 5808* raise a perpendicular up to intersection with the main diagonal (10 × 10); from the square 5 × 5 take an arrow up to the marked number (2030*); from the number 2030 * raise a perpendicular to its intersection with the main diagonal (9 × 9); from the square 9 × 9 take an arrow up to marked number 4269*; from the 4269* raise a perpendicular to its intersection with the main diagonal. In such a way we have established optimal "route" 1-2-5-9-10, which means that for S.A. "Nistru - Olăneşti" optimal variant is to produce tomatoes and afterwards to conserve them. The minimum cost for these agricultural activities will be 7519 lei per tonne of tomatoes.

Risks (economic losses, misses, reducing profit) in agricultural activities can be generated and by insufficient implementation of programming methods. Currently, specialists in the application of economic-mathematical methods have developed a large arsenal of methods and algorithms that can lowered risk coefficient of economic activities. Particular importance for practitioners have presented mathematical methods accessible for specialists from other fields. Mathematical methods are the basis of decisions management (no risk) and can contribute significantly to increasing productivity in agriculture, and more.

In economic theory by using mathematical programming methods can be determined the minimum coefficient of risk. Next, we consider some methods of "compliance" of agricultural producer to market requirements, we deduce methodology for determining the minimum coefficient of risk. Market prices on agrifood products oscillates under the impact of several factors. Accordingly, demand D (t) is oscillating. Supply S (t), in turn, has its own oscillations. The shaded surfaces shown in Figure 3 represents the moments when the farmer can take advantage of gaps may incur losses. Farmer losses are its risks. The problem is reduced: by minimize potential losses of farmers. Determination of the minimal coefficient of risk decisions is adoption of scientific - practical argued decisions.

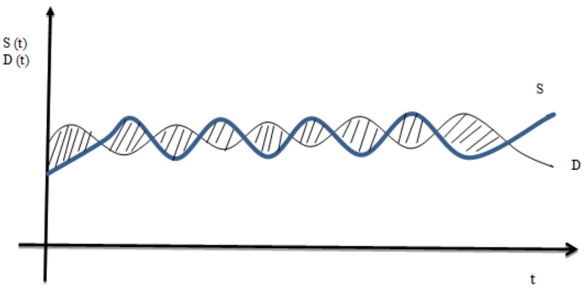

Figure 3. The evolutions of agricultural products demand, supply
Source: elaborated by author

Production costs (k) depend on the volume of S (t) production at time t. That is, the production costs can be expressed by the function f (S(t)) with the following properties: f'(S(t))>0; f"(S(t))>0 (Figure 4).

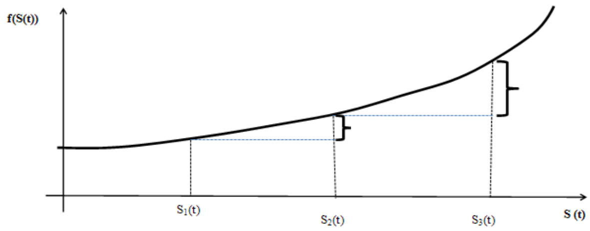

Figure 4. Growth rate of production costs exceed the growth rate of products volume
Source: elaborated by author

Agricultural enterprise in time t can provide the volume of products by S (t); demand of the respective products constitutes D (t); the volume of products at the initial moment (t=0) constitutes R (0) at the time t R(t) = S(t) – D(t) + R (0). The total costs of agricultural enterprise K consist of total production costs and from the additional expenses related to the surplus items or misses the potential profits.

$$K = \tau \int_0^{\tau} (S(t) - D(t) + R(o))dt + \int_0^{\tau} f(S(t))dt$$

Objective function value K represents the total production costs and additional expenses related to the surplus supply over demand or misses the potential profits. The function K depends not on the value of certain variables, but by a function S (t). The problem of the farmer shall be reduced to determining optimal function of output growth over time. From the infinity of possible variants of these functions must be chosen the function for which the total cost K will be minimal. Determination of minimum value of the functional K, in this case, is unconditional. In principle, the farmer may introduce additional conditions on matters variables S (t), R (t). In principle, the farmer may introduce additional conditions on matters variables S (t), R (t). In order to determine function S (t) that minimizes the functional value K (S (t)) we shall use Euler's equation. To deduce this equation we consider integral

$$I = \int_a^b F(S(t), S'(t), t)dt.$$

We accept that the function S (t) and its variation ΔS (t) are the first and second derivatives with respect to t.

Total change in the functional

$$\Delta I = \int_a^b \left(\frac{\partial F}{\partial S(t)} \Delta S(t) + \frac{\partial F}{\partial S'(t)} \Delta S'(t)\right) dt$$

Or

$$\Delta I = \int \downarrow a^{\uparrow} b ▒ 〖\partial F/\partial S(t) \Delta S(t)dt〗$$

$$+ \int \downarrow a^{\uparrow} b ▒ 〖\partial F/\partial S'^{(t)} \Delta S'^{(t)}dt〗$$

$$= \int \downarrow a^{\uparrow} b ▒ 〖\partial F/\partial S(t) \Delta S(t)dt〗 +$$

$$+[\partial F/\partial S(t) \Delta S(t)] ■ (b@a)$$

$$- \int \downarrow a^{\uparrow} b ▒ d/dt\ \partial F/(\partial S^{\uparrow\prime}(t))\Delta S(t)dt$$

$$= \int \downarrow a^{\uparrow} b ▒ (\partial F/\partial S(t) - d/dt \partial F/$$

It results therefrom: $\frac{\partial F}{\partial S(t)} - \frac{d}{dt}\frac{\partial F}{a S'(t)} = 0$

Euler's differential equation.

We apply the Euler's equation for determining the minimum conditions necessary by the functional (3.1):

$$\frac{\partial E}{\partial S(t)} = \tau\ ;\ \frac{d}{dt}\frac{\partial F}{\partial S'(t)} = \frac{d}{dt} f'(S(t)) = 0$$

therefore

$$\frac{\partial F}{\partial S(t)} - \frac{d}{dt}\frac{\partial F}{\partial S'(t)} = \tau - \frac{d}{dt} f'(S(t)) = 0$$

It follows

$\tau - d/dt f^{\uparrow\prime}(S(t) = f^{\uparrow n} (S(t)) * S'(t)$

where:

$f'(S(t))$ - marginal production costs;

$\frac{d}{dt} f'(S(t))$ - modification of marginal costs, which must coincide with τ .

In other words $\tau * dt = f^{\uparrow n}(S(t) * S'(t)$.

Production costs and the volume of finished products are in direct dependence. In other words, production costs are determined by function:

$$K = \tau \int_0^T (S(t) - D(t) + R(o))dt$$

$$+ \int_0^T f(S(t))dt$$

will have the minimum value when $\tau - \frac{d}{dt} f'(S(t)) = \frac{d}{dt}(as^2(x) + bS(x) + c)'$ $= 2as'(x)$, therefore

$(x) = s'(x) = \frac{\tau}{2a}$, when we obtain

$$S(x) = \frac{\tau}{2a} t + C$$

For the period (0, t) the volume of production constitutes

$$S(x) = \int_0^t (\frac{\tau}{2a} t + C)dt = \frac{\tau}{4a} t^2 + C * t$$

Let us examine a concrete example of planning the production volume during the period (0, t). Based on the data form no. 9-CAI agricultural enterprises "Carahasani - Agro" and "Nistru - Olănești" Table 1, by using Lagrange polynomial:

$$f(s) = \frac{(s - s_1)(s - s_2)}{(s_0 - s_1)(s_1 - s_2)} f(s_0) +$$

$$+\frac{(s-s_0)(s-s_2)}{(s_1-s_0)(s_1-s_2)}f(s_1)+$$
$$+\frac{(s-s_1)(s-s_0)}{(s_2-s_1)(s_2-s_0)}f(s_0)$$

We determine production costs f (s) depending on the volume of production for wheat $f^{(s1)}_{001_1}$, corn $f^{(s2)}_{001_8}$, seed corn $f^{(s3)}_{001_9}$:

$$f^{(s1)}_{001_1} = 0{,}00_{2 s_1^2(t)} + 0{,}034 s_1(t) + 1 \text{ (wheat)}$$

$$f^{(s2)}_{001_8} = 0,0_{1 s_2^2(t)} + 0{,}05 s_2 + 1 \text{ (corn)}$$

$$f^{(s3)}_{001_9} = 0{,}00_{2 s_3^2} + 0{,}053 s_3 + 1 \text{ (seed corn).}$$

We calculate the volume of production for the period (0, t):

$$\widetilde{S_1}(t) = \int_0^t \left(\frac{\tau_{011_1}}{0{,}00_4} t + k_1\right) dt = \frac{\tau_{001_1}}{0{,}00_8} t^2 + t k_1$$

$$(t) = \int_0^t \left(\frac{\tau_{001_8}}{0{,}0_2} t + k_2\right) dt = \frac{\tau_{001_8}}{0,0_4} t^2 + t k_2$$

$$\widetilde{S_3}(t) = \int_0^t \left(\frac{\tau_{001_9}}{0,0_4} t + k_3\right) dt = \frac{\tau_{001_9}}{0,0_8} t^2 + t_3$$

Table 1. The quantity and cost of finished products

Products	Code	$S_{(0)}$	$f_{(s(0))}$	SRL „Carahasani – Agro”		S.A.” Nistru – Olăneşti”	
				Quantity	The cost of finished products	Quantity	The cost of finished products
Cereals and grain legumes – total	0010	0	0,3	29,9	2,7	565	11,0
Wheat	0011	0	0,2	21,9	1,9	32,4	3,4
Grain legumes	00170	0	0,005	0,33	0,047	1,02	0,28
Corn – total	0018	0	0,02	2,6	0,24	23	7,3
Seed corn	0019	0	0,001	0,017	0,01	10,9	6,09
Sunflower	0020	0	0,1	5,2	1,0	6,21	1,3
Sunflower Seeds	0021	0	0,003	0,11	0,033	0,08	0,12
Vegetable field	0130	0	0,04	1,22	0,367	5,0	1,07
Total fruits and berries	0155	0	0,07	4,3	0,7	8,5	1,3
Stone fruits	0165	0	0,07	4,3	0,7	6,1	0,8
Cattle and poultry in live weight	0220	0	0,02	1,04	1,9	0,2	0,4
Cattle in live weight	0230	0	0,02	1,04	1,9	0,12	0,3
The whole milk	0300	0	0,01	6,5	1,4	0,7	0,17

Source: Specialized forms of agricultural enterprises no. 9 - CAI activity for S.A "Nistru - Olăneşti" and SRL "Garahasani - Agro" from Stefan Voda district

Thus, production plans for each considered crop are expressed by linear functions in relation to t, are increasing functions. Functions $S_1(t)$, $S_2(t)$, $S_3(t)$ can be represented geometrically by straight angular coefficients: $\frac{\tau_{011_1}}{0{,}00_4}$, $\frac{\tau_{001_8}}{0{,}0_2}$, $\frac{\tau_{001_9}}{0{,}0_4}$, which intersect the ordinate axis at the distances k_1, k_2, k_3.

Variations in demand D(t) are rigid, the farmer complies market and to reduce the area determined by the intersection of S(t) * D(t), curve D(t) "segmented" it, each segment is located at the optimal distance to D(t) (Figure 5).

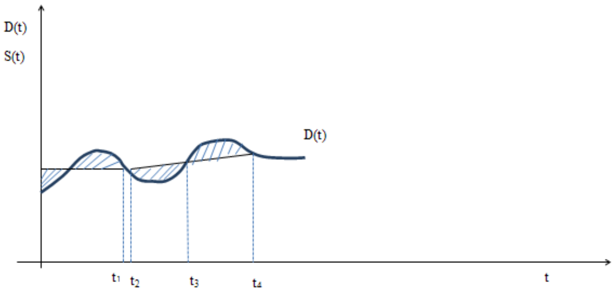

Figure 5. Interpretation of minimal risk

Source: elaborated by author

The gap between demand D (t) and supply S (t) is represented by the shaded spaces. Problem solutions are discrete: supply S (t) "down" or "climb" depending on fluctuations in market prices. Function of production costs can be a third degree polynomial:

$f(s(t)) = as^3(t) + bs^2(t) + cs(t) +$

In this case the supply function will not be linear but a logarithmic curve also: we get a solution which consists in the fact that the discrete supply function, during certain periods, moves in the "up", "down". Processes exposed creates prerequisites for reducing the amount of possible risk, but not guided by risk. The risk is high or low depending on quality of manager's decision. The manager can reduce, increase the number of risky situations (producing risks). The manager makes decisions, usually under conditions of uncertainty. Optimal coefficient of risk manager can determine it with the formula:

$$P(S(t)) = \frac{\tau_{1-f''(s(t))}}{\tau_1 + \tau_2},$$

where:

τ_1, τ_2 - specific production costs, of deficit.

In many cases in economic activities: the development of high incomes is accompanied by high risks. The risk can be quantified by using dispersion, standard deviation from the line (equation) regression, coefficient of correlation. Income hoped (expected) - by using mathematical expectancy.

Dependence between risk and incomes is expressed by function:

$$\tau_{\downarrow} i = \tau_{\downarrow} f + \beta_{\downarrow} i(\tau_{\downarrow} m - \tau_{\downarrow} f)$$

where: τ_f - created income norm;
τ_m - potential income (probably);
β_i- risk coefficient of asset i;
τ_i - hoped income.

CONCLUSIONS

From the conducted researches we can conclude the following:

- An effective management system must evolve progressively by applying advanced techniques, methods and principles of quality, competitiveness and risk management.
- The risks can be managed through optimal decisions taken by the manager, which minimizes the risk coefficient. Through an insufficient level of information, risks can be generated by the manager himself.
- In conditions of uncertainty is important for the enterprise organization of analytical test procedures, calculation, deduction, analysis of the occurrence of probabilities generating the potential risks.
- In the market economy appears necessary of risk assessment and evidence and elaboration of a decision-making mechanism. In complicated situations, the man is usually more prone to making decisions under risk conditions. In addition, his training to use risk is determined the most part by the results of the previous decisions.

REFERENCES

Berzon N.I., Volodin S.N., 2009. Oţenka finansovih activov po criteriu “risc - dohodnosti” s uciotom deitelinosti investirovania. EIVSHE, nr. 3, p. 311-325.

Lange O., 1970. Decizii optime, bazele programării. Ed. Ştiinţifică, Bucureşti, p. 316

Maximilian S., 2009. Modelarea proceselor economice. Chişinău, ULIM, p. 226.