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AGRICULTURAL UNIVERSITY OF SZCZECIN
FACULTY OF ECONOMICS AND ORGANIZATION OF FOOD ECONOMY

MODELLING OF ECONOMY IN SPECIALLY PROTECTED REGIONS

Proceedings of the international conference held on 9-11 june 1994 in Drawno, Poland

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MODELLING OF ALTERNATIVE AGRICULTURAL SYSTEMS ECONOMY IN HILL REGIONS OF CZECH REBUBLIC

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Before any attempt to model the interaction between agriculture and ecology is undertaken we have to identify the principles and problems. In the literature the terms such as alternative agriculture, organic farming, bioproduction, low input systems, ecologically friendly production, etc., are used side by side. Some authors, incl. us, prefer to use the expression "sustainable development of agricultural production", which more or less includes the content of all other terms.

In our contribution we use the expression, "alternative agriculture" to indicate all changes in inputs, structure of crop and animal husbandry, soil management, etc., which should have positive effects upon environment. The typical examples are the conservative soil management as an assumption for low chemical inputs into integrated crop production systems which produce

the healtly food and protect the environment. A complex application of these approaches, however, increase principally the demands for the level of management, as well as the demand for the education in ecology and marketing of both the farmers and the consumer population.

One of the typical features of market economy were the structural crises, which were the reasons for rapid increase in prices of energy and raw materials. These changes usually initiated the fast development of utility saving technologies. Due to the absence of the category "value" and therefore the lack of the cost estimates of the components of the environment, there does not exist the feed-backs in the alternative agricultural systems.The main priority is to set up the systems of cost estimation of land as a the basic production tool in agriculture, as well as of the basic element of the landscape.

The variability of the environmental model is due to the complex character of an ecology. Within current environmental models we can identify two different groups:

1. Economic-mathematical models of the production structures and systems, used for long term projection of the sustainable development of agricultural production.

2. Partial models of individual components of the environment, investigating the natural and technical laws of the dynamics of the given phenomena.

The current trends are directed toward the unification of both approaches into the complex hierarchical compartmental models, as described in our second contribution. The models, however complex, cannot be the goals themselves, but they can be invaluable in the targeting of the management in given area.

The models of the agroecosystems can be classified into the following categories:

A. According to the formal tools used:

1. Models based on the classical tools of the economic--mathematical models, ie. linear programming and structural analysis. Such models are valuable at the regional and farm level. The reasonable selection of the vector of activities, of the set of limiting assumptions, and of the definition of the goal function makes possible to suggest such a structure of the agricultural production, which does not have an adverse effect upon the environment, whilst maximizing the efficiency of the enterprise. In connection with the distribution models they can serve for the optimal allocation of the available resources for the revitalisation of the environment.
2. Dynamic models are based upon the FORRESTER models of dynamic behaviour, which allow the monitoring of the interaction between agricultural production and ecology.
3. Econometrical models are constructed using the statistical analysis of the long term economical and ecological observations. They are very useful in the diagnostics and prognosis of some ecological phenomena. However, they can not be used to predict the behaviour of the new systems after the realization of the structural changes.
4. Simulation models make possible an interactive aproach to the model building from partial compartments, using heuristics, statistics, biometrics, and other scientific fields.

B. According to the use of the models:

1. Diagnostic models, explaining the cases, interactions, and predicting the consequences of the reproduction process upon environment.
2. Project models, serving for an investigation of the new structures, technologies and measures, aiming at the reduction of environmental pollution from the reproductive process.
3. Prognostic models make possible to anticipate changes both of agricultural production and of the components of environment after restructuring of the enterprise in pre-selected time horizont. conversion period. The ecological models have, however, some specific features. The first feature is the problem of the criteria selection. Some authors use as a principal criteria "the ecological load" as a complex character.

LAMSER (1986) considered it as an economical expression of losses due to the pollution of environment , together with inputs, necessary to protect the environment. The second feature is the result of unprecise quantification of ecological criteria. In construction of our models we meet criteria , defined for example as "to reduce as much as possible". The formulation of such orders is possible using the theory of "fuzzy" groups.

The third feature is the necessity to take into consideration the extreme cases, which are usually excluded. However, the serious ecological crises were the results of the extreme, unpredicted conditions. For that reason the criterium "to minimize the risk" often appears in ecological models.

The current results of the application of ecological models indicate the fast development in the near future in two respects:

1. the application of the already known procedures, used up to now in other fields of modelling, and

2. the fast development of new models and procedures just for the purposes of ecology, based for instance on the image processing and graphical information systems (GIS).

2. Case study.

The economic-mathematical model from the category A.1 has been used for the project of the restructuring of agricultural production in the hill region of Bruntal, where are the catchment areas of the drinking water reservoirs for the industrial area around Ostrava.

Our research is aiming at the comparison between the current state of conventional agriculture and the proposed alternative of sustainable, environmentally friendly, development of low input agricultural production.

Let us suppose that in the given region there exists the conventional system of farming (I). We want to introduce there the alternative sustainable system (II). The inputs and outputs of the systems are denoted as x_1 , y_1 , and x_2 , y_2 , respectively.

In both systems the inputs are transformed into the outputs according to the relations

$$\text{(I)} \qquad y_1 \leq A_1 \, x_1 \, ,$$

$$\text{(II)} \qquad y_2 \leq A_2 \, x_2 .$$

We assume, that the matrices A_1 and A_2 are rectangular with the number of columns n being larger than number of rows m,

which means that both systems have unlimited number of solutions. The aim is now to compute- from the known components of the vectors $x_1 \geq 0$, and $x_2 \geq 0$/*ie.* the production structure the system which produce the maximum gain, providing the observation of ecological limits, formulated in the systems (I), and (II).

We have to find the solution of the models

Model I and Model II

$$y^1 = b_1 - A^1 \cdot x^1 \qquad y_2 = b^2 - A^2 \cdot x^2$$
$$z^1 = C^1 \cdot x^1 \qquad z_2 = C^2 \cdot x^2$$
$$x^1 \geq 0 \qquad x^2 \geq 0$$

Now it is important to analyse both solutions from the point of view of gains Z_1 and Z_2. We can arrive into following alternatives:

(a) $Z_1 = Z_2$.

A new proposed alternative structure of sustainable development is found as profitable as the conventional agricultural system.

It is therefore possible to apply it in the given region.

(b) $Z_1 > Z_2$.

The alternative structure is less profitable than the convetional one by the difference $M = (Z_1 - Z_2)$. The realization of such an ecological structure is not possible without the subsidy M.

(c) $Z_1 < Z_2$.

The proposed structure of sustainable development is more profitable than the conventional one, due to the lower inputs and higher market prices of organic production.

If the farm is not profitable in the conventional regime and the lost is subsidied, the subsidy must be considered in the estimation of the system (II).

4. Conclusions

The construction of the succesful economic-mathematical model needs a close cooperation of the farm managers and model builders from the extension service. They both must meet basic requirements, which are not yet common in our country:

1. Comprehensive understanding of the rules of the market economy as applied to the alternative agriculture.
2. New methods of measuring the farm performance using fixed and variable cost of organic products, cash flow etc.
3. An appreciation of how farm businesses are managed in the market economy.
4. Understanding of the processes in the philosophy of the organic farming and in the management of the production and marketing the main agricultural commodities.

The participation of the farm managers in the model's construction and exploitation can greatly increase the value of the models in the process of restructuring of agricultural enterprises necessary in the specially protected areas.

The application of such models is necessary before any attempt to convert the conventional systems into alternative one is carried out.

The proposed way of model building should be prefered, because of the possibility of fast economical evaluation of different ecological strategies at the period of conversion. On the other hand, our approach can be used for the estimation of the fixed and/or variable cost of different components of the environment. The models, however, should not be seen as means to an end only, when plans are required for a bank or subsidy purposes, but should be actually used as powerful tools in the agricultural management.

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