# OPTIMIZATION OF THE DIMENSION OF FRUIT GROWING PLANTATIONS IN THE BACĂU COUNTY, IN ORDER TO INCREASE THE ECONOMIC EFFICIENCY OF PRODUCTION

# OPTIMIZAREA DIMENSIUNII PLANTAȚIILOR ŞI A PRODUCȚIEI DE FRUCTE ÎN FERMELE POMICOLE DIN JUDEȚUL BACĂU ÎN SCOPUL CREŞTERII EFICIENȚEI ECONOMICE A PRODUCȚIEI

***BREZULEANU S.***
University of Agricultural Sciences and Veterinary Medicine Iasi

***Abstract.*** *A determining factor in increasing the economic activity at the Joint-Stock Company of BENEŞTI is the dimension of fruit growing areas within the whole sector for the main species. As regards the optimum dimension of fruit growing plantations, from the analysis of technical-economic indicators during 2004-2006, we had in view the following criteria: minimization of production expenses per fruit growing hectare, minimization of production expenses per plum tree cultivated hectare, minimization of production expenses per apple tree cultivated hectare. The paper had in view only the whole dimension of the fruit growing farm and the dimension of the main fruit tree species cultivated at the agricultural farm.*

**Rezumat.** *Un factor determinant în creşterea performanțelor activității economice la S.C. BENEŞTI S.A îl reprezintă dimensionarea suprafețelor pomicole, pe ansamblul sectorului şi în cazul principalelor specii. În ceea ce priveşte dimensionarea optimă a plantațiilor pomicole, din analiza indicatorilor tehnico-economici, în perioada 2004-2006, s-au avut în vedere următoarele criterii: minimizarea cheltuielilor de producție la un hectar pomicol; minimizarea cheltuielilor de producție la un hectar cultivat cu prun; minimizarea cheltuielilor de producție la un hectar cultivat cu măr. Analiza s-a limitat la dimensionarea de ansamblu a exploatației pomicole şi la dimensionarea principalelor specii pomicole cultivate de societate agricolă.*

## MATERIALS AND METHODS

The methodology of calculating and optimizing the dimension of fruit growing farms, cultivated intensively, was applied to the Joint-Stock Company of BENEŞTI - Stănişeşti, Bacău County, a farming company known for its fruit growing production in the area of the Zeletin Basin.

## RESULTS AND DISCUSSIONS

The fruit growing company is an important fruit supplier, supplying the market of the Bacău County and of the neighbouring counties, as well as for exportation. The great and diversified demands for fruits, as well as the availability of fields and soil climatic conditions, have contributed to the introduction and extension under intensive system, of fruit tree species and varieties, very valuable from the nutritional viewpoint, and extremely solicited on market.

We refer in this study especially to plum tree growing, but also to apple tree and cherry tree cultures. Since setting up, such an assortment structure has brought important benefits to the farming societies.

During the analysed period (2005-2007), the fruit growing area was the same, with certain prospects of increasing the area occupied by fruit growing plantations.

The first approach for setting up a fruit growing plantation is choosing properly the field.

The practice pointed out the factors of fruit agro-productivity, which one may take into account in choosing the fields for orchard setting up, such as: climatic, soil and relief conditions, biological peculiarities of plants and growing technological systems.

The fruit species (varieties) have specific biological demands to the climatic and soil factors, which must be met by choosing the fields meant to their growing. The achievement of this fundamental condition for the harvest level requires both the deep knowledge of fruit tree needs and tolerances to different climate and soil factors, and the knowledge of the regime of these factors, of reciprocal relations and of the relations to the fruit trees, under different climate, soil and water conditions.

Although in the fruit growing structure of the Joint-Stock Company of BENEŞTI- Stănişeşti, Bacău County, apple trees and cherry trees occupy insignificant areas after plum trees, these species were not extended at the level of possibilities. The ratio between young and fruitful orchards is not proper, knowing that a good perspective fruit growing must have permanently in its structure 25% of young orchards. This case was not found at the Joint-Stock Company of BENEŞTI, where young areas occupied by apple trees or cherry trees represent 2-3% of the total fruit growing area, situation determined by extremely high costs of setting up fruit tree plantations.

A determining factor in increasing the performances of the economic activity at the Joint-Stock Company of BENEŞTI is dimensioning the fruit growing areas, on the entire field and in case of main species.

As concerns the optimum dimensioning of fruit growing plantations, during 2004-2006, from the analysis of technical-economic indicators, we had in view the following criteria: minimising the production expenses at one ha of fruit trees; minimising the production expenses at one ha cultivated with plum trees; minimising the production expenses at one ha cultivated with apple trees.

The analysis was limited to the dimensioning of fruit growing farm and to the dimensioning of main fruit tree species cultivated in the farming company.

The economic-mathematical optimization model refers to the parabolic regression, of the following type: y = ax2 + bx + c, where: x = dimension of the fruit growing area, respectively of the area cultivated with plum trees and of the area cultivated with apple trees; y = dimension of production expenses per ha.

The obtained parabolic regressions are the following: For the fruit growing area of the farm y = 2.2129466x2 – 1781.016942x + 381934.0039; Correlation ratio *) (R) = 0.8906

*) Coefficient expressing the intensity of connections between the variables of the model in case of non-linear models. For the area cultivated with plum treesy = 4.14444765x2 – 2357.11475x + 364184.4317 ; Correlation ratio (R) = 0.8344 ; For the area cultivated with apple trees y= 150.69848x2 – 29854.8816x + 1484549; Correlation ratio (R) = 0.9787.

From the analysis of the models of parabolic regression, we may draw the conclusion that intensifying the connection between the dimension of fruit tree areas and the level of production expenses per ha is very tight, the correlation ratio having values comprised between 0.8344 and 0.9787. It means that the degree of determining the expenses per ha is almost entirely influenced by the size of fruit tree

areas: 79% in case of fruit growing plantations; 69.6% in case of plum tree plantations and 95.8% in case of apple tree plantations.

The high level of the correlation ratio also pointed out that the connection between the size of fruit growing areas and the level of production expenses per ha was correctly described by the chosen parabolic regression. Any other model could not describe correctly the dependence between dimension and expenses per ha of the fruit growing plantation.

Related to the chosen criterion of minimising the production expenses at the area unit, the optimum dimension was established in case of fruit growing plantations from the Joint-Stock Company of BENEŞTI. Thus, the optimum fruit growing area is of **120 hectares**, dimension that minimises the expenses per ha at only 43586.215 thousand lei, a more reduced level than the one registered in case of smaller or larger sizes than this dimension, which is the best.

If we consider the dimension according to fruit tree species, we must point out that the agricultural exploitation must resize its structure on species and to promote those that find favourable climatic conditions; these are plum trees and apple trees. As concerns the plum tree growing, the established regression equation has indicated as optimum the area of 64 ha, meaning a more reduced area cultivated with this crop by 13% than the real one (80 ha). If this size is promoted, one may get a level of expenses per ha of 29,038.412 thousand lei, more reduced with 43% than in case of a dimension of 50 ha and by 19% than in case of a dimension of 70 ha.

This case emphasises the need to optimise the dimension of fruit farms.

The optimization of the structure of fruit tree plantations according to species, under conditions of certain areas, limited as size, is very important, allowing the establishment of the optimum ratio between various species having positive economic effects, and it represents a very complex problem that can be solved by means of calculation mathematical models.

Taking into account the above-mentioned, we are going to present the economic-mathematical model of optimizing the fruit tree plantations according to species, within the Joint-Stock Company of BENEŞTI, Bacău County.

The elaboration of the mathematical optimization model was done in the following stages:

1. **Determination of variables .**We have taken into account the species that meet natural and economic conditions, the most favourable within the area (apple tree, cherry tree and plum tree). Considering that within the company there are areas planted only in intensive system, two or three variables were established for each species, according to the earliness of the production: $X_1$ – area with intensive apple trees, late varieties; $X_2$ –area with intensive apple trees, summer varieties; $X_3$ –area with intensive cherry trees, late varieties; $X_4$ –area with intensive cherry trees, late varieties ;$X_5$ –area with intensive plum trees, late varieties; $X_6$ –area with intensive plum trees, semi-late varieties; $X_7$ –area with intensive plum trees, late varieties; $X_8$ – other species in intensive system (sour cherry trees, apricot trees).

2. **Determination of technical and economic coefficients.**The technical and economic coefficients were extracted from the production technologies established for each species, representing values reported to the area unit (ha).

Based on the technical and economic coefficients from table 1 and on those mentioned in the working stages, the following restraints were formulated: 1) The entire area meant for fruit tree plantations should be occupied: $X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 = 120$ ha; 2) Area cultivated with intensive apple trees, late varieties; 3) Area cultivated with intensive apple trees, summer varieties; 4) Area cultivated with intensive cherry trees, late varieties; 5) Area cultivated with intensive cherry trees, late varieties; 6) Area cultivated with intensive plum trees, early varieties; 7. Area cultivated with intensive plum trees, semi-late varieties; 8) Area cultivated with intensive plum trees, late varieties; 9) Area cultivated with other varieties; 10) Limiting the labour consumption: $120 X_1 + 100 X_2 + 230 X_3 + 185 X_4 + 125 X_5 + 142 X_6 + 156 X_7 + 180 X_8 \geq 0$ days/man; 11) Limiting the fuel consumption:$300 X_1 + 280 X_2 + 230 X_3 + 210X_4 + 250 X_5 + 260 X_6 + 270 X_7 + 200 X_8 \geq 0$ litres; 12) Limiting the chemical fertilizer consumption: $300 X_1 + 250 X_2 + 350 X_3 + 300X_4 + 350 X_5 + 400 X_6 + 400X_7 + 250 X_8 \geq 0$ kg a.s.; 13) Limiting pesticide expenses: $1000X_1 + 850 X_2 + 800 X_3 + 650 X_4 + 600 X_5 + 650 X_6 + 700 X_7 + 500 X_8 \geq 0$ thousand lei; 14) Limiting the expenses with different materials :$50 X_1 + 60 X_2 + 60 X_3 + 60 X_4 + 60 X_5 + 60 X_6 +60 X_7 + 50 X_8 \geq 0$ thousand lei; 15) Limiting total production expenses :$34150 X_1+28180 X_2+16490 X_3+16200 X_4+16740 X_5+18550 X_6+19750 X_7+9860 X_8\geq 0$; 17) Non-negativity conditions: $X_1 \geq 0$; $X_2 \geq 0$; $X_3 \geq 0$; $X_4 \geq 0$; $X_5 \geq 0$; $X_6 \geq 0$; $X_7 \geq 0$; $X_8 \geq 0$; $X_9 \geq 0$; $X_{10} \geq 0$; $X_{11} \geq =0$. Function objective – profit maximising:$15250 X_1+51134 X_2 + 7510 X_3 + 8800 X_4 + 3580 X_5 + 6270 X_6 + 7150 X_7 +3250 X_8 \rightarrow$MAXIM.

As concerns the above – mentioned restraints, we must explain the following: The 120 ha represent the area of fruit tree plantations the company proposed to exploit in the prospect of year 2010 and which resulted after the action of optimizing the fruit tree areas from the Zeletin Basin. From this area, about 20 ha are trained for planting with different species, the exploitation being done in intensive system; The company has in exploitation significant areas of plantations with different species. Taking into account their relatively young age, some of them will be kept under exploitation until reaching the minimum profitableness threshold. The prospect strategy of the company has in view that all the areas should be done in intensive system; The level of mean yields and the incomes for each species are found at a high level, for ensuring a corresponding mass of the total profit, in order to achieve the economic competitiveness of the company. This made that the size of the technical coefficients (consumption of chemical fertilizers and manure, fuel and labour) and the economic ones (total production expenses) should not be restrictive within the mathematical relations. This consumption of factors corresponds to the technological demands, which will be used for ensuring the established production levels.; The prices for the capitalization of production, which are found at the level of total incomes for each product, were established according to the prices practiced by the company in 2007, with different economic agents, both in the country and at exportation, taking into account the trend of the price evolution of the production factor and of the fruits; e) The Joint-Stock Company of BENEŞTI has as aim, by the total volume of the estimated profit, to insure its own funds, both for the periodic

running of the production cycle and for the development, restructuration and modernization of the production structures within the company.

Data comprised in the economic-mathematical model have been ordered, being found in its design (tab. 2).

After solving this model, in which the function objective was maximising the profit, it resulted the structure on species of fruit tree plantations (tab. 3).

*Table 3*

**Structure on species of fruit tree plantations– optimized variant**

| No. | Species / variant | Area - ha - | Structure - ha - |
|---|---|---|---|
| 1 | Intensive apple trees, late varieties | 10 | 8.3 |
| 2 | Intensive apple trees, summer varieties | 30 | 25.0 |
| 3 | Intensive cherry trees, early varieties | 6 | 4.6 |
| 4 | Intensive cherry trees, late varieties | 7 | 5.4 |
| 5 | Intensive plum trees, early varieties | 25 | 19.2 |
| 6 | Intensive plum trees, semi-early varieties | 40 | 30.8 |
| 7 | Intensive plum trees, late varieties | 0 | 0 |
| 8 | Other species | 2 | 1.5 |
| | Total | 120 | 100.0 |

Of the total area of fruit tree plantations, the seed species represent 33.3 % (apple tree), while stone species (cherry tree, plum tree) have the highest percentage.

*Table 1*

**Technical and economic coefficient for the optimization of fruit tree plantation structure on species**

| Specification | | MU | Intensive apple trees winter | Intensive apple trees summer | Intensive cherry trees | | Intensive plum trees | | | Other species |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Late | Early | Early | semi early | Late | (cherry trees apricot trees) |
| VARIABLES | | | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ |
| MEAN YIELD | | t/ha | 32 | 27 | 10 | 8 | 12 | 14 | 15 | 8 |
| CONSUMPTION: | Labour | d.m. | 120 | 102 | 230 | 185 | 125 | 142 | 156 | 180 |
| | Manure | ton | 15 | 15 | 12 | 12 | 12 | 12 | 12 | 10 |
| | Chemical fertilizers | Kg s.a | 300 | 250 | 350 | 300 | 350 | 400 | 400 | 250 |
| | Fuel (gasoil) | litres | 300 | 280 | 230 | 210 | 250 | 260 | 270 | 200 |
| | Insectofungicides and herbicides | RON | 1000 | 850 | 800 | 650 | 600 | 650 | 700 | 500 |
| | Diverse materials | RON | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 50 |
| TOTAL PRODUCTION EXPENSES | | RON | 34150 | 28180 | 16490 | 16200 | 16740 | 18550 | 19750 | 9860 |
| PRODUCTION COST | | RON /kg | 1.06 | 1.93 | 1.95 | 2.02 | 0.97 | 1.03 | 0.88 | 1.0 |
| VALORIZATION PRICE | | RON /kg | 1.72 | 2.1 | 2.5 | 3.0 | 2.2 | 2.0 | 2.4 | 1.3 |
| VALUE OF THE PRODUCTION AT VALORIZATION PRICE | | RON | 49400 | 39520 | 24000 | 25000 | 20320 | 248210 | 26900 | 13110 |
| RAW PROFIT | | RON | 59000 | 50000 | 16000 | 55200 | 51200 | 12000 | 30500 | 10000 |

*Table 2*

**Design of the economic-mathematical model of optimization on species of fruit tree plantations**

| No. | NAME OF RESTRAINT | V A R I A B L E S | | | | | | | | Sign | Size of restraint | MU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | | | |
| 1 | Total area | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | = | 120 | ha |
| 2 | Minimum area with intensive apple trees- winter | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ≥ | 7 | ha |
| 3 | Maximum area with intensive apple trees- winter | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ≤ | 10 | ha |
| 4 | Minimum area with intensive apple trees- summer | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | ≥ | 27 | ha |
| 5 | Maximum area with intensive apple trees- summer | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | ≤ | 30 | ha |
| 6 | Minimum area with intensive cherry trees- winter | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | ≥ | 6 | ha |
| 7 | Maximum area with intensive cherry trees- late | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | ≤ | 12 | ha |
| 8 | Minimum area with intensive cherry trees- winter | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ≥ | 4 | ha |
| 9 | Maximum area with intensive cherry trees-early | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ≤ | 10 | ha |
| 10 | Minimum area cultivated with intensive plum trees -early | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | ≥ | 25 | ha |
| 11 | Maximum area cultivated with intensive plum trees -early | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | ≤ | 30 | ha |
| 12 | Minimum area cultivated with intensive plum trees- semi-early | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | ≥ | 40 | ha |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | Maximum area cultivated with intensive plum tree- late | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | ≤ | 15 | ha |
| 14 | Area cultivated with other species - classic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | ≥ | 2 | ha |
| 15 | Consumption of manure | 15 | 15 | 12 | 12 | 12 | 12 | 12 | 10 | ≥ | 0 | tons |
| 16 | Consumption of chemical fertilizers | 300 | 250 | 350 | 300 | 350 | 400 | 400 | 250 | ≥ | 0 | kg a.s. |
| 17 | Consumption of gasoil | 300 | 280 | 230 | 210 | 250 | 260 | 270 | 200 | ≥ | 0 | litres |
| 18 | Consumption of labour | 120 | 102 | 230 | 185 | 125 | 142 | 156 | 180 | ≥ | 0 | d.m. |
| 19 | Total production expenses | 34150 | 28180 | 18490 | 16200 | 16740 | 18550 | 19750 | 9860 | ≥ | 0 | RON |
| 20 | Total income | 49400 | 39520 | 24000 | 25000 | 20320 | 24820 | 26900 | 13110 | ≥ | 0 | RON |
| F.O. | Maximising the profit | 15250 | 11340 | 7510 | 8800 | 3580 | 6270 | 7150 | 3250 | -> | Max | RON |

# CONCLUSIONS

The optimization of the dimension of the fruit tree area from the Joint-Stock Company of BENEŞTI means an increase by 20 %, compared to the present size (100 ha), and the promotion of only two fruit tree species, which are fit for an intensive fruit growing: plum trees, on the optimum area of 64 ha and apple trees, on the optimum area of 56 ha, that is with 46 ha more than today.

Under conditions of an optimum size-farm, its manager can monitor directly the development of the main technological works, know the coverage degree of the execution possibilities of these works and take urgent measures in case of appearing some discordances. It is ideal for the manager to be involved in organizing and ruling the fruit tree farm, starting with the decision of setting up the fruit tree plantation, establishing the objectives and continuing the selection of species and varieties assortments, growing systems , land preparation and planting, until harvesting and valorization of fruit tree production.

Because at the Joint-Stock Company of BENEŞTI, the rational use of production factors may be done only within a certain field area, the rational organization and rule of the activity should have in view the dimensioning of field areas, which allow the efficient use of production factors , specific to the fruit tree farm. This dimensioning of the cultivated areas may be solved by two modalities: either by using more compact areas, for the application of modern and rational technologies, which reduce at maximum the production expenses, or by placing crops on optimum size-areas, for increasing the profitableness of the produces.

Our study has shown that the proposed changes concerning the way of using the land fund and the structure of cultures represent not only the rational use of land but also its protection, and of the environment, generally

## REFERENCES


1. **Brezuleanu S., Ciurea I., Ştefan G., Brezuleanu Carmen Olguța, 2001**- *Tendințe privind orientarea structurilor de producție în agricultura zonelor defavorizate din Moldova* Universitatea de Ştiințe Agricole şi Medicină Veterinară Bucureşti, Facultatea de Management, Inginerie Economică în Agricultură şi Dezvoltare Rurală.
2. **Brezuleanu S., 2004 –** *Management agricol –teorie şi practică*. Editura Performantica Iaşi.
3. **Chetty Sylvie, 1996 –** *The Case Study Method for Research in Small and Medium Sized Firms.* International Small Business Journal Vol. 15 nr. 1
4. **Isac, I., 2000** - *Managementul tehnico-economic al exploatației pomicole,* Editura Pământul, Piteşti.
5. **Merce E., Merce Elena, 1993 –** *Dimensiunea optimă a exploatației agricole*. Lucr. Ştiințifice seria Agricultură-Horticultură, vol. 46, USAMV, Cluj Napoca