
VALUE ASSESSMENT OF FRUIT ORCHARDS BASED ON THE COSTS OF ESTABLISHMENT

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ABSTRACT

The necessity for value assessment of fruit orchards (an orchard as a whole and/or individual fruit trees grown therein) arises in instances of the damage or destruction of orchards caused by climatic factors, intentional harm, expropriation, the construction of public facilities at the orchard site (such as highways, railways, power lines, etc.), changes in ownership, and expert mediation in various legal disputes. The value assessment of orchards based on the total costs of establishment involves determining all expenditures incurred from the very establishment of the orchard until its full development, id est until reaching such productivity that the value of production exceeds the incurred production costs and the annual annuity payment. The theoretical-methodological procedure for assessing the value of fruit orchards based on the total costs of establishment, or their cultivation value, is illustrated using a peach orchard as an example.

Introduction

The value assessment of fruit orchards ranks among the most challenging and complex undertakings in fruit production, as it often requires considering a large number of different factors. The assessor, typically an experienced expert, must possess a thorough understanding of the biological characteristics and economic dynamics of fruit production. The knowledge of biological characteristics of fruit production is necessary due to significant differences between fruit crops according to ecological conditions, cultivation intensity, orchard conditions at different stages of its lifespan,

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etc. Understanding the economic dynamics of fruit production is essential due to variations in required investment funds for establishing an orchard, market prices of individual fruit crops and cultivars, and the proximity and connectivity of the orchard to consumer centers (Sredojević & Jovanović, 1998; Milić & Lukač Bulatović, 2017).

Concrete data for assessing the value of a fruit tree are often lacking, requiring the assessor to rely on personal observations and acquired experience. The biological valuation of a single fruit tree can be conducted by an agricultural expert specializing in fruit growing, whereas the economic valuation can be performed by agricultural economists or economists based on previous analyses.

The following methods are applied to assess the value of fruit trees according to their life stage:

1. the value assessment of fruit trees in the investment period (the establishment and care of young fruit trees),
2. the value assessment of fruit trees before reaching half of their average lifespan (the period of growing productivity),
3. the value assessment of fruit trees at half of their average lifespan (the period of full productivity) and
4. the value assessment of fruit trees after reaching half of their average lifespan (the period of declining productivity).

The value assessment of fruit trees based on the total costs of establishment (the investment period) or their cultivation value entails determining all expenditures incurred from the very establishment of the orchard until reaching the full productivity of fruit trees. If subjected to compound interest, such expenditures are reduced by the discounted values of expected yields in the period under consideration (Sredojević & Jovanović, 1998). Introducing intercrops among young orchard trees during cultivation renders the aforementioned value assessment method more complex. The complexity arises from the allocation of production costs between the fruit orchard and the intercrops cultivated therein.

The value assessment of fruit orchards based on their yield value is also applied to evaluate the economic efficiency of the orchard by comparing its yield and cultivation (acquisition) values (Milić et al., 2005). In addition to these values, there is also the capital value, which, alongside other methods such as the internal rate of return, the payback period of invested funds, etc., is utilized to determine the economic effectiveness of the orchard.

When assessing the value of an orchard, depreciation (the annual write-off of the total investment value of the orchard as an asset) must be taken into account because an orchard, as a perennial plantation, falls under fixed assets. The lifespan (or the production period) of an orchard is calculated from the year in which a profit is realized (when the production value exceeds the production costs) until the year in which the production

value decreases to the level of total production costs. The depreciation period of an orchard varies depending on the fruit crop, rootstock, cultivation form, etc.

This paper presents a theoretical-methodological procedure for assessing the value of fruit orchards based on the total expenditures incurred from the very establishment of the orchard until its full development, i.e. until reaching such productivity that the value of production exceeds the incurred production costs and the annual annuity payment ((Production Value (V_p) – Production Costs (T_p) = Profit)). The value determination of fruit orchards based on the total costs of their establishment is illustrated herein using a peach orchard as an example.

Materials and methods

The cultivation or acquisition value of a fruit orchard represents the sum of all expenditures incurred from its establishment until reaching the regular annual cropping, the value of which exceeds the annual costs. The cultivation value of an orchard is calculated in the course of assessing the economic effectiveness of its establishment and utilization. As an indicator, it is compared to the yield value of the orchard.

The total amount of monetary investments during the orchard establishment period, reduced by the market value of the yields obtained during this period, constitutes the value of the orchard at the beginning of its utilization:

$$V_0 = u_0 + (u_1 + u_2 + \dots + u_{m-1} + u_m) - (v_1 + v_2 + \dots + v_{m-1} + v_m)$$

V_0 - the total amount of investments in the establishment of the orchard, or the value of the orchard at the beginning of the utilization period;

u_0 - one-time investments (costs) incurred during the establishment period (clearing, cleaning, land preparation for planting, procurement of seedlings, planting, fence installation, etc.);

$u_1, u_2 \dots u_m$ - the costs of fertilization, care, and protection of the orchard in individual years of its establishment;

$v_1, v_2 \dots v_m$ - the market value of yields in individual years of the orchard establishment.

During cultivation, fruit orchards require significant financial investments and are commonly financed through borrowed funds (loans) (Sredojević, 1998) For this reason, it is necessary to calculate interest on the determined amount of total investments at a specified interest rate for m years (Sredojević & Jovanović, 1998; Milić & Lukač Bulatović, 2017).

By applying the compound interest calculation, the total amount of investments in establishing the orchard, increased by the corresponding amount of interest, is determined by discounting to the ultimate moment of interest accrual (at the end of the m year) as follows:

$$V_0 = u_0 \times r^m + (u_1 \times r^{m-1} + u_2 \times r^{m-2} + \dots + u_{m-1} + u_m) - (v_2 r^{m-2} + v_3 \times r^{m-3} + \dots + v_{m-1} \times r + v_m)$$

where:

r - denotes the interest factor $(1+i)$

i - denotes the interest rate

The present theoretical-methodological procedure for the value assessment of orchards based on the costs of their establishment or cultivation value is illustrated herein using a peach orchard as an example. The costs accounted are those related to an investment peach orchard project in the Bačka region (the Autonomous Province of Vojvodina, the northern part of Serbia) and are presented per unit capacity (per hectare).

Results with discussions

When assessing the value of fruit orchards, especially their productivity, it is necessary to consider not only the current condition of the orchard but also environmental conditions, fruit crops and cultivars, rootstocks, general care, and everything else that may affect the current and prospective yields and the longevity of the fruit trees. For example, if the most suitable rootstock is not selected for establishing the orchard, the lifespan of the tree will be shorter and the expected yield per tree will be lower, thus reducing the value of the tree compared to the case of optimal selection (Vukoje & Milić, 2009; Milić & Lukač Bulatović, 2017). In principle, it is easier to assess the value of young trees that have not yet borne fruit than those in production. With young trees, investment expenditures and orchard care costs during establishment are more or less the same for the same cultivation form, the same level of intensity, the same fruit crop, and so forth, allowing for a precise and adequate assessment to be conducted.

In assessing the value of fruit trees not yet in production, the investment period encompasses the time from the establishment of the orchard to the full development of the fruit trees, or until reaching such productivity that the value of production exceeds the incurred production costs and the annual annuity payment. In this assessment, it is necessary to determine the investment expenditures and maintenance (care) costs of the orchard during the cultivation period as accurately as possible.

Understanding the investment period is essential for calculating annual depreciation, which is charged against the fruit production costs.

The cultivation value of an orchard is also calculated during the assessment of the economic effectiveness of its establishment and utilization. In this case, in addition to calculating the investments in establishing the orchard, it is necessary to calculate the investments in replacing the worn-out machinery during the period of orchard utilization (Sredojević & Jovanović, 1998). This is achieved by discounting the planned future investments in replacing the worn-out machinery to the final moment of the orchard establishment period, or the beginning of its exploitation.

The investment expenditures and maintenance costs during orchard establishment comprise the following items: material costs (costs of seedlings, basic fertilizers, markers, and various auxiliary materials), variable costs of machinery (fuel and lubricants, maintenance costs, the functional depreciation of used machinery), fixed costs of machinery and equipment, labor costs (temporary and permanent workers), and costs of outsourced services.

On balance, the key elements of assessing the cultivation (acquisition) value of an orchard are as follows:

1. The amount of investment required for establishing the orchard up to the completion of planting – including land preparation for planting (costs of fertilization, deep plowing, and other preparatory activities), procurement of seedlings, poles, wires, planting, and all associated costs, orchard area landscaping (construction of roads, installation of fencing, and other related activities), irrigation systems, etc.
2. The costs of regular maintenance and care of the orchard annually – including the costs of fertilization, soil cultivation, pruning, pest and disease control, general orchard care, and harvesting and transportation costs in years of initial low yield. In addition to direct costs, which vary depending on the fruit crop, cultivation form, and production conditions, the assessor must also consider administrative costs, insurance, etc. When assessing the amount of investment and all costs related to tree cultivation annually, the method of calculation based on market prices is applied. The market prices at the time of assessment are used for calculating materials and services, whereas human labor is valued according to the qualification structure of individual work operations.
3. By summing up the aforementioned assessment elements, the total value of the orchard is calculated, which, when divided by the number of fruit trees per unit area, provides the estimated value of a single fruit tree. If the entire orchard or individual fruit trees already produce initial low yield, the value of such yield is subtracted from the total value of the orchard.

A recapitulation of the costs incurred in establishing a peach orchard is presented in Table 1.

Although significant investments per unit capacity are required for establishing a peach orchard, such investments find justification in the relatively long and profitable period of full orchard productivity, which can last (depending on the cultivar, rootstock, soil, and climate) 15 to 25 years (Gangwar et al., 2008; Lukač Bulatović, 2014).

Table 1. A recapitulation of the total costs of establishing a peach orchard

Period of exploitation: 15 years Planting density: (4,5 x 3.5 m) (approximately 630 trees/ha) Areas: 1 ha		
Year (m)	Description of costs	Iznos (EUR/ha)
0	Costs of land preparation for establishing the orchard ⁴	1,200.0
	Costs of planting ⁵	2,100.0
	Costs of fence installation ⁶	1,650.0
	Costs of drip irrigation system installation ⁷	2,700.0
	Other costs ⁸	300.0
	Total investments in the zero year	7,950.0
	Discount factor (1,08 ^m)	1.2597
	Discounted investments in the zero year	10,014.6
1.	Costs of care in the first year ⁹	960.0
	Discount factor (1,08 ^m)	1.1664
	Discounted investments in the first year	1,119.7
2.	Costs of care in the second year ¹⁰	1,050.0
	Discount factor (1,08 ^m)	1.0800
	Discounted investments in the second year	1,134.0
3.	Costs of care in the third year ¹¹	1,280.0
	Value of initial low yield in the third year ¹²	138.0
	Discount factor (1,08 ^m)	2.0000
	Discounted value of initial low yield in the third year	138.0
	Discounted investments in the third year (reduced by the value of initial low yield)	1,142.0
Total amount of investment		11,102.0
Discounted investments (0-3)		13,410.3

Source: Author's calculations

- 4 Costs of terrain leveling, fertilization (the procurement, delivery, and spreading of organic (30 t/ha) and mineral fertilizers (700 kg/ha)), deep plowing (50-60 cm deep) , harrowing (2x)
- 5 Costs of purchasing seedlings and planting (site marking, digging holes, the preparation and planting of seedlings, watering)
- 6 Costs of purchasing poles and wire, and costs of fence installation
- 7 Costs of constructing a drip irrigation system (well drilling, the procurement of pump and irrigation systems)
- 8 Costs of road and path maintenance, filling empty spaces, protection and others
- 9 Harrowing (6x), plowing, the spreading of nitrogen fertilizers (300 kg/ha), protection (3x), watering
- 10 The same as in the first year with the addition of pruning (6 working days)
- 11 The same as in the first and second years with the addition of harvesting (4 working days)
- 12 Reduced by harvesting costs

According to the tabular calculation of investments for establishing a peach orchard (the investment expenses and costs of care and maintenance of the orchard) in the specified cultivation system, for $m = 3$ and $i = 0.08$, the amounts are as follows:

the initial investment in the zero year.....	$u_0 =$ EUR 7,950.00
the investment in the first year of establishing the orchard.....	$u_1 =$ EUR 960.00
the investment in the second year of establishing the orchard.....	$u_2 =$ EUR 1,050.00
the investment in the third year of establishing the orchard.....	$u_3 =$ EUR 1,280.00
the value of initial low yield in the third year of establishing the orchard.....	$v_3 =$ EUR 138.00

$$V_0 = (7,950 \times 1.08^3 + 960 \times 1.08^2 + 1,050 \times 1.08 + 1,280) - 138$$

$$V_0 = \text{EUR } 13,410.3 \text{ (per hectare)}$$

$$V_0 \approx \text{EUR } 21.3 \text{ (per tree)}$$

When calculating the value of an orchard, if the average annual costs of establishing the orchard are utilized, denoted as $u_1 = u_2 = u_3 = \dots = u_1 = u$, and the average annual orchard revenues, denoted as $v_1 = v_2 = v_3 = \dots = v_1 = v$, then the total investment amount, increased by the calculated amount of intercalary interest (Sredojević & Jovanović, 1998), can be computed as follows:

$$V_0 = u_0 \times r^m + u \frac{r^{m-1}}{r-1} - v \frac{r^h - 1}{r-1}$$

where:

u = average annual costs (expenditures),

v = average annual revenues,

m = the number of years of the orchard establishment,

h = the number of yield years in the orchard establishment period (the number of years of initial low yield).

In such determination of total investment amounts, it is assumed that both revenues and expenditures occur at the end of the year.

The total amounts of investment in the orchard establishment represent the initial value of these assets, i.e. the value of the orchard at the beginning of the period of their utilization. This value is known as the cultivation value of the orchard. It serves as the basis for depreciating the investment assets, which will gradually be allocated,

during the period of utilization, to the obtained yields in the form of established annual depreciation costs. Upon commercializing the achieved yields, the assets invested in their production will be multiplied.

Comparable to all other basic assets in agriculture, orchards also undergo depreciation. The calculation of orchard depreciation consists of two parts: determining the basis for depreciation and allocating the basis to individual production processes or cycles, or to time periods during which the asset is utilized (Milić & Lukač Bulatović, 2017). However, in agriculture, it is common for a basic asset to be constructed or established over several years, which is a constant occurrence in the establishment of perennial plantings. Determining the basis for depreciation in perennial plantings would not pose a greater difficulty if it were not known that the resources invested in establishing the plantation would be tied up for a longer period and that perennial plantings would begin to yield at some point during the establishment period (albeit in small quantities, but with a certain volume and value).

The perennial plantings considered basic assets in agriculture encompass productive orchard areas, grapevine areas, plantings for wind protection, erosion control, and sand fixation, and industrial plantings such as hop plantations and forests (Milić & Lukač Bulatović, 2017). This implies that young, newly established orchards, grapevines, and hop plantations do not possess the characteristics of basic assets because additional investments are made until they begin bearing fruit (the care of the plantation in the first, second, and third year, the installation of supports, etc.), significantly increasing their initial value. Therefore, newly established plantings are deemed ongoing investments until they start yielding fruit.

One of the methods for assessing fruit orchards based on their acquisition or cultivation value (the bases for depreciation) is the following procedure (Milić & Lukač Bulatović, 2017):

$$V = (A + B + C)x f x d - E$$

where

V = the value of the orchard (trees),

A = the costs of orchard establishment including planting,

B = the costs of annual maintenance and care of the orchard,

C = the intercalary interest for investment,

f = the correction factor according to the condition of the orchard for potential yield and market value relative to the structure of fruit crops and cultivars,

d = the discount factor (infalction rate),

E = the production value in the assessment year, reduced by the harvest costs (the initial low-yield value).

The correction factor of the orchard general condition at the moment of assessment is used to draw conclusions about its potential production. Based on the growth of fruit trees, balance of cultivation form, health condition, etc., the estimated value of fruit trees can be adjusted downwards or upwards. Accordingly, if the growth of fruit trees is better, and the prospect of earlier entry into the bearing period and achieving high yields is more favorable, or if the orchard as a whole is in better condition, then their estimated value should be higher and vice versa. For example, the investment costs for establishing 1 hectare of peach orchard, using the inclined palmette cultivation form, may be equal to or even lower than those for establishing 1 hectare of plum orchard of the same cultivation form (Milić & Lukač Bulatović, 2017). However, the nominal value of 1 hectare of young peach orchard is certainly higher than that of plum, and a single tree of an early pear cultivar near consumer centers is certainly nominally more valuable than a tree of the “Kaluderka” cultivar, even though their determined investment value will be the same through calculation. Therefore, the correction factor comprises multiple elements, which need to be individually constructed and calculated in each specific case.

The costs of establishing perennial orchards significantly depend on the fruit crop cultivated and the planned level of orchard intensity (Lukač Bulatović, 2013, 2014; Badiu et al., 2015; Lukač Bulatović et al., 2017). The costs of planting and caring for one hectare of intensive peach orchard amount to HRK73,000 (Ivić, 2004). The approximate costs of establishing and maintaining one hectare of high-intensity pear orchard during the investment period amount to USD17,500 (Keserović, 2004). The costs of establishing one hectare of apple orchard are as follows: EUR5,000 for extensive planting, EUR10,000 for semi-intensive planting, EUR20,000 for modern dense planting without irrigation and drainage, and EUR30,000 for modern dense planting with irrigation and drainage (Mišić, 2003). The total investment value of an intensive quince orchard is 3,630 EUR/ha (Milić et al., 2010). The required investment for intensive grape cultivation amounts to approximately 30,000 EUR/ha (Sredojević et al., 2015). The initial cost of investment in litchi plantation was estimated to be ₹ (Indian Rupee) 32,157.43 per hundred plants - Kayastha et al., 2022. In the structure of total orchard establishment costs, the largest share is attributed to planting costs: the costs of purchasing seedlings, marking the planting sites, digging pits, preparing seedlings for planting, and irrigation (Milić et al., 2010; Kawalpreet & Jatinder, 2016). Orchard maintenance costs are lower in the initial years of establishment, but significantly increase with the orchard's age (Raghav & Srivastava, 2015; Manpreet et al., 2016; Kawalpreet & Jatinder, 2018; Łakomiak & Zhichkin, 2020).

In investments in fruit growing and agriculture in general, the amount of investment and the length of the investment period are significantly influenced by biological processes, technical and technological execution capabilities, and the duration of individual tasks. Therefore, in the process of investing in orchard establishment, the conditions for initial orchard fruiting and investment activation are not simultaneously created. Specifically, the time of initial fruiting varies according to the orchard type, with

noticeable differences within the same type of orchard relative to individual cultivars. Additionally, periods of varying intensity with increasing, peak, and declining yields occur during the exploitation of orchards. These are often conditioned by agricultural work processes based on cultural, technical-technological, and economic foundations.

Conclusions

There is often a practical need for the value assessment of an orchard as a whole and/or individual fruit trees grown therein, arising in instances of the damage or destruction of the orchard caused by extreme weather events, intentional harm, expropriation, the construction of public facilities at the orchard site, changes in ownership, inheritance division, and expert mediation in various legal disputes.

Different methods are applied to assess the value of fruit orchards according to their life stage, the most frequent of which is based on their acquisition (cultivation) and yielded values. In principle, it is easier to assess the value of young orchards that have not yet borne fruit than those in production. In young orchards, investment expenditures and orchard care costs during establishment are more or less the same for the same cultivation form, the same level of intensity, the same fruit crop, etc.

The value assessment of orchards based on the total costs of establishment involves determining all expenditures incurred from the very establishment of the orchard until its full development, i.e. until reaching such productivity that the value of production exceeds the incurred production costs and the annual annuity payment ((Production Value (V_p) – Production Costs (T_p) = Profit)). The cultivation value of an orchard is calculated in the course of assessing the economic effectiveness of its establishment and utilization. As an indicator, it is compared to the yield value of the orchard.

The costs of establishing fruit orchards depend on a number of factors such as the area and type of orchards, cultivation system, rootstock, cultivar, duration of the establishment period, dynamics of orchard establishment, distribution of investments over the years of orchard establishment, level of the calculated interest rate, and timing of achieving initial low yields.

The cultivation value of an orchard represents its initial value, serving as the basis for the orchard depreciation. The depreciation period of an orchard varies depending on the fruit crop, rootstock, cultivation form, etc.

The value assessment of fruit orchards based on the total costs of their establishment is of paramount importance to resolving numerous issues in practice, particularly under economic operation conditions exclusively guided by market principles.

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Conflict of interests

The authors declare no conflict of interest.

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