Prediction of profitability of topworking in older apple orchards under contemporary economic conditions of the Czech Republic

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ABSTRACT: In the Czech Republic, there is still a predominance of obsolete apple orchards that were established more than 15 years ago and that are not profitable under contemporary conditions. Typical features of these orchards are low or medium tree densities, freely growing semi-standard trees or hedgerows on semi-dwarf, or sometimes also on vigorous, rootstocks. The farmers are not always in a position to completely renovate them, and therefore they are interested in their topworking. The present paper studied the effectiveness of this measure under the current economic and market conditions of this country, using 3 types of orchards with different spacings and rootstocks and 5 groups of tree densities. Four cultivars were chosen as examples of different starting statuses for the modelling of subsequent development in three time horizons and for the prediction of profitability of this treatment. The profitability is based on an increase in farmer prices for cultivars that are presently recommended for replacement of the older ones according to the recent development of these prices on the fresh market. In the case of topworking for Spartan cv., an economic return of the measure can be expected at the earliest after 8 years of running the treated orchard. The greatest increase in profit can be achieved in orchards on the rootstock M 9. Nevertheless, with the decline of tree numbers in the orchard, or with the increase in tree losses, the general economic effectiveness of topworking notably falls. In the case of trees on the rootstock MM 106, this measure can have an economic effect only if at least 80% of the trees is in a good health state and it is presumed that the orchard will be used for another 10 years at least. A list of recommended cultivars to be used for replacement of the old ones is given.

Keywords: apple orchards; top-working; economics; costs; profit; cultivars; tree densities; rootstocks; yields

Topworking is a practice of changing the entire tree top or a part of it to a different cultivar by means of grafting. Apple trees are topworked to a more preferable cultivar, and sometimes to provide better conditions for cross-pollination (Teskey, Shoemaker 1972). This practice of changing cultivars was quite common in the past when the longevity of apple orchards was much longer (Stanton, Dominick 1964). Recent world developments of apple growing systems are towards very dense plantings whose economic efficiency is based on very fast returns of the invested costs that are extremely high (Weber 2000). In these plantings, it is not possible to use topworking because the lack of harvest for one or two years would switch the whole economic balance into a loss.

Currently, the situation in the Czech Republic is different because new orchards with high planting densities that could be compared with European standards (Janssen 1992; Widmer, Krebs 2000) are still in the minority. On the contrary, there is a predominance of obsolete apple orchards that were established more than 15 years ago and that are not regarded as sufficiently efficient under contemporary conditions. For these reasons, the average yield in commercial apple orchards in this country has fluctuated between 14.4 and 21.6 t/ha only during the last five years (Buchtová 2001). Typical features of many of these old orchards are low or medium tree densities, in row systems of freely growing semi-standard trees or hedgerows on semi-dwarf or sometimes also on vigorous rootstocks. Because of the strong tree growth, these orchards are relatively demanding for the extent of pruning. As regards the cultivars, Spartan and Idared were the most frequently used, however sometimes even such cultivars as Oldenburg, Ontario or Boskoop could still be found there. In recent years, these apples are increasingly more difficult to sell on the fresh market due to competition of more valuable varieties, and therefore many growers sell them only for processing at a very low price.

On the other hand, a majority of smaller fruit producers in this country who started their apple growing business only after the recent privatization manage with a permanent shortage of financial means because of the weak economy of the country and cannot afford to invest a lot of money into the renovation of their orchards. The capital investment necessary for establishing a new apple orchard has multiplied in comparison with previous periods whereas revenues from present fruit plantings have increased at a lower rate. That is why these growers now have to ask a question whether it is

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worth investing in a partial renewal of their orchards by topworking.

For the above reasons, the researchers conducted this study aimed at predicting the final economic balance after applying this alternative in a range of presently obsolete orchards that still exist in this country. For this purpose, we have used our own results gathered by evaluation of cultivars in a range of apple orchards and information on present costs and incomes obtained from five farms (own unpublished data), and certain statistical data elaborated and published by the Fruit Union of the Czech Republic. To estimate the possible direction for further development, we used a modelling method that is analogous to some procedures already used in the past (STEHR 1988).

MATERIAL AND METHODS

For this study three models of orchards with different tree spacings and rootstocks were chosen, all of which were the most frequently planted in the Czech Republic during the period 1970–1990. These three variants were further subdivided into five partial groups to simulate different densities of coverage by healthy trees in real orchards. The reduction in the original number of trees could be due not only to their complete loss but also to severe damage of the trees for example by wood diseases or mechanically during previous orchard management, etc. We assigned an average yield per tree (as a mean for each rootstock from several cultivars) to these source parameters that was obtained from the results of appraisals in selected orchards of given types during 1997–2001. Based on the set tree numbers and average tree yields, we calculated the average annual yields (tons) per hectare for particular variants and partial groups.

As examples of different economic situations in older apple orchards, four cultivars were chosen: Spartan, Oldenburg, Boskoop and Ontario. These cultivars greatly differed in total economic returns per hectare in the past.

Concerning flat costs, we separately took into account the required fixed costs that have to be spent annually in orchards regardless of standing conditions and other variable costs. The fixed costs included all mechanized works and labour input that were connected with orchard management, materials and consumable costs (chemicals for plant protection, fertilizers, etc.), depreciation, and land rent or land tax. The variable costs included expenditures for tree pruning (that would change according to the number of trees per hectare), costs of harvesting, transport and post-harvest manipulation and treatments of harvested apples. The total income for Spartan cv. was calculated from the total crop, providing a 75% share of extra fancy and fancy class ex post under the contemporary average farmer price of the cultivar (8,450 CZK for one ton) and surplus share of apples for processing ex post under the contemporary farmer price of 2,200 CZK for one ton.

In the case of Oldenburg cv., the total income was calculated provided that the whole crop was sold as apples for processing. For Boskoop cv., the total income was estimated to be about one third lower and for Ontario cv., about one half lower than it was for Spartan cv. The estimated decrease due to the reduction in average yield of these cultivars corresponded mainly to different tendencies for biannual bearing.

Costs of topworking were recorded on four different farms. Data on a new entry into bearing after topwor-

Table 1. Source parameters of apple orchards

Rootstock	Spacing (m)	Original number of trees per hectare	Share of missing trees (%)	Current number of trees per hectare	Average yield per tree (kg)	Yield per hectare (t/ha)	Average annual fixed costs (CZK per hectare)	Average annual variable costs (CZK per hectare)
M 9	4 × 2	1,250	5	1,188	11.3	13.4	41,550	33,366
			10	1,125	11.3	12.7	41,550	31,610
			20	1,000	11.3	11.3	41,550	28,097
			30	875	11.3	9.9	41,550	24,585
			40	750	11.3	8.5	41,550	21,073
MM 106	5 × 3	665	5	632	17.5	11.0	41,550	30,946
			10	599	17.5	10.5	41,550	29,317
			20	532	17.5	9.3	41,550	26,059
			30	466	17.5	8.1	41,550	22,802
			40	399	17.5	7.0	41,550	19,545
M 1	6 × 4	416	5	395	27.5	10.7	41,550	33,567
			10	374	27.5	10.3	41,550	31,800
			20	333	27.5	9.1	41,550	28,267
			30	291	27.5	8.0	41,550	24,734
			40	250	27.5	6.9	41,550	21,200

Table 2. Costs expended for topworking per hectare of apple orchard

Rootstock	Spacing (m)	Number of trees per hectare*	Labour expenses per tree (CZK)	Material expenses per tree (CZK)	Costs of tree training (2–3 years) per tree (CZK)	Total costs of topworking per hectare (thousands of CZK)
		A	B	C	D	= A (B+C+D)
M 9	4 × 2	1,188	21.5	25	17	75.4
		1,125	21.5	25	17	71.4
		1,000	21.5	25	17	63.5
		875	21.5	25	17	55.6
		750	21.5	25	17	47.6
MM 106	5 × 3	632	30.7	50	28	68.7
		599	30.7	50	28	65.1
		532	30.7	50	28	57.8
		466	30.7	50	28	50.6
		399	30.7	50	28	43.4
M 1	6 × 4	395	44.9	75	56	69.5
		374	44.9	75	56	65.9
		333	44.9	75	56	58.5
		291	44.9	75	56	51.2
		250	44.9	75	56	43.9

*Note: Model situations with different losses of trees

king were taken from cultivars, and evaluated in twelve orchards (BLAŽEK, VARGA 2002). For simplification of the following calculations, the absence of harvest after topworking (as well as the time needed for training of topworked trees) were rounded by two years in the case of trees on M 9 rootstock, by 2.5 years for MM 106 and by three years for trees on M 1 rootstock. During these periods of yield absence after topworking, only fixed costs were calculated in the general balance besides the flat costs of topworking, and not the variable costs (because the costs of tree training were included in the costs of topworking).

In the general balance of incomes after topworking, the same average yield was used as with trees without topworking, however, for 75% proportion of extra fancy and fancy class ex post the farmer price of 12,300 CZK for one ton was used that was obtained by averaging concurrently the farmer price for all cultivars presently recommended for topworking of obsolete varieties.

To compare the given economic calculations in relation to world currencies, the exchange rate of the Czech Crown fluctuated during the time of the evaluation as follows: 1 USD = 38 CZK and 1 EURO = 33 CZK.

RESULTS AND DISCUSSION

A survey of average yields per tree that were recorded in older orchards, and after accounting for categories of different tree densities in tons per hectare (that were used for subsequent calculations), are given in Table 1. These yields ranged between 6.9 t/ha and 13.4 t/ha according to the main variants and tree densities. The average annual value of fixed costs in the monitored farms was 41.5 thousand CZK. Variable costs fluctuated from 19.5 to 33.4 thousand CZK in the orchard variants and groups.

Costs of topworking are given in Table 2. These costs included labour expenses for topworking itself, material costs (mainly the price of budwood), and costs of tree training before restoration of its bearing. These costs range between 43.5 and 75.4 thousand CZK per hectare.

The average farmer price for the most important early winter apple cultivars that are grown in the Czech Republic are shown in Table 3. The best apples for the fresh market were sold for about 50% higher price than

Table 3. Average farmer price for apples in the Czech Republic from October to December 2001 (ANONYMOUS 2001)

Cultivar	Average farmer price (CZK per kg)
Jonagored	13.3
Golden Delicious	13.2
Jonagold	13.1
Topaz	13.0
Rubín	12.8
Šampion	12.3
Florina	11.1
Rubinola	11.0
Jonathan	9.3
Spartan	8.4
Apples for processing	2.2

Table 4. Total expected economic effect of topworking of Spartan cv. for three different periods of growing (thousands CZK)

Rootstock	Spacing (m)	Number trees per hectare	After 10 years of the orchard running						After 8 years of the orchard running						After 6 years	
			No topworking			Topworking			No topworking			Topworking			No topworking	Topworking
			Total flat costs	Total income	Profit or loss	Total flat costs	Total income	Profit or loss	Total flat costs	Total income	Profit or loss	Total flat costs	Total income	Profit or loss	Profit or loss	Profit or loss
M 9	4 × 2	1,188	750	923	173	758	1,048	**289**	600	738	138	608	786	**177**	104	65
		1,125	732	874	142	740	992	**252**	586	699	114	594	744	**150**	85	49
		1,000	697	777	80	704	882	**178**	558	622	64	565	662	**97**	48	16
		875	662	680	18	668	772	**104**	529	544	14	536	579	**43**	11	–18
		750	627	583	–44	632	662	**29**	501	466	–35	507	496	–11	–26	–51
MM 106	5 × 3	632	725	761	35	717	810	**93**	580	608	28	468	594	22	21	–49
		599	709	721	11	701	767	**66**	567	576	9	455	562	**3**	7	–59
		532	677	640	–36	669	682	**12**	541	512	–29	430	500	–34	–22	–80
		466	644	560	–84	638	597	–41	515	448	–67	405	437	–71	–50	–102
		399	611	480	–131	606	511	–95	489	384	–105	380	375	–109	–79	–123
M 1	6 × 4	395	752	748	–4	720	743	**23**	601	599	–3	570	531	–39	–2	–101
		374	734	709	–25	704	704	0	587	567	–20	558	503	–55	–15	–109
		333	699	630	–69	672	626	–47	559	504	–55	533	447	–86	–41	–125
		291	663	551	–112	640	548	–93	531	441	–90	508	391	–117	–67	–140
		250	628	473	–156	608	469	–139	502	378	–124	483	335	–147	–93	–156

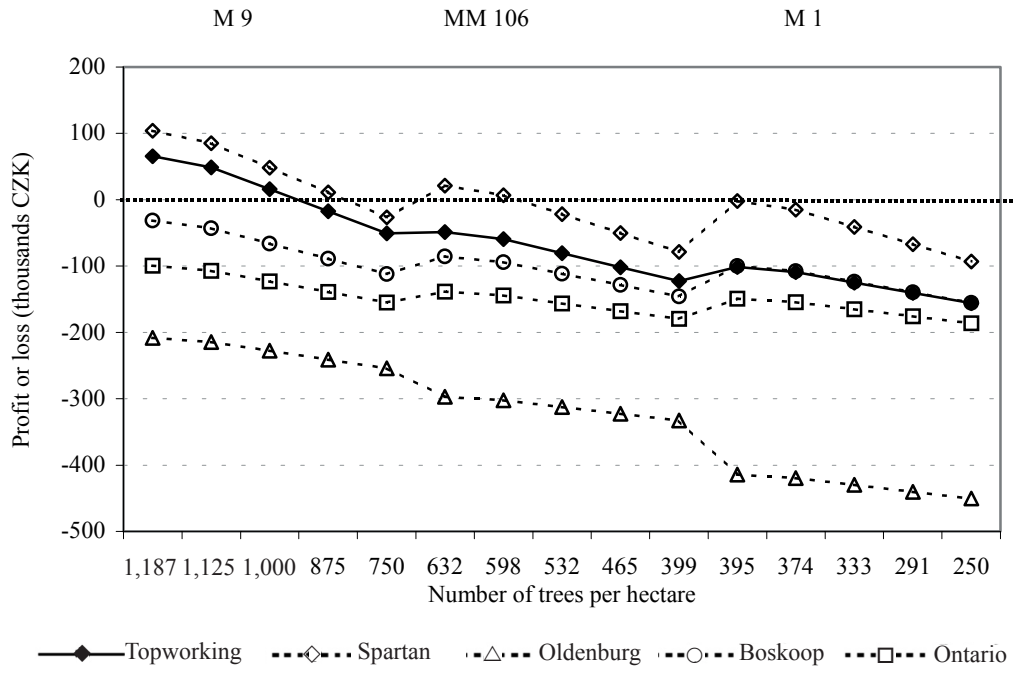

Fig. 1. Profitability of topworking after 6 years of orchard exploitation under different model situations

the average, which was close to the price of Spartan. The apples of the majority of old cultivars were also sold for a similar price. Apples for processing were sold at a nearly four times lower price than the average price on the fresh market.

The total expected economic effect of topworking under contemporary price levels in the Czech Republic, and without overhead costs for Spartan cv., is given in Table 4. It is evident from the data that the benefit of topworking can be realized in this case at the earliest

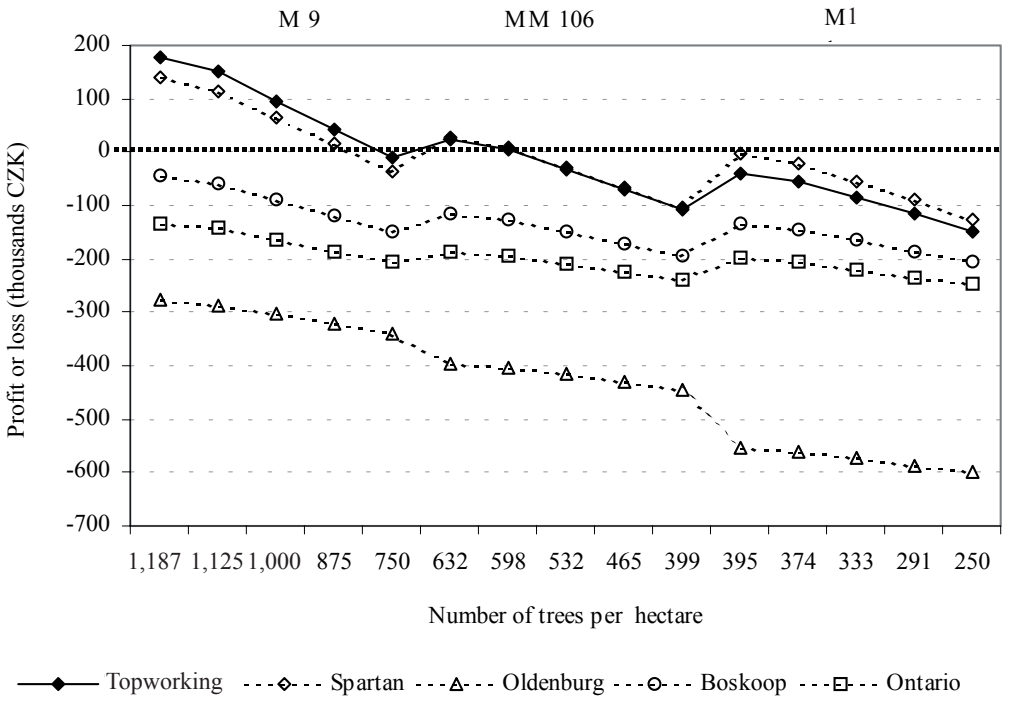

Fig. 2. Profitability of topworking after 8 years of orchard exploitation under different model situations

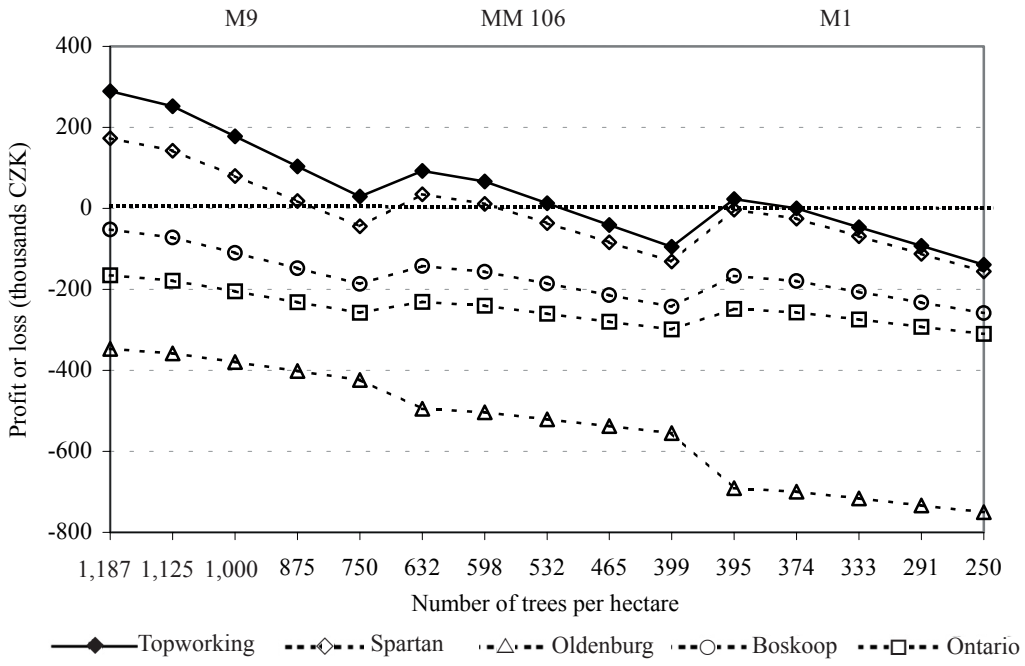

Fig. 3. Profitability of topworking after 10 years of orchard exploitation under different model situations

after 8 years of running the orchard. The greatest profit could be achieved in orchards on the rootstock M 9. Nevertheless, with the decline of tree numbers in the orchard or with the increase in tree losses, the general economic effectiveness of topworking notably falls. In the case of trees on the rootstock MM 106, this measure can have an economic effect only if at least 80% of the trees are in a good health state and it is presumed that the orchard will be used for another 10 years at least. With trees on vigorous rootstock M 1, economic backflow of topworking could be expected only in the case of a very healthy orchard without any losses.

The results of the economic balance of the investigation on the effects of topworking in the case of all four observed cultivars (Spartan, Oldenburg, Boskoop and Ontario) are illustrated in Figs. 1–3. The anticipated profit or loss (pursuant to contemporary prices) is compared after balancing total direct costs (without overhead) and total incomes for the given periods of further exploitation of these orchards. It is obvious from the data that topworking with a valuable cultivar greatly reduces the extent of economic loss, but the grower can ensure the achievement of real profit only under certain circumstances.

In the case of running orchards only for a six-year period since topworking (Fig. 1), the profit of the treatment could be expected only with trees on the rootstock M 9 at densities 1,000 trees per 1 ha or higher, particularly with all of the cultivars except Spartan cv.

If the orchards were managed for the duration of 8 years (Fig. 2), the profit or increase in the profit could be achieved after topworking with all cultivars on the rootstock M 9 at higher densities than 750 trees per hectare. After topworking of trees on the rootstock MM 106 with supposedly 8 years of orchard management, a profit could be obtained only in the variant with the highest number of trees.

In the potential case of managing an orchard for the duration of 10 years (Fig. 3), it would be possible to achieve a profit or increase in the profit after topworking by all cultivars and all tree densities; however, the profit rate is greatly increased with standing tree density. In the case of trees on the rootstock MM 106, a profit could be expected only with higher tree densities, and in the case of trees on the rootstock M 1, only the variant with the highest number of trees would be expected to be close to the boundary of profit.

Certain positive results of the effect of topworking on restoring profitability in some of the old orchards that were found in this work contrast with the statement that at the present time apple orchards with average yield under 15 t/ha could not be profitable (PIENĄŻEK et al. 1995). It can be seen from our results that lower yields may be compensated by higher prices of new cultivars with higher fruit quality (BERRITT 1999).

It is obvious from the above presented results that the total expected profitability of topworking is not dependent from a certain value of the income on the variety that should be replaced, but on the vigour of rootstock (or rather on the type of orchard), on completeness of the stand and on the good health state of the trees, which are the basic presumptions of long-term exploitation of a given orchard. In conclusion, it should be emphasized that the effects of topworking are also considerably dependent upon the proper choice of a suitable cultivar that should be determined by the market (and thereby presumed to win a higher farmer price) and should have

at least an average level of yield in the given climatic and soil conditions.

Similarly, the results in common present orchards after topworking are better the more modern the orchard and the higher its tree density. This conforms to previously published papers aimed at the influences of these factors (STEHR 1988; JANSSEN 1992; WIDMER, KREBS 2000).

On the basis of the overall evaluation of a broad set of varieties and with respect to their climatic and soil requirements, the following cultivars are recommended to be used for replacement of obsolete ones by topworking (BLAŽEK, VARGA 2002):

For warm regions (annual mean temperature above 9°C): Golden Delicious, Gala, Jonagold, Florina, Goldstar and among the new ones: Braeburn.

For regions with annual mean temperature 7.5–9°C: Jonagold, Topaz, Angold, Gala, Rosana, Melodie, Šampion, Rubinola, Selena, Rubín, Bohemia and Gold Bohemia.

For cold regions (annual mean temperature below 7.5°C): Jonalord, Rajka, Rosana, Rubinola, Rubín, Bohemia and Gold Bohemia.

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Předpověď rentability přeroubování starších výsadeb jabloní v současných ekonomických podmínkách České republiky

ABSTRAKT: V České republice stále ještě převažují výsadby jabloní zastaralého typu, které byly založeny před 15 a více lety a v současných podmínkách již nejsou rentabilní. Typické pro tyto výsadby jsou středně husté až řidší spony, tvary volně rostoucích zákrsků obvykle v pásovém uspořádání a použití středně silně nebo i silněji rostoucích podnoží. Pěstitelé většinou nemají dostatek finančních prostředků, aby tyto výsadby mohli nahradit zcela novými, a proto projevují zájem o jejich přeroubování. Naše práce se proto zabývá studiem efektivnosti tohoto zásahu v současných tuzemských ekonomických a tržních podmínkách ve třech různých typech výsadeb charakterizovaných různým sponem a použitou podnoží v pěti skupinách s různým počtem stromů na 1 ha. Pro navození podobných podmínek, které se vyskytují v současné praxi, byly jako příklad použity čtyři odrůdy navzájem se lišící svou současnou rentabilitou, a formou modelování dalšího vývoje byla pro tři různé časové horizonty předpovězena rentabilita jejich přeroubování. Tato rentabilita je založena na vyšší ceně jablek odrůd, které jsou v současné době doporučovány pro náhradu starších kultivarů, a to v souladu s vývojem cenové diferenciace odrůd na současném domácím trhu s jablky pro přímý konzum. V případě přeroubování odrůdy Spartan lze očekávat ekonomickou návratnost tohoto zásahu nejdříve po osmi letech dalšího provozování sadu. Nejvyšší rentabilitu přeroubování lze očekávat ve výsadbách na podnoži M 9. S poklesem pokryvnosti porostu (v důsledku úhynu stromů) však tato rentabilita výrazně klesá. V případě stromů na podnoži MM 106 by mohlo být přeroubování efektivní, jen pokud je nejméně 80 % stromů zcela zdravých, aby se u nich dala předpokládat ještě nejméně desetiletá životnost. Přeroubování stromů na vzrůstné podnoži již není ani v případě dobré pokryvnosti porostu příliš rentabilní. Při přeroubování ostatních méně hodnotných odrůd je rentabilita tohoto zásahu obdobná. Je rovněž uveden seznam odrůd, které jsou doporučovány pro přeroubování méně hodnotných kultivarů.

Klíčová slova: výsadby jabloní; přeroubování; rentabilita; náklady; zisk; odrůdy; spony; podnože; výnosy

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