

Table 3: Optimal solutions and economic indicators for all three farms maximizing EGM

Description	Farm 1	Farm 2	Farm 3
Economic indicators (EUR)			
Revenue	15,414	55,911	547,464
Variable costs (VC)	5,000	25,000	300,000
EGM	10,414	30,911	247,464
SD of EGM	3,344	11,622	112,214
EGM/ha	20,828	15,455	12,373
EGM/h*	4.77	4.76	4.65
Share of SD in EGM (%)	32	38	45
Land Area			
Production activities included in the production plan			
Blueberry Duke (ha)	0.19	0.00	13.84
Blueberry Bluecrop (ha)	0.00	1.02	0.00
Strawberry Clery (ha)	0.31	0.98	6.16
Labour input			
Family labour (h)	2,182	3,722	550
Hired labour (h)	0	4,657	88,651
Total labour (h)	2,182	8,379	89,201
Utilized family labour (%)	24.80	84.59	100.00
Post optimal analysis			
Reduced costs (EUR)			
Raspberry Willamette	-5,670	-3,660	-5,490
Blueberry Duke	0	-700	0
Blueberry Bluecrop	-1,570	0	-620
Strawberry Maja	-5,470	-6,980	-5,670
Shadow prices (EUR)			
Arable land	19,520	0	933
Hired labour (VI month)	0	4.6	0
Working capital	0.13	0.42	0.20

*EGM/h - Expected Gross Margin per hour

It is apparent (Table 3) that for small family farms (Farm 1) the optimal production results from highly intensive strawberry production (Clery variety) on 62% of available land and blueberry Duke on the rest. In this case Farm 1 would achieve 10,414 EUR of EGM, where revenues amounted to 15,414 EUR, and total variable costs present 32%.

In such a case total variance measured as a standard deviation (SD), is 3,344 EUR, which is 32% of the EGM and shows a relatively high variability. Since this family farm utilises only family labour, the cost of labour is not included in the variable costs. Further analysis shows that such a farm achieves 20,828 EUR/ha of EGM, which is 4.77 EUR/h. However, due to the

seasonal work, only 25% of available family labour is utilised which at the end worsens the productivity result by 74%.

The post-optimal analysis on this farm (Farm 1) shows that blueberry Bluecrop, as less productive activity, is the next closest alternative to optimal plan for this farm. However optimal EGM at farm level would be reduced for 1,570 EUR per each additional ha included in production plan instead strawberry Clery or blueberry Duke. Due to relatively intensive production on such a family farm shadow price for arable land is 19,520 EUR, which means that for each additional unit of arable land, under this circumstance, EGM would theoretically increase by 19,520 EUR.

The semi-large family farm (Farm 2) has a total EGM of 30,911 EUR (Table 3), and the associated risk measured as SD is 11,622 EUR, which is 38% of EGM. This shows that such a production plan is even more risky than for the smaller farm, which is mainly due to hired labour. All hired labour is utilised from May to August. In these months the needs for labour are higher and could not be covered with family labour. Total costs for hired labour amounts in this case to 36% of total variable costs. Due to hired labour this percentage is expectedly higher than on small family farm (Farm 1). The EGM per hectare is therefore 26% lower than on Farm 1 (15,455 EUR). Per hour of labour utilised EGM amounts to 4.76 EUR. However, in this case EGM per working hour falls if also non-utilised family labour is considered (3.42 EUR/h), which is due to equal availability throughout the year and not only in the production seasons.

For this farm the optimal production plan is utilising 49% of land for highly intensive strawberry (Clery) and 51% of the land for producing blueberry (Bluecrop). Even though blueberry Duke has higher EGM per ha (20,033 EUR), blueberry Bluecrop is the optimal option (EGM 18,341). The reason is the limited availability of working capital, which is the main bottleneck for this farm. The capital requirements for Bluecrop (2,965 EUR/ha) are less than for variety Duke (3,936 EUR/ha). In this way there will be more utilized land area, what results with higher total EGM.

Farm 3 has much larger business scope compared to the previous two family farms. The maximum EGM is 247,464 EUR. The optimal production plan comprises blueberry Duke (69%) and highly intensive strawberry Clery (31%). These are options with the highest

EGM/ha. However, for this farm type, such an optimal production plan is the most risky, compared to the other two (Farm 1 and Farm 2). Namely, the total SD is 45 % of EGM. Costs for hired labour present 56% of the variable costs. The realized EGM is 12,373 EUR/ha or 4.65 EUR/h.

We analysed also how efficient the three farms are in reducing risk or achieving at the same level of risk higher EGM (Table 4). Regarding the risk reduction efficiency considering diversification of production plan, the most efficient is the small family farm (Farm 1). This holds down to 42% of risk reduction, where Farm 2 and Farm 3 become more efficient. On average decreasing SD by 1 EUR cost 3.06 EUR on the small family farm (Farm 1), for the semi-large farm (Farm 2) that cost was 3.09 EUR. The largest cost was for the large business farm (Farm 3) where that cost amounted to 3.25 EUR.

Table 4: Cost to reduce risk by 1 EUR

Description	Farm 1	Farm 2	Farm 3
Cost to reduce risk (EUR)	3.06	3.09	3.25

On Figure 1, we present three different scenarios on the small family farm (Farm 1) with a total arable land of 0.5 ha, with household members providing all the labour. The difference between three scenarios (Figure 2, 3 and 4) is in the choice of production activities in the optimal production plan. Generally, in BiH, berry farms grow maximum two varieties so we modelled what happens with risk reduction strategy and efficiency if this is a case.

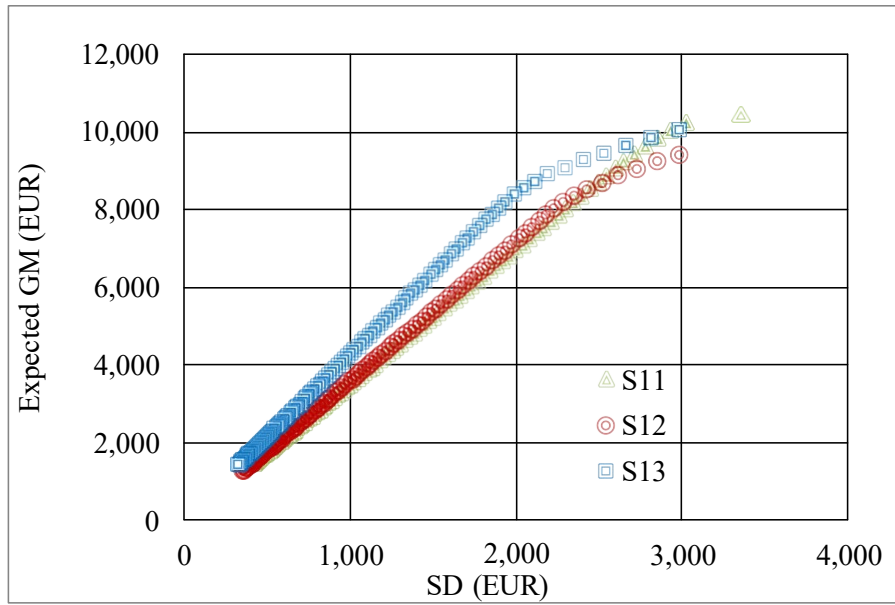


Figure 1: E-V efficient frontiers for different scenarios on small family farm

The first scenario (S11), a combined cultivation of blueberries and strawberries (Figure 2), produces the maximum EGM with highly intensive production of strawberry Clery on an area of 0.31 ha and blueberry Duke on an area of 0.19 ha. This result is the same as in the baseline case for Farm 1 (Table 2). Further analysis shows that with a slight reduction in total EGM the farm would achieve a significant (9.64% – 19.21%) reduction of risk (SD). Including blueberry Bluecrop in the plan (up to 70.51% of arable land) and strawberries on the rest, the EGM decreases by only 2%, however SD decreases by 9.64%. To reduce the risk for 1 EUR, it is necessary to sacrifice only 0.64 EUR of EGM. With further risk reduction, less risky but also less productive blueberry Bluecrop enters optimal production plan, replacing more intensive blueberry Duke. This variety is less risky because it needs less capital and labour.

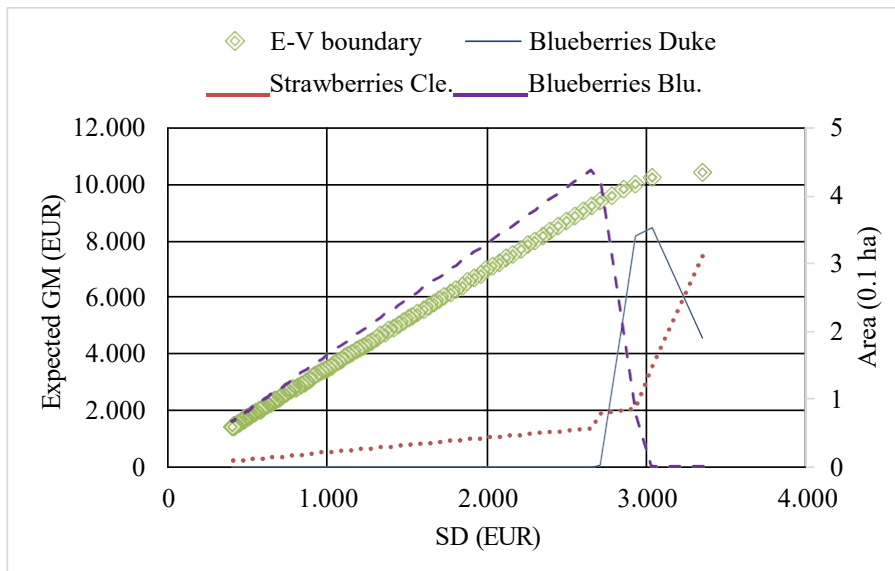


Figure 2: E-V efficient frontiers for combined cultivation of blueberries and strawberries (S11) on small family farm (Farm 1) and changes in optimal production plan

The second possible combination (Figure 3) is the production of raspberries and strawberries (scenario S12). The optimal solution is 0.32 ha of strawberry Clery and 0.18 ha of raspberry Willamette. This scenario provides an EGM of 9,414 EUR, which is 7.24% lower than in S11, but the risk is lower for 10.93%, making scenario (S12) less risky than the first scenario (S11). The reduced cost for raspberry Meeker amounts to -718 EUR/ha, and for raspberry Tulameen -858 EUR/ha. Therefore they don't enter an optimal solution. The shadow price for capital was high and it amounts to 0.67 EUR. With the reduction of riskiness of the production plan, the share of the labour and capital less intensive raspberry Willamette production significantly increases. The efficiency of the risk reduction is somewhat lower than in the case S11.

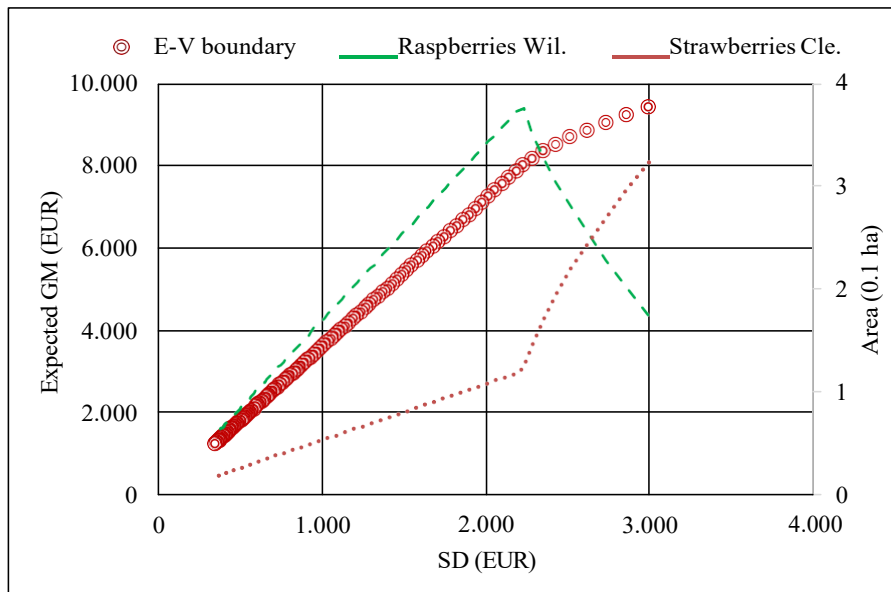


Figure 3: E-V efficient frontiers for combined cultivation of raspberries and strawberries (S12) on small family farm (Farm 1) and changes in optimal production plan

In the last scenario (S13), raspberries and blueberries activities could enter the optimal production (Figure 4). An optimal solution is cultivation of the blueberry variety (Duke) on the area of 0.5 ha. In such a case (S13) EGM is 10,016 EUR, which is 3.81% lower than in baseline scenario (Farm 1) and S11, but still higher (for 6.40%) than in S12. However, on the other hand the riskiness of such production is lower (2,993 EUR) than in S11 and S12. As is apparent from Figure 4, with reducing riskiness of the production plan (left side on Figure 4), there are less blueberry Duke included and larger share of the intensive production of raspberry Willamette enter optimal solution. The reasons are lower variable costs and lower prices variability on the market. For an even larger decrease of variability (36.36%) optimal solutions enters less demanding and less risky blueberries Bluecrop and raspberry Willamette. It is interesting that intensive production of strawberries was not an interesting alternative for any of the observed farms.

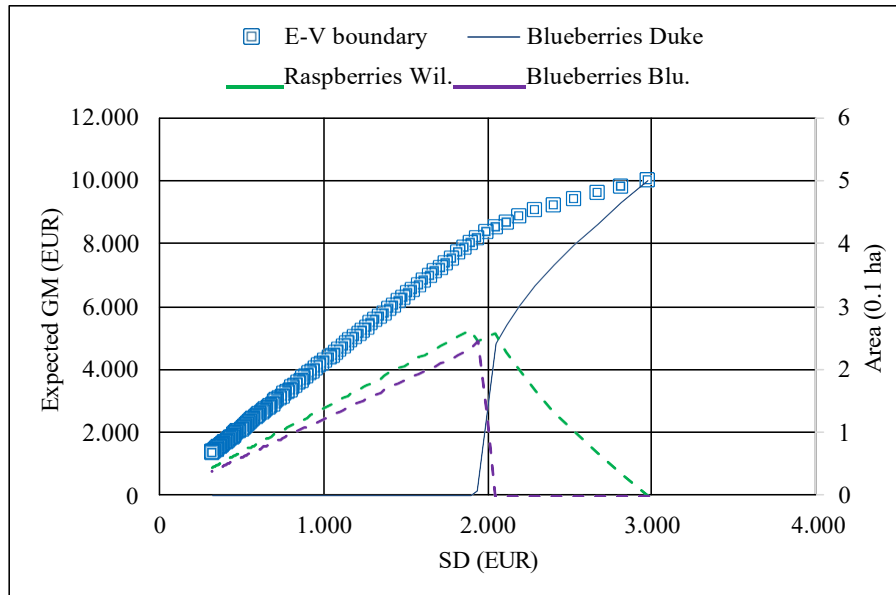


Figure 4: E-V efficient frontiers for combined cultivation of blueberries and raspberries (S13) on small family farm (Farm 1) and changes in optimal production plan

Conclusion

Results show that small farms are the most efficient in risk reduction with up to a 42% decrease, but for further theoretical reductions semi-large and large farms have more opportunity for efficient risk reduction. However, on the other side, decreasing SD by one EUR on small family farms cost 3.06 EUR, for semi-large farm it is 3.09 EUR, while for the large business farms it is 3.25 EUR. Also, small family farms have the best productivity per ha and per utilized labour unit, but because of the seasonal character of berry production activities, they have a significant unutilized family labour (75.20%). This worsens the result per available labour unit on small farms by 74%. Optimal option for maximal EGM on such a small family farm (Farm 1) is highly intensive strawberry Clery on 62% of land and blueberry Duke on the rest. On semi-large farm (Farm 2) optimal combination is 51% blueberry Bluecrop and 49% highly intensive strawberry Clery, while for a large commercial farm highest share has blueberry Duke with 69% in combination with of highly intensive strawberry Clery (31%). Results show that working capital is the most significant bottleneck at the small family farms. Shadow price for capital ranges between 0.13 – 0.67 EUR for the small farm, 0.42 EUR for semi-large and 0.20 EUR for large berry fruit farms.

Further analyses of small family farms show that the most productive combination of activities (strawberry Clery and blueberry Duke) is also the riskiest one. With higher share of strawberry Clery (62%), also EGM (10,414 EUR) and SD (3,352 EUR) are significantly higher. If the optimal production includes blueberry Duke at up to 70.51% of land and strawberries on the rest, the EGM decreases by 2%, however riskiness measured as SD decreases for 9.64%. In all scenarios, the less capital and less labour intensive productions of raspberry Willamette and blueberry Bluecrop are less risky and therefore very competitive. These activities are less productive, but still appropriate to be part of a less risky solution. The intensive production of strawberries was not an interesting alternative for any of the observed farms only highly intensive production of Clery.

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