ProfitFruit: Decision Support System for Evaluation of Investments in Fruit Production

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Abstract

Innovative techniques were developed in the Isafruit project in order to create a more ecological sustainable way of fruit growing. Before fruit growers will consider implementation of these innovations they need information concerning their economic sustainability. The economic model ProfitFruit is made to evaluate the profitability of innovative techniques. ProfitFruit includes a database with quantitative data concerning apple growing in three European fruit growing regions: North Germany (Jork), Switzerland and the Netherlands. Data include amounts of inputs and its costs, yield and prices, labour demand and costs for fixed assets. ProfitFruit calculates returns, gross margin, marginal gross margin, fixed costs as well as labour income of the entrepreneur. ProfitFruit is used for the economic evaluation of the Isafruit Casa sprayer, of mechanical thinning, and of hot water treatment to prevent storage rot. In general, the Isafruit Casa sprayer is the most profitable of these techniques. If the sprayer functions well, it will decrease costs and therefore increase returns when compared to a standard spraying machine. Therefore, fruit growers who can afford the investment might invest in this technique. Also mechanical thinning instead of chemical thinning may be profitable, especially if it results in better product quality and higher prices. Hot water treatment increases total costs, compared with the chemical way of protection. Therefore not many integrated fruit growers will decide to apply this technique, not even when it becomes more effective or if additional labour demand decreases. However, due to problematic storage rot and high prices for organic apples (no chemicals allowed), hot water treatment seems profitable in organic production. Also a desired reduction of the residues on apples might stimulate hot water treatment. In general, costs and labour demand will be critical success factors for implementation of innovative techniques which are meant to spare the environment.

INTRODUCTION

ProfitFruit is one of the work packages of the Isafruit project. The mission of Isafruit is to improve human health through increased consumption of fruit, produced in a sustainable way. The view of Isafruit is that better fruit quality and availability, a higher convenience of fruit and fruit products and improved consciousness of consumers result in higher consumption. Higher fruit consumption is supposed to result in increased health and well-being. The strategic objective of Isafruit is to increase fruit consumption by taking a total chain approach, identifying the bottlenecks and addressing them by consumer driven preferences.

ProfitFruit work package WP 5.3 aims at providing knowledge and methods to improve the capacity of farms in economical terms to deliver more fruits with the desired quality standards. Decision support system ProfitFruit is build within WP 5.3. This paper presents the results of calculations, using ProfitFruit, of the effects of innovative apple production techniques on gross margin and labour income, including sensitivity analyses. Background of these calculations is that the more ecologic sustainable way of fruit production techniques studied in the Isafruit project must also be economic sustainable (profitable) for the fruit growers to be implemented.

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MATERIAL AND METHODS

The decision support system (Schreuder and Peppelman, 2007) was built in Excel and was based on standard data for apple growing, concerning yield, fruit prices, input costs, labour demand and costs for fixed assets. For this paper, only the Dutch standard data (Peppelman and Groot, 2004) were used, although the model also includes Swiss and German standard data. The most important basic data are presented and explained in Table 1. In standard scenario's, 3% of the yield is lost during harvest, 80% of the yield is sold after storage and standard storage loss is 5%.

Using ProfitFruit, calculations were made for new and innovative techniques, mostly developed in other Isafruit Work Packages. the new techniques directly affected yield (kg/ha), quality (price), input costs, labour demand and fixed assets, and if yield was effected also costs for storage and selling changed. All effects on labour demand are assumed to concern temporary labour (€ 10/hour), affecting marginal costs. First, the experts and engineers who developed the new techniques were asked to present or estimate effects on yield and quality, material use, labour demand and price of machines. Based on this information, the most likely effects of the new techniques on gross margin en labour income of apple growers were calculated. Next, in sensitivity analyses, the price of machines, effects on product quantity and quality and/or effects on storage loss and additional labour demand for these techniques were varied. The following techniques were studied:

Isafruit Casa Sprayer

The Isafruit Casa sprayer is developed in Isafruit Work Package 5.1. The machine reduces chemical use by adopting the dosage depending on location and wind, measured amount of leaves at the trees and measured health status of the trees. For a description of the sprayer see Van de Zande et al. (2008). P. Marucco, G. Doruchowski, J. van der Zande and M. Wenneker (pers. commun.), who developed this sprayer, estimated a 50% reduction of chemicals used for crop protection and growth regulation, compared to the standard. Extra costs for the sprayer (sensors, software and other components) are estimated at € 21,000. The operational speed is expected to be the same as the operational speed of a standard spraying machine, so no extra labour is needed. Yield and quality are supposed to be not affected by the use of the Isafruit Casa sprayer.

Mechanical Thinning

Chemical thinning is substituted by a mechanical way of thinning, using a special machine. This saves one spraying with ATS (€ 53/ha). Labour demand for application is the same as for standard: the same driving time is needed for the mechanical thinning as for the eliminated spraying. It is estimated to save 5 labour hours due to reduced labour demand for the following hand thinning. The extra machine costs are € 8,500 and no effects on yield and quality are expected.

Hot Water Treatment

Hot water treatment, also named 'hot water dipping', is developed in Isafruit Work Package 4.1. In this paper, hot water treatment is supposed to be combined with an antagonist treatment for acceptable results. Costs for the equipment are estimated at € 55,000 (Maxin and Klopp, 2004; Schirmer et al., 2004; Schreuder, 2006). Due tot hot water treatment, one chemical spraying can be omitted, saving € 53 per ha. Extra costs for energy and antagonists are € 57 and € 168 per ha, respectively. Total extra labour hours (4 tonnes/hour capacity) and the antagonist treatment are estimated at 21 hour/ha.

RESULTS AND DISCUSSION

First the relevant technical and financial data for the standard situation are presented (Table 1). Then the financial effects from use of the innovative production methods are shown, followed by sensitivity analyses per technique.

Innovative Production Methods

The effects of application of the innovative techniques on costs and returns are presented in Table 2. These calculations are made with the assumption that the innovative techniques do not affect amount or quality of the apples. In Dutch conditions, the Isafruit Casa sprayer shows possibilities for a better economic result, whereas mechanical thinning does not show a relevant economic impact. Hot water treatment causes higher costs and therefore lower returns than standard.

Although the Isafruit Casa sprayer is € 21,000 more expensive than a standard spraying machine, total costs are lower than in the standard situation. This is caused by the 50% reduction of chemicals, resulting in lower annual costs for chemicals and a lower 'total of fixed costs' (due to € 254 reduced annual fixed establishment costs). The reduction of costs for chemicals is supposed to be € 300/ha during the first year and € 400/ha during the following years. Therefore marginal costs as well as fixed costs are reduced compared to the standard situation.

Mechanical thinning results in a small reduction of costs for chemicals (€ 53/ha) and for manual thinning (5 hours/ha), but extra costs for a thinning machine (€ 8,500). Annual fixed establishment costs are € 43 higher. The extra costs are slightly compensated by the savings.

Hot water treatment results in € 53/ha reduction of costs for chemical crop protection, but also requires € 57/ha extra for fuel and € 168/ha for antagonists, and further causes € 321/ha extra annual fixed costs for the equipment and 21 hours more temporary labour. As shown in Table 2, in normal Dutch conditions this is an unprofitable technique.

Sensitivity Analysis Innovative Methods

Contrary to the previous calculations, for the sensitivity analysis we assumed that the innovative production methods might cause differences in product quality. Also investment costs for the equipment and labour demand are varied.

1. Isafruit Casa Sprayer. Table 3 shows the effects of a 10% higher or lower replacement value of the Isafruit Casa sprayer than assumed in de standard calculation, on gross margin and labour income. Standard estimated price for the sprayer was € 36,000, of which € 15,000 for a standard spraying machine and € 21,000 extra costs for adaptations on this machine. Of course, a 10% increase or reduction of the replacement value for this sprayer does not affect the marginal gross margin. It only causes minimal differences in the fixed costs. This can be explained: 10% of € 36,000 euro is € 3,600. On a farm with 15 hectare, this is € 240/ha. These are machine costs and only the depreciation costs (7,5%) and maintenance are calculated, resulting in additional costs of approximately € 20/ha/year.

2. Mechanical Thinning. It was assumed that mechanical thinning does not affect yield or quality and did it slightly increase the labour income of the fruit grower (Table 2). The economic effects are analysed when mechanical thinning does affect product quantity and quality (Table 4). Scenario's with a 10% yield loss due to mechanical thinning, combined with 5 or 10% higher prices as a result of increased quality, are analysed.

Since the higher prices don't entirely compensate the reduced yield, returns are lower in these scenarios, but also costs are lower. Nevertheless gross margin is lower in both alternative scenarios. Due to reduced labour costs for apple picking and grading and for storage and transport, marginal costs are considerably lower when yield decreases. In the scenario with 5% higher prices, the reduction of the returns is just a little over-compensated by the costs-reduction. However, when improved quality after mechanical thinning results in 10% higher prices the labour income of the apple grower increases € 725/ha compared to mechanical thinning and € 827 compared to Standard. The latter saving is comparable with the calculated savings of the Isafruit Casa sprayer.

3. Hot Water Treatment. This technique is meant to reduce the use of chemicals before harvest to decrease losses during the storage period, caused by storage rot. It can be used in integrated apple production, but it's more common to use it in organic apple production.

Integrated Apple Production. It was estimated that using hot water treatment losses due to storage rot are 5% and extra labour demand is 21 hours/ha. Table 5 shows the effects of more (10%) or less (2.5%) storage loss. Doubling or halving of the storage loss considerably affects returns. The effect on labour income is smaller, due to reduced or increased costs for transport and auction. Halving the extra labour demand reduces marginal costs (labour costs). In all scenario's hot water treatment is economically worse than the Standard technique (Table 1).
Organic Apple Production. In organic apple production no chemical protection of the apples is allowed, and without special measures losses during cold storage generally are between 15 and 30% (Heijerman and Roelofs, 2010). In this study 5% harvest loss and 20% storage loss were used in the calculations for organic apples. The economic effects of hot water treatment in organic apples, resulting in a 10% or even 5% storage loss are presented in Table 6. In organic apple production hot water treatment is very profitable when losses during storage can be reduced from 20% tot 10%. This is due to the high losses without treatment and the high price for organic apples (€ 0.90/kg). Of course, if further reduction of storage loss to 5% without additional costs is possible, profitability is even better.

CONCLUSIONS

The ProfitFruit model is an easy-to-use tool to compare plantings with different growing techniques.

Innovative growing techniques, developed in Isafruit, have different economic effects. In Dutch conditions with 15 ha Elstar, the Isafruit Casa sprayer is profitable and a 10% higher or lower price than estimated by the experts hardly effects the labour income of the apple grower. Mechanical thinning is less profitable unless it increases quality – and therefore price – of the apples. In average Dutch conditions hot water treatment is not profitable for integrated apple producers, but in organic apple production it might be very profitable if it solves storage rot problems.

In general, input costs and labour demand are critical success factors for implementation of innovative techniques which are meant to spare the environment.

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Tables

Table 1. Basic data for a standard Elstar planting in the Netherlands.

	The Netherlands
Farm size (ha apple)	15
Yield (kg/ha)	42,000[1]
Average price (€/kg)	0.384
Returns (€/ha)	15,010
Input costs (€/ha)	4,364
Gross margin (€/ha)	10,646
Marginal costs (€/ha)	8,623
Marginal gross margin (€/ha)	2,023
Fixed labour demand (hours/ha)[2]	220
Temporary labour demand (hours/ha)[2]	509

[1]Yield is 42,000 kg/ha of which, due to losses during harvest and storage, 39,095 kg can be delivered.
[2]Total labour demand for growing, picking and grading. Temporary labour demand is supposed to be hired (€ 10/hour); fixed labour is supposed to be family labour and not paid.

Table 2. Financial results for an Elstar planting[1] in the Netherlands (farm size 15 ha), standard and with application of different innovative growing or post harvest techniques.

	Standard	Isafruit Casa sprayer	Mechanical thinning	Hot water treatment
Returns (€/ha)	15,010	15,010	15,010	15,010
Input costs (€/ha)	4,364	3,787	4,310	4,538
Gross margin (€/ha)	10,646	11,223	10,700	10,472
Marginal costs (€/ha)	8,623	8,623	8,573	8,833
Marginal gross margin (€/ha)	2,023	2,600	2,127	1.638
Fixed costs (€/ha)	9,850	9,701	9,852	10,171
Labour income (€/ha)[2]	-7,827	-7,101	-7,725	-8,533

[1]Yield is 42,000 kg/ha of which, due to losses during harvest (3%) and storage (5%), 39,095 kg can be delivered.
[2]With a price level of € 0.384/kg for Elstar and a farm size of 15 ha an average Dutch apple grower will not receive a positive income when all farm-economic costs are included. However, since many apple growers accept a very low compensation for their invested capital and for family labour, and use their machines longer than the depreciation period, they are able to continue their business.

Table 3. Sensitivity analysis for a 10% higher or lower replacement value of the Isafruit Casa sprayer (ICS) in an Elstar planting[1] in the Netherlands (farm size 15 ha).

	ICS (€ 36,000)	ICS + 10% (€ 39,600)	ICS -10% (€ 32,400)
Returns (€/ha)	15,010	15,010	15,010
Input costs (€/ha)	3,787	3,787	3,787
Gross margin (€/ha)	11,223	11,223	11,223
Marginal costs (€/ha)	8,623	8,623	8,623
Marginal gross margin (€/ha)	2,600	2,600	2,600
Fixed costs (€/ha)	9,701	9,722	9,680
Labour income (€/ha)	-7,101	- 7,122	- 7,081

[1]Yield is 42,000 kg/ha of which, due to losses during harvest (3%) and storage (5%), 39,095 kg can be delivered.

Table 4. Sensitivity analysis for 10% reduction of quantity, combined with 5 or 10% higher prices due to Mechanical Thinning (MT) in an Elstar planting in the Netherlands (farm size 15 ha).

	MT no further effects	-10% prod. +5% price	-10% prod. +10% price
Yield (kg/ha)	42,000	37,800	37,800
Returns (€/ha)	15,010	14,184	14,860
Input costs (€/ha)	4,310	4,126	4,212
Gross margin (€/ha)	10,700	10,059	10,647
Marginal costs (€/ha)	8,573	7,794	7,795
Marginal gross margin (€/ha)	2,127	2,264	2,852
Fixed costs (€/ha)	9,852	9,852	9,852
Labour income (€/ha)	- 7,725	- 7,588	- 7,000

Table 5. Sensitivity analysis for storage loss after hot water treatment (HWT) and for HWT without antagonists in an Elstar planting in the Netherlands (farm size 15 ha).

	HWT standard	10% loss	2.5% loss	5% loss no antagonists[1]
Yield sold (kg/ha)[2]	39,095	37,466	39,909	39,095
Returns (€/ha)	15,010	14,360	15,335	15,010
Input costs (€/ha)	4,538	4,422	4,596	4,369
Gross margin (€/ha)	10,472	9,938	10,739	10,641
Marginal costs (€/ha)	8,833	8,715	8,892	8,728
Marginal gross margin (€/ha)	1,638	1,223	1,846	1,913
Fixed costs (€/ha)	10,171	10,171	10,171	10,171
Labour income (€/ha)	-8,533	-8,948	-8,325	-8,258

[1]-/- €168 costs/ha (antagonists) and 10.5 hours instead of 21 additional labour hours/ha.

[2]Yield is 42,000 kg/ha. Due to losses during harvest (3%) and storage (standard 5%) the quantities in the table are sold.

Table 6. Sensitivity analysis for storage loss after hot water treatment (HWT) in an organic Elstar planting in the Netherlands (farm size 15 ha, yield 35,000 kg/ha, average apple price € 0.90/kg), with different effects on storage losses.

	ORGANIC 20% storage loss	ORGANIC + HWT 10% storage loss	ORGANIC + HWT 5% storage loss
Yield sold (kg/ha)	27,919	30,578	31,907
Returns (€/ha)	25,127	27,520	28,717
Input costs (€/ha)	5,846	6,432	6,613
Gross margin (€/ha)	19,281	21,088	22,104
Marginal costs (€/ha)	7,276	7,572	7,616
Marginal gross margin (€/ha)	12,005	13,516	14,488
Fixed costs (€/ha)	12,521	12.542	12,542
Labour income (€/ha)	- 516	974	1,946