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ANALYSIS

# Life cycle management on Swiss fruit farms: Relating environmental and income indicators for apple-growing

Patrik Mouron [a,*], Roland W. Scholz [a], Thomas Nemecek [b], Olaf Weber [a]

[a] *Swiss Federal Institute of Technology (ETH), Department of Environmental Sciences, Institute for Human–Environment Systems, ETH Zentrum, HAD, CH-8092 Zurich, Switzerland*

[b] *Agroscope FAL Reckenholz, Swiss Federal Research Station of Agroecology and Agriculture, CH-8046 Zurich, Switzerland*

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**Abstract**

Integrated fruit production (IFP) has been practiced in Switzerland on a large scale basis since the late 1980s, with the aim of improving sustainable farming. The guidelines of IFP emphasise an ecosystem approach that is based on scientific knowledge about self-regulatory mechanisms at the tree and orchard level. Empirical studies at the farm level are rare. An understanding of the relationship between income and environmental impacts at the farm level is a prerequisite for devising a robust system for orchard portfolio management. An income analysis based on full cost principle and environmental life cycle assessment were applied to 445 annual data sets of apple orchards, recorded on 12 specialised fruit farms over a period of 4 years. The main result was that environmental impacts such as ecotoxicity, eutrophication and non-renewable energy use did not necessarily increase when farms increased their income. A higher input level of pesticides, fertilisers and machinery did not lead to increased yields and receipts. In contrast, the choice of apple cultivars and high investment in pre-harvest labour hours were significantly correlated with high eco-efficiency and high farm income. The results of this study were summarised in a pyramid-shaped management model, providing key issues of successful orchard farming and attributing management rules to master them. The management pyramid indicates that cognitive competences such as distributional, conditional and non-linear thinking are crucial when knowledge from tree and orchard management is integrated at the farm level. A main recommendation is that more attention should be paid to improving management competence in order to contribute to sustainable farming.


*Keywords:* Farm management; Life cycle assessment (LCA); Environmental impact; Income analysis; Integrated fruit production (IFP); Sustainable farming; Apple orchards

## 1. Introduction

Integrated fruit production (IFP) is a system approach with the aim of improving sustainable farming. The central objective of IFP is to produce high

* Corresponding author. Tel.: +41 44 780 48 46; fax: +41 44 632 10 29.
*E-mail address:* patrik.mouron@env.ethz.ch (P. Mouron).

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quality food by using natural resources and regulatory mechanisms while replacing polluting inputs (IOBC, 2002, p. 1; Boller et al., 2004, p. 4). In addition, IFP not only takes the protection of the environment into account but also the income of the fruit-grower as well as health aspects of farmers and consumers. The emphasis on the better understanding of agro-ecosystems as a base for sustainable farming is widely supported by researchers into agricultural production systems (Andrews and Reganold, 2004; Bertschinger et al., 2004a). Lewis et al. (1997), for example, conceptualised the vision of IFP as a total system approach. In Switzerland, this approach began towards the end of the 1970s (Boller et al., 1998) and, by the late 1980s, was already practiced on a larger scale. In 2001, 94% of Swiss apple acreage was managed according to IFP guidelines and 5% according to organic guidelines. Guidelines in these production systems are based on research addressing single trees and blocks of trees (orchards) while empirical data at farm level concerning the portfolio management of orchards are rare. There are noteworthy gaps in evidence concerning whether the self-regulatory approach of IFP works in practice at the farm level or whether there is a fundamental trade-off between farm income and environmental impacts, thereby calling for policy interventions.

Several studies on income/environment trade-offs in agricultural production systems have investigated specific inputs at the farm level (e.g., fertilisers, pesticides). In the case of insect management, Lohr and Park (2002) reported that "In practice, American farmers do not always choose sustainable practices, even when they can improve their farm economic and environmental conditions by doing so." Wilson and Tisdell (2001) reported similarly paradoxical behaviour with respect to pesticide use. Archer and Shogren (2001) suggested that taxes might be the only way to reduce herbicide inputs in arable crops. For grassland systems, Oglethorpe and Sanderson (1999) found that different policy instruments could have positive effects on management inputs, which in turn improve ecological diversity. In the case of nitrogen management in arable crops, Brady (2003) found that policy interventions are necessary and cost-efficient because the self-regulatory mechanisms of conventional farming are insufficient in preventing negative effects on water quality outside of the farm. In contrast, Falconer and Hodge (2001) concluded that taxes on pesticide inputs might be less effective than supporting a shift from conventional farming to agro-ecosystem oriented production systems such as integrated or organic farming. Similar results are reported by Van Lierde and Van den Bossch (2004) for fruit-growing in Belgium, where farms with IFP achieved similar incomes to conventional farms but with fewer environmental impacts. The advantage of system-oriented production is also reported in comparative studies of different apple production systems for the USA (Reganold et al., 2001) and for Switzerland (Bertschinger et al., 2004b).

Despite the input restrictions detailed by the guidelines for integrated and organic farming, in practice the performance of farms within such defined production systems varies widely. Rigby et al. (2001) applied an indicator of environmentally sound practice to horticultural producers in the UK. They found that organic producers generally had higher scores than conventional producers. However, since the within-group variation was substantial, there was some overlap between the scores of the two producer groups. The authors consequently suggested that it would be an over-simplification to equate organic production with environmental sustainability. Considerable variation for economic indicators within an otherwise homogeneous group of farms in Switzerland has also been reported (FAT, 2000; Mouron and Scholz, 2005) as well as for environmental impacts (Rossier and Gaillard, 2004; Mouron et al., 2005). These results indicate the presence of substantial freedom for farm management practices within the guidelines of official production systems. However, it is still an open question if this entrepreneurial freedom within a production system leads to trade-offs between farm income and environmental impacts.

The objective of this paper is to identify ecological–economic success criteria in a homogeneous group of integrated fruit farms in Switzerland. This is done (i) by analysing the influence of farm-structure variables such as the experience of the farm manager, farm size, the amount of orchards and the cultivar mix on farm income and environmental impacts; (ii) by analysing the correlation between farm income and environmental impacts at the farm level and (iii) by explaining the observed relationship between income and environmental impacts of fruit-growing when