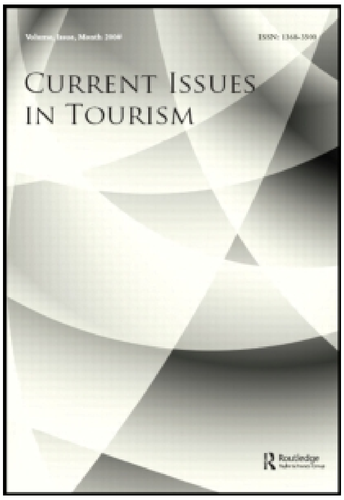

Current Issues in Tourism
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t901682222

Coupling tourism development and agricultural processes in a dynamic environment

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Online publication date: 15 April 2010

To cite this Article Gal, Yoav , Gal, Adiv andHadas, Efrat(2010) 'Coupling tourism development and agricultural processes in a dynamic environment', Current Issues in Tourism, 13: 3, 279 — 295
To link to this Article: DOI: 10.1080/13683500903141147
URL: http://dx.doi.org/10.1080/13683500903141147

Current Issues in Tourism
Vol. 13, No. 3, May 2010, 279–295

Coupling tourism development and agricultural processes in a dynamic environment

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(*Received 23 December 2008; final version received 22 June 2009*)

The role of agriculture in the Israeli economy has been declining, and a combination of essential trends has resulted in the emergence of tourism as alternative sources of economic growth in rural areas. These changes have created a new situation, in which tourism-related developments in the rural areas of Israel have become part of the activities of many farm owners. Thus, the Israeli rural environment is a single, tightly coupled system and should be analysed as such. The growth of rural tourism in the Israeli agricultural sector raises several questions, addressing whether rural tourism and farming are synergetic, and the effects of tight coupling between tourism development and agricultural processes. This article presents a simulation model of the coupling effects in which tourism development and agricultural processes are tightly coupled. Our model examined large numbers of different scenarios and the possible outcomes of a decision the farm owner takes in a routine situation of uncertainty. A typical Israeli farm owner embarks on tourism development activities mainly because of stress. Our model shows that adding tourism activities does not increase profit dramatically, but it does increase the variance of profit, which means greater exposure to risks.

Keywords: agricultural-processes; coupled business systems; dynamic environment; tourism development

Over the last 50 years, as the role of agriculture in the Israeli economy has declined (AC – The Agricultural Center of Israel, & Boroshak, 2008; Bank of Israel (BOI), 2008; Kislev, 2002; MOAG, 2007a; MOAG, 2008), a combination of essential economic and social trends has resulted in the emergence of tourism as an alternative source of economic growth in rural areas (MOAG, 2006; MOAG, 2007b). Regardless of the decline in its importance, the effects of agriculture on the environment are significant and complex, with both positive and negative impacts at local and national levels. Key drivers of change include: structural shifts in the economy, between manufacturing and services; rising demand for rural leisure and recreation; and increasing preference for rural living. These changes have created a new situation in which tourism-related developments in the rural areas of Israel have become part of the activities of many farm owners (Apelbom & Cohen, 2007; Cohen, 2007; Kimhi, 2004).

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ISSN 1368-3500 print/ISSN 1747-7603 online

DOI: 10.1080/13683500903141147
http://www.informaworld.com

Thus, the Israeli rural environment is a single, tightly coupled system and should be analysed as such. An analysis that treats tourism development and agricultural processes as separate or a loosely coupled system would lack an important attribute, because it would neglect the effects of coupling between agriculture and tourism. Therefore, the growth of rural tourism in the Israeli agricultural sector raises several questions concerning whether rural tourism and farming are synergetic, and the effects of tight coupling between tourism development and agricultural processes.

Tchetchik, Fleischer, and Finkelshtain (2007) applied a discrete-choice equilibrium model to study the rural tourism industry in Israel, and to jointly estimate the effect of lodging and farm characteristics on consumer preferences and firms' costs.

We present a different approach from the concept of seeking an equilibrium behaviour in a dynamic environment, and believe that, in the case of Israel, the results of their model might lead the farm owner to over-invest. Their claim that industry may develop either by increasing the number of businesses or by raising the number of accommodation units per business, without a dramatic drop in prices, raises some difficulties.

The results of the discrete-choice equilibrium model presented by Tchetchik et al. (2007), show that apparently, rural tourism would still be profitable, even in the extreme case in which the scope of the rural tourist industry doubles. We find such a claim to be unrealistic, primarily because the effect of tight coupling between tourism development and agricultural processes is ignored. An analysis that treats them separately thus lacks an important attribute. Unco-ordinated tourism development and agricultural processes is likely to lead to tangible business inefficiency, as well as analytical miscalculations. Lack of co-ordination between organisational processes is a subject widely covered in the literature and is beyond the scope of this article.

This article presents a simulation model of the coupling effects in which tourism development and agricultural processes are tightly coupled. We used iThink software (http://www.iseesystems.com), version 7.0.1 for Windows.

Literature review

As noted, this article presents a new approach to examining and analysing rural tourism development and agricultural processes, as one integrated whole, and proposes a simulation model to do so. The literature review focused on articles or research attempts to develop models wherein rural tourism and farming are synergetic.

The link between tourism and agriculture

In tourism studies and more broadly in the social sciences, tourism is treated as an exotic set of specialised consumer products occurring at specific times and places. Much tourism theory defines tourism by contrasting it to home geographies and quotidian routines; tourism is what they are not. It is 'a no-work, no-care, no-thrift situation'. The main focus in such research is on the extraordinary, on places other than home. Tourism is an escape from home, a quest for more desirable and fulfilling places. As a result, tourism studies produce fixed dualisms between the life of tourism and everyday life: extraordinary and ordinary, pleasure and boredom, liminality and rules, exotic others and significant others, to mention just a few. Such 'purification' means that everyday life and tourism end up belonging to different ontological worlds, the worlds of the mundane and the exotic, respectively (Larsen, 2008).

The same division into different ontological worlds exists in the realms of tourism development and agricultural processes. Previous studies have recognised the importance of coordination between tourism development and agricultural processes, but they did not define the principles and theories required to enable coordination between them when the rural area is regarded as a single linked or coupled system. Only a few articles address this relationship, mostly contending that they are mutually beneficial (Fleischer & Tchetchik, 2002; Gariv, 2008). Although mentioned in the relevant literature, the level and extent of the links between tourism and agriculture in the provision of rural accommodation have not been rigorously examined. Getz and Page (1997) failed to find published articles that examine tourism as a rural business activity. The lacuna in this article is compounded by the absence of any theoretical research published in mainstream tourism journals referring to the coordination between tourism development and agricultural processes. Furthermore, although the role of agriculture in maintaining and shaping the natural landscape in rural regions of industrial countries has received a great deal of attention in recent years, these environmental and agricultural links have attracted much less attention from policy-makers and researchers (Sharpley & Roberts, 2004).

Of course, continuous growth in tourism has been affected by the world-wide economic crisis. However, assessing the impact of the crisis on this specific sphere is difficult to estimate at present, it is beyond the scope of this paper and the model examines overall trends over time. The reasons for the recent emergence of tourism as an important rural economic activity globally are twofold. First, growth in income and leisure consumption combined with a sharp reduction in transportation costs has increased the demand for rural tourism. Second, rapid technological advances in agriculture, accompanied by a sharp decline in terms of trade have induced exits from farming. Searching for alternative sources of income, many farmers have become entrepreneurs in the rural tourism business (Tchetchik et al., 2007).

Interestingly, the issue of best use of resources for agricultural operations by those who are also seeking to develop tourism options has also been discussed regarding wine tourism, albeit not within the same theoretical framework. One of the themes identified from this literature is that wine tourism and regional development are coupled. Wine tourism can be the core business for many smaller wineries. Several disadvantages to producers choosing to sell wine at the cellar door have been identified on the basis of a study of visitors to Texas wineries, these are: increased costs and management time, capital required and inability to substantially increase sales (Hall et al. 2000). Research on wine tourism has expanded rapidly since the early 1990s, with approximately two-thirds of the literature coming from Australia and New Zealand; Canada and the USA are the dominant sources of the remaining literature. Noteworthy is the fact that almost no such research is being conducted in Europe or other parts of the world, as far as we know. However, methods are still relatively crude, and studies still tend to be regionally focused and quite generic in nature (Mitchell & Hall, 2006).

Apparently, the link between agro-tourism and agriculture is weakening. Farmers who adopted tourism on their farms as an additional source of income, gradually withdrew from agricultural activities. As a result of this transition, the active farm is no longer a necessary component of rural tourism (Busby & Rendle, 2000).

Small scale tourism themes

A number of pertinent themes and many specific topics and issues have been identified in the tourism literature. The principal themes relate to small businesses, which are widely recognised as being predominant in tourism and the hospitality sphere, and the fact that this field is dominated by owner-operators, and entrepreneurs. A major focus of these studies is the motives and goals of these entrepreneurs. Other important themes include family life and gender issues within this sphere of business endeavour, and the connections between this business sphere and development, including sustainability issues (Cawleya & Gillmorb, 2008; Getza & Carlsena, 2005).

Like rural tourism operators in other parts of the world, most of those in Israel went into the business in order to supplement their income and to enable them to stay on the farm (Fleischer & Pizam, 1997; Fleischer & Tchetchik, 2002, 2005; Gariv, 2008). The typical Bed & Breakfast (hereinafter: B&B) operation was found to be a small business, operating only during a short season, and generating a relatively low income. In industrialised countries like the UK, where the population is largely urban, 200,000 farms disappeared between 1966 and 1995. Government figures show that 17,000 farmers and farm workers left the land in the year 2003, having failed to make a living. While only 5% of the population in the EU is still farming, at least half a million farm workers were still leaving the land annually before the EU was enlarged by 15 new members in May 2004. In the USA, between 1950 and 1999, the number of farms decreased by 64% to less than 2 million, and the farm population declined to less than 2%. Canadian statistics reveal a similar process: the number of farms decreased by 10% between the 1996 census and 2001 (Gala, 2005).

Poverty among farmers appears to be a chronic problem in Western Europe (Meert, Van Huylenbroeck, Vernimmen, Bourgeois, & Van Hecke, 2005). In the EU, diversification and pluriactivity are promoted by agricultural policies as possible survival strategies for farmers. Tourism is suggested as a possible strategy for generating additional income for family farms (Bršćić, 2006). A case study which explored the linkages between tourism, community and development forces in the peri-urban zones of Sydney, Australia shows that the principal motivation for farmers to engage in tourism was economic sustainability (Knowd, 2006).

Agro-tourism

Rural tourism has been the object of intensive research for several years, because its importance for the sustainability of rural communities has been long recognised. The results, however, show little evidence of the importance of the rural theme to the rural tourists themselves. The visitors, in fact, are fairly informal in their holiday behaviour and display limited interest in the rural lifestyle (Frochot, 2005).

In Israel, the terms agro-tourism and rural tourism are not clearly defined. Other countries also have not distinguished these two terms (Bršćić, 2006). Agro-tourism is narrowly defined as tourism activity organised on the farm and by the farmers. Other segments of rural tourism might be, but are not necessarily, organised by farmers. Instead, entrepreneurs who are not involved in agricultural activity initiate and operate them (Ciani, 1999; OECD, 1994).

Clearly, rural tourism is based on rural services but, according to some authors, the way in which tourism development relates to agriculture is unclear. Fleischer and Tchetchik (2002, 2005) question whether these inter-relationships are mutually beneficial; they considered that potential benefits can accrue to a farmer running a tourist business, through more efficient use of labour and capital, but they also found that the active farm does not have any value for the visitors. Does the impact of agro-tourism lead to any increase in agricultural production in the region in which it is taking place? Bršćić (2006) thinks not. A preliminary study in Croatia during August 2002 involved interviews with a sample of 43 agro-tourism households. The results indicated that the development of agro-tourism activities had no significant effect on the increase of agricultural production among such households. Moreover, the owners of agro-tourism households were not planning to increase their agricultural production.

The OECD (1994) named 17 potential benefits that tourism could bring to rural development, of which the most important ones were: job retention and creation, farm support, conservation of land and historic buildings, preservation of rural crafts and arts, environmental improvements, increased role of women, and introduction of new ideas and initiatives. However, it also named several problems that could arise from tourism-based rural development, related to environmental damage, socio-cultural problems, housing; incoming entrepreneurs, traffic congestion, and issues of planning, local control, public participation and partnership. Unfortunately, no precise formula exists that the OECD could use to predict whether the advantages would outweigh the disadvantages or vice versa.

Rural tourism in Israel

Rural tourism in Israel is based on natural amenities and the rural way of life. The accommodations consist of B&B facilities in all types of rural settlements, and local restaurants offering a variety of cuisine, ranging from vegetarian food, ethnic and home-style cooking, to a variety of popular and even sophisticated restaurants. Popular activities associated with rural vacations include water sports, nature walks, visiting national parks and touring rural settlements. A national census of B&B operations in the rural regions of Israel identified the characteristics of the operators and the guests. Comparing the results with those of similar surveys conducted in Europe and North America indicate that the rural tourism business was, in many but not all aspects, similar throughout the world.

The market segments attracted to such vacations in Israel were young families with children living at home, with college-educated parents who earned above-average Israeli incomes (Fleischer & Pizam, 1997; Fleischer & Tchetchik, 2002, 2005; Gariv, 2008). In other regions, the typical market segments for B&B operations were middle-aged families with children. For example, in Austria, 66% of the tourists were aged between 31 and 49, most of them accompanied by children under the age of 16. In Minnesota, in the USA, the majority of visitors were families in their thirties and forties with children. They were from higher income level brackets and had college educations. Similar findings were obtained in a national survey of vacation farms in the USA. Vacation farm guests were found to be city dwellers, adults with children, who were employed as professionals or owned their own businesses. The profile of visitors described in Canada was the same, and surveys among visitors to B&B accommodations in Germany and Spain yielded similar results (Fleischer & Pizam, 1997).

Theoretical framework

The model utilised by Tchetchik et al. (2007) applies a discrete-choice equilibrium model with product differentiation to study the rural tourism industry in Israel, and to jointly estimate the effect of lodging and farm characteristics on consumer preferences and firms' costs. The model accounts for heterogeneity in tastes and technologies and allows for unobservable product characteristics. Simulation results demonstrate the growth potential of the industry and show that the government can play an important role in catalysing growth via investment subsidisation, deregulation of supply and information distribution.

The equilibrium model is one way to observe reality. Nevertheless, the problem of understanding complex system behaviour and the challenge of developing easy-to-use models are apparent in the fields of environmental management. However, mathematical models are appealing in social and natural science, in which cause and effect relationships are confusing. These models, however, run the risk of becoming detached from reality, sacrificing realism for analytical tractability. As a result, these models are accessible only to the trained scientist, leaving others to believe or not believe the model's results (Ruth & Hannon, 1997).

In general, system simulation theory distinguishes between system structure and system behaviour. A system's behaviour is the relationship it imposes between its input time histories and output time histories. The structure of the system includes its states and state transition mechanisms. A continuous complex dynamic system model can place a value on one of its parts, but the actual destination of this output is not determined until the model becomes a component in a larger system and a coupling scheme is specified. The model can therefore be reused in any applications context in which its behaviour is appropriate, and coupling to other components makes sense (Zeigler, Praehofer, & Kim, 2000).

The model

Most models fit into one of three general classes: models that represent a particular phenomenon at a point in time; a comparative static model that compares some phenomena at different points in time; or a dynamic model developed to show the changes in processes over time. Dynamic models are those that try to reflect changes in real or simulated time, and take into account that the model's components are constantly evolving as a result of previous actions (Ruth & Hannon, 1997). The world is not static or comparatively static, therefore the models treating it as if it were, quickly become obsolete and perhaps even misleading. The model described in this article examines the tourism development and agricultural processes in detail, as a single, tightly coupled system. The simulation model is discrete, dynamic and stochastic: in it, the system evolves over simulated time by a representation in which the stated variables change instantaneously at separate points in time.

Our presentation of the model follows the exposition of the theory of modelling and simulation in complex dynamic systems. When building a model of processes, the level of detail should be sufficient to represent the question at hand, but not so detailed as to cause excessive complexity (Sherman & Schultz, 1998). In the present case, the system was assumed to have two main components: tourism development, and agricultural processes seen as a unit. The dependant variable was the extent of coordination between the tourism development and the flow of agricultural processes. Hence, the simulation model consists of three elements:

- The tourism function, which describes potential income from rural tourism development;
- The agricultural function which describes a typical farm income; and
- A co-ordination function that describes the adjusted income of a typical farm, which consists of an agricultural activity and a tourism-development venture.

The tourism function

We begin with simulating the tourism function by using common methods of exponential models forecasting.[1] The equation of the tourism function represents the trend factor of the farm owner's possible income from rural tourism per month. A farm owner who operates tourism facilities in Israel can be characterised by the following (Fleischer & Tchetchik, 2005):

(a) Rural tourism is based on natural amenities and the rural lifestyle. The accommodation is provided by B&B activities in kibbutzim, moshavim (the two major types of agricultural co-operative settlements in Israel) and other, private types of rural settlements.
(b) The decline in the ability of farm agriculture to generate sufficient income has caused many farmers to seek new sources of income, and to try to diversify their agricultural base.

(c) The vacation is one in which a vacationer occupies a large proportion of his/her time engaged in recreational activities on a farm, ranch or in a country home and its environment.
(d) The B&B is a commercial venture of a country vacation host, who opens his/her home and/or property to paying guests, so that they may enjoy recreational activities in a predominantly rural environment. A plethora of restaurants, offering a wide range of culinary styles and cuisines, have sprung up in rural areas for the tourists. The tourists' experiences of the natural environment have been enhanced by the development of various enterprises: water sports, e.g., rafting and kayaking, guided nature walks, jeep tours in more rugged areas, rappelling, horseback riding, etc. Typical rural tourism enterprises are small-scale, traditionally operated and relatively isolated geographically, and their individuality gives them a sense of place.

Based on the above characteristics, the typical farm owner, used to dealing mainly with agriculture, follows a typical growth curve when he embarks on a tourism venture. The curve must belong to the logistic functions family because it fits a general development process. This means that growth develops along the 'S' curve. We prefer to use the following function in the model because of its simplicity:

$$Y(t) = \frac{K}{1 + C \cdot e^{-r \cdot t}},$$

where

- $Y(t)$ is the profit level from the tourism venture in month t; 't' $= 1-60$, i.e., a 5-year period.
- K, the maximum profit level allowed in the model. We assume that the typical farm owner can gain a profit of about NIS 25,000 per month from tourism activities. This assumption is based on about 30% occupation for eight accommodation units, with an average rent of NIS 500 per night. All other tourism activities in the model earn more or less the same profits.
- C, the number of tourism activities. We assume that a typical farm owner can manage no more than five such activities: B&B, restaurant, jeep trips, agricultural visitor centre, and other small local activities.
- r, the growth rate was calculated as 20% per annum. Rural tourism in Israel has seen an annual growth rate of 15% in the last 20 years (Fleischer, Engel, & Tchetchik, 2005). Tchetchik et al. (2007) assume that, in the Israeli case, the tourist industry may develop by increasing either the number of businesses or the number of accommodation units per business, without a dramatic drop in prices. They thus conclude that, even in the extreme case in which the size of the industry doubles, rural tourism would still be profitable.

The agricultural function

Agricultural processes are characterised by the following features:

(a) Decision-makers in the rural areas, in general, want to develop tourism and to combine agriculture and tourism as income sources (Cohen, 1998).
(b) For intensive specialised farms in the Israeli agriculture, the average branch size and the average profitability per branch per unit are shown in Table 1. Profitability

Table 1. Typical branch size.

Branch	Unit	Farm size	Gross profit without wages of farm owner (in NIS[a] per annum)
Dairy	Litre	600,000	131,000
Citrus	Dunam	110	1700
Orchard, irrigated	Dunam	80	2880
Orchard, un-irrigated	Dunam	60	30
Veg., open	Dunam	300	140
Veg., greenhouses	Dunam	80	2500
Flowers	Dunam	60	2100
F.C. open	Dunam	10,000	30
F.C. irrigated	Dunam	5000	90
Poultry	Battery hen	6000	44,000

Source: Ministry of Agriculture and Rural Development, Rural Planning and Development Authority, POB 30, Bet Dagan 50200, Israel.
Note: 1000 litre = 1 m^3.
[a]Exchange rate: 1 USD = 4 NIS.

was calculated according to the cost accounting made by the Department of Production Economics of the Extension Services of the Ministry of Agriculture (Hadas, 2003).

(c) The basic unit is the agricultural estate. Generally, in a specific area the estates are similar in size. The various branches were created from the macro data for Israeli agriculture, as calculated by the Department of Investment Financing Development of the Ministry of Agriculture and Rural Development, and the Central Bureau of Statistics (CBS – Central Bureau of Statistics of Israel, 2006). The average size of the typical Israeli agricultural estate is 30 dunams (3 ha/7.5 acres) with a water quota of 27,000 m^3. It is important to note that the intensive specialised farmer manages more than just his/her own estate (see Table 1, column 2; Hadas, Madleg, Weiss, & Dotan, 2002).

(d) We assume that an average Israeli farm, as represented in the model, is sufficiently representative of the agricultural reality as we know it (see Table 2; CBS – Central Bureau of Statistics of Israel, 2008).

(e) Even though there is no such farm at the individual level, the typical average Israeli farm takes into account trends and weights that affect Israeli agriculture. Of course, the typical farm type does not really exist, but it reflects the average behaviour pattern of the Israeli farm owner (Table 3).

(f) In our model, we do not take into consideration the differences between areas or between farm types. Differences exist, of course, but the generalisation helps in understanding the coupling effects between tourism development and agricultural processes.

(g) Table 3 shows the gross profit of the typical farmer, excluding the wages of the farm owner, in nominal NIS per annum (Hadas, 2003).

(h) The estimation of the income flow is based on working data published by the Ministry of Agriculture and Rural Development, and was set according to the relative income of the branch. We adjusted a polynomial equation to fit the calculated data and used it in the simulation model to create the agricultural function. The equation describes the distribution of profits throughout the year; see Figure 1 (Rural Planning and Development Authority, 2001, 2006).

Table 2. Structure of Israeli agricultural output, 2006–2007.

Branch	Overall production (in '000,000 NIS[a])	% by production value (total)
Dairy	2926	16
Citrus	1011	5
Orchard, irrigated	3809	21
Orchard, un-irrigated	10	0
Veg., open	3930	21
Veg., greenhouses	700	4
Flowers	1187	6
Field crops open	600	3
Field crops irrigated	860	5
Poultry	3485	19
Total	18,518	100

Source: Ministry of Agriculture and Rural Development, Investment Financing Development, POB 30, Bet Dagan 50200, Israel.
[a]Exchange rate: 1 USD = 4 NIS.

Table 3. Gross profit of a typical farm.

Branch	Gross profit without wages of farm owner (in NIS[a] per annum)
Dairy	20,699
Citrus	10,209
Orchard, irrigated	47,391
Orchard, un-irrigated	1
Veg., open	8913
Veg., greenhouses	7560
Flowers	8077
Field crops open	9720
Field crops irrigated	20,899
Poultry	8281
Total	141,751

Source: CBS – Central Bureau of Statistics of Israel (2008), Publication No. 1335, August, Israel.
[a]Exchange rate: 1 USD = 4 NIS.

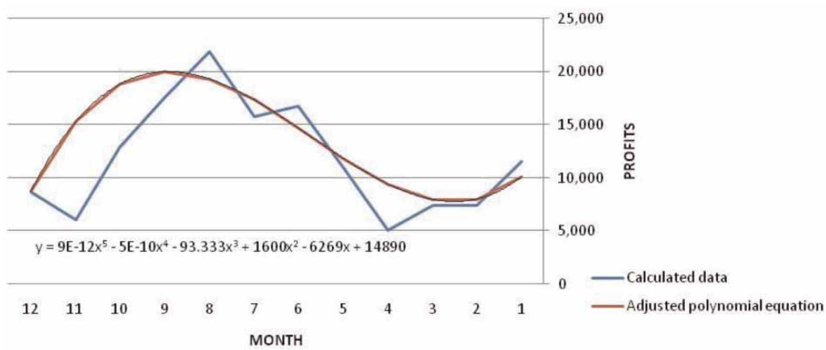

Figure 1. An adjusted polynomial equation to the calculated monthly agricultural profit.

(i) We assumed, for modelling purposes, that the distribution of profits throughout the year is influenced only by random events, such as frost, heat waves, labour shortages, etc. We did not measure the effects of terms of trade, inflation, or other similar factors. We also assumed that during the years 1995–2006, the average distribution of profit throughout the year reflected the agricultural structure, with small and negligible changes.

The agricultural function in the model was estimated from the average data of Israeli agriculture for the years 2003–2008, as shown in Tables 1–3, with the following parameters, as described in Figure 1:

$$\mathrm{Pr} = -93.333^{*}\mathrm{m}^{3} + 1,600^{*}\mathrm{m}^{2} - 6,269^{*}\mathrm{m} + 14,890,$$

where Pr is the agricultural profit per month in month *t*; '*t*' $= 1-12$, i.e., a 1-year period, and *m*, the month.

The coordination function

Within the model, we assumed that the farm owner has a limited number of work days and that, subject to this limitation, he prefers to divide his time between the agricultural activities and the tourism development, in accordance with their expected monthly profits.

The model aims to evaluate the influence of coupling between tourism development and agricultural processes in a dynamic environment. We assume that the agricultural function can be affected by random events subject to environmental constraints, e.g., drought, natural risks, changes in international prices, etc., up to $\pm 50\%$. We assume that the tourism function is less sensitive and can also be affected by random events subject to terms of trade, changes in international prices, etc. up to $\pm 20\%$.

The coupling effect in the model is described by the Cobb–Douglas equation:

$$\mathrm{CD}_{(\mathrm{t})} = A_{(t)}^{\alpha} * \mathrm{T}_{(\mathrm{t})}^{\theta},$$

where $\mathrm{CD}_{(t)}$ is the coupled profit level from tourism venture and agricultural activities in month *t*; '*t*' $= 1-60$, a 5-year period; $A_{(t)}$, the agricultural profit in month *t*; $T_{(t)}$, the tourism profit in month *t*; α, the coefficient of agricultural importance; θ, the coefficient of tourism importance. In order to keep the equation under terms of constant returns: $\alpha + \theta$ must equal 1.

The model of Tchetchik et al. (2007) applies a discrete-choice equilibrium model (Berry, 1994; Fershtman, Gandal, & Markovich, 1999) with product differentiation to study the rural tourism industry in Israel and to estimate the effect of lodging and farm characteristics on consumer preferences and firms' costs. Their model enables a joint estimation of both the demand and cost parameters, using only data of the aggregated-firms level, and simulations of the industry equilibrium.

We present a different model from the concept of seeking an equilibrium behaviour in a dynamic environment. Our model, in which tourism development and agricultural processes are tightly coupled, shows that in the case of Israeli tourism, the industry could not develop either by increasing the number of businesses or by raising the number of accommodation units per business, without having an impact on agricultural activities. Instead of a model which simulates industry equilibrium, in our model, each step of the simulation creates a system output that in turn is the next step's input. Thus, tourism development and agricultural processes mutually affect each other in a dynamic environment.

Limitations

(a) No reference has been found for previous utilisation of such a model to estimate the effect of co-ordination between tourism development and agricultural processes.

(b) There is no statistical database regarding rural tourism in Israel, and some of the assumptions above are based on interviews with experts and farm owners who operate rural tourism activities.
Since there is no statistical database, the set of equations in the simulation model represents behaviour patterns in the rural areas of Israel, which experts agree are acceptable and considered 'good enough' and sensible.

(c) Even though Systems Thinking software like iThink is a valuable tool for constructing models to understand dynamic systems, the software has its limitation: http://www.iseesystems.com/softwares/Business/IthinkSoftware.aspx.

(d) The major issue with the content of our model has to do with the filter we employ to sift from reality the essential raw materials from which to construct our representations of that reality. Of course, this problem is not exclusive to this model, and can be found in many other models as well.

Discussion

Over the last 50 years, the typical farm owner in Israel has been occupied primarily in agriculture. By initiating a tourism venture which follows a typical growth curve, the farm owner increases the number of activities on the farm. Therefore, the flows associated with the tourism development and the agricultural processes are tightly coupled. Lack of co-ordination between them is likely to create tangible business inefficiency and any analysis that treated them separately would lack an important attribute.

Figure 2 shows the behavioural pattern of the system, as calculated by the simulation model. Both the pattern of agricultural profit and that of tourism profit are close enough to the behavioural pattern, as revealed by past data. The model output shows higher profit from agriculture during the second half of the year and lower profit at the beginning of the year, apart from random changes resulting from weather, and changes in prices, exchange rates, etc. In parallel, development of new enterprises associated with tourism creates low but increasing profits for at least 3 years and higher profits during the fourth and fifth years, but with exposure to risks that characterise the tourism industry. Risks are reflected in the model by higher variance.

Figures 3 and 4 show only selections of the outcomes. However, these results strongly refute the possibility of unlimited growth potential. Figure 3 presents the results of coupling effects in a dynamic, time-varying market environment, in which tourism development and agricultural processes are tightly coupled, when the emphasis is on agriculture, i.e., where $\alpha = 0.7$ and $\theta = 0.3$. Figure 4 differs only in the interchanging of the parameters values, i.e., $\alpha = 0.3$ and $\theta = 0.7$, which places greater emphasis on the tourism venture.

Figure 3 represents a 5-year period in which the incomes from agriculture and tourism are coupled but in which, from the farm owner's point of view, agriculture is the main business of the farm. The results of the simulation show that even though the farm owner starts a new tourism venture, the coupled profit is not significantly affected and,

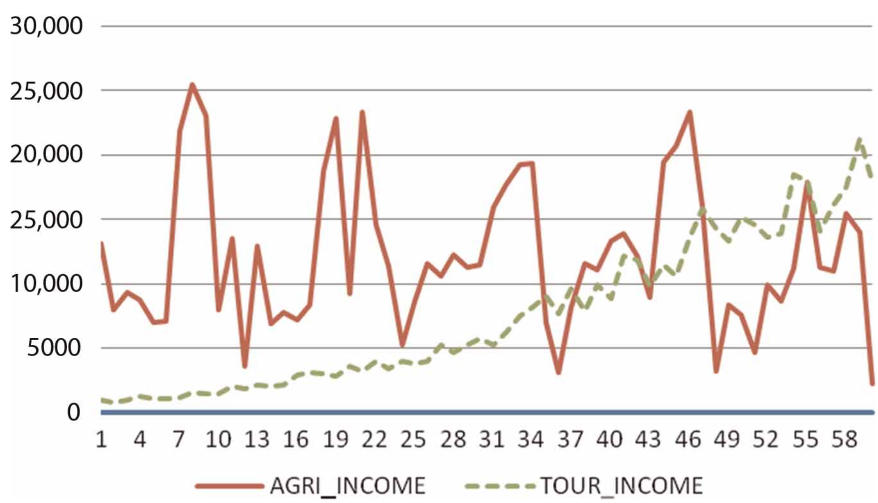

Figure 2. Typical behaviour of agricultural income and tourism income in the simulation model (NIS).

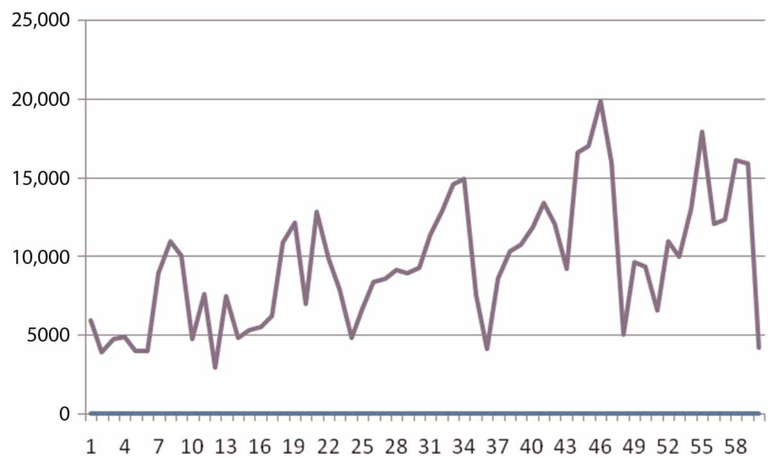

Figure 3. The co-ordinated income function when agriculture is more important (in NIS, $t = 0.3$).

moreover, the profit variance during the fourth and fifth years is increased. This can be attributed to the likelihood that when a tourism venture is added to an agricultural activity, without proper attention to its management, the contribution of the new venture to the total profit is most probably not significant. It also is reasonable to suppose that adding a new activity without proper management resources results in difficulties in running the old business, and contributes to greater variance.

It is important to note that usually, the typical farm owner added new tourism activities when the profit level from agriculture failed to meet his/her expectations. We do not claim that it is impossible to find a successful farmer who earns an acceptable profit from agriculture, and who also starts to develop a new tourism venture, but usually this is not the case. Figure 4 represents a 5-year period in which incomes from agriculture and tourism are

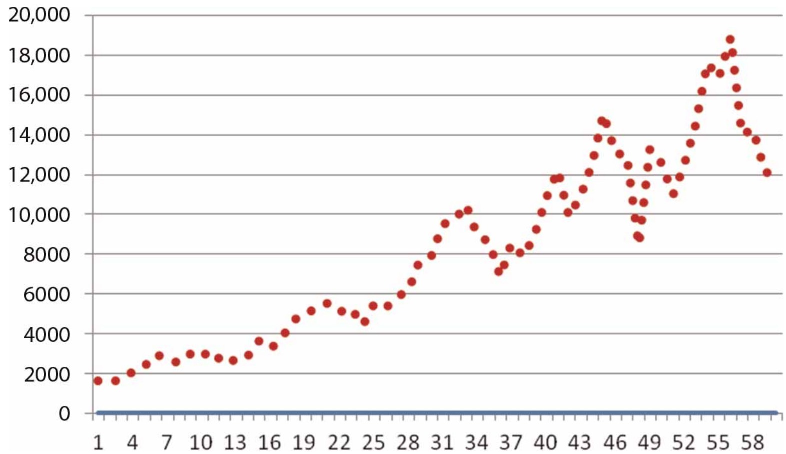

Figure 4. The co-ordinated income function when tourism is more important (in NIS, $t = 0.7$).

coupled, but in which, from the farm owner's point of view, tourism is the main business of the farm. The coupled profit increases during the 5-year period in accordance with the growth curve of the tourism development. However, because the tourism venture is new and most of the farm owner's efforts are devoted to this new venture, the profit received is lower. On the other hand, the model result could represent a situation in which the farm owner faced a decrease in agricultural incomes and that was the real reason for trying to develop new tourism activities. In both cases, this is a situation the results of which can be considered to be a fair representation of reality. Even though the farm owner devotes most of his time to tourism during the fourth and fifth years, the variance of his profit increases because of the coupling of the agricultural activities, mainly because of the summer harvests.

The model of Tchetchik et al. (2007) supposes that, in the Israeli case, the tourist industry may develop by increasing either the number of businesses or the number of accommodation units per business, without a dramatic drop in prices; even in the extreme case in which the size of the industry was doubled, rural tourism would still be profitable. However, we found this to be very difficult to achieve in a typical farm in Israel. Our model shows that adding tourism activities does not increase profit dramatically, but it does increase the variance of profit, which means greater exposure to risks.

The present conclusions are based on the findings from an Israeli case study. Additional research is still required, which would involve comparisons among several countries or regions, in order to validate these conclusions and to confirm that they represent a behavioural pattern and are not applicable to only one case study. The findings are not yet meant to be regarded as a 'law of nature' but are the result of examination of a hypothesis that was found true in Israel. Generality of the conclusion should be sought from similar studies in other countries or regions. The authors would welcome interaction with researchers who wish to conduct such studies. Nevertheless, the importance of the findings rests on their possible contribution to the development of a management tool that could help to improve the coupling between tourism development and agricultural processes in a dynamic environment. The findings are important because the effect of tight coupling among the processes is usually ignored, and an analysis that treated these processes individually would lack an important attribute.

Note

1. As quoted by: Hanke and Retsch (1998). Also described by: Makridakis, Wheelwright, and Hyndman (1998).

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Appendix: model simulation equations

```
CD Function
a=1-t
AGRI_INCOME=IF (TRANSFER_CONDITION=100) AND (MAX_DAYS=1) THEN
(AGRICULTURAL_PERFORMANCE/AGRI__Work)*AGRICULTURE_WORKING_DAYS
ELSE AGRICULTURAL_PERFORMANCE
AGRI_INCOME_PER_DAY=AGRI_INCOME/AGRICULTURE_WORKING_DAYS
Agri_out=IF(AGRI_INCOME<100) THEN 0.5 ELSE
INT(AGRI_INCOME/100)
AVG_AGRI_DAY=(DELAY(AGRI_INCOME_PER_DAY,6)+
DELAY(AGRI_INCOME_PER_DAY,5)+
DELAY(AGRI_INCOME_PER_DAY,4)+
DELAY(AGRI_INCOME_PER_DAY,3)+
DELAY(AGRI_INCOME_PER_DAY,2)+
DELAY(AGRI_INCOME_PER_DAY,1)+
AGRI_INCOME_PER_DAY)/7
AVG_INCOME_PER_MONTH=9900
AVG_TOUR_DAY=(DELAY(TOUR_INCOME_PER_DAY,6)+
DELAY(TOUR_INCOME_PER_DAY,5)+
DELAY(TOUR_INCOME_PER_DAY,4)+
DELAY(TOUR_INCOME_PER_DAY,3)+
DELAY(TOUR_INCOME_PER_DAY,2)+
DELAY(TOUR_INCOME_PER_DAY,1)+
TOUR_INCOME_PER_DAY)/7
CDA=INT(AGRI_INCOME^ a*10)/10
CDT=INT(TOUR_INCOME^t/10)*10
CD_Function=IF(AGRI_INCOME<=0) THEN
K*((TOUR_INCOME)^t)
ELSE IF(TOUR_INCOME<=0) THEN
K*((AGRI_INCOME)^a) ELSE
K*((AGRI_INCOME)^a)*((TOUR_INCOME)^t)
CD_output=IF(CD_Function/100<=1) THEN 1 ELSE
CD_Function/100
K=1
t=0.3
TOUR_INCOME=IF (TOURISM_WORKING_DAYS>TOUR_Work) THEN
(TOURISM_PERFORMANCE/TOUR_Work)*TOURISM_WORKING_DAYS ELSE
TOURISM_PERFORMANCE
TOUR_INCOME_PER_DAY=TOURISM_PERFORMANCE/TOUR_Work
Tour_out=IF(TOUR_INCOME<1000) THEN 0.5 ELSE
INT(TOUR_INCOME/1000)

PERFORMANCE
UNATTACHED:
AGRICULTURAL_PERFORMANCE=IF
   ((ax*MONTĤ\end3+bx*MONTH^2+cx*MONTH+dx)<=0)
THEN 3000
ELSE
Randomize_2*(ax*MONTH^3+bx*MONTH^2+cx*MONTH+dx)
UNATTACHED:
TOURISM_PERFORMANCE=GROWTG_CURVE*Random_1
ax=-93.333
bx=1568
cx=-6269
dx=14898
```

```
MAX_DAYS=IF (TOTAL_DAYS=OWNER_DAYS) THEN 1
ELSE 99
Randomize_2=RANDOM(0.5,1.5)
Random_1=RANDOM(0.8,1.2)
TRANSFER_CONDITION=IF
TOURISM_PERFORMANCE<=AVG_INCOME_PER_MONTH)
THEN 1 ELSE 100

WORK_CONDITION_2=IF ((TRANSFER_CONDITION+MAX_DAYS)=2) THEN 2
ELSE 999

TOURISM GROWTH CURVE
UNATTACHED:
GROWTG_CURVE=K_2/(1+C*exp(-(R)*FIVE_YEARS_PERIOD))
C=0*PARAMETER_CHANGE_1+30
C_OUT=C/10
K_2=25000
Maximum_1=300
PARAMETER_CHANGE_1=IF (RANDOM(0,Maximum_1)<= 20) THEN 3 ELSE
IF (RANDOM(0,Maximum_1)<= (20+Step_1)) THEN 4 ELSE
IF (RANDOM(0,Maximum_1)<= (20+Step_1)) THEN 5 ELSE
IF (RANDOM(0,Maximum_1)<= (20+Step_1)) THEN 6 ELSE
IF (RANDOM(0,Maximum_1)<= (20+Step_1)) THEN 7 ELSE 8
R=0.075
R_FOR_RESULTS=R*100
Step_1=50

WORK
AGRICULTURE_WORKING_DAYS=IF
(TOURISM_PERFORMANCE<=AVG_INCOME_PER_MONTH)
THEN AGRI__Work
ELSE IF ((OWNER_DAYS-TOUR_Work)<0) THEN 0
ELSE IF ((OWNER_DAYS-TOUR_Work)>AGRI__Work) THEN AGRI__Work ELSE
(OWNER_DAYS-TOUR_Work)
AGRI__Work=INT((0.0109*MONTH^5-0.33177*MONTH^4+3.5081*MONTH^3-
15.434*MONTH^2+27.81*MONTH-1.3105))

FIVE_YEARS_PERIOD=TIME-60*xy
MONTH=TIME-12*xm
OWNER_DAYS=30
TOTAL_DAYS=AGRICULTURE_WORKING_DAYS+TOURISM_WORKING_DAYS
TOURISM_WORKING_DAYS=MIN((OWNER_DAYS-
AGRICULTURE_WORKING_DAYS),TOUR_Work)

TOUR_Work=IF (FIVE_YEARS_PERIOD<12) then 10 ELSE
IF (FIVE_YEARS_PERIOD<24) then 15 ELSE 5
xm=INT((TIME-1)/12)
xy=INT((TIME-1)/60)
YEAR=IF (FIVE_YEARS_PERIOD<13) THEN 1 ELSE
IF (FIVE_YEARS_PERIOD<25) THEN 2 ELSE
IF (FIVE_YEARS_PERIOD<37) THEN 3 ELSE
IF (FIVE_YEARS_PERIOD<49) THEN 4 ELSE
IF (FIVE_YEARS_PERIOD<61) THEN 5 ELSE 6
```