調查研究—方法與應用/第 41 期
2018 年 10 月，頁 57-86

Research Articles

Constructing an Evaluation Model of Agricultural Tourism Production Value with a Fuzzy AHP Approach

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ABSTRACT

Agriculture in Taiwan has undergone transformation. The once production-based agriculture has now been supplemented or even replaced on many small farms by a service-based model. The managerial model of agricultural tourism is becoming more diversified, and the market of agricultural tourism is moving toward a mature market structure. With the emergence of agricultural tourism, the production value thus generated has become important. However, an explicit index and criteria for assessing the current value of agricultural tourism is needed. This study establishes such an index for statistical evaluation of the production value of the agricultural tourism industry, deploying the Delphi method and fuzzy analytic hierarchy process (FAHP). We establish three main criteria, including products, services, and expenditures. Overall, agricultural products remain an important statistical index of production value in agricultural tourism. The present study

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suggests that the concerned authorities in agricultural tourism apply agricultural products as the core production value output. This study will enable them to estimate and quantify the production value of agricultural tourism in Taiwan.

Keywords: agricultural tourism production value, fuzzy analytic hierarchy process, agricultural products, core production value output

運用模糊層級分析法構建農業旅遊產值之評估模型*

陳彥呈** 李青松***

摘要

國內農業旅遊乃由生產性的事業轉型為服務性的事業，在新興服務事業裡農業旅遊具有很大的發展空間，由於農業旅遊經營的型態與規模趨於多元，促使農業旅遊產業市場逐漸趨向一個成熟的市場結構；然而隨著農業旅遊的興起，其所創造的產值也相形重要，而評估農業旅遊的產值目前則較無明確的調查指標與標的，因此建立評估農業旅遊之產業產值統計模式是值得深入探討的。本研究透過專家德菲法與模糊層級分析等質量兼具的方法來建構農業旅遊產值指標。研究結果顯示，農業旅遊產值統計指標主要區分為農業產品、旅遊服務、娛樂消費等三大指標，在整體觀點方面，農業產品係為較重要的調查統計指標。因此本研究建議農業旅遊相關主管機關應以農業產品作為農業旅遊主要核心指標，以期能更精確作為農業經濟發展之標的。

關鍵詞：農業旅遊產值，模糊層級分析法，農業產品，核心產值指標

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* 本文爲農委會補助研究計畫 101 農科-5.2.3-輔-#1(8) 之部分成果，感謝農委會經費補助。

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A. Introduction

In the era of industrialization and globalization, some traditional agriculture businesses have begun to decline, particularly those without the economic scale to sustain profitable operations. The challenges these relatively small farm owners face include poor commodity prices, rising input costs, and globalized competition, among others, all of which are substantially eroding small farm incomes across the United States, Europe, and throughout the world (McGehee 2007). In response to these recent developments, small farm owners have begun to transform their farms and agriculture businesses from pure farm production into agricultural tourism businesses (Addinsall et al. 2017; Doh et al. 2017; Karampela et al. 2016). Agricultural tourism is increasingly being viewed as a 'desirable diversifier' in this context for local and regional economies, not least because one positive externality of tourism growth is its role in increasing the supply of local services as well as the less obvious social contribution of tourism to expanding local leisure spaces, especially in marginalized, peripheral regions (Butler and Rogerson 2016). By combining agriculture production and tourism services, these businesses are able to create much higher profit and differentiate themselves from other, single-operation counterparts. We are observing more and more of this transformation and diversification, in which farms combine the elements of production, life, eco-environment, tourism, landscape and cultural resources in Taiwan.

Taiwan is located at a pivotal position in East Asia and has very advanced agriculture development in high-added-value products. According to the historical records of the Council of Agriculture in Taiwan, agriculture

production was the major contributor to Taiwan's economy before 1980, during which period large-scale agriculture techniques and knowledge were developed and applied. Thereafter, the contribution of agriculture to GDP dropped gradually, from 7.51% in 1980, to 4.00% in 1990, and 1.98% in 2000, as industrial processing and service industries started to prosper (Council of Agriculture, 2018a). The number is still growing, which suggests a vast market opportunity for agricultural tourism. While Taiwan enjoys a beautiful natural environment and the visitors it brings, researchers have yet to provide a systematic evaluation model for such a market.

There are currently 330 registered leisure farms in Taiwan (Council of Agriculture, 2018b). The real number is expected to be much higher because small-scale leisure farm owners tend to not apply for a license, to avoid fees and administrative procedures. To provide a proper development strategy, this study intends to find related criteria and sub-criteria for evaluating agricultural tourism's production value. We deploy a two-stage analysis consisting of a fuzzy Delphi method in the first stage to collect and reach consensus on experts' opinions, and a fuzzy analytic hierarchy process (FAHP) in the second stage to establish agricultural tourism criteria priorities and weights. This study focuses on leisure farms as the main subject in building our evaluation model because the leisure farm is one of the most popular forms of agricultural tourism. Leisure farms take advantage of a bucolic view, natural ecology, and environmental resources, and provide activities such as agriculture, forestry, fishery and ranching, as well as farmland culture and lifestyle (Chang 2003).

According to past research, the decreasing traditional agricultural production is mainly subject to the following reasons: falling prices of agricultural commodities, higher production costs, the impact of globalization,

and elasticity of the commodities market. All these factors jointly lead to a decline in agricultural profits (Doh et al. 2017). Past research has indicated that the managerial strategy of leisure agriculture influences both the economy and the environmental. Neglecting the reproduction of leisure agriculture while adopting roundabout production might render leisure agriculture an "investment combination" of the tertiary industry, thus failing to attain the expected effect. The other associated production activities of leisure agriculture, which are inseparable from traditional agriculture, can add to the economic effect (Butler and Rogerson 2016).

The result of this study contributes in establishing a model for evaluating agricultural tourism production value. Decision makers can use the result of this study to establish efficient and profitable plans for their agricultural tourism businesses. As a highly efficient and flexible method of decision making, FAHP (fuzzy analytic hierarchy process) helps decision makers undergo hierarchical analysis and make the best decisions by referring to a specific concept. The complex problems inherent in the production value of agricultural tourism are thus systematize Through hierarchical construction of mutually affecting relations (factors), researchers can obtain consistency regardless of the complexity of problems, uncertainty of risk or judgmental chaos. Comprehensive evaluation can be made by using quantitative judgment, thus providing decision makers with sufficient information on the one hand and reducing risk on the other hand.

By referring to the conceptions or viewpoints offered by experts from leisure agriculture, this study aims to investigate the production value of agricultural tourism. The AHP (analytic hierarchy process) is applied to assess the order of priority of agricultural tourism products. The best projects can thus be selected and the needs are decided. The researchers apply

the pairwise comparison method of FAHP to reduce the complexity of the decision-making process. Finally, the results are generalized and the statistical index and criteria for assessing agricultural tourism production value are established.

In the following sections, we first discuss the literature on agricultural tourism. A brief introduction about the Delphi method and fuzzy analytic hierarchy procedure (FAHP) implemented in our study follows. Finally, the results are summarized and conclusions for practitioners and researchers are provided.

B. Agricultural tourism

1. Agricultural tourism—definition, and developmental trend in Taiwan

Agricultural tourism is a type of tourism product directly connected with the agrarian environment, agrarian products or agrarian stays (Liang 2017; Qiu and Fan 2016; Scaglione and Mendola 2017). Agricultural tourism includes all rural enterprises which incorporate both a working farm environment and a commercial tourism component (McGehee 2007; McGehee et al. 2007; Weaver and Fennell 1997), and provides activities of hospitality performed by agricultural entrepreneurs and their family members that must remain connected and complementary to farming activities (Sonnino 2004). Marques (2006) described agricultural tourism as a specific type of rural tourism in which the hosting house must be integrated with an agricultural estate, inhabited by the proprietor, allowing visitors to take part in agricultural or complementary activities on the property. Agricultural tourism includes a wide variety of activities, for example, tours, overnight stays, special events and festivals, on-farm stores, fee-based

fishing and hunting, crop mazes, bird-watching, hiking, cross-country skiing, horse-riding and recreational harvesting. However, those developed on a non-working farm using a staged farmland setting do not count as authentic agricultural tourism activity (Barbieri and Mshenga 2008). Phillip et al. (2010) built a typology for defining agricultural tourism by asking three key questions: Is it tourist activity based on a working farm? What is the nature of tourists' contact with agricultural activity? Does the tourist experience authentic agricultural activity? In Taiwan, we define agricultural tourism as an upgrade from traditional agricultural production, in which primary products such as milk, rice and fruit are produced. Agricultural tourism in Taiwan, featuring the combination of production, life and ecology, differs from other types of tourism activities. It focuses on promoting local features such as the growing seasons, climate, geography, culture, people and their work. Our definition of agricultural tourism is similar to the definition of 'working farm, direct contact, authentic agricultural tourism (WFDCA)' (Phillip et al. 2010).

Challenged by rapid growth in industry and commerce in the 1960s and 1970s, Taiwan's agriculture stagnated and shrank. To help Taiwan's agriculture resolve the dilemma on the one hand and to elevate farmers' income, there is a need to accelerate agricultural transformation and adjust the structure of agricultural from that of a primary or 'level-one' industry (agriculture) to a combination of levels one, two (primary product processing) and three (service) (based on the Taiwanese government's classification scheme). The range of agricultural management needs to be expanded. Agricultural products should be service-oriented, including tour agriculture, leisure agriculture and agricultural transport. In the 70s and late 80s, we witnessed tour farms being open to visitors for fruit picking, cuisine

appreciation and product purchase. By the late 90s, tour farms were found to further develop as leisure agriculture. In addition to providing agricultural products, tour farms became a leisure attraction, providing the pleasure of being in a pastoral setting (Huang and Chang 2015). The "agriculture plus tour" managerial model can help develop agricultural production, conserve the ecological environment, and enhance agricultural tourism. Moreover, it can help farmers make more profit, thus enabling the rural economy to become more prosperous. This is the main developmental trend of agricultural tourism in Taiwan (Wu 2016).

At present, the providers of Taiwan's agricultural tourism have undergone transformation. The once production-based model of agriculture is now being replaced by a service model. By proactively combining agricultural ecology and leisure activities, we can make the managerial model of agricultural tourism become more diversified. The market of agricultural tourism can hopefully move toward a mature market structure (Zavalloni et al. 2015). With the emergence of agricultural tourism, the production value thus generated has become important. Unlike assessment of value in the tourism industry, investigation of the present-day value of agricultural tourism lacks an explicit index and criteria for assessment. This is one of the problems pending solution. In view of this phenomenon, this study regards it as important to establish an index for statistical investigation of the production value of the transforming agricultural tourism industry.

2. Motivations for agricultural tourism development

Various studies have pointed out that the most prevalent motivations for agricultural tourism development are economic reasons, i.e. small farms are gradually being driven out of business due to lack of economic scale.

Transforming into agricultural tourism businesses helps these small farm owners exploit the strength of small scale and refined agrarian production (Busby and Rendle 2000; McGehee 2007; Nickerson et al. 2001; Weaver and Fennell 1997). McGehee (2007) found that the top two motivations for agricultural tourism development among small farm families in Virginia are to create additional income and to fully utilize resources. Nickerson et al. (2001) identified 11 different motivations or reasons for diversification in farms (i.e., developing agricultural tourism): (1) fluctuations in agriculture income, (2) employment for family members, (3) additional income, (4) loss of government agriculture programs, (5) meeting a need in the recreation or vacation market, (6) companionship with guests or users, (7) interest or hobby, (8) better use of farm resources, (9) success of other farm recreation business, (10) education of the customer, and (11) tax incentives. Small farm owners in Taiwan face similar conditions despite the geographical and cultural differences. Taiwan's government defines agriculture as a level-one industry, primary product processing as a level-two industry, and the service industry as level three (Cheng et al. 2011). Transforming into agricultural tourism enlarges the scope of small farms by combining all three levels of operation. Agricultural tourism contains primary product production, food processing, food and beverages, accommodation, education, tour package service, and entertainment. Such diversification effectively utilizes the strength of smaller farms, while avoiding competing with larger farms that feature mass agricultural production.

3. Successful elements of agricultural tourism

Agricultural tourism activities can take many forms, including farm stays, bed and breakfasts, pick-your-own produce, agricultural festivals,

and farm tours for children, or hayrides (McGehee 2007). When developed sustainably, agricultural tourism can increase the long-term potential for higher-margin on-farm sales of value-added products and services, particularly for small farms in crisis (Bowler et al. 1996; McGehee 2007). Agricultural tourism contains several activities mentioned above. An appealing part of tourism development is that not only the agricultural tourism farm, but other economic sectors such as travel agencies and transportation may benefit from the tourists. This fact is important when seeking partnerships or assistance from agencies and other businesses (Liang 2017; Qiu and Fan 2016; Scaglione and Mendola 2017).

Possible travel expenditures resulting from agricultural tourism include buying farm products, lodging, transportation, food and hospitality, retailing and recreation (Wicks and Merrett 2003). Wu et al. (2003) listed several sources of agricultural tourism production value in Taiwan, including exhibition, store sales, tours to experience harvesting and cultivating, venues, guided tours, food and beverages, camping and barbeque sites, accommodations, karaoke, and parking. The focus group results of Wilson et al. (2001) suggest that the following ten factors and conditions are most important for successful tourism development in rural areas: (1) a complete tourism package, (2) good community leadership, (3) support and participation of local government, (4) sufficient funds for tourism development, (5) strategic planning, (6) coordination and cooperation between businesspersons and local leadership, (7) coordination and cooperation between rural tourism entrepreneurs, (8) information and technical assistance for tourism development and promotion, (9) good convention and visitors bureaus, and (10) widespread community support for tourism.

4. Changes brought by agricultural tourism

The diversification of farming into tourism is in fact a fundamental change, a fact often overlooked by leisure farm owners, since it demands new skills and competencies that require learning (Brandth and Haugen 2011). We know that tourism in the form of housing and catering for visitors is not a new activity on farms, as historically people from the cities have turned to the countryside for recreation and holidays. Traditionally, hosting guests was part of common rural hospitality (e.g., simple beds, rooms and food) and not necessarily a professional business (Brandth and Haugen 2011). The gap that farm owners have to cross is the process of commoditization, the scope and variety of activities, and enough marketing efforts to bring in a profitable amount of customers (Veeck et al. 2016).

Agricultural tourism is an "old" business model, noticed recently as a possible means of salvation for small farm owners who can no longer sustain pure agricultural identities. Douwe van der Ploeg (2010) proposed the concept of a "repeasantization" process, which accurately describes this phenomenon. Repeasantization is characterized by three elements: use of the farm resource base, autonomy, and adding value. More specifically, repeasantization means strengthening the farms' resource base without making them dependent upon financial and industrial capital. The farms' own resource base (e.g., primary product, agricultural knowledge, natural view, and accommodation space) is diversified and combined into new products. This translates into increased autonomy, with greater opportunity and more space for decision-making and learning. The third point concerns adding value. The shift enlarges the value added at both the level of the farm and the sector as a whole, because it progresses through the creation

of new, additional income, not through the takeover of other farms, but the utilization of unused resources. In short, agricultural tourism redefines the farm from being limited to the production of raw materials only, into a multi-product business with many new ways of relating to society and nature (Douwe van der Ploeg, 2010). It is a process which changes farming by crossing beyond "the traditional boundaries of the specialized farming enterprise". Depending on the level of involvement, Brandth and Haugen (2011) classified three levels of agricultural tourism: agricultural tourism as the main activity, agricultural tourism as an equal combination with agriculture, and agricultural tourism as an additional activity or a hobby.

As the number of agricultural tourism businesses grows in Taiwan, there are few materials available to prioritize production value criteria, i.e. which dimension farm owners should put more efforts into to maximize profit. This study intends to fill this gap by conducting a two-stage analysis combining the Delphi method and FAHP. The prioritized criteria should provide farm owners and researchers a picture of the composition of leisure farm production value. The leisure farms discussed in this study are classified as farms operating agricultural tourism as the main activity. Therefore, readers must bear in mind that the production value priorities determined in this study are best suited for this kind of agricultural tourism business.

C. Research Methods

1. Triangular fuzzy numbers

Zadeh (1965) first described fuzzy set theory, which is a decision-making method in a fuzzy environment (Bellman and Zadeh 1970). It has been applied by an increasing number of studies to deal with uncertain,

fuzzy problems (Tsaur et al. 2002; Tsaur and Wang 2007). Fuzzy numbers are a fuzzy subset of real numbers, and represent the expansion of the idea of a confidence interval (Tsaur and Wang 2007). The following is a set of triangular fuzzy numbers with the membership function: $\mu_A(X)=(L, M, U)$, in which

$$\mu_A(X)=\begin{cases}(X-L)/(M-L), L\leq X\leq M\\(X-U)/(M-U), M\leq X\leq U, -\infty<L\leq M\leq U<\infty\\0, \textit{otherwise}\end{cases} \quad (1)$$

M is the maximum membership function, such that $\mu_A(M)=1$. L and U are the lower and upper bounds of the fuzzy number; greater width of this range stands for more fuzziness and uncertainty of the choice (Chen et al. 2014). These are shown in Fig. 1. The fuzzy AHP of this study uses triangular fuzzy numbers to project an expert's choice onto the fuzzy interval, in which the choices are made by linguistic values.

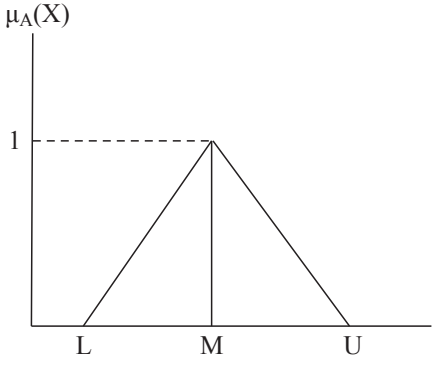

Figure 1 Triangular membership function of fuzzy numbers

2. Fuzzy Delphi method

Fuzzy Delphi method (FDM) was proposed by Ishikawa et al. (1993), and was derived from the traditional Delphi technique and fuzzy set theory. Chen et al. (2014) indicated that applying the FDM to group decisions can solve the fuzziness of a common understanding of expert opinions. Therefore, this study adopts a revised FDM which is based on triangular fuzzy numbers. As for the selection of fuzzy membership functions, previous studies were usually based on triangular fuzzy numbers, trapezoidal fuzzy numbers or Gaussian fuzzy numbers (Hsu et al. 2010). This study applies the triangular membership functions and fuzzy theory to solving the group decision.

FDM uses three steps to calculate weights: (1) building the structure on indicators of production value in agricultural tourism, (2) setting up the evaluations of weights, (3) selecting suitable indicators of production value in agricultural tourism. Moreover, this study sets triangular fuzzy numbers, L, M and U: L is the lower bound for FDM to find out the common understanding of the group decision, M is the geometric mean, and U is the upper bound. Finally, this study applied the defuzzification method introduced by Cheng (1997).

3. Linguistic variable

Linguistic variables mean a variable whose values are words or sentences in a natural or artificial-form language (Zadeh 1975). It is very difficult for conventional quantification to express reasonably those situations that are overtly complex or hard to define. Thus, the notion of linguistic variables is necessary in such situations (Tsaur and Wang 2007). Linguistic vari-

ables provide a basis for approximate reasoning for a more realistic framework of interpreting human reasoning in two-valued logic. The linguistic variables used in this research are 'equally important', 'moderately important', 'important', 'very important', and 'extremely important' (Chen et al. 2014). All the elements on the main diagonal of the pairwise comparison matrix are exactly 1, i.e. $a_{ij}=(1, 1, 1)$, $\forall i=j$, which means any criterion or sub-criterion should be completely equal to itself (Kang et al. 2012). Table 1 is the fuzzy number and its represented triangular membership sets.

Table 1 Membership function of triangular fuzzy numbers

Fuzzy numbers	Linguistic variables	Triangular membership function
$\tilde{1}$	equally important (EQ)	(1, 1, 3)
$\tilde{3}$	moderately important (MI)	(1, 3, 5)
$\tilde{5}$	important (I)	(3, 5, 7)
$\tilde{7}$	very important (VI)	(5, 7, 9)
$\tilde{9}$	extremely important (EI)	(7, 9, 9)

Source: Kang et al. (2010); Chen et al. (2014)

4. Fuzzy Analytic Hierarchy Process

The analytic hierarchy process (AHP) was first proposed by Saaty (1977), and involves three basic steps: (1) decomposition, or the construction of the hierarchy; (2) comparative judgments, or defining and executing data collection to obtain pairwise comparative data on elements of the hierarchical structure; (3) synthesis of priorities, or construction of an overall priority rating (Harker and Vargas 1987). This technique provides a means of prioritizing the various elements in the hierarchy, thus helping governments and industry practitioners focus on the most important issues (Cheng

and Li 2001). The application of fuzzy AHP is still new, and is flourishing (Chen et al. 2014). Researchers have various practical applications and methods to conduct fuzzy AHP analysis. Fuzzy AHP is reported to assist with decision making in supplier selection (Amid et al. 2011; Chan and Kumar 2007; Chen et al. 2014; Cho et al. 2012; Kang et al. 2012), machine tool evaluation (Ayağ and Gürcan Özdemir 2012), decision support systems (Cakir and Canbolat 2008), and eco tour plan selection (Lai et al. 2013). The influence of each element will differ. Collectively, the various elements influence expectations to different degrees (Deng et al. 2002; Lee and Huang 2012). The AHP could be used to evaluate the definite alternatives in multi-criterion decision-making problems, as in Eq. (2).

$$[A_k]=[a_{ij}]=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix}, k=1, 2, \cdots, n \qquad (2)$$

The fuzzy analytic hierarchy process (FAHP) applied in this study is modified from Buckley (1985), and Hsu (1999). The fuzzy AHP uses five steps to calculate weights and relative weights of the elements of each level: (1) Decide the evaluation criteria and sub-criteria.

This study first decided the criteria and sub-criteria for an evaluation model of agricultural tourism production value with FDM, then selected key evaluation items, and calculated weight by FAHP. This study invited a total of 30 experts consisting of professors of tourism management (6), agricultural tourism association chairpersons (6), agricultural tourism business owners and managers (6), government officials (6) and travel agency managers (6). The participants did not know the identities of the other par-

ticipants. This study received 29 experts' questionnaires, for a received ratio of 96.667%.

Table 2 Data collection analysis

Sources	Field	Total Experts	Received Experts	Received Ratio %
Professors of tourism management	Scholar	6	5	
Agricultural tourism association chairpersons	Industry	6	6	
Agricultural tourism business owners and managers	Industry	6	6	96.667
Government officials	Government	6	6	
Travel agency managers	Industry	6	6	
Total		30	29	

(2) Administer FAHP questionnaire

After the criteria and sub-criteria were decided, the experts were required to perform pairwise comparison between each criterion and sub-criterion. This study used linguistic variables to reflect the experts' ratings of the relative importance between two criteria, which are transformed into triangular fuzzy numbers (see Table 1).

(3) Check the consistency of the pairwise comparison matrix.

Saaty (1977) proposed a consistency index (CI) and consistency ratio (CR) for measuring the consistency of decision makers' judgments. CI and CR are defined as:

$$CI=(\lambda_{max}-n)/(-1) \tag{3}$$

$$CR = CI / RI \tag{4}$$

RI refers to random index, whose values are given by Teng in Table 2. CR should be less than 0.1 for a consistent and acceptable comparison. Perfect consistency implies a CR value of 0 (Kulak and Kahraman 2005).

Table 3 RI table

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

(4) Aggregate and defuzzify the expert pairwise comparison matrix.

To calculate the weights and priorities of criteria, we must first aggregate the pairwise comparison matrix of each expert's $\tilde{a}_{ij}$ as follows:

$$\tilde{a}_{ij} = (L_{ij}, M_{ij}, U_{ij}) \tag{5}$$

$$L_{ij} \leq M_{ij} \leq U_{ij}, \text{ and } L_{ij}, M_{ij}, U_{ij} \in [1/9, 1] \cup [1, 9] \tag{6}$$

$$L_{ij} = \text{Min}(X_{ij}) \tag{7}$$

$$M_{ij} = \sqrt[n]{\prod_{k=1}^{n} x_{ij}} \tag{8}$$

$$U_{ij} = \text{Max}(X_{ij}) \tag{9}$$

The triangular fuzzy positive reciprocal matrix for the relative importance of the two criteria can be computed by using Eq. (3)–(7).

The FAHP substitutes the specific for *aij* with a triangular fuzzy number $\tilde{a}_{ij}$, implying that triangular fuzzy numbers replace the judgments in the pairwise comparison matrix to set the criteria and resolve the fuzzy consensus problem among experts (Hsu and Chen 2007). As A_k was an n-by-n matrix $\tilde{A}_k$ is derived as follows:

$$[\tilde{A}_k]=[\tilde{a}_{ij}]=\begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \cdots & 1 \end{bmatrix}, k=1, 2, \cdots, n \tag{10}$$

This study used the center of area method (COA) to obtain the crisp values for further calculations of criteria weights and priorities. We applied COA for matrix $\tilde{A}_k$, and compute as follows:

$$F_{ij}=\frac{\int_{-\infty}^{\infty}\mu_A(X)xdx}{\int_{-\infty}^{\infty}\mu_A(X)dx,\ \forall i,j} \tag{11}$$

The function $\mu_A(X)$ is the characteristic function of the triangular fuzzy number given in Eq. (1). Therefore, we obtain all pairwise comparison matrixes in crisp values as:

$$G=\begin{bmatrix} 1 & F_{12} & \cdots & F_{1j} \\ 1/F_{12} & 1 & \cdots & F_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ 1/F_{1j} & 1/F_{2j} & \cdots & 1 \end{bmatrix} \tag{12}$$

(5) Calculate criteria weights and priorities

After defuzzification, we can obtain a pairwise comparison matrix with crisp values, which can be used to calculate weights of each criterion and sub-criterion. This study adopts Eq. (13) to calculate the final criterion weights W_i (Saaty 1977).

$$W_i=\frac{\left(\prod_{i=1,j=1}^{n}F_{ij}\right)^{1/n}}{\sum_{i=1,j=1}^{n}\left(\prod_{i=1,j=1}^{n}F_{ij}\right)^{1/n}},\ i,j=1, 2, \cdots, n \tag{13}$$

D. Application of fuzzy AHP for production values in agricultural tourism

After a previous literature review, we decided on the criteria and sub-criteria for evaluating agricultural tourism production values by the consensus of experts and FDM. The participants consisted of 29 experts in related areas, such as professors of tourism management, agricultural tourism association chairmen, agricultural tourism business owners and managers, government officials, and travel agency managers.

After the Delphi questionnaires were collected, the results of FDM were calculated. The opinions of the experts in the FDM questionnaires were converted to triangular fuzzy numbers, with defuzzified values figured out after calculation. This study adopted elements with a threshold above 0.500 (Chang and Wang 2006), and the key evaluation items with values below the threshold of 0.500 were deleted.

After being defuzzified, the values of evaluation items ranged from 0.503 to 0.763. Therefore, all 11 factors influencing agricultural tourism production value selection were analyzed through application of FDM to the experts' opinions. The fuzzy AHP (FAHP) was used to integrate the experts' opinions to evaluate the significance of various evaluation criteria given by the experts.

The hierarchy structure includes three levels with interrelated decision criteria: level one is the top goal; level two includes three evaluation criteria; and level three has eleven sub-criteria as shown in Fig. 2. This study employs the fuzzy AHP to identify the importance of each indicator of production value in agricultural tourism. The 29 experts used linguistic variables (Table

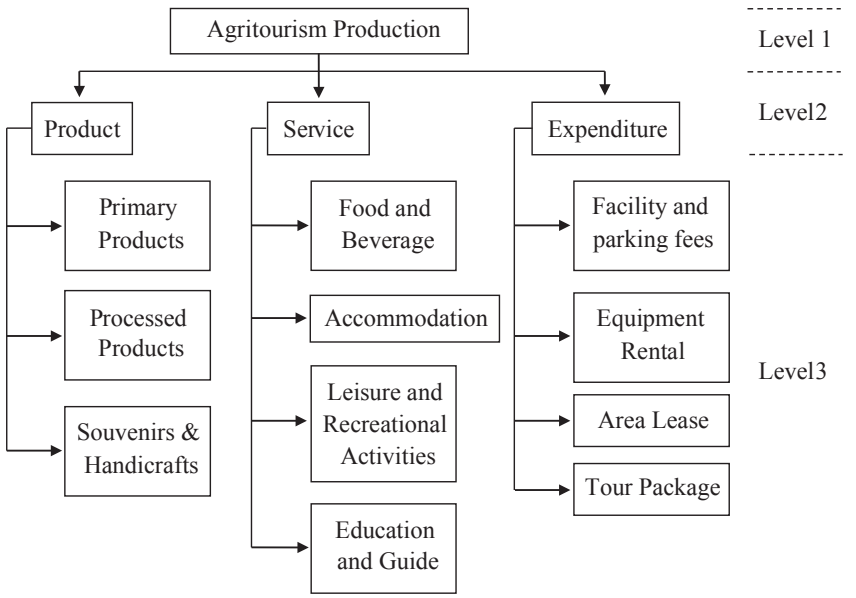

Figure 2 The hierarchical structure of agricultural tourism production value

1) to perform pairwise comparisons between criteria and sub-criteria. After collecting these questionnaires, we calculate the CI based on Eq. (3) to check the consistency of the expert opinions. All CI are less than 0.1, suggesting that all experts' pairwise comparison matrices are consistent.

Table 4 Pairwise comparison questionnaire sample

Which criteria should be emphasized more to construct indicators of production value in agricultural tourism?									
	EI	VI	I	MI	EQ	MI	I	VI	EI	
Product										Service
Product										Expenditure

Table 5 shows the fuzzy analytic hierarchy process results by calculating the pairwise comparison scores of each expert. Among three dimensions, product has higher weight (0.412), followed by service (0.346) and expenditure (0.242). Despite the fact that agricultural tourism emphasizes service-oriented operations more, experts still regarded the product dimension as a more important contributor to the production value of agricultural tourism business.

In the product dimension, there's higher weight on souvenirs and handicrafts (0.425), following by processed products (0.355) and primary products (0.240). Tourists participating in a tour are easily influenced by the environmental atmosphere that leads to most of their shopping being on gifts and souvenirs during or after the tour. Tourists are unlikely to buy primary products from the farms, such as milk or agricultural products. The secondary products such as processed food, as well as souvenirs and handicrafts, are the primary contributors to agricultural tourism business profits.

In the service dimension, there's higher weight on leisure and recreation activities (0.300), suggesting the main reason tourists participate in agricultural tourism is to experience the features of traditional farm life, farm labor and ecology. The second highest indicator is food and beverage (0.259). This comes naturally, as, in the period of stay, tourists hope to eat local specialty meals at the farm as a part of the agricultural tourism experience. The third indicator, education and guide (0.257), suggests an educational purpose of agricultural tourism was expected by experts, in which family tourists are the major type of tourist group and they would want their children to learn during the tour.

In the expenditures dimension, there's higher weight on tour package arrangement (0.455). Tourists who are busy at work and other tasks have

less time to collect tour information and plan. Therefore, a complete and comfortable tour package provided by agricultural tourism businesses is quite essential for those who do not have time or energy to plan a tour themselves. Tourists' needs of renting camping sites, barbeque grounds, orchards and gardens lead to the second highest weight indicator being area lease (0.208). It also provides a great opportunity for families or friends to spend their time together on the tour and experience more about farms and agriculture. The third indicator is equipment rental (0.195). Equipment for fishing, harvesting or primary product processing is essential for tourists to participate in various farm activities, and most of them will not bring their own equipment for such tours.

Table 5 Criteria weights and priorities

Criteria	Sub-criteria	Weight	Priority	Relative Weight	Priority
Product 0.412	Primary products	0.240	3	0.099	5
	Processed products	0.335	2	0.138	2
	Souvenirs and handicrafts	0.425	1	0.175	1
Service 0.346	Food and beverage	0.259	2	0.089	6
	Accommodation	0.184	4	0.064	8
	Leisure and recreational activities	0.300	1	0.104	4
	Education and guide	0.257	3	0.089	7
Expenditure 0.242	Facility and parking fees	0.142	4	0.035	11
	Equipment rental	0.195	3	0.047	10
	Area lease	0.208	2	0.050	9
	Tour Package	0.455	1	0.110	3

E. Conclusions

For agricultural tourism business owners in Taiwan, the largest impediment is insufficient advertising for agricultural tourism and leisure farms prior to visitor trips, and a lack of interpretation services and brochures provided by leisure farms during trips (Chang 2003). Visitors do not have any channel to gather information about leisure farms before, during or after trips. As we mentioned before, most farms are small businesses and cannot afford to advertise on an effective scale. Their primary advertising means which we can observe are social networking sites (e.g., Facebook and Twitter) and word-of-mouth recommendation. Both are passive and small scale. Therefore, an organization consisting of agricultural tourism business owners should be formed to promote collaboration and cooperation. The Council of Agriculture of Taiwan should facilitate and spread information on agriculture tourism to the public and foreign travelers. Basic agricultural tourism management courses (e.g., tourism management and marketing strategy) given by experts and professors will certainly help farm owners in operating their businesses.

Our study steps in to fill the gap and provides a clear, simple and efficient evaluation model for the purpose. Experts from various area including tourism scholars, agriculture associations, agriculture businesses, agriculture operators, agriculture government, and tourism business were assembled for our two-stage approach. We used a fuzzy Delphi method in the first stage to build a credible hierarchical construct from opinions of experts who are in academics, industry, and government, and applied fuzzy AHP to decide the relative importance of each criterion.

This study demonstrates that a production value evaluation of agricultural tourism can be based on agricultural products, tour service and expenditure as a preliminary design of indices. Agricultural products, in particular, are regarded as the core production value index. Agricultural products include relevant primary products tourists would like to buy, related secondary refined agricultural products, and souvenirs. It is suggested by this study that the relevant authorities conduct statistical analysis of the primary products, secondary products and related souvenirs pertaining to a specific agricultural tourism attraction.

Overall, in terms of value added, experts or professionals in agricultural tourism give the highest weight to tour services. Notwithstanding, agricultural products still remain relatively important in overall agricultural tourism production value. This points to the fact that as far as supply is concerned, agricultural tourism production value is an area of multiple phases, including agricultural products, tour services, and expenditures. Agricultural products, however, are the core production value output of a specific agricultural tour site. Therefore, experts and professionals in agricultural tourism regard agricultural products as an important statistical index of agricultural tourism production value. Based on the above description, the present study provides the concerned authorities in agricultural tourism with a new direction. This study will enable them to estimate and quantify the production value of agricultural tourism.

An important implication of our result is that people may think agricultural tourism is only a new type of tour. However, as we can see, experts put more emphasis on the product dimension, and it sets agricultural tourism apart from usual types of tours, which put more emphasis on hospitality services. This suggests that the tour may be an attraction to

bring in tourists, and agricultural tourism businesses hope to earn most of their profit by selling value-added secondary products, and souvenirs and handicrafts. This is the main difference between agricultural tourism and more typical tours, with the latter making most of their profit by providing special and delicious food and beverages, hospitable accommodations, and fun and exciting activities. Another reason for such emphasis is the off-season. Small farm owners can maintain a stable economic stream by producing high-added-value crops in the off-season, and can attract visitors with pick-your-own activities and processed products in the boom season (Addinsall et al. 2017; Doh et al. 2017; Karampela et al. 2016; Scaglione and Mendola 2017; Veeck et al. 2016). Overall, our study provides a quite useful model for evaluating agricultural tourism production value. Owners, investors, officials and researchers can apply this model to their needs.

There are still some limitations to our research. While we did our best to include experts and professionals, the composition of the panel of experts for the Delphi and FAHP methods still does not represent all opinions and perspectives. We advise further research to expand the panel of experts to those from various areas, positions and perspectives to generate universally acceptable results. The research subject was leisure farms in Taiwan. In other geographic regions, the climate, ecology, culture and habits are different (Busby and Rendle 2000; Phillip et al. 2010). Our research result may only apply to areas which have conditions similar to those in Taiwan (e.g., parts of China and Southeast Asia). Further studies in other areas may provide different results.

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