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Application of AHP for Selection of Environmentally Friendly Crop Cultivation in Mae Hong Son Province

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ABSTRACT

The purpose of this research was to analyze alternative plant models under environmentally friendly production systems through participatory processes of the communities in Mae Hong Son province. The 140 samples consisting of farmers and stakeholders were selected by using purposive sampling method. The analytical hierarchy process (AHP) was used as a tool for decision making. Under the criterions of physical characteristic, and sustainability aspect, there were nine feasible environmentally friendly crops that could be cultivated in the Mae Hong Son province which were separated into three crop types such as field crops, horticulture, and vegetable. The results shown that tiger peanut, garlic, and cabbage were the first priorities of each crop type. In addition, under the conditions of waste control, waste treatment, reduce, reuse and recycle, pollution prevention, and water conservation, tiger peanut should be planted in the Mueang and Pang Mapha districts, garlic should by grown in the Pai and Khun Yuam districts, and cabbage should be cultivated in the Sop Moei and Pang Mapha districts. The findings of this research were used for creating environmentally friendly alternative crop production manuals and policy recommendations for sustainable natural resource management in the Mae Hong Son province.

Keywords: Environmentally Friendly System, Sustainability, Crop Selection, Planting Area Selection, the Analytical Hierarchy Process

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Background and Significance of the Research Problem

Nowadays, even though the environment and natural resources are important to human life, the exploitation of humans have caused a degradation of natural resources and the environment, resulting in terrible crises in the atmosphere, soil, water, forests, wildlife, and energy around the world (Downey et al., 2010; Tyagi et al., 2014,). Many countries, including Thailand, were concerned about these situations and have tried to find measures or policies to solve them. Like the situation in Mae Hong Son province, one of the northern provinces of Thailand, the natural resources and the environment have been changing dramatically and had continuous negative impacts resulting from the inefficient use of natural resources, the lack of sustainable resource rehabilitation and maintenance, and the failure of clean environmental management, especially in highlands which are accounted for 87.12% of the total area (Mae Hong Son Province, 2019. Due to unfavorable terrain, the forest area was continuously destroyed to expand agricultural land for monoculture. In addition, the improper use of agricultural chemicals near watersheds caused widespread environmental impacts. The government and related agencies in Mae Hong Son province were, therefore, trying to find suitable plant alternatives for environmentally friendly agriculture systems in each area to create food security and sustainable agriculture in Mae Hong Son province.

Sustainable agriculture was traditionally defined by integrating three pillars consisting of environmental protection, economic development and social responsibility, and would contribute to food security in aspects of availability, access, utilization and stability (FAO, 2014; Latruffe et al., 2016; Lynch et al., 2019). Under the economic dimension, strategic and operational decision of plant selection deals with financial implications of crop type such as quantity of yields, production costs, technologies, and equipment requirements (Roy et al., 2014; Cobuloglu & Buyuktahtakin, 2015; Zulfiqar & Thapa, 2017). Furthermore, other economic factors such as economic returns to agriculture (Vogdrup-Schmidt, 2019, p.36) and agricultural market (Rao et al., 2019; Eichler et al., 2020; Talukder et al., 2020) are considered as the criteria. In terms of the social aspect of the sustainable crop selection, the folk wisdom inheritance (Taitaemthong et al., 2018; Taitaemthong et al., 2019), working conditions (Lebacq et al., 2013; Cobuloglu & Buyuktahtakin, 2015; Latruffe et al., 2016), and quality of life (Lebacq et al., 2013; Latruffe et al., 2016). Finally, to address the environmental aspect, reduction of pollution including greenhouse gas emission (Cobuloglu & Buyuktahtakin, 2015; Latruffe et al., 2016; Lynch et al., 2019) and natural resource conservation such as water, soil, etc. (Lebacq et al., 2013;

Laurance et al. 2014; Charnsungnern & Tantanasarit, 2017; Rasmussen et al., 2017; Talukder et al., 2020) should be included in the decision-making process.

Due to these various economic, social and environmental indicators, the multi-criteria decision-making (MCDM) tools, which were the techniques based on setting alternatives along with various criteria involved in the decision-making process, were used for selecting the proper crop type (Cobuloglu & Buyuktahtakin, 2015). From the literature reviews of qualitative research methodologies in many agricultural studies, such as the studies of Chavez et al. (2012), Cobuloglu & Buyuktahtakin (2015), Veisi et al. (2016), Baffoe (2019), De Marinis & Sali (2020), they shown that the analytic hierarchy process (AHP) was a multi-applicable and the most popular method of MCDM. The AHP technique was suitable tool for analyzing complex and unstructured problems in various decision situations. It provided a rational and comprehensive framework which was utilized hierarchical structures to represent a problem and judgement options by providing a systematic methodology to calibrate numeric scale for measuring the qualitative performances. In the AHP analysis, the experts and stakeholders, who were the key actors, played a role for constructing critical indicators to achieve overall goal and joint weighting the criteria and alternatives which, finally, lead to the priorities of options for good decision.

Consequently, in this research, the AHP approach was applied for selecting environmentally friendly crops in Mae Hong Son Province under the criterion of sustainable agriculture. The findings of this research were used for creating environmentally friendly alternative crop production manuals and policy recommendations for sustainable natural resource management in the Mae Hong Son province.

Research Objective

This research aimed to analyze alternative plant models under environmentally friendly production systems through participatory processes of the community.

Scope of Research

The targeted research areas were in the seven districts of Mae Hong Son province, such as Pai, Mueang, Khun Yuam, Mae La Noi, Mae Sariang, Sop Moei, and Pang Mapha. Moreover, the research population included farmers, agricultural research officers, land development department staffs, staffs of the Forest Resource Management Office 1 Mae Hong Son, Mae Hong Son Farmers Council staffs, and agricultural product buyers. All data in this research were collected from October 2017 to September 2018.

Research Methodology

1. Research sampling methods

Because the main actors in the AHP process were the experts and key stakeholders, the agricultural experts, the staffs of agricultural government and private agencies, and the leaders of farmer groups were selected as the samples of this research by using purposive sampling method. Sample size was set quota of 20 people in each district of Mae Hong Son province in order to attend the focus group meeting, representing 140 samples in total.

2. Research methods

For achieving the objective of research, three major steps were conducted in the methodology.

1) Feasibility analysis of crop planting in Mae Hong Son province

Initially, the feasible crops for cultivation in Mae Hong Son province were analyzed by being separated into three categories of crop types, i.e. field crop, horticulture, and vegetable. For analyzing the suitability between crop types and planting areas such as geography, soil texture, temperature, rainfall, and relative humidity, the geographic information system or GIS was used as a tool. In addition, the information taken above was used for feasibility analysis under sustainable agriculture conditions. The criterion was determined by the literature reviews mentioned above in section 1 and the opinions of experts and stakeholders at the focus group meeting. Under economic perspective, this research focused on quantity of yields, production costs, and market trend. Whereas the social and environmental aspects were group together because of mutual opinions at the focus group concerning with changes in environmental activities that had a direct impact on the livelihood and social practices inevitably. Thus, the social and environmental aspects consisted of pollution free, natural resource conservation, and folk wisdom inheritance. Moreover, physical characteristics, such as planting area, crop period, and crop maintenance, were also considered in crop planting options because they indicated the possibility and behavioral changes of the farmers in cultivation. The data of feasibility analysis was collected by using the questionnaire, interview and focus group meeting, and analyzed by using descriptive statistics. The selected crops obtained in this step were used as information for investigating the appropriate environmental friendly crops.

2) Selection of the environmental friendly crops

After obtaining the important fundamental information mentioned above, the environmental friendly crops were selected by using participatory action research (PAR) and

focus group methods. Moreover, the AHP was applied for making the decision on the crop selection. The AHP approach began with creating the hierarchy structure for making the decision consisting of a goal, the criteria for assessing the goal's suitability, the sub-criteria that may or may not be set as indicator of main criteria, and the alternatives which are options for the decision (Saaty, 2008; Russo & Camanho, 2015).

In this step, the goal of the decision was having the appropriate environmental friendly crops for cultivation in Mae Hong Son province. Thus, the decision conditions according to the aforementioned feasibility analysis, such as economic, social and environmental, and physical aspects, were used again as the main criteria and sub-criteria. After setting the hierarchy of decision, pairwise comparison matrix will be set for comparison of criterion, sub-criterion, and alternative importance in accordance with the nine-level measurement of Saaty (1990; 2008), which was a scale from 1 (equally important) to 9 (extremely more important). The pairwise comparison matrix, $M = [m_{ij}]$, was shown in Equation (1);

$$M = [m_{ij}] = \begin{bmatrix} 1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & 1 & \cdots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & 1 \end{bmatrix} \quad (1)$$

where w_i was the weight of the i^{th} alternative, sub-criterion, or criterion.

After that, the simple normalized row sum (SNRS) was used as a tool for aggregating individual weights, as called approximation method, and normalizing the priority by dividing an individual weight by the aggregating weights. The normalized value is equal to 1.

In this stage, the local weights (LW) which represented the weight of each criterion are taken. Then, the global weights (GW) of each hierarchy were calculated by multiplying the LW of each criterion in that hierarchy by the LW in the same component of the higher hierarchy. It led to the priority of choices. Moreover, In order to confirm the consistency of decision-making, the consistency ratio (*CR*) is tested by a comparison of weighting of criteria or alternative, $CR = CI/RI$, where *CI* is the consistency index calculated by $(\varphi_{\max} - n)/(n-1)$, and *RI* is the random consistency index evaluated by following Saaty (1990, p.13-14). The CR should be lower than 0.10 to confirm that the decision is consistent and the eigenvalue can be used to weigh the criteria, sub-criteria and/or alternatives.

3) Selection of the cultivation areas for environmental friendly crops

In order to achieve the goal of appropriate environmentally friendly cultivation area, there were five criterions and seven alternatives of environmentally friendly cultivation areas for decision-making. The criterions consisted of 1) waste control, 2) waste treatment, 3) reduce, reuse and recycle, 4) pollution prevention, and 5) water conservation, and the choices of planting areas are located at the seven districts of Mae Hong Son province such as Pai, Mueang, Khun Yuam, Mae La Noi, Mae Sariang, Sop Moei, and Pang Mapha, After that, the decision was made by using the AHP approach. The results of every step led to the choices of appropriate environmentally friendly crops for cultivation which should encourage farmers in Mae Hong Son province to adopt this idea as part of their labor.

Results

1. Feasible crops for cultivation in Mae Hong Son province

The results found that the Mae Hong Son province has an area of approximately 12,681.259 square kilometers. More than 80.00% of the topography is made up of complex high mountains and abundant natural forest with a height ranging from 100 to 2,000 meters above sea level. Flat land is limited to 10.00% of the provincial area. The climate in Mae Hong Son province is hot and humid with a fog throughout the year. In 2017, the average annual temperature was 21.05 degrees Celsius with a relative humidity of 69.09% and the average rainfall throughout the year is approximately 1,249.60 millimeters (MHSGIS, 2015). In addition, the result of the interview with the provincial agricultural officers in Mae Hong Son province stated that there were many soil textures and series in the Mae Hong Son areas. The information mentioned above was used for feasibility analysis in three aspects such as physical characteristics, economic aspects, and social and environmental aspects through the focus group meeting with the farmers. The feasible crops for cultivation in Mae Hong Son province were separated into field crops consisting of sesame, highland rice and tiger peanut, horticulture such as coffee, konjac and garlic, and vegetable, namely cabbage, pumpkin, and napa cabbage.

2. Environmentally friendly crop selection

The feasible plants mentioned above were chosen as the alternative crops for making a decision of the priority of environmentally friendly crop planting selection by using AHP. In order to achieve the goal of environmentally friendly crop selection, there were three criterions consisting of physical characteristics, economic, and social and environmental aspects.

In the field crop planting selection analysis (shown in Table 1), the farmers gave importance to the physical characteristics in the first priority. Considering the sub-criterion, the

results revealed that the farmers chose planting areas in the first ranking with a global weight of 0.4058, and then followed by crop maintenance, quantity of yields, production costs, and pollution free with the global weights of 0.1645, 0.1033, 0.1033, and 0.056, respectively. In terms of the first importance of field crop planting selection, the tiger peanut was chosen at the first ranking with the global weight of 0.348.

Table 1 Weight and Priority of Field Crop Planting Selection

Criterion	Sub-criterion	Alternative of vegetable cultivation					
		Sesame		Highland rice		Tiger peanut	
		LW	GW	LW	GW	LW	GW
Physical characteristics GW = 0.6370	Planting area LW = 0.6370, GW = 0.4058	0.5499	0.2231	0.2099	0.0852	0.2402	0.0975
	Crop period LW = 0.1047, GW = 0.0667	0.1285	0.0086	0.4858	0.0324	0.3856	0.0257
	Crop maintenance LW = 0.2583, GW = 0.1645	0.1396	0.0230	0.3325	0.0547	0.5278	0.0868
Economic GW = 0.2583	Quantity of yields LW = 0.4000, GW = 0.1033	0.1085	0.0112	0.5469	0.0565	0.3445	0.0356
	Production costs LW = 0.4000, GW = 0.1033	0.1260	0.0130	0.4161	0.0430	0.4579	0.0473
	Market trend LW = 0.2000, GW = 0.0517	0.6337	0.0327	0.1744	0.0090	0.1919	0.0099
Social & environment GW = 0.1047	Pollution free LW = 0.5396, GW = 0.0565	0.1396	0.0079	0.3325	0.0188	0.5278	0.0298
	Resource conservation LW = 0.2970, GW = 0.0311	0.2000	0.0062	0.4000	0.0124	0.4000	0.0124
	Folk wisdom inheritance LW = 0.1634, GW = 0.0171	0.4000	0.0068	0.4000	0.0068	0.2000	0.0034
Total GW of horticulture cultivation alternatives		**0.3326**		**0.3189**		**0.3485**	
Priority of horticulture cultivation alternatives		**2**		**3**		**1**	

Source: Authors' Analysis

Considering the priority of horticulture planting selection (represented in Table 2), the farmers gave the first importance to economic criterion. When analyzing the key of sub-criteria, market trend, quantity of yields, production costs, planting area, and folk wisdom inheriting were ranked importantly in order, with the global weights of 0.2968, 0.1484, 0.1484, 0.1230, and 0.091, respectively. For choosing the horticulture cultivation, the farmers selected garlic as a first priority with the global weight of 0.4286.

Table 2 Weight and Priority of Horticulture Planting Selection

Criterion	Sub-criterion	Alternative of vegetable cultivation					
		Coffee		Konjac		Garlic	
		LW	GW	LW	GW	LW	GW
Physical characteristics GW = 0.2493	Planting area LW = 0.1571, GW = 0.1230	0.4600	0.0566	0.2211	0.0272	0.3189	0.0392
	Crop period LW = 0.1958, GW = 0.0488	0.2493	0.0122	0.1571	0.0077	0.5936	0.0290
	Crop maintenance LW = 0.3108, GW = 0.0775	0.2493	0.0193	0.1571	0.0122	0.5936	0.0460
Economic GW = 0.5936	Quantity of yields LW = 0.2500, GW = 0.1484	0.3275	0.0486	0.2599	0.0386	0.4126	0.0612
	Production costs LW = 0.2500, GW = 0.1484	0.2402	0.0356	0.5499	0.0816	0.2098	0.0311
	Market trend LW = 0.5000, GW = 0.2968	0.2493	0.0740	0.1571	0.0466	0.5936	0.1762
Social & environment GW = 0.1571	Pollution free LW = 0.1840, GW = 0.0289	0.2493	0.0072	0.5936	0.0172	0.1571	0.0045
	Resource conservation LW = 0.2318, GW = 0.0364	0.3108	0.0113	0.4934	0.0180	0.1571	0.0045
	Folk wisdom inheritance LW = 0.5842, GW = 0.0917	0.4000	0.0367	0.2000	0.0183	0.4000	0.0367
Total GW of horticulture cultivation alternatives		**0.3015**		**0.2673**		**0.4286**	
Priority of horticulture cultivation alternatives		**2**		**3**		**1**	

Source: Authors' Analysis

In view of vegetable planting selection, economic perspective was also the most important aspect in the main criteria as well as market trend, quantity of yields, production costs, crop maintenance, and pollution free which was shown in Table 3. Moreover, the results represented that cabbage was given first priority with the global weight of 0.3842.

3. Cultivation area selection for environmentally friendly crops

The AHP structure for selecting environmentally friendly cultivation area was shown in Figure 1 and the priorities of environmental friendly crop cultivation area selection by using AHP were revealed in Table 4.

Table 3 Weight and priority of vegetable planting selection

Criterion	Sub-criterion	Alternative of vegetable cultivation					
		Cabbage		Pumpkin		Napa cabbage	
		LW	GW	LW	GW	LW	GW
Physical characteristics GW = 0.2318	Planting area LW = 0.2493, GW = 0.0578	0.2631	0.0152	0.5472	0.0316	0.1897	0.0110
	Crop period LW = 0.1571, GW = 0.0364	0.2102	0.0077	0.1836	0.0067	0.6062	0.0221
	Crop maintenance LW = 0.5936, GW = 0.1376	0.2000	0.0275	0.6000	0.0826	0.2000	0.0275
Economic GW = 0.5842	Quantity of yields LW = 0.2500, GW = 0.1460	0.4934	0.0721	0.1958	0.0286	0.3108	0.0454
	Production costs LW = 0.2500, GW = 0.1460	0.2098	0.0306	0.5499	0.0803	0.0351	0.2402
	Market trend LW = 0.5000, GW = 0.2921	0.6000	0.1753	0.2000	0.0584	0.2000	0.0584
Social & environment GW = 0.1840	Pollution free LW = 0.6483, GW = 0.1193	0.2493	0.0297	0.5936	0.0708	0.1571	0.0187
	Resource conservation LW = 0.1220, GW = 0.0225	0.4126	0.0093	0.2599	0.0058	0.3275	0.0074
	Folk wisdom inheritance LW = 0.2297, GW = 0.0423	0.4000	0.0169	0.2000	0.0085	0.4000	0.0169
Total GW of vegetable cultivation alternatives		**0.3842**		**0.3733**		**0.2424**	
Priority of vegetable cultivation alternatives		**1**		**2**		**3**	

Source: Authors' Analysis

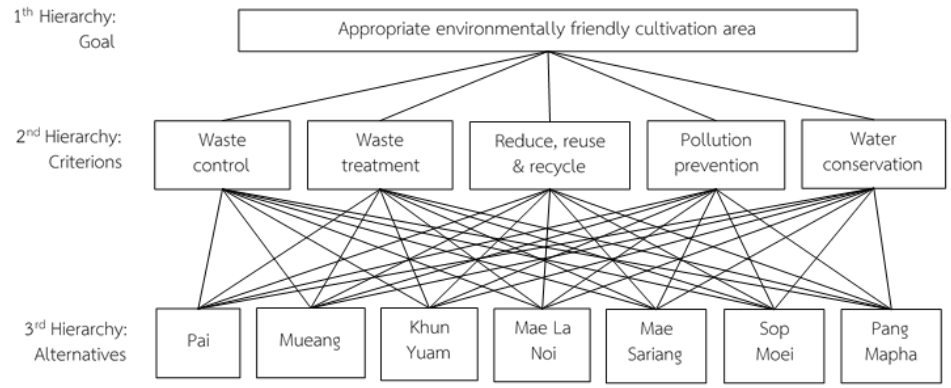

Figure 1 AHP for Selecting Environmentally Friendly Cultivation Area

Source: Authors' Analysis

The results in Table 4 indicated that sesame should be cultivated in the Mueang and Khun Yuam districts, highland rice should be planted in the Khun Yuam and Mae La Noi districts, tiger peanut should be grown in the Mueang and Pang Mapha districts, coffee should be grown in the Mae La Noi and pang Mapha districts, konjac should be planted in the Mae Sariang and Sob Moei districts, galic should by grown in the Pai and Khun Yuam districts, cabbage should be cultivated in the Sop Moei and Pang Mapha districts, pumpkin should be grown in the Pai and Mae Sariang, and napa cabbage should be cultivated in the Mae La Noi, and Mae Sariang districts.

Table 4 Weight and priority of environmental friendly crop cultivation area selection

Crop type		Alternative of environmental friendly crop cultivation area						
		Pai	Mueang	Khun Yuam	Mae La Noi	Mae Sariang	Sop Moei	Pang Mapha
Sesame	Total GW	0.1302	0.2244	0.1499	0.1219	0.1134	0.1320	0.1282
	Priority	4	1	2	6	7	3	5
Highland rice	Total GW	0.0790	0.0942	0.2442	0.1609	0.1253	0.1552	0.1412
	Priority	7	6	1	2	5	3	4
Tiger peanut	Total GW	0.0554	0.2980	0.1748	0.0950	0.0941	0.1012	0.1815
	Priority	7	1	3	5	6	4	2
Coffee	Total GW	0.1794	0.1019	0.0686	0.2688	0.0764	0.0856	0.2192
	Priority	3	4	7	1	6	5	2
Konjac	Total GW	0.0492	0.1162	0.1109	0.1250	0.3135	0.1720	0.1132
	Priority	7	4	6	3	1	2	5
Garlic	Total GW	0.2879	0.1183	0.1763	0.1313	0.1015	0.0841	0.1007
	Priority	1	4	2	3	5	7	6
Cabbage	Total GW	0.0594	0.1072	0.1307	0.0971	0.0971	0.2107	0.2977
	Priority	7	4	3	5	5	2	1
Pumpkin	Total GW	0.2651	0.0873	0.0926	0.1791	0.1921	0.0860	0.0978
	Priority	1	6	5	3	2	7	4
Napa cabbage	Total GW	0.0750	0.1477	0.1251	0.2590	0.1554	0.1040	0.1338
	Priority	7	3	5	1	2	6	4

Source: Authors' Analysis

The summary of appropriate environmental friendly crops separated in cultivation areas in the Mae Hong Son province are shown in Figure 2.

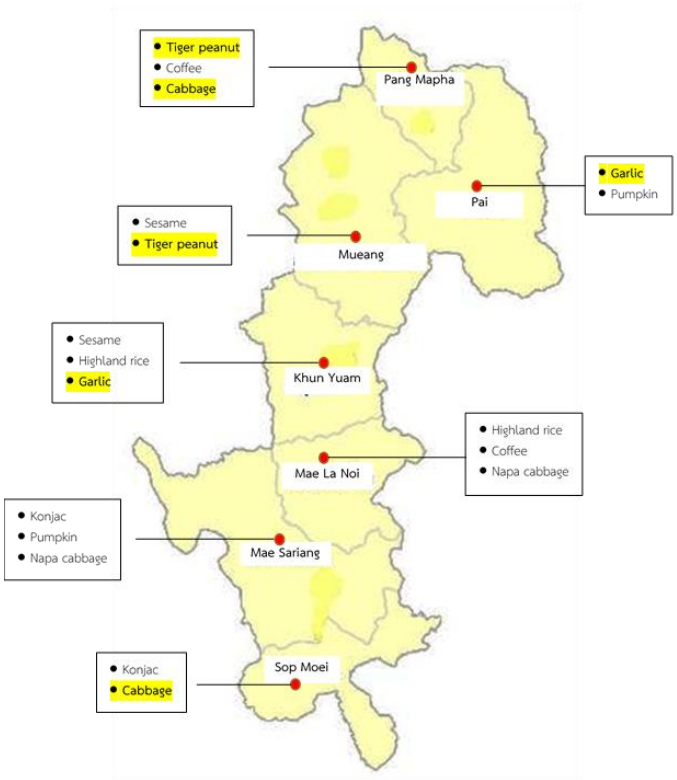

Figure 2 Appropriate Environmental Friendly Crops Separated in Cultivation Areas

Source: Authors' Analysis

Conclusion

Because of the problems of natural resources and environmental management in the Mae Hong Son province, this research focused on analyzing alternative plant models under environmentally friendly production systems in the Mae Hong Son province. The AHP was applied for making a decision for the 140 selected samples of farmers and stakeholders. The GIS and feasibility analysis under physical characteristics, and sustainability conditions were used to investigate feasible crops for cultivation in the Mae Hong Son province. The results shown that there were nine feasible environmentally friendly crops which were separated into three crop types such as field crops (i.e. sesame, highland rice and tiger peanut), horticulture (i.e. coffee, konjac, and garlic), and vegetable (i.e. cabbage, pumpkin, and napa cabbage).

The nine feasible environmentally friendly crops mentioned above were set as the alternatives for considering the most important plant in each crop type category. The tool for solving this problem was the AHP approach which analyzed the alternatives under sustainable agriculture criteria (such as economic, social and environment) and physical aspect. The results

shown that in the field crop planting, the farmers chose the tiger peanut as the most important crop whereas in the field crop cultivation, garlic was selected as a first priority. In terms of vegetable planting selection, cabbage was given the first priority.

Aside from choosing environmentally friendly plants, the appropriate planting areas for those plants were also considered. The result indicated that Mueang district should cultivate sesame and tiger peanut, Khun Yuam district should plant sesame, highland rice and garlic, Mae La Noi district should grow highland rice, coffee and napa cabbage, Pang Mapha district should cultivate tiger peanut, coffee and cabbage, Mae Sariang district should cultivate konjac, pumpkin and napa cabbage, Sop Moei district should crop konjac, and Pai district should grow garlic, cabbage and pumpkin.

Discussion

Considering the importance of criterions and sub-criterions, the results revealed that economic was the first priority. Most of the farmers in the Mae Hong Son province earned an income where the amount was dismally lower than the poverty line. The average household income in the agricultural sector was approximately 37,389 baht per year (Office of Agricultural Economics, 2018). Thus, it was not surprising that the economic variable was the top important variables for decision making. These findings corresponded to the previous studies of Tache & Oba (2010), Ostwald et al. (2013), Su et al. (2017), Devkota et al. (2019). In terms of the priorities of sub-criterions, the results shown that the market trend, planting area, quantity of yields, production costs, and pollution free were the top five priorities. Why was the market trend sub-criteria the most important options in decision making? Due to the rapidly changing consumer preferences in accordance with market trends such as the demand for healthy food and clean food, farmers were trying to connect the marketing relations, stories of goods, local knowledge and marketing strategies together, and develop new products that are environmentally friendly coupled with increasing the amount of yields and reducing production costs for achieving the commercial goals. To stress this issue, some researchers argued that environmentally friendly farms were less productive than conventional farms (Berezow, 2016), as well as incurring higher production expenses resulting from spending more on labor, and marketing charges (Uematsu & Mishra, 2012). However, many studies were consistent in showing that environmentally friendly farms have more input used efficiently while bringing about technical efficiency (Issaka, 2016). In addition, despite lower yields, environmentally friendly farm was more profitable than conventional farms due to organic premiums (Nemes, 2009; Griffith, 2015), as well as having a

small carbon footprint, conserving and improving soil health, and replenishing natural ecosystems for clean water and air which were free from toxic residues (Schrama et al., 2018).

In views of pollution free perspective, in fact, after the crops were harvested, there were many agricultural residuals and wastes such as stems, stalks, straws, leaves etc. The farmers have to prepare the area for the new crops. The traditional way to do that was burning which brings about air pollution. However, farmers were constantly concerned about being blamed for causing pollution due to their technique of clearing away the area for farming.

For the environmentally friendly crop selection, the results shown that tiger peanut, garlic, and cabbage were the first priorities of each crop type which should be planted in the Mueang and Pang Mapha districts, the Pai and Khun Yuam districts, and the Sop Moei and Pang Mapha districts, respectively.

Suggestions

1. Application:

The results of this research represented the significant environmentally friendly plants and the appropriate areas were chosen for cropping those plants. These findings were beneficial to government and private agencies as well as local stakeholders in establishing a strategic policy of setting up zones for growing crops and managing natural resources and in order to achieve agricultural sustainability and food security. Furthermore, these findings was used to create a guidebook on environmentally friendly alternative crop production and utilized for managing sustainable natural resource in the Mae Hong Son province. However, the limitation of this research was an inefficient coordination between the production and marketing sectors, which was a major obstacle to decision-making in changing farmer's cultivation behaviors.

2. Further Research:

Future research should be added the research and development concepts in the marketing and value chain in order to drive the environmentally friendly cultivation as a whole and achieve organic agricultural city development goal of Mae Hong Son province.

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