Research article

Study on the Factors of Awareness for the Production and Development of Vegetables by Farmers in Cambodia

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Abstract Recently, vegetable has also been cultivated by many farmers in Cambodia due to the increase of its demand in the local market. The main objective of this study was to clarify the awareness levels of the local farmers with an emphasis on agriculture production information for the sustainable development of vegetable production. Based on the multiple correspondence analysis results, the information required by local farmers was shown to be different depending on farm management scale. It can be concluded that it is important to provide information and technology that is adapted to the development stage of agricultural management of each local farmer. Moreover, a categorical principal component analysis is used to categorize and clarify the effectiveness of kind of agricultural production information was needed to develop vegetable production.

Keywords categorical principal component analysis, Cambodia

INTRODUCTION

In Southeast Asia, the rapid increase of population and lifestyle transition results the increase of demand in various agricultural crops particularly on vegetables. Although the main agricultural product in Cambodia is rice, vegetable has also been cultivated recently by many farmers.

According to the Census of Agriculture of the Kingdom of Cambodia (National Institute of Statistics, 2013), a wide variety of vegetables were cultivated across the country including leafy, stem and fruit bearing, root, bulb and tuberous, leguminous green, and others. Leafy vegetables such as Water Convolvulus (*Ipomoea aquatica*), Cabbage (*Brassica oleracea*), Lettuce (*Lactuca sativa*), Green Garlic (*Allium sativum*), Spring Onion (*Allium fistulosum*), Celery (*Apium graveolens*), Spinach (*Spinacia oleracea*), Watercress (*Nasturtium officinale*), Chinese Kale (*Brassica oleracea*), Clover (*Trifolium L.*), Amaranth (*Amaranthus L.*) and Pigweed (Amaranthus) are amongst of the common vegetables produced in the country. Tomato (*Solanum lycopersicum*), Bitter Melon (*Momordica charantia*), Watermelon (*Citrullus lanatus)*, Wing Bean (*Psophocarpus tetragonolobus*), Bhendi (*Abelmoschus esculentus*), Snake Gourd (*Trichosanthes cucumerina*), Ivy Gourd (*Coccinia grandis*), Winter Squash *(Cucurbita moschata*), Chili (*Capsicum*), Cucumber (*Cucumis sativus)*, Muskmelon (*Cucumis melo*), Eggplant (*Solanum melongena*), Gourd (*Lagenaria siceraria*), Green Gourd (*Cucurbitaceae*) are also some of the commonly cultivated fruit bearing vegetables. Fruit bearing vegetables were cultivated over 35,000 ha of which cucumber covers the largest area accounting 7,000 ha followed by watermelon at more than 6,000 ha while chili and pumpkins are at 5,000 ha each. However, many of these areas are cultivated in small scale and for the purpose of farmer's household consumption. In addition, many local farmers cultivate vegetables during the dry season that results lesser production than cultivated in the wet season. Those conditions contributed a limited supply of vegetable in the market. To boost up and sustain the

production of vegetables in Cambodia, it was determined that there is a need to support small scale vegetable growers in technical, farm inputs and a win-win price control of vegetable in the market (Chen et al., 2018). However, there is also a need to find out the instincts of farmers on how they will deal the possible supports they need. Therefore, this study has been proposed to clarify the awareness levels of the local vegetable growers with an emphasis on agriculture production information.

METHODOLOGY

The research site was in Kampong Cham Province. It is located at the northeast of Phnom Penh, and southeast of Siem Reap. In Kampong Cham Province during the French colonial period, the hilly terrain was developed as a rubber plantation zone. The population of Kampong Cham province is approximately 1.75 million and much of the population is engaged in agriculture. Table 1 shows the acreage and domestic share of major vegetables in Kampong Cham province. According to table 1, Kampong Cham Province is a major producing center of cabbage, lettuce and muskmelon.

Table 1 Acreage of major vegetables produced in Kampong Cham Province

Kind of Vegetables		Cambodia Planted Area (ha)	Kompong Cham Planted Area (ha)	Kompong Cham Composition ratio (%)
Leafy or Stem Vegetables	Water Convolvulus	2306.5	39.9	1.7
	Cabbage	648.6	223.0	34.4
	Lettuce	824.8	153.0	18.5
	Chinese Kale	327.4	11.2	3.4
Fruit-Bearing Vegetables	Chilli	4637.8	618.4	13.3
	Cucumber	6894.5	164.0	2.4
	Muskmelon	1901.9	847.4	44.6
	Eggplant	2997.4	103.8	3.5
	Gourd	1687.4	61.8	3.7
	Pumpkin	4624.9	22.7	0.5
	Tomato	1065.2	22.7	2.1
	Watermelon	5911.8	71.8	1.2
	Bhendi	406.2	302.0	74.3
Total		34234.4	2641.5	7.7

Source: Census of Agriculture of the Kingdam of Cambodia 2013

In this study, the following two multivariate analyses are applied. Firstly, Correspondence analysis is an analysis method that visualizes the cross-tabulation and facilitates the interpretation of the survey results. In this study, correspondence analysis is an appropriate method for understanding the awareness of local farmers and the results of the response patterns of necessary agricultural information. Secondly, Categorical principal component analysis is an analysis method for classification by integrating strongly correlated variables and creating new synthetic variables. Categorical principal component analysis is an appropriate method for creating new synthetic variables from many variables such as local farmer attributes agricultural information for vegetable production, and information sources, which is one of the purposes of this study. In addition, a previous study (Yamada et al., 2018) used categorical principal component analysis to classify farm management characteristics for development assistance in rural Cambodia.

The research site was ten districts in Kampong Cham Province, Cambodia. The target area of the questionnaire survey consisted of the following ten districts: Batheay district: 45 respondents (10.3% of the total respondents), Chamkar Leu district: 50 (11.4%), Chueng Prey district: 36 (8.2%), Kaoh Sotin district: 46 (10.5%), Kampong Siem district: 38 (8.7%), Krong Kampong Cham district:

48 (11.0%), Kang Meas district: 44 (10.1%), Prey Chhor district: 36 (8.2%), Srei Santhor district: 50 (11.4%) and Stueng Trang district: 44 (10.1%).

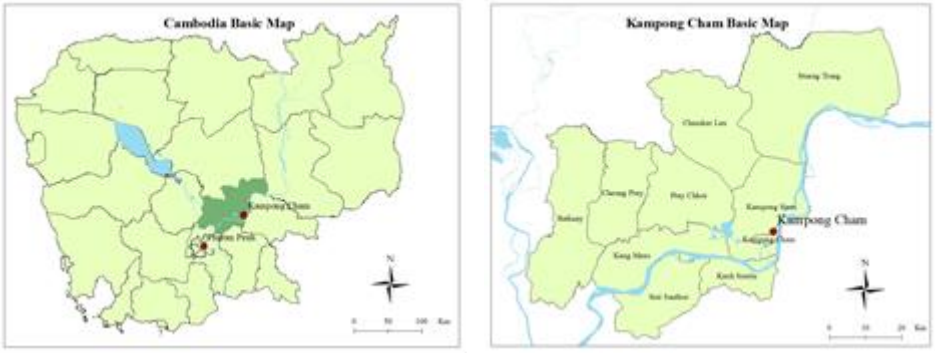

Fig. 1 Location of the study site in Kampong Cham Province

RESULTS AND DISCUSSION

Table 2 shows the index of the questionnaire carried out, which contains categories for gender, age of the respondent, educational background, farm acreage, cropping pattern, sales destination and farmers' revenues.

Table 2 Demographic information of respondents

Index		Number of response (n)	(%)	Index		Number of response (n)	(%)
Gender	1. Male	282	64.5	Cropping pattern	1.Vagetables	43	9.8
	2. Female	155	35.5		2.Rice	48	11.0
Age	1.Less than 29 years old	17	3.9		3.Rice,Vagetables	98	22.4
	2.30-39years	113	25.9		4.Rice,Vagetables,fruit	248	56.8
	3.40-49years	140	32.0	Sales destination	1.Middleman only	302	69.1
	4.50-59years	116	26.5		2.Middleman and Market in the village	53	12.1
	5.More than 60 years old	51	11.7		3.Market in the village only	57	13.0
Educational background	1. Never had been to school	42	9.6		4.Other market only	25	5.7
	2. Primary	228	52.2		5.No answer	7	1.6
	3. Secondary	133	30.4	farmers' revenues	1.Less than 1,000,000 Riel	30	6.9
	4. High school	33	7.6		2.1,000,000-2,999,999 Riel	169	38.7
	5.College/University	1	0.2		3.3,000,000-4,999,999 Riel	122	27.9
Farm acreage	1.Less than 0.5 ha	91	20.8		4.5,000,000-6,999,999Riel	57	13.0
	2.0.6-1ha	116	26.5		5.7,000,000-8,999,999 Riel	32	7.3
	3.1.1-1.5ha	117	26.8		6.More than 9,000,000 Riel	27	6.2
	4.1.6-2ha	40	9.2				
	5.More than 2.1ha	73	16.7				

Source : Survey Date

The attributes of the respondents are as follows. Concerning the "Gender" of the respondents, 64.5% were "male" and 35.5% were "female." Concerning the "Age" of the respondents, the majority of respondents were between the ages of "40-49" years (32.0%), followed by "50-59" years (26.5%) and "30-39" years (25.9%). The lowest percentage was aged "Less than 20 years" old. Concerning the "Educational background", the majority of respondents had "Primary" (52.2%), followed by "Secondary" (30.4%) and lastly "Have never been to school" (9.63%). Concerning the "Farm acreage" of the respondents, the majority of respondents were between a farm acreage of "1.1-1.5" ha (26.8%), followed by "0.6-1.0" ha (26.5%) and "Less than 0.5" ha (20.8%). Concerning the "Cropping pattern" of the respondents, the majority of respondents were "Rice, Vegetables, Fruit" (56.8%) followed by "Rice, Vegetables" (22.4%). Concerning the "Sales destination" of the respondents, about 70% of the local farmers answered "Middleman only". Concerning the "farmers' revenues" of the respondents, the majority of respondents were between the farmers' revenues of "1,000,000-2,999,999" Riel (38.7), followed by "3,000,000-4,999,999" Riel (27.9%) and "5,000,000-6,999,999" Riel (13.0%).

As a result, vegetable production is carried out by local farmers with a management area of 1.5ha or less, and most of the produced vegetables are shipped to Middlemen. In addition, women are often involved in vegetable production.

Characteristic of Respondents and Data of the Information for Sustainable development of Vegetable Production by Multiple Correspondence Analysis

This part clarifies characteristics of respondents and the information for sustainable development of vegetable production by Multiple Correspondence Analysis. The indices used for the analysis are X1: Farm acreage, X2: Farmers' revenues, X3: Information about seeds, X4: Information about machinery, X5: New technology information, X6: Information about chemical fertilizer, X7: Information about organic fertilizer, X8: Market information, X9: Information about training, X10: Price information, X11: Information about harvest and X12: Planting information. Figure 1 shows the results of the answer pattern for Characteristic of respondents and information with an emphasis on sustainable development of vegetable production by Multiple Correspondence Analysis. According to the results of Multiple Correspondence Analysis, respondents with small farm acreage and low income are X3: Information about seeds, X6: Information about chemical fertilizer and X12: Planting information. Furthermore, the local famer who answered the farm acreage as 1.1-1.5 ha was found to be related to X5: New technology information and X9: Information about training. Additionally, the local famer who answered the farm acreage as 1.6-1.2 ha and more than 2 ha were found to be related to X10: Price information and X11: Information about harvest. This clarified the characteristics of the local farmer consciousness and information of the emphasis on sustainable development of vegetable production. According to the results of Multiple Correspondence Analysis, it was clear that the preference divisions of the local farmers were difference of farm acreage as important characteristics for the classification.

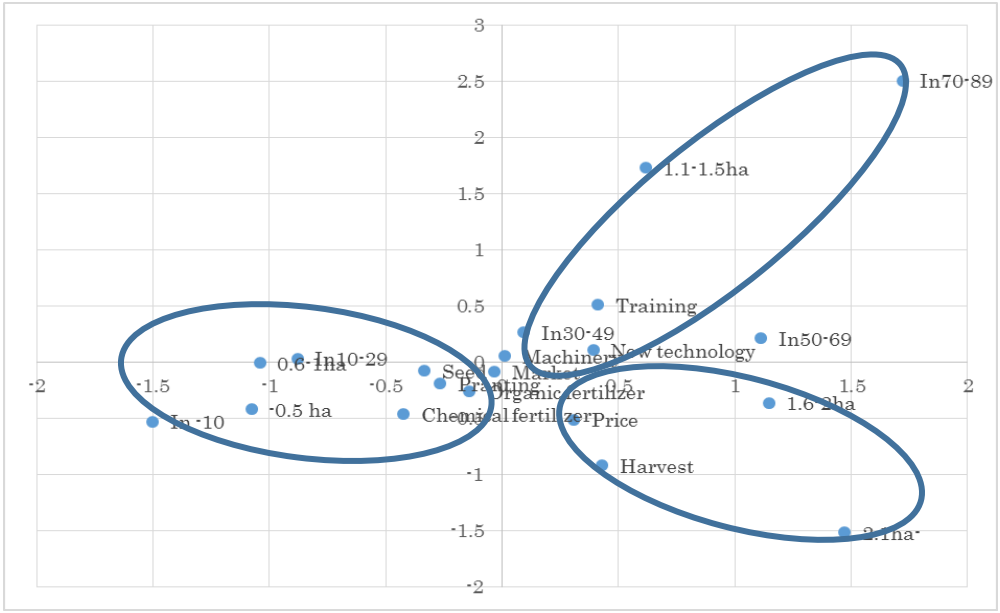

Fig. 2 The result of answer pattern for the local farmers consciousness and required agricultural information (Correspondence Analysis)

Grouping of Respondents by Category Principal Component Analysis

In this section, information on each variable, such as farmer attributes, cultivated land, the information for sustainable development of vegetable production and Information source are summarized and a "total index" is created and grouped. We employed a categorical principal

component analysis for this purpose. Index and answer patterns used for categorical principal component analysis were as follows.

Table 3 Estimation results of categorical principal component analysis

	Index	FACTOR 1	FACTOR 2
X1	Gender	-0.072	0.176
X2	Age	-0.112	0.206
X3	Educational background	0.264	-0.037
X4	Cultivated land	0.294	-0.096
X5	Average annual income from agricultural activity	0.422	-0.438
X6	Cropping pattern	-0.176	0.303
X7	Sales destination	-0.402	0.361
X8	Information about seeds	0.223	0.502
X9	Information about machinery	0.348	0.538
X10	New technology information	0.208	0.078
X11	Information about chemical fertilizer	0.216	0.518
X12	Information about organic fertilizer	0.251	0.337
X13	Market information	0.342	0.149
X14	Information about training	0.570	-0.073
X15	Price information	0.486	0.511
X16	Information about harvest	0.491	0.393
X17	Pranting information	0.081	0.396
X18	Government officer (DDAFF officer)	0.494	-0.318
X19	Village leader	0.326	-0.130
X20	Other farmers in the village	-0.294	0.053
X21	Parents	-0.375	0.368
X22	Scientist	0.152	0.122
X23	NGO officer	0.538	-0.384
X24	Other (Community)	-0.090	-0.041

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Note Eigenvalue: Factor 1; 2.69, Factor 2; 2.44

Table 3 shows the estimation results of the categorical principal component analysis. At the same time, the eigenvalues of each factor were factor 1: 2.69 and factor 2: 2.44. In the following, it is confirmed for each principal component what index feature an element constitutes. In the following, it is confirmed for each principal component what index feature an element is constituted. Firstly, the indices positively contributing to factor 1 were X3: Educational background (0.264), X4: Cultivated land (0.294), X5: Average annual income from agricultural activity (0.422), X10: New technology information (0.208), X14: Information about training (0.570), X18: Government officer (DDAFF officer) (0.494) and X23: NGO officer (0.538). From these indices, factor 1 can be interpreted as "the factor representing the priority of information for the future of agricultural management". Secondly, the index positively contributing to factor 2 were X1: Gender (0.176), X2: Age (0.206), X6: Cropping pattern (0.303), X7: Cultivated land (0.361), X8: Information about seeds (0.502), X9: Information about machinery (0.538), X11: Information about chemical fertilizer (0.518), X17: Planting information (0.396), and X21: Parents (0.368). From these indices, factor 2 can be interpreted as "Factors expressing intention to form production areas by collaboration".

For local farmer grouping, it can be classified into the following 4 groups from each positive and negative combination of factor 1 and factor 2. Group 1 is local farmers that are positive for both" the factor representing the priority of information for the future of agricultural management" and "Factors expressing intention to form production areas by collaboration." This group is under

situations that ensure stable income such as agricultural machinery is in place, has an interest in improving the quality of agricultural crops and sales outlets and also shows an understanding of cooperation with others. Therefore, it is suggested that local farmers classified as group 1 are suitable as model farmers for projects for sustainable vegetable production. The local farmers of group 2 are positive for "the factor representing the priority of information for the future of agricultural management" and negative for "Factors expressing intention to form production areas by collaboration". This group is already aiming to achieve modern agricultural production and to advance agricultural management on an individual level. This is considered to be highly adaptable to projects aimed at improving the agricultural techniques for vegetable production of local farmers, such as the start of new crops and Introduction of new customers. Group 3 are local farmers that are negative for both "the factor representing the priority of information for the future of agricultural management" and "Factors expressing intention to form production areas by collaboration." It is speculated that the local farmers in this group are in a situation where the infrastructure required for agricultural production is not well developed. Therefore, a project is needed to disseminate basic agricultural production techniques. The local farmers of group 4 are negative for "the factor representing the priority of information for the future of agricultural management" and "Factors expressing intention to form production areas by collaboration" positive. Similar to Group 3 and Group 4, the development of agricultural production infrastructure is not sufficient. However, the local farmers expect the development of regional agriculture by collaborating with others to offset its weaknesses. In addition, local farmers classified as Group 4 and Group need to propose to expand vegetable production from self-consumption by the houses to vegetable production for sale.

According to the results of categorical principal component analysis, local farmers who produce vegetables were found to have disparities in the development stage of agricultural management. In addition, it became clear that local farmers have a different awareness of the priorities of information for the future of agricultural management and their intentions for the formation of main producing areas.

CONCLUSION

In this study, focusing on the vegetable production in Cambodia, the local farmers analyzed what kind of agricultural production information was needed to develop vegetable production based on data obtained from a questionnaire survey. Therefore, the main objective of this study was to clarify the characteristics of awareness of the local farmers with an emphasis on information of agriculture production.

The results of the analysis are summarized as follows. Based on the multiple correspondence analysis results, the information required by local farmers was shown to be different depending on farm management scale. Based on the categorical principal component analysis results, the relevance of awareness for the production and development of vegetables and the information required by local farmers became clear. In addition, local farmers with multiple sales destinations are highly conscious of the factor representing the priority of information for the future of agricultural management.

According to the results of the analysis, for the development of vegetable production in Cambodia, it can be concluded that it is important to provide information and technology that is adapted to the development stage of agricultural management of each local farmer.

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