



Classification by Characteristics of Farm Management for Development Aid in Rural Area of Cambodia

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Abstract The main objective of this study is to clarify the characteristics of farm management based on the indicators of agricultural production. A categorical principal component analysis was applied to categorize and clarify the effectiveness of their farm management. The research site was Samroung Commune, Prey Chhor District, Kampong Cham Province, Cambodia. The results of the analysis are summarized as follows. 1) Even in the same commune, the differences were found among villages when the features were grasped from the indicators of agricultural production of each village. 2) Based on the categorical principal component analysis results, farm management was classified and clarified based on the characteristics of each category. According to the results of the analysis, it was indicated that it is necessary to classify agricultural production information of the target area in order to support effectively with full use of the abilities of support organizations.

Keywords categorical principal component analysis, Cambodia

INTRODUCTION

In recent years, industrialization has progressed rapidly in Cambodia. However, the main industry in Cambodia's rural areas is still self-sufficient agriculture. In Cambodia there are many local farmers who cannot emerge from poverty due to low productivity of their land and increased expenditure on pesticides and chemical fertilizers. Development aid has been diversified by support organizations with the Official Development Assistance (ODA) through NGOs, universities, research institutes, or CSR activities of companies. In order to tackle the problems in rural areas, development aid project is expected to formulate and plan by using technology, know-how and networks based on the characteristics and strengths of each support organization. Support organizations require detailed investigation and analysis of local agricultural production in order to formulate an effective plan and to select a reasonable target site. In addition, it is also important to know exactly what kinds of technology and support that meets the needs of local farmers. According to the above mentioned background, the main objective of this study was to clarify the characteristics of farm management based on the indicators of agricultural production. Also, a categorical principal component analysis was applied to categorize and clarify the effectiveness of their farm management.

METHODOLOGY

An Index of Agricultural Production of Each Village

The research site was Samroung Commune, Prey Chhor District, Kampong Cham Province, Cambodia. The Kampong Cham Province is located in the northeast of Phnom Penh, and southeast of Siem Reap. In the 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 about 1,750,000 and much of the population is engaged in agriculture. At the target area in Samroung commune of Kampong Cham Province, the amounts of agricultural chemicals have increased over the last ten years. Although it contributed to an increase in the agricultural productivity in the short term, the degradation of soil and water environment became more severe. Also, local farmers have suffered from several diseases such as throat pain or dermatitis due to the inappropriate application of agricultural chemicals (Kobayashi, T. and Yamamoto, H. 2009). Therefore, there are many farmers who expect to shift to a sustainable farming system based on natural resource circulation. At this site, the Institute of Environmental Rehabilitation and Conservation (ERECON) carried out the project on promoting sustainable Agriculture at Kampong Cham Province in Cambodia (April/2011-March/2016). This project aims to promote sustainable agriculture based on natural resource circulation with low chemical input by targeting the local farmers.

The target area of the questionnaire survey consisted of the following eleven villages: Bontey Thmey, Kondal Koang, Preykhcheay, Samroung, Smei, Sodey, Svayprey, Takrit, Thmey, Tompong Risey, and Veal. The survey period lasted from July to August 2011. The number of useful responses we received per area are as follows: Bontey Thmey: 61 respondents (13.8% of the total respondents), Kondal Koang: 33 respondents (7.4%), Preykhcheay: 35 respondents (7.9%), Samroung: 54 respondents (12.2%), Smei: 13 respondents (2.9%), Sodey: 56 respondents (12.6%), Svayprey: 49 respondents (11.1%), Takrit: 38 respondents (8.6%), Thmey: 37 respondents (8.4%), Tompong Risey: 37 respondents (8.4%) and Veal: 30 respondents (6.8%). There were 443 respondents in total.

RESULTS AND DISCUSSION

Table 1 shows the aggregated results of indicators showing the characteristics of agricultural management for each village. The following are the characteristics of Bontey Thmey. The average agricultural annual income is the highest among the 11 villages, and the ratio of answering that the aged cultivated land area is 1.5 ha or more is relatively high. In addition, irrigation development rate and expenditure amount and usage amount for chemical fertilizer were the largest among the 11 villages. The following are the characteristics of Kondal Koang. Local farmers replied that 75.8% had 3-5 family members. All respondents replied that they have irrigation facilities. Furthermore, the expenditure on chemical fertilizer is high. The following are the characteristics of Preykhcheay. The proportion of full-time farmers is the lowest among the 11 villages. The proportion of farmers responding that the cultivated land area is 0.2-0.5 ha is 45.7%. Local farmers raising chickens are as many as 91.4%. The following are the characteristics of Samroung. All the farmers who answered are producing rice. Ownership of tillers, harvesters, and threshing machines is higher than that of other villages. Also, the proportion of farmers producing vegetables is 64.8%, the highest among the 11 villages. The following are the characteristics of Smei. The proportion of full-time farmers is the largest among the 11 villages. In addition, the characteristics of agricultural management are farmers who are engaged in vegetable production and fruit tree production, mainly with rice production. The following are the characteristics of Sodey. Local farmers responding that the number of family members was 6-8 was 50%. Sodey was characterized by a relatively large number of family members compared to other villages. The following are the characteristics of Svayprey. The proportion of farmers doing livestock production is the largest among the 11 villages. It is also the village with the lowest expenditure and usage of chemical fertilizer. The following are the characteristics of Takrit. The characteristics of the agricultural management of Takrit are rice production and breeding of livestock.

Table 1 An index of agricultural production of each village

Actual number		All Sample	Banteay Thmey	Kondal Koang	Preykhch eay	Sam roung	Smei	Sodey	Svay prey	Takrit	Thmey	Tompang Risey	Veal
Index		443	61	33	35	54	13	56	49	38	37	37	30
Number of family members	Less than 2 persons	49	41	0	3	2	0	0	0	1	0	2	0
	3-5 persons	233	17	25	19	31	8	25	28	22	13	22	23
	6-8 persons	137	2	6	12	15	4	28	19	15	19	11	6
	9-10 persons	18	0	2	1	6	1	0	1	0	4	2	1
	More than 14 persons	2	0	0	0	0	0	0	1	0	1	0	0
Type of farm management	Full-time farmers	277	39	22	15	34	10	35	34	26	28	21	13
	Rice	437	58	33	35	54	12	55	49	38	37	36	30
	Vegetables	161	27	5	14	35	8	18	15	11	5	18	5
	Fruits	91	16	5	14	3	6	16	2	7	2	8	12
	Live stock other	397 7	50 0	27 2	32 1	51 0	9 1	51 1	48 0	36 0	31 2	34 0	28 0
Average of farmers' revenues (1000 Riel)		3,772	6,420	3,537	3,859	2,689	3,158	3,216	2,815	3,804	3,858	2,772	4,362
Total area (owned)	Less than 0.2 ha	10	2	0	1	4	0	0	0	0	2	0	1
	0.2-0.5ha	86	6	7	16	8	4	11	13	4	4	11	2
	0.6-1ha	140	16	9	11	25	5	18	20	11	6	9	10
	1.1-1.5ha	78	10	10	1	10	0	13	6	9	8	5	6
	More than 1.5 ha	125	24	7	6	7	4	14	10	14	17	12	10
	Don't have	3	3	0	0	0	0	0	0	0	0	0	0
Using irrigation	Fully	98	24	6	3	13	3	16	6	4	12	6	5
	Partly	307	35	27	15	40	9	36	40	32	23	26	24
	Not at all	38	2	0	17	1	1	4	3	2	2	5	1
Number of livestock farms	Chickens	383	47	28	32	46	12	52	42	27	34	35	28
	Cattle	414	55	33	34	53	12	54	47	38	36	22	30
	Pig	33	5	3	5	7	0	2	1	2	5	3	0
	Duck	66	10	7	4	7	3	12	13	2	3	2	3
	Water buffalo	22	0	0	0	0	0	0	0	0	0	22	0
Using chemical fertilizer	Riel (1000 Riel)	971	1,398	1,160	786	805	861	759	634	1,176	1,048	1,077	918
	USD	237	341	285	192	197	210	185	155	287	256	263	224
	Kg	412	578	479	304	419	367	326	271	488	466	418	358
	Sack	8	11	10	6	7	7	7	6	10	9	8	7
Farm machinery	Yes	421	57	33	31	53	13	53	48	35	37	32	29
	Not	22	4	0	4	1	0	3	1	3	0	5	0
Composition ratio		All Sample	Banteay Thmey	Kondal Koang	Preykhch eay	Sam roung	Smei	Sodey	Svay prey	Takrit	Thmey	Tompang Risey	Veal
Index		443	61	33	35	54	13	56	49	38	37	37	30
Number of family members	Less than 2 persons	11.1	67.2	0	8.6	3.7	0	0	0	2.6	0	5.4	0
	3-5 persons	52.6	27.9	75.8	54.3	57.4	61.5	44.6	57.1	57.9	35.1	59.5	76.7
	6-8 persons	30.9	3.3	18.2	34.3	27.8	30.8	50	38.8	39.5	51.4	29.7	20
	9-10 persons	4.1	0	6.1	2.9	11.1	7.7	0	2	0	10.8	5.4	3.3
	More than 14 persons	0.5	0	0	0	0	0	0	2	0	2.7	0	0
Type of farm management	Full-time farmers	62.5	63.9	66.7	42.9	63	76.9	62.5	69.4	68.4	75.7	56.8	43.3
	Rice	98.6	95.1	100	100	100	92.3	98.2	100	100	100	97.3	100
	Vegetables	36.3	44.3	15.2	40	64.8	61.5	32.1	30.6	28.9	13.5	48.6	16.7
	Fruits	20.5	26.2	15.2	40	5.6	46.2	28.6	4.1	18.4	5.4	21.6	40
	Live stock other	89.6 1.6	82 0	81.8 6.1	91.4 2.9	94.4 0	69.2 7.7	91.1 1.8	98 0	94.7 0	83.8 5.4	91.9 0	93.3 0
Average of farmers' revenues (1000 Riel)		-	-	-	-	-	-	-	-	-	-	-	-
Total area (owned)	Less than 0.2 ha	2.3	3.3	0	2.9	7.4	0	0	0	0	5.4	0	3.3
	0.2-0.5ha	19.4	9.8	21.2	45.7	14.8	30.8	19.6	26.5	10.5	10.8	29.7	6.7
	0.6-1ha	31.6	26.2	27.3	31.4	46.3	38.5	32.1	40.8	28.9	16.2	24.3	33.3
	1.1-1.5ha	17.6	16.4	30.3	2.9	18.5	0	23.2	12.2	23.7	21.6	13.5	20
	More than 1.5 ha	28.2	39.3	21.2	17.1	13	30.8	25	20.4	36.8	45.9	32.4	33.3
	Don't have	0.7	4.9	0	0	0	0	0	0	0	0	0	0
Using irrigation	Fully	22.1	39.3	18.2	8.6	24.1	23.1	28.6	12.2	10.5	32.4	16.2	16.7
	Partly	69.3	57.4	81.8	42.9	74.1	69.2	64.3	81.6	84.2	62.2	70.3	80
	Not at all	8.6	3.3	0	48.6	1.9	7.7	7.1	6.1	5.3	5.4	13.5	3.3
Number of livestock farms	Chickens	86.5	77	84.8	91.4	85.2	92.3	92.9	85.7	71.1	91.9	94.6	93.3
	Cattle	93.5	90.2	100	97.1	98.1	92.3	96.4	95.9	100	97.3	59.5	100
	Pig	7.4	8.2	9.1	14.3	13	0	3.6	2	5.3	13.5	8.1	0
	Duck	14.9	16.4	21.2	11.4	13	23.1	21.4	26.5	5.3	8.1	5.4	10
	Water buffalo	5	0	0	0	0	0	0	0	0	0	59.5	0
Using chemical fertilizer	Riel (1000 Riel)	-	-	-	-	-	-	-	-	-	-	-	-
	USD	-	-	-	-	-	-	-	-	-	-	-	-
	Kg	-	-	-	-	-	-	-	-	-	-	-	-
	Sack	-	-	-	-	-	-	-	-	-	-	-	-
Farm machinery	Yes	95	93.4	100	88.6	98.1	100	94.6	98	92.1	100	86.5	96.7
	Not	5	6.6	0	11.4	1.9	0	5.4	2	7.9	0	13.5	0

Source: Surveyed data

In particular, all local farmers replied that they were breeding cattle. The average number of cattle raised was 5.03. The following are the characteristics of Thmey. In Thmey, the proportion of local farmers with a total area of more than 1.5 ha is 45.9%. The following are the characteristics of Tompong Risey. The average agricultural annual income is 2,771,621.62 Riel (4,000 Riel = 1 USD), the lowest among 11 the villages. The following are the characteristics of Veal. The average agricultural longevity amount is 4,361, 533.33 Riel, the second largest among the 11 villages. The characteristics of agricultural management of Veal are rice production and fruits. Based on the

above information, even in the same commune, differences were found in each village when the features were grasped from the indicators of agricultural production of each village.

Grouping of Respondents by Category Principal Component Analysis

In this section, information on each variable, such as farmer attributes, cultivated land, labor force indicator, agricultural product awareness in the target area is 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 2 Index and answer patterns for categorical principal component analysis

Index	Answer category
X1 Gender	1. Male, 2. Female
X2 Age	1. Less than 20years old, 2. 20–29years, 3. 30–39years, 4. 40–49years, 5. More than 50 years old
X3 Educational background	1. Never had been to school, 2. Primary, 3. Secondary, 4. High school, 5. College, 6. University
X4 Numbers of family persons	1. Less than 2 persons, 2. 3-5, 3. 6-8, 4. 9-10, 5. More than 10persons
X5 Children less than ten years old	1. No one, 2. 1-2, 3. 3-5, 4. 6-8, 5. 9-10, 6. More than 10
X6 Family living years in this village	1. Less than 2 years, 2. 3-5, 3. 6-10, 4. 11-15, 5. 16-20, 6. 21-25, 7. 26-30, 8. 31-35, 9. 36-40, 10. More than 41 years
X7 Duration of agricultural experience	1. Less than 2 years, 2. 3-5, 3. 6-10, 4. 11-15, 5. 16-20, 6. 21-25, 7. 26-30, 8. 31-35, 9. 36-40, 10. More than 41 years
X8 Full-time farmer	1. Yes, 2.No
X9 Family agricultural workers(Full time)	1. No one, 2. 1-3, 3. 4-6, 4. 7-9, 5. More than 10
X10 Family agricultural workers(Part time)	1. No one, 2. 1-3, 3. 4-6, 4. 7-9, 5. More than 10
X11 Employed worker	1. Yes, 2. No
X12 Paddy field	1. Less than 0.2 ha, 2. 0.2-0.5 ha, 3. 0.6-1.0 ha, 4. 1.1-1.5 ha, 5. More than 1.5 ha
X13 Farmland irrigated	1. Yes, fully, 2. Yes, partly, 3. Not at all
X14 Common forests	1. Yes, 2. No
X15 Farmers Group	1. Yes, 2. No
X16 Raise poultry	1. Yes, 2. No
X17 Raise cattle	1. Yes, 2. No
X18 Raise pigs	1. Yes, 2. No
X19 Reduction targets of chemical fertilizer	1. 0-20%, 2. 20-40%, 3. 40%-60%, 4. 60%-80%, 5. 80%-100%
X20 Reduction targets of chemical pesticide	1. 0-20%, 2. 20-40%, 3. 40%-60%, 4. 60%-80%, 5. 80%-101%
X21 Agricultural machinery	1. Yes, 2. No
X22 Conversation about agriculture with children	1. None, 2. Once a week, 3. Few times a week, 4. Once a month, 5. Few times a month, 6. Once a 6 months, 7. Once a year, 8. Other
X23 Knowledge on sustainable agriculture	1. Don't know, 2. Know less, 3. Know, 4. Know better, 5. Know well
X24 Participation in agricultural cooperatives	1. Yes, 2. No
X25 Collaboration with people from other villages	1. Yes, 2. No
X26 Important for agricultural production	1. Taste, 2. Shape, 3. Size, 4. Other
X27 Important for agricultural products sales	1. Safety of food, 2. Brand of food, 3. Place of market, 4. Other
X28 Acquisition of agricultural information and technology	1. Government officer, 2. Village leader, 3. Other farmers in the village, 4. Scientist, 5. NGO officer, 6. Other
X29 Introduction of chemical fertilizer	1. Before 1960, 2. 1961-1970, 3. 1971-1980, 4. 1981-199, 5. 1991-2000, 6. 2001-2005, 7. 2006-2010, 7. Other
X30 Introduction of chemical pesticide	1. Before 1960, 2. 1961-1970, 3. 1971-1980, 4. 1981-199, 5. 1991-2000, 6. 2001-2005, 7. 2006-2010, 8. Other

Source: Surveyed data

In Table 3, the estimation results of the categorical principal component analysis is shown. At the same time, the eigenvalues of each factor were factor 1: 2.87 and factor 2: 2.52. In the following, it is confirmed for each principal component what index feature an element is constituting.

Firstly, the indices positively contributing to factor 1 were X3: Educational background (0.42), X8: Full-time farmer (0.17), X12: Paddy field (0.20), X13: Farmland irrigated (0.11), X21: Agricultural machinery (0.13), X29: The commencement of chemical fertilizer (0.72) and X30:

The commencement of chemical pesticide (0.72). From these indices, factor 1 can be interpreted as "the factor representing the degree of achievement of modernization of agricultural production".

Secondly, the index positively contributing to factor 2 were X1: Gender (0.31), X15: Farmers Group (0.32), X24: Participation in agricultural cooperatives (0.46), X25: Collaboration with people from other villages (0.28), X26: Important for agricultural production (0.42), X27: Important for agricultural products sales (0.37) and X28: Acquisition of agricultural information and technology (0.40). 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. In addition, Table 4 shows average values of scores of factor 1 and factor 2 of all respondents for each village.

Table 3 Estimation results of categorical principal component analysis

Index	FACTOR	
	1	2
X1 Gender	-0.10	0.31
X2 Age	-0.69	-0.22
X3 Educational background	0.42	-0.30
X4 Numbers of family persons	-0.10	-0.16
X5 Children less than ten years old	0.36	0.18
X6 Family living years in this village	-0.64	-0.20
X7 Duration of agricultural experience	-0.56	-0.24
X8 Full-time farmer	0.17	-0.14
X9 Family agricultural workers(Full time)	-0.11	0.05
X10 Family agricultural workers(Part time)	-0.10	-0.20
X11 Employed worker	-0.06	0.01
X12 Paddy field	0.20	-0.21
X13 Farmland irrigated	0.11	-0.15
X14 Common forests	-0.11	0.00
X15 Farmers Group	0.14	0.32
X16 Raise poultry	-0.10	-0.08
X17 Raise cattle	-0.02	-0.08
X18 Raise pigs	-0.12	-0.04
X19 Reduction targets of chemical fertilizer	0.03	-0.58
X20 Reduction targets of chemical pesticide	0.10	-0.59
X21 Agricultural machinery	0.13	-0.16
X22 Conversation about agriculture with children	-0.24	-0.46
X23 Knowledge on sustainable agriculture	0.06	-0.42
X24 Participation in agricultural cooperatives	-0.01	0.46
X25 Collaboration with people from other villages	-0.12	0.28
X26 Important for agricultural production	-0.17	0.42
X27 Important for agricultural products sales	-0.04	0.37
X28 Acquisition of agricultural information and technology	-0.16	0.40
X29 The commencement of chemical fertilizer	0.72	-0.06
X30 The commencement of chemical pesticide	0.72	-0.13

Source: Surveyed data

Note: Eigenvalue Factor 1; 2.867, Factor 2; 2.520

The group 1 is a local farmer that is positive for both "factor representing the achievement degree of modernization of agricultural production" and "Factors expressing intention to form production areas by collaboration." The average of respondents is Thmey. This group is in a state where infrastructure for agricultural production such as irrigation facilities and 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 the

support target is suitable as a target area for new projects in all support organizations such as government agencies, NGOs, educational research institutes, and companies.

The local farmer of group 2 is "factor representing the achievement degree of modernization of agricultural production" positive and "Factors expressing intention to form production areas by collaboration" negative. The average of respondents are Preykhcheay and Samroung. 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 of local farmers, such as the start of new crops. Therefore, a support organization suitable for this group is regarded as a research institution, such as a university with advanced technology.

Table 3 Average value of respondents by village

Village	Bontey Thmey	Kondal Koang	Preykh cheay	Sam roung	Smei	Sodey	Svayprey	Takrit	Thmey	Tompang Risey	Veal
Group	Group 3	Group 4	Group 2	Group 2	Group 3	Group 4	Group 4	Group 4	Group 1	Group 3	Group 3
Factor 1	-0.02	-0.06	0.50	0.10	-0.01	-0.08	-0.09	-0.10	0.13	-0.17	-0.17
Factor 2	-0.11	0.39	-0.13	-0.45	-0.10	0.14	0.22	0.01	0.60	-0.39	-0.11

Source: Surveyed data

The group 3 is a local farmer that is negative for both "factor representing the achievement degree of the modernization of agricultural production" and "Factors expressing intention to form production areas by collaboration." The average of respondents are Smei, Veal, Tompang Risey and Bontey Thmey. The local farmer of this group is not sufficiently developed for agricultural production infrastructure. In addition, a project is needed to disseminate basic agricultural production techniques. Economic assistance is indispensable for the development of agricultural production infrastructure. Therefore, it is suggested that a support organization capable of financial assistance, like a company, is effective.

The local farmer of group 4 is "factor representing the degree of achievement of modernization of agricultural production" negative and "Factors expressing intention to form production areas by collaboration" positive. The average of respondents are Takrit, Kondal Koang, Sodey and Svayprey. Similar to Group 4 and Group 3, the development of agricultural production infrastructure is not sufficient. However, the local farmer is expecting the development of regional agriculture by collaborating with others to offset its weaknesses. Therefore, a support organization suitable for this group is effective NGO which can support agriculture by cooperation for villages and communes.

CONCLUSION

In this study, the main objective of this study was to clarify the characteristics of farm management based on the indicators of agricultural production. In addition, a categorical principal component analysis was used to categorize and clarify the effectiveness of their farm management. The results of the analysis are summarized as follows.

Even in the same commune, differences were found among villages when the features were grasped from the indicators of agricultural production of each village.

According to the categorical principal component analysis results, farm management was classified and clarified on the basis of the characteristics of each category.

Specifically, for local farmer grouping, it may be classified into the following 4 groups from each positive and negative combination of factor 1 and factor 2. According to the results of the analysis, it was indicated that it is necessary to classify agricultural production information of the target area in order to support effectively with full use of the abilities of support organizations.

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