Research article

Challenges and Prospects for Increasing Vegetable Production in Cambodia

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Abstract Vegetable production in Cambodia is minimal; thus, 70% of the country's internal consumption is dependent on imported vegetables, primarily from Thailand and Vietnam. Although the government is encouraging vegetable production, clarifying the status, issues, and challenges is crucial to establishing detailed strategies for vegetable production in the country. This study aimed to identify the challenges and prospects of vegetable production in Cambodia by examining the status of vegetable cultivation, including production volumes and varieties, vegetable business conditions, and producers' socio-economic characteristics. A commune in Takeo province, which has year-round access to agricultural water, was selected as the study area. Semi-structured interviews based on a questionnaire were conducted with both vegetable producers and non-producers for comparative analysis. Producers were asked about their vegetable production and other income-generating activities and expenditures. Non-producers were asked about their income-generating and expenditure activities. Valid responses were obtained from 113 vegetable-producing households (HHs) and 89 non-producing HHs. The survey results indicated that 97% of vegetable producers had a surplus; however, the average net profit (35 USD) was minimal compared with other income sources, such as factory work. The net profit was strongly influenced by the production volume derived from the size of owned farmland and the limited planted area due to unsuitable production methods. Nevertheless, nearly 60% of non-producers had arable upland, but they stopped production owing to a lack of sales channels. Thus, the low production volume per producer and limited sales channels were identified as the key challenges Cambodia faces in terms of increasing vegetable production volumes.

Keywords vegetable production, current status, issues, challenges, Cambodia

INTRODUCTION

Cambodia is located on the Indochina Peninsula and is surrounded by Thailand, Laos, and Vietnam (Fig. 1). Owing to rapid economic growth in recent years, Gross National Income (GNI) per capita exceeded 1,000 USD in 2013. It reached 1,500 USD in 2018 (World Bank, 2023. However, as many people live below the poverty line in rural areas, it is one of the poorest countries. Agriculture accounts for 25% of the country's GDP. In addition, about 40% of the people in Cambodia are engaged in agriculture, which is one of the country's core industries. The main crops include rice, maize, and cassava. Although self-sufficiency in rice has been achieved, vegetable production could have been more active, with approximately 70% of domestic consumption dependent on imports

from neighboring countries. In response to this situation, Cambodia's Rectangular Strategy (Royal Government of Cambodia, 2013) indicated the necessity of research activities to develop a policy framework for expanding vegetable production. During the expansion of vegetable production, anyone can purchase domestic vegetables, and increasing production and distribution volume is necessary to realize the situation (Fig. 2). Existing research on vegetable production in the country covers marketing channels, such as market status (Itagaki, 2010), marketing (Olney et al., 2009), and logistics (Kawahara and Yoshida, 2006). However, research should focus more on the reality and challenges of production volume, including the yield, acreage, and number of producers, which is essential for exploring the potential for expanding production.

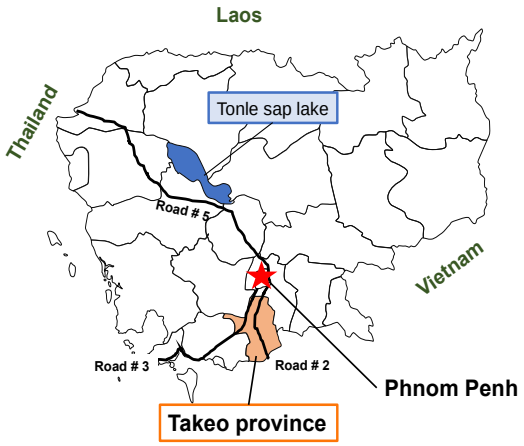

Fig. 1 Map of Cambodia showing the study area

OBJECTIVE

This study aims to identify the challenges of vegetable production for increasing production volume in Cambodia by clarifying the status of vegetable cultivation, including production amount and varieties, vegetable production business conditions, and producers' socio-economic characteristics.

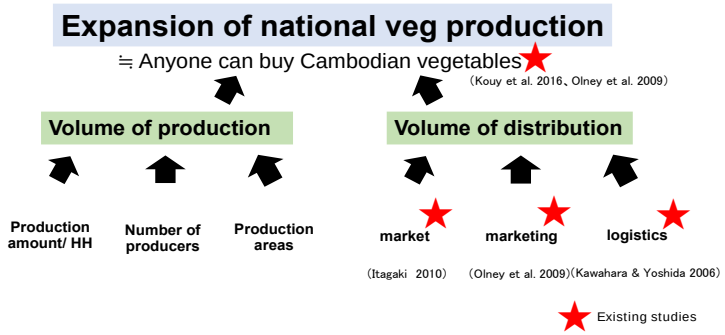

Fig. 2 Concept map of the study

METHODOLOGY

The survey area is in Takeo Province, about 80 km south of the capital Phnom Penh. It is Cambodia's main agricultural production area (Fig. 3). A commune comprising 12 villages near a huge reservoir constructed during the Pol Pot regime was selected as the study area. This commune has year-round access to agricultural water, such as reservoirs and irrigation, and has been confirmed as a vegetable production area. It is 20 minutes by car from one of the largest markets in the province along National Road No. 3. This road connects to Sihanoukville Port, the only port in Cambodia, and Phnom Penh, the capital city (Fig. 3).

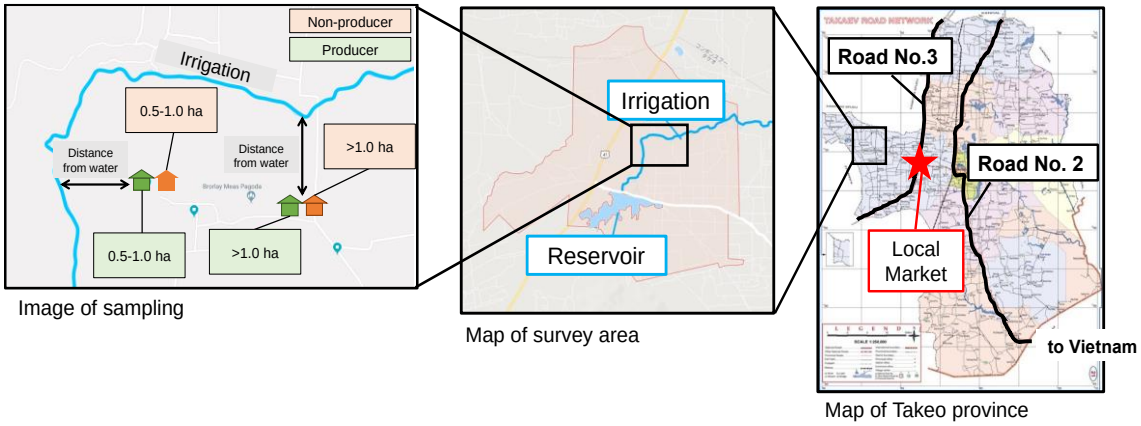

Fig. 3 Study area and sampling

For comparative analysis, a semi-structured interview based on a questionnaire was conducted with both vegetable producers and non-producers. All households in the area producing vegetables for sale during the 2017 production season were selected as "vegetable producers." All the other households in this area were automatically identified as "non-producers." To select non-producers facing natural environments and economic conditions similar to those faced by producers were selected through stratified sampling. Stratification was based on water access and agricultural land ownership (Table 1). First, the neighbors of each "producer" who could access the same water source were selected as candidate respondents. Then, we selected households in the same land size category as neighboring "producers" among the candidates. Only households that met the criteria were selected. Consequently, 122 vegetable-producing and 92 non-producer HHs were selected as subjects for the survey. Producers were asked about their vegetable production activities from October 2016 to September 2017 and their other income-generating activities and expenditures. Non-producers were asked about their income-generating activities and expenditures. The number of valid responses included 113 (92.6%) producer HHs and 89 (96.7%) non-producer HHs.

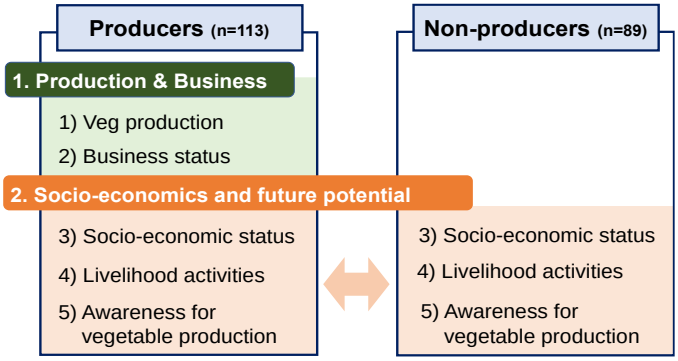

Fig. 4 Data collection framework

Table 1 Results of stratified sampling

Area (ha)	Producers[1]	(%)	Non-producers[1]	(%)
below 1.0	30	(26.5)	27	(30.3)
1.0-	50	(44.2)	35	(39.3)
2.0-	25	(22.1)	23	(25.8)
3.0-	8	(7.1)	4	(4.5)
Total	113	(100.0)	89	(100.0)

**Number of households and ratio*

This study first focuses on the respondents' profile, followed by vegetable production status and business conditions, including costs and profits. Then, we explore the possibility of increasing

production and producers by conducting a comparative analysis of the socio-economic status, including household composition, income, and awareness of both producers and non-producers (Fig. 4).

RESULTS AND DISCUSSION

Socio-economic Status of Respondents

Table 2 shows the profile and socioeconomic status of all respondents. Producer HHs had fewer family members than non-producer HHs. Producer HHs had fewer female members, children under 15, and employed members. By contrast, the average age of each household and the primary agriculture worker were significantly higher in producer HHs. The sizes of owned agricultural land did not differ due to stratified sampling according to land size; both producer and non-producer HHs tended to have an upland field suitable for vegetable production. No socio-economic or cultural anthropological studies were found to provide background on the significant differences in household composition. Household income data are analyzed in the later section.

Status of Vegetable Production

A total of 27 vegetables were produced by the respondents, including peanuts (30 HHs), pumpkins (23 HHs), melons (22 HHs), water spinach (21 HHs), and yams (21 HHs), with an average of 2.7 items per household (Fig. 5). Many of these were seen as native vegetables in the tropics, and direct sowing was the mainstream. Therefore, it is assumed that the vegetable production in this area is not for specific demands, such as exporting or sending to foreign residents in the country but for local needs. Vegetable cultivation averaged 4.8 months per year and was concentrated in the dry season. Substantially little cultivation occurs during the rainy season (Fig. 6). It is common to grow vegetables using paddy fields after harvesting rice in Cambodia, according to existing studies (Hamano et al., 2013). In that case, cultivation in the rainy season is physically impossible. However, the producers in this region should be able to cultivate vegetables even in the rainy season, as more than 70% (80 HHs) of them own upland fields (Table 2).

Table 2 Socio-economic profile of respondents

Respondents' attributes	Producers (N=113)	Non-producers (N=89)	Total (N=202)	P-value[1]
Total number of HH[2] members	4.1	4.6	4.3	0.049 *
Female	2.0	2.5	2.2	0.003 **
Male	2.1	2.1	2.1	0.957
Workforce (age 16-64)	2.9	3.1	3.0	0.546
Age 15 or more	1.0	1.3	1.1	0.028 *
Age 65 or more	0.3	0.2	0.3	0.212
Employed worker	0.4	0.7	0.5	0.009 **
Average age among all members	36.2	28.7	33.0	0.000 **
Main agriculture worker				
Age	52.4	46.0	49.6	0.000 **
Years of schooling	5.1	5.0	5.1	0.995
Owned agricultural land area[3]	1.49 (113)[4]	1.43 (89)	1.5	0.567
paddy field	1.16 (113)	1.31 (89)	1.2	0.266
upland field	0.45 (80)	0.49 (21)	0.5	0.315

1 Mann-Whitney U test P-value: *(P<0.05) **(P<0.01)
2 HH: Household
3 average area in hectar
4 Respondents who own each type of land

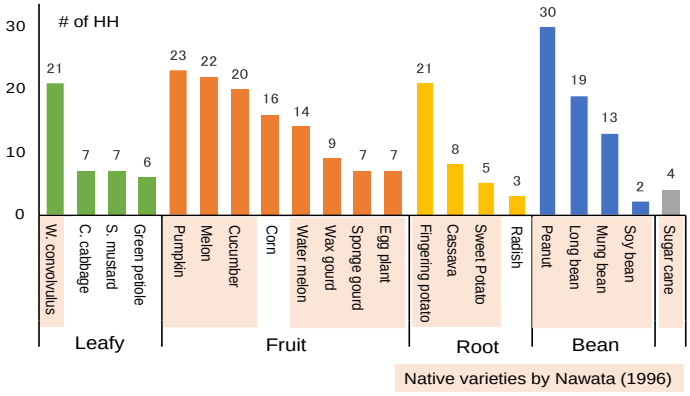

Fig. 5 Vegetable items produced

As a result of asking about vegetable production, the most common answer was damage by pests and disease (63.0%), followed by lack of water (39.8%), growth failure (32.4%), and lack of labor force (17.6%) (Table 3). Additionally, many producers needed help using pesticides, including how to use them appropriately (Table 4). Unsuitable cultivation techniques were sometimes observed, such as crawling cultivation that cultivates vine vegetables, including cucumber, horizontally without using any poles. Those vegetables will be placed directly on the soil, and insects will quickly eat them. Moreover, the fruits will be soaked in rainwater and quickly rot.

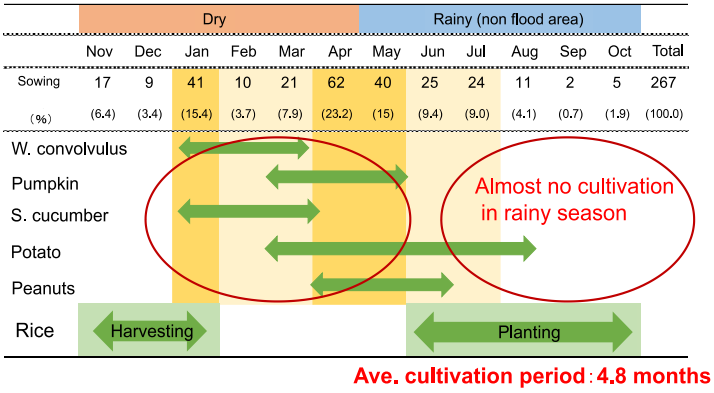

Fig. 6 Cultivation calendar and timing of seeding

Table 3 Issues of vegetable production

Problems of veg. production	# of HH (%)	
Lack of water	43	(39.8)
Excess water by flooding	13	(12.0)
Growth failure	35	(32.4)
Damage by diseases & insects	68	(63.0)
Lack of labor force	19	(17.6)
Hight costs	13	(12.0)
No special problem	4	(3.7)
Total	195	(180.6)

Multiple answers allowed (N=100)

Table 4 Problems of using pesticides

Problems of using pesticide	# of HH (%)	
Selection	71	(65.7)
How to use	67	(62.0)
Amount to use	55	(50.9)
Pests & diseases control	55	(50.9)
Others	13	(12.0)
Total	261	(241.7)

Multiple answers allowed (N=100)

Although this area has a vast reservoir built during the Pol Pot regime in the 1970s, only the primary channel works. Water is not well distributed far from the reservoir owing to the poor irrigation system. These results imply that a probable reason for rare cultivation in the rainy season is the difficulty of pests and disease management due to a lack of knowledge and appropriate cultivation techniques. Another possible explanation is that producers may need more workforce to grow vegetables and rice simultaneously, even if there is land.

Business Conditions of Vegetable Producers

Analysis of the vegetable producers' business revealed that 100 out of 113 producer HHs (88%) sold vegetables. Still, three HHs (3%) were at a loss, or in the red, as shown in Fig. 7. The average monthly net profit was 35 USD or 166 USD for the cultivation period. This is considerably small compared to the study area's factory labor wage of 160–200 USD/month. Thirteen households did not sell vegetables for unknown reasons, even though they produced them with the intention of selling.

A comparative analysis was done by dividing producers into two groups based on the median profit to find the critical factors for lower or higher profits (Table 5). Producers above the median tended to own more upland and planted areas, resulting in significant production and sales volumes and larger profits. Their cost per hectare, unit yield, and unit selling price were lower than those of producers below the median. Although this study did not include own labor costs, productivity was nearly the same between the two groups. In this survey, no producers planted in the same farmland twice; thus, the planted area's size equals the owned farmland area. Therefore, the larger the farmland area owned, the larger the net profit obtained.

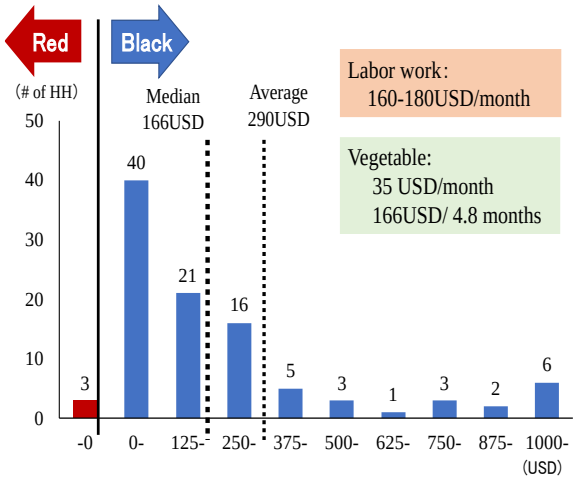

Fig. 7 Profits from vegetable production (N=100)

Pearson's correlation coefficients show positive correlations between net profit and total sale amount, cost, planted area, production, sales volume, number of items, and upland field ownership. Meanwhile, unit yield, which is also an essential component of production volume, was not correlated with net profit and costs per hectare (Table 5). Thus, profits from vegetables seem to be influenced more by production scale than by productivity.

Table 5 further shows the material inputs households used. Among 100 producer HHs, 69 purchased seeds, 79 purchased fertilizers, 39 purchased pesticides, 4 hired workers, 21 rented machinery, and 51 purchased fuels. However, these costs did not influence the net profits.

Table 6 shows the results of the analysis of the relationship between the unit yield of four kinds of vegetables and six material input costs. The costs of seeds, fertilizer, and fuel had highly significant positive correlations with leafy vegetables and beans yields. Labor and rental fees had a weak relationship with root vegetable yields, whereas fruit vegetable profits were not correlated with any input goods. Seeds and fertilizer costs had a highly significant correlation with profits. Some input material costs, such as pesticides, had slightly negative relationships with the unit yield of some vegetables. Pesticides are generally effective at preventing crop loss to pests, diseases, and weeds; however, producers may lack knowledge on how to use them appropriately. Thus, introducing inputs could be more effective in increasing unit yields and profits in vegetable production.

The critical factor of net profits for vegetable producers in this area is production scale — not strategic production, such as low cost, high selling price, high productivity, and high yield. The World Bank (2015) has indicated that the farm size of small-scale farmers is decreasing while that of large-scale farmers is expanding. Rural households with smaller agricultural land have fewer

opportunities to get more significant net profits from current vegetable production. Small landholders need to increase productivity, selling price, or production frequency for more profits. Increasing productivity needs technical improvement, including appropriate ways of using input materials, such as fertilizers and pesticides.

Table 5 Status of vegetable production and the results of the analysis

Variables	Unit	All producers N=100	r[1]	above 166USD N=50	below 166USD N=50	P-value[2]
Total sale amount	USD	328	0.995 **	571	84	0.000 **
Total cost	USD	38	0.466 **	52	23	0.011 *
Net profit	USD	290	1.000	520	61	0.000 **
Total sales amount/ha	USD/ha	1,989	0.064	2,047	1,931	0.007 **
Total cost per hectare[3]	USD/ha	464 (100)	-0.119	261 (50)	666 (50)	0.461
seeds	USD/ha	282 (69)	-0.082	171 (33)	383 (36)	0.862
fertilizers	USD/ha	306 (76)	-0.010	263 (40)	354 (36)	0.397
pesticides	USD/ha	63 (39)	0.020	49 (21)	78 (18)	0.460
labor fee	USD/ha	396 (4)	-0.022	147 (3)	1,146 (1)	0.500
rental machines	USD/ha	111 (21)	0.009	146 (10)	80 (11)	0.756
fuel	USD/ha	533 (51)	-0.108	103 (30)	1,149 (21)	0.034 *
Net profit/ha	USD/ha	1,526	0.169	1,786	1,265	0.000 **
Total planted area	ha	0.31	0.510 **	0.43	0.19	0.000 **
Total production	kg	1,115	0.641 **	1,917	313	0.000 **
Total sale volume	kg	735	0.850 **	1,253	217	0.000 **
Unit yield	kg/ha	11,440	-0.009	9,979	12,902	0.058
Unit price	USD/kg	0.60	0.005	0.61	0.59	0.150
Number of items	number	2.73	0.322 **	3.24	2.22	0.013 *
Self-consumption	kg	380	0.204 *	664	97	0.004 **
Main agriculture worker	age	52.02	0.019	53.68	50.36	0.155
Education	yrs	4.92	0.032	4.82	5.02	0.601
Years of schooling	yrs	20.08	0.018	22.32	17.84	0.084
Owned agricultural land area	ha	1.49	0.222 *	1.7	1.28	0.075
paddy field	ha	1.15	0.036	1.25	1.05	0.420
upland field	ha	0.34	0.375 **	0.45	0.23	0.049 *

1 Peason's correlation coefficient between net profit and other variables
* significant at 5% level, ** significant at 1% level (two-sided)

2 Mann-Whitney U test * significant at 5% level, ** significant at 1% level (two-sided)

3 The number in parentheses ( ) indicates the number of households that have invested costs.

Table 6 Relationship between costs and unit yield and profits

Costs (USD/ha)	Unit yield (kg/ha)				Unit yield (kg/ha)	Profits (USD/ha)
	Leafy (N=27)	Fruit (N=61)	Root (N=33)	Beans (N=59)		
Seeds	0.509 **	0.101	-0.127	0.456 **	0.847 **	0.857 **
Fertilizers	0.525 **	0.230	0.263	0.833 **	0.396 **	0.424 **
Pesticides	-0.022	0.230	-0.065	0.909 **	0.073	0.018
Labor fee	-	-	0.392 *	-0.045	-0.016	0.000
Rental fee (machine)	0.320	0.005	0.407 *	-0.018	0.053	0.086
Fuel	0.538 **	0.159	0.334	0.829 **	0.304 **	0.088

* significant at 5% level, **significant at 1% level (two-sided) by peason's correlation analysis

Characteristics of Producer Households

Table 7 shows the structure of household income for both vegetable producers and non-producers. The average total household income was 2,309 USD, and there was no significant difference between producers and non-producers. Non-agricultural income accounted for an extremely high proportion of total household income. This trend was common for both producers and non-producers. However, the average agricultural income of vegetable producers was two times greater than that of non-producers. Additionally, the composition of agricultural income, such as rice, natural resources, and processing, was significantly different between the two groups. The primary source of income for each household shows that more than 50% (55.8%) of vegetable producers and 73.1% of non-producers depend on non-agricultural income. Only 21 HHs (18.6%) of all producers answered that vegetable production was their primary source of income. Although vegetable production was an essential contributor to the agricultural income of producers, its contribution to total household income is still low.

Perceptions of Producer and Non-producer Households

This study asked producers and non-producers about their perception of vegetable production. Among 100 producers, 74% of them answered positive intentions for future production, including increasing production amount (6%), the number of product items (24%), and production area (7%), as well as maintaining the current production (37%) (Table 8). Since current vegetable production does not bring much economic benefit, and many producers mentioned production issues (Tables 3 and 4), producers may see some benefit or significance, such as self-consumption other than financial benefit. Figure 8 shows the results of asking for future intentions for non-producers. Among 89 non-producers, 63% (56 HHs) had experience in vegetable production for sale. According to the socio-economic profile of all respondents of this study (Table 2), 23.6% (21 HHs) of 89 HHs had an upland field. Additionally, 78% (69HHs) answered that they want to produce vegetables for sale. The results show that the number of vegetable producers in this region may be increased. However, clarifying why they stopped vegetable production and eliminating their concerns is necessary.

Table 7 Structure of household income and primary sources of income

Income sources	Income souces[(a)]							Main source of income[(b)]			
	All respondents[3]		Producers[3]		Non-producers[3]		P-value	Producers[4] (%)		Non-producers[4] (%)	
Total household income	2,309	(202)	2,113	(113)	2,558	(89)	0.530				
Agricultural income	412	(202)	570	(113)	211	(89)	0.000 **				
vegetable	257	(113)	257	(113)	0	(0)	-	21	(18.6)	0	(0.0)
rice	-97	(202)	90	(113)	-335	(92)	0.000 **	13	(11.5)	12	(13.5)
animals	177	(122)	205	(78)	127	(44)	0.094	7	(6.2)	3	(3.4)
N. resources[1]	116	(106)	115	(68)	117	(38)	0.007 **	4	(3.5)	3	(3.4)
N. resources[2]	467	(13)	462	(12)	525	(1)	0.615	3	(2.7)	0	(0.0)
processing	787	(17)	116	(8)	1,383	(9)	0.002 **	0	(0.0)	6	(6.7)
rice milling	-385	(14)	-513	(11)	85	(3)	0.456	2	(1.8)	0	(0.0)
Non-agricultural income	1,996	(192)	1,661	(105)	2,400	(87)	0.032 *	16	(14.2)	11	(12.4)
off-farm business	2,594	(46)	2,493	(24)	2,704	(22)	0.800	34	(30.1)	43	(48.3)
employed work	1,986	(107)	1,551	(52)	2,397	(55)	0.002 *	13	(11.5)	11	(12.4)
Remittence	355	(144)	378	(89)	319	(55)	0.510	113	(100.0)	89	(100.0)

(a) Income in USD from each souce

(b) the number of household according to the result of calculation of each household income

1 rsources: fruits, fishes, medicinal plants, mushrooms, etc. (backyard)

2 rsources: fruits, fishes, medicinal plants, mushrooms, etc. (forest etc.)

3 ( ) indicates the number of household

4 according to the result of calculation of each household income

*significant at 5% level, **significant at 1% level (two-sided) by Mann-Whitney U test

Table 8 Future intentions of producers

Future vegetable production	# of HHs	(%)
Increase production amount	6	(6.0)
Increase # of products	24	(24.0)
Increase production area	7	(7.0)
Keep current production	37	(37.0)
Decrease production	6	(6.0)
Stop production	17	(17.0)
Others	3	(3.0)
Total	100	(100.0)

Single answer (N=100)

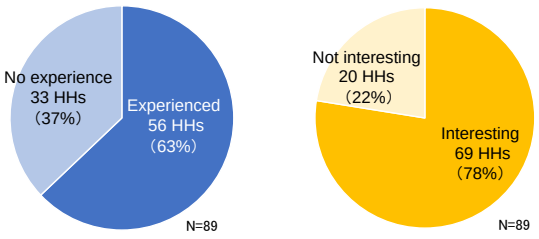

Fig. 8 Future intentions of non-producers

CONCLUSION

This study attempted to identify the challenges to increasing the vegetable production volume in Cambodia by clarifying the status of vegetable cultivation, including production amounts and varieties, vegetable production business conditions, and producers' socio-economic characteristics. The results implicated two major challenges for increasing vegetable production volume in Cambodia and several means to achieve them.

The first challenge is to increase production volume per producer. This study showed that vegetable production in rural Cambodia is profitable, but the profits need to be more significant to sustain the family as their primary income source. The critical factor for low net profits from vegetable production was the production scale derived from the size of owned farmland — not strategic production, such as low cost, increased selling price, increased productivity, or high yield. Growing farmland area or productivity is essential to increase production volume per producer. However, land size, including farmland, is reducing owing to a system of equal inheritance among siblings in Cambodia (Acharya et al., 2003; World Bank, 2013; Diepart, 2015), and a growing number of households (more than 25% in the low land) live with less than 0.5 ha of land, which is not enough to sustain a family throughout the year (Taylor, 2011). Therefore, increasing the total planting area will be more practical than expanding the farmland size. In the study area, most producers did not cultivate any vegetables during the rainy season, despite owning arable upland areas, owing to the risk of disease due to unsuitable cultivation methods. The limited cultivation is thought to be owing to the avoidance of damage from pests and root rot that tend to occur during the rainy season. The annual planted area is expected to increase through the appropriate use of pesticides and the introduction of cultivation techniques, such as ridges and stanchions, to allow cultivation in the rainy season and double-cropping. The development and introduction of a combination of suitable cultivation techniques, agricultural materials, and chemicals in Cambodia may positively influence the production volume.

Increasing the number of producers will be another challenge to obtain more production volume with the limited farmland size per household. This study identified that more than 60% of non-producers would produce vegetables, with 23.6% having an upland field. The main reason for stopping vegetable production was the limitation in sales channels and the difficulties of making the channel by themselves. However, nearly 80% of non-producers were interested in starting vegetable production. To involve experienced households and new producers, vegetable production needs to be more attractive as a profitable income-generating activity. Currently, rural households with smaller agricultural land have few opportunities to attain reasonable net profits from vegetable production. As mentioned above, the net profit should be improved by increasing production volume. Moreover, post-harvesting issues, such as quality management, the sales channel for rural small-scale producers, and value addition are as significant as those for other agricultural products in Cambodia. Developing a one-stop service for agriculture-related issues, including technical and informative dimensions, is urgent.

This study focused only on the status of vegetable production. Further studies to verify the above-mentioned means to increase output per producer, such as developing a combination of suitable cultivation techniques, agricultural materials, and chemicals, are needed. In addition, the

target of this study was limited to the active vegetable-producing area with enough agricultural water throughout the year. Further studies need to cover potential production areas to discuss the possibility of expanding the total production area in the country.

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