Impacts of Agricultural Cooperatives on Farmers' Revenues and Farm Households' Food Security in Cambodia: A Case Study of Tram Kak District, Takeo Province

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Impacts of Agricultural Cooperatives on Farmers' Revenues and Farm Households' Food Security in Cambodia:

A Case Study of Tram Kak District, Takeo Province

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Impacts of Agricultural Cooperatives on Farmers' Revenues and Farm Households' Food Security in Cambodia:

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Abstract

Agriculture is considered as the most important sector in Cambodia, and nearly 80% of the population live in rural areas in 2015. Due to the importance of this sector, the Ministry of Agriculture, Forestry and Fisheries (MAFF) has started promoting agricultural cooperatives for the purposes of increasing agricultural production, diversifying agricultural production, creating income-generating activities and expanding markets for agricultural products. This is to ease the development of agriculture sector, to collectively link with private sectors, to gain technology and credit, to stabilize food supply to local and international markets, and especially to improve rural socio-economic conditions. Agricultural cooperatives have been promoted since 2003 in Cambodia; however, very limited studies have been done regarding the impacts of those agricultural cooperatives on farmers' welfare. Hun *et al.* (2017) previously conducted a study on members' perception of success in agricultural cooperatives in Cambodia, and they found that members perceived revenue related indicators (e.g. dividend from agricultural cooperatives, ease of selling agricultural products and access to marketing information) and food security related indicators (e.g. technical improvement in poultry, cow and pig raisings and access to paddy for consumption when in need) as among the most important ones of success in their agricultural cooperatives. This study attempts to find out if agricultural cooperatives really have actual positive effects on farmers' revenue and food security. The objectives of this study are to identify the factors influencing farmers' decision on membership in agricultural cooperatives and to assess the impacts of those cooperatives on farmers' revenues and farm households' food security.

Firstly, factors influencing farmers' decision on membership in agricultural cooperatives were identified using probit model. The results indicated that farmers who sold their paddy and had contacted extension workers were more likely to become the members of agricultural cooperatives. In contrast, farmers who had higher off-farm income and male-headed-household farmers were less likely to join the cooperatives.

Secondly, propensity score matching technique was employed to assess the impacts of agricultural cooperatives on farmers' revenues. The results of propensity score matching illustrated that there were no significant differences in paddy yield and revenue because the cooperatives have not provided sufficient trainings, members did not actively attend the trainings and the cooperatives failed to provide better prices comparing to other traders. However, those agricultural cooperatives had positive effects on livestock revenue and total farm revenue because they provided training on livestock operation and encourage members to raise more livestock. Members could obtain livestock and total farm revenues at US$219 and US$403, respectively higher than non-members.

Thirdly, a study on impacts of agricultural cooperatives on farm households' food security was conducted using household dietary diversity score and instrumental variables technique. The results showed that members in agricultural cooperatives had higher food security score because agricultural cooperatives provided agricultural trainings, so that the members could consume the agricultural products they produced as food and sell them for revenue. Also, members could use credit service of agricultural cooperatives to purchase food, and they could use rice bank service as food or sell paddy they borrowed to purchase food. Moreover, agricultural land size, household income, owing TV, access to good roads and livestock operation positively influenced the food security score.

According to the results summarized above, some recommendations could be drawn to improve farmers' revenues and food security. The government should promote more extension service, so the benefits of agricultural cooperatives could be disseminated to farmers more widely. The cooperatives should expand paddy markets and strengthen price negotiation power by increasing equity capital to procure more paddy from members, and by capacity-building of board directors in marketing expertise. Furthermore, farmers with livestock should be encouraged to join the agricultural cooperatives to increase their revenues and improve their food security because the cooperatives can provide good technical supports for livestock raisings. The cooperatives should provide trainings on paddy production, so farmers with small paddy land size can increase their paddy yield and improve their food security status. The cooperatives should provide agricultural trainings for the livestock operation, so farmers can better operate to increase their household income. They can also afford to have a TV when the household income is improved, leading to better food security. Roads should be improved, so farmers could easily travel to do their off-farm jobs, transport their agricultural products, buy food or find available food in their village.

Keywords: agricultural cooperatives, farmers' revenues, propensity score matching, food security, instrumental variable, Cambodia

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List of Abbreviations

2SLS: 2 Stage Least Squares

ADB: Asian Development Bank

ATT: Average Treatment Effect for the Treated

ATU: Average Treatment Effect for the Untreated

CAC: Census of Agriculture in Cambodia

CSES: Cambodia Socio-Economic Survey

FAO: Food and Agriculture Organization

GDP: Gross Domestic Product

HDDS: Household Dietary Diversity Score

ICA: International Cooperative Alliance

IV: Instrumental Variables

KHR: Khmer Riels

MAFF: Ministry of Agriculture, Forestry and Fisheries

MOP: Ministry of Planning

NCDD: National Committee for Sub-National Democratic Development

NGO: Non-Governmental Organization

NIS: National Institute of Statistics

PSM: Propensity Score Matching

RGC: Royal Government of Cambodia

USAID: United States Agency for International Development

USD: United States Dollar

WFP: World Food Program

Chapter 1

Introduction

1.1. Background

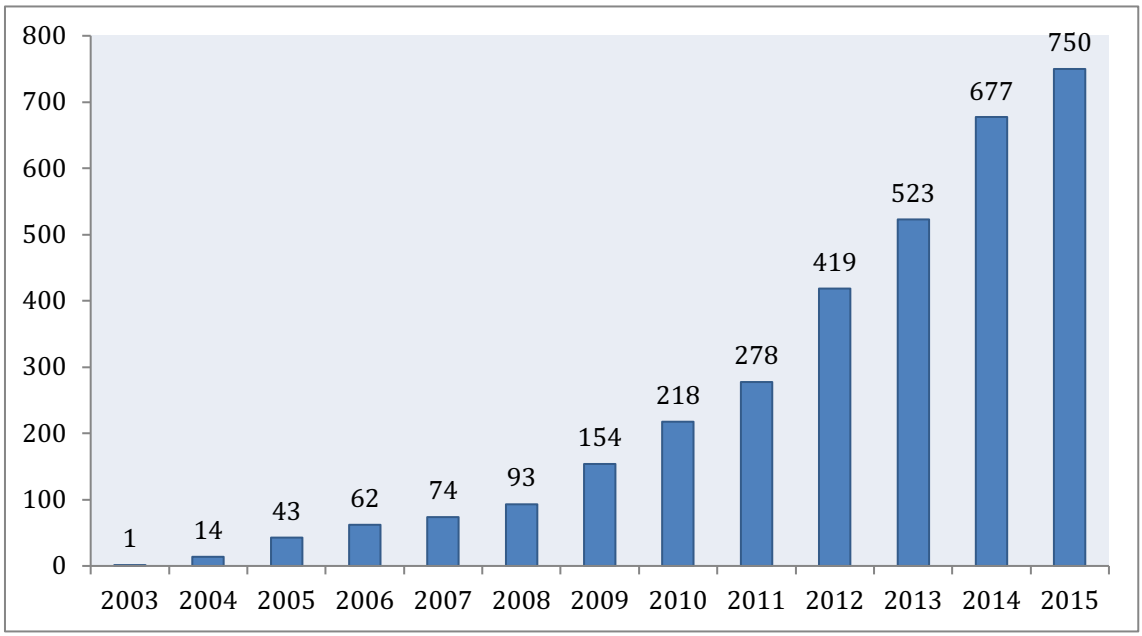
The population of Cambodia was estimated at 14.68 million in 2013 (National Institute of Statistics [NIS], 2013). Among the total 3.16 million households, 2.5 million households lived in rural areas (Asian Development Bank [ADB], 2014). Agriculture shared more than 30% of the gross domestic product (GDP) (Ministry of Agriculture, Forestry and Fisheries [MAFF], 2015), and it employed approximately 45.3% of the total workforce in 2014 (MAFF, 2016).

Due to the significance of agriculture in Cambodia, MAFF has initiated programs to promote the agricultural cooperative movement in the country. These programs are intended to boost agricultural production, diversify crop production, create income-generating activities through business development and also expand markets for commercializing all kinds of agricultural products produced by the cooperative members (MAFF, 2008). The development of agricultural cooperatives has been in focus in order to ease the development of agriculture sector, to collectively link with private sectors, to gain technology and credit, to stabilize the food supply to local and international markets, and especially to develop agricultural cooperatives as rural agricultural enterprises with the purpose of improving rural socio-economic situations (MAFF, 2016).

The Cambodian government started promoting agricultural cooperative movement in 2003, and the number of agricultural cooperatives significantly increased from 2003 to 2015. Between 2003 and 2015, as many as 750 agricultural cooperatives were established and registered throughout the country with total members of 78,126 with

share value of 22,186.19 million KHR and total capital of 36,091 million KHR (MAFF, 2016).

Figure 1.1 Number of agricultural cooperatives in Cambodia from 2003 to 2015



Source: MAFF, 2016

1.2. Overview of agriculture in Cambodia

1.2.1. Demographic characteristics

Cambodia is a Southeast Asian country surrounded by Thailand, Laos and Vietnam, and its total land area is 181,035 square kilometers. The population of this country in 2014 was estimated at 15.2 million, and between 1998 and 2014, the population increased with the annual population growth rate of 1.79% (NIS, 2015). Of the 15.2 million in Cambodia in 2014, a total of 11,772 thousand people (nearly 78% of total population) lived in rural areas (NIS, 2015).

Table 1.1 Population by residence in thousands and percent

Residence	Census 1998	Census 2008	CSES 2014
Cambodia	11,438	13,396	15,184
Urban	1,796	2,614	3,412
Rural	9,642	10,782	11,772
Urban/rural	18.6	24.2	29.0

Source: NIS, 2015

In 2014, woman shared 51.1% (7,748 thousands) while the man shared 48.9% (7,436 thousands), and the sex ratio was 96% (NIS, 2015). Table 1.2 shows the population by sex in census 1998, census 2008 and Cambodia Socio-Economic Survey (CSES) 2014.

Table 1.2 Population by sex in thousands and percent

Sex	Census 1998	Census 2008	CSES 2014
Woman	5,926	6,880	7,748
Man	5,511	65,16	7,436
Both sexes	11,438	13,396	15,184
Sex ratio (men/woman)	93.0	94.7	96.0

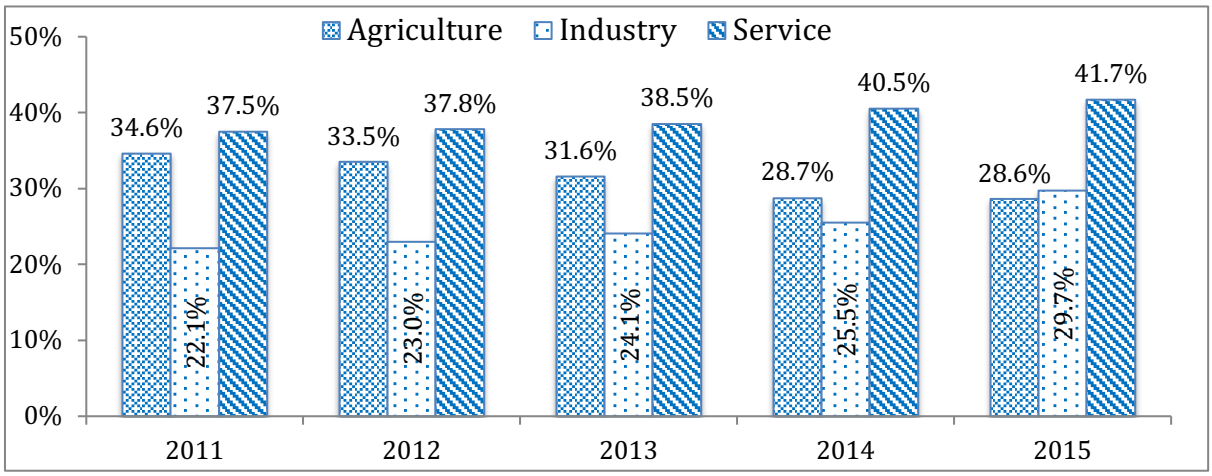
Source: NIS, 2015

1.2.2. Contribution of agriculture in GDP

Among the total 3.16 million households in the country, 2.5 million households lived in rural areas (ADB, 2014). Agriculture contributes 28.6% to GDP while industry and service sectors contributed 29.7% and 41.7%, respectively in 2015. Changes in this contribution of agriculture in Cambodian economy depend on the development of other sectors (industry, construction and service). Noticeably, the contribution of agriculture

decreased from 34.6% to 28.6% from 2011 to 2015 due to growths of industry, construction and service sectors (MAFF, 2016).

Figure 1.2 Contribution of agriculture in Cambodian economy 2011-2015



Source: MAFF, 2016

1.2.3. Labor forces in agricultural sector in 2009 and 2014

In context of Cambodian economy, workforce is classified into 3 categories: 1) workforce in agricultural sector, 2) workforce in industry sector and 3) workforce in service sector. Recently, workforce in agricultural sector has decreased noticeably. In 2009, workforce in agricultural sector was 57.6% of total workforce and it dropped to 48.7% in 2013. In 2014, agricultural workforce declined to only 45.3%. Lately, trends of people migrating to urban areas for job opportunities in other sectors other than agriculture and to overseas have become popular. Workforce in industry sector was only 15.9% in 2009 and increased to 24.3% in 2014. For workforce in service sector, it was only 26.5% in 2009 and increased to 30.4% in 2014 (MAFF, 2016).

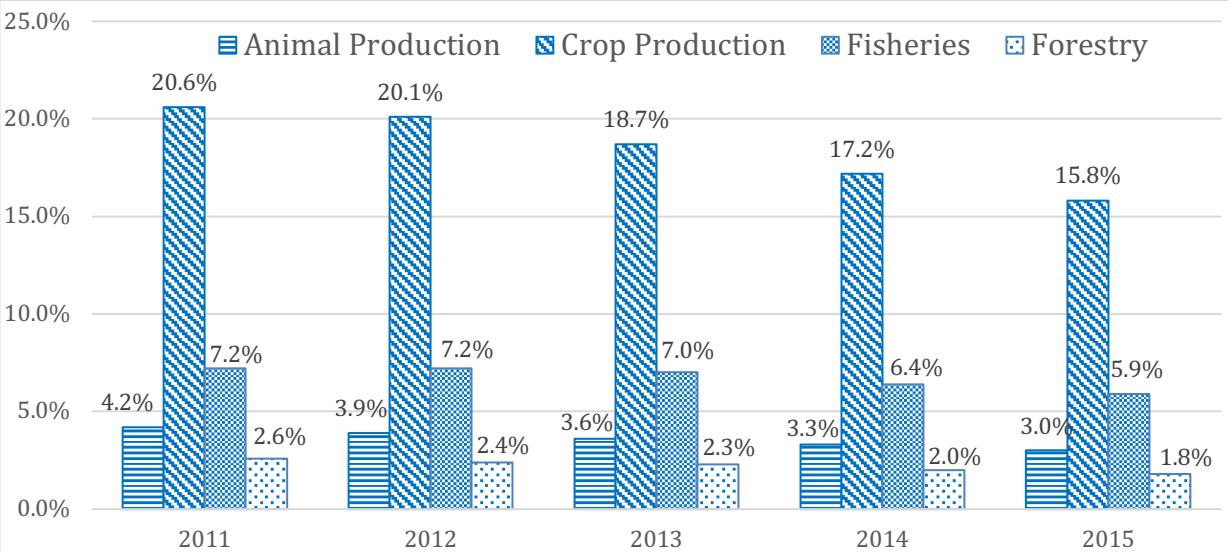
Table 1.3 Labor forces (age 15-64 years) by sectors and geography in 2009 and 2014

Industrial sector (main occupation)	CSES 2009				CSES 2014			
	Cambodia	Phnom Penh	Other urban	Other rural	Cambodia	Phnom Penh	Other urban	Other rural
Employed population (in thousands)	7,469	686	735	6,048	8,235	1,059	957	6,220
Agriculture (percent)	57.6	1.9	24.0	68.0	45.3	2.5	17.0	56.9
Industry (percent)	15.9	21.2	17.8	15.0	24.3	28.2	25.4	23.5
Service (percent)	26.5	76.9	58.3	17.0	30.4	69.3	57.6	19.6
Other (percent)	0.0	-	-	0.0	0.1	0.0	0.1	0.1
Total (percent)	100	100	100	100	100	100	100	100

Source: NIS, 2015

Note: CSES= Cambodia Socio-Economic Survey

Figure 1.3 Contribution of sub sectors in GDP 2011-2015



Source: MAFF, 2016

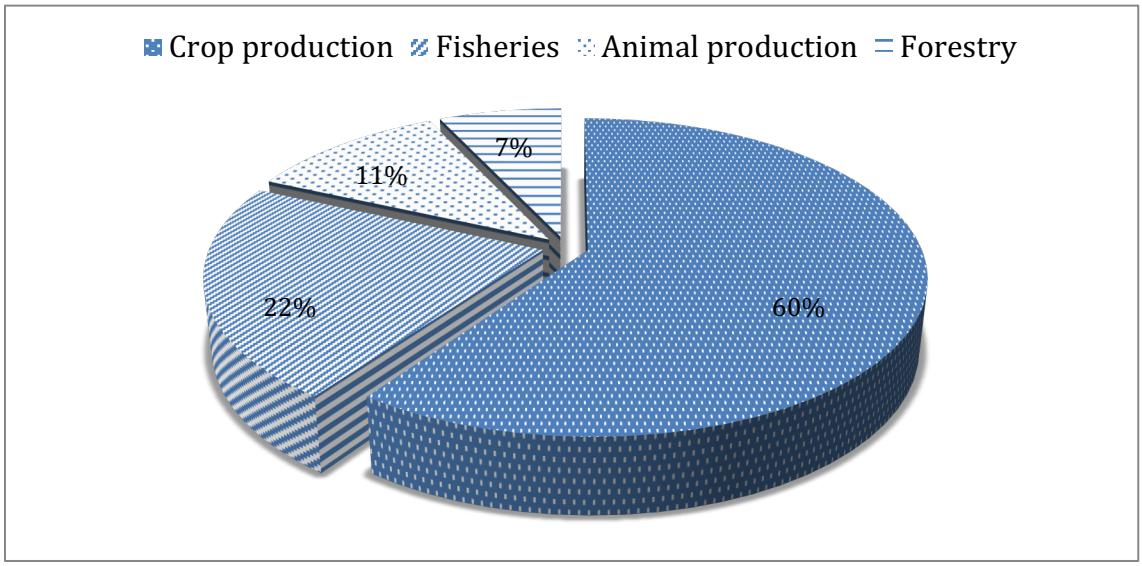
As previously mentioned, the contribution of agriculture sector in GDP decreased because of the expansion of industry and service sectors. The contribution of sub sectors

in GDP in 2015 includes crop production 15.8%, animal production 3%, fisheries 5.9% and forestry 1.8% which were decreased from 20.6%, 4.2%, 7.2% and 2.6%, respectively in 2011. Noticeably, crop production and fisheries are the main drives in agricultural production. Animal production which is another important sub sector in supplying domestic demand and export has to be heavily developed.

1.2.4. Components of sub sectors in agriculture

In Cambodian agriculture, crop production shared more than half of the total agricultural products (60%) in 2015 while fisheries, animal production and forestry contributed 22%, 11% and 7%, respectively in the total agricultural products (MAFF, 2016). Crop production especially rice production is still the main source of income for Cambodian farmers (MAFF, 2015).

Figure 1.4 Sub-sectors of agriculture in Cambodia in 2015



Source: MAFF, 2016

1.2.5. Land ownership

Agricultural land is defined as the land that households owned or cultivated, rented in, rented out, free use of land, etc., to use for vegetable growing, agricultural or farming activities such as crop production, livestock production, fishing and fish breeding and private forestry. It excludes land under permanent pasture, wood or forest and all other non-agricultural land used for residence purpose or for other enterprise activities.

In 1989, privatized landownership was started. At that time, farming households were encouraged to submit application for land title to the land they had cultivated. Approximately 4 million land titles were claimed, and these applications were speedily processed by the central cadaster authorities. Households whose main occupation were agriculture got the land in accordance with number of household members and other household characteristics. Anyhow, there have been major changes on socio-economic characteristics due to refugee repatriation, population growth, urbanization and economic growth), which increases the land demand for various purposes (NIS, 2016).

Table 1.4 Agricultural land by gender of household head and zone in 2014 (thousands and %)

Zone	Women		Men		Total
	Ha	%	Ha	%	Ha
Cambodia	412	12.2	2,977	87.8	3,389
Phnom Penh	3	15.2	19	84.8	23
Plain	165	15.1	932	84.9	1,097
Tonle Sap	153	10.8	1,263	89.2	1,416
Coastal	25	12.4	175	87.6	200
Plateau/Mountain	66	10.1	588	89.9	654

Source: NIS, 2016

The statistics of agricultural land are often accumulated into five zones. Table 1.4 below reveals that Tonle Sap has the biggest portion of agricultural land in Cambodia in 2014, followed by Plain. Phnom Penh shared the smallest share of agricultural land as it is the center of trade, industry and service sectors. Female headed households own about 12% (412,000 ha) of the total agricultural land (3,389,000 ha) in the country.

Table 1.5 Number of households with agricultural land by area and zone in 2014

Area	Cambodia	Phnom Penh	Plain	Tonle Sap	Coastal	Plateau/ Mountain
	Number					
Less than 10,000 m^2	2,674	31	1,215	826	202	400
10,000 m^2 – 19,999 m^2	221	1	85	79	17	39
20,000 m^2 – 29,999 m^2	242	0	65	97	16	64
30,000 m^2 – 39,999 m^2	102	0	23	47	7	25
40,000 m^2 – 49,999 m^2	44	1	7	24	1	11
50,000 m^2 – 99,999 m^2	53	0	10	29	1	12
100,000 m^2 – and above	20	0	7	10	0	2
Total	3,358	33	1,412	1,113	245	555
	%					
Less than 10,000 m^2	79.6	93.6	86.0	74.3	82.4	72.1
10,000 m^2 – 19,999 m^2	6.6	1.8	6.0	7.1	7.1	7.1
20,000 m^2 – 29,999 m^2	7.2	0.6	4.6	8.7	6.6	11.5
30,000 m^2 – 39,999 m^2	3.0	0.5	1.6	4.2	2.8	4.6
40,000 m^2 – 49,999 m^2	1.3	1.6	0.5	2.1	0.5	2.1
50,000 m^2 – 99,999 m^2	1.6	0.6	0.7	2.6	0.5	2.2
100,000 m^2 – and above	0.6	1.3	0.5	0.9	0.2	0.4
Total	100	100	100	100	100	100

Source: NIS, 2015

Table 1.5 reveals the number of households having agricultural land in 2014. As shown, nearly 80% all households in Cambodia had owned agricultural land of less than 10,000 m^2 or 1 hectare while around 14 percent of all households had owned the agricultural land of between 20,000 m^2 and 30,000 m^2.

1.2.6. Crop production and export of agricultural products

The main agricultural activities performed by agricultural households in Cambodia were cultivating temporary and permanent crops. Temporary crops were the crops whose growing cycle is less than one year, and the farmers have to plant or sow it again for another production cycle. In Census of Agriculture in Cambodia, temporary crops were crops cultivated seasonally during the research reference periods and classified into 14 categories such as cereals and grain, leguminous grain plants, oil seed crops, root, tubers and bulk crops, spices, condiments, aromatic and medicinal plants, industry crops and a various variety of vegetables. Permanent crops were the crops whose growing cycle lasts more than one year and found to be still standing and productive within agricultural holdings.

Number of households involving with crop cultivating activities were estimated to be 1,979,000 households in rainy season and 738,000 households in dry season in 2009. The total number of households involving crop cultivation were 2,713,000 in rainy season and 832,000 in dry season in 2014.

Table 1.6 Number of household activities by main groups of crop production and season in 2009 and 2014. In thousand households and percent.

Main groups of crop production	CSES 2009			CSES 2014		
	Total	Wet season	Dry season	Total	Wet season	Dry season
	Number of households					
Cereals harvested for grain	1,969	1,627	341	2,721	2,289	432
Tubers and leguminous plants	154	75	79	231	137	94
Industrial temporary crops	108	67	41	74	35	39
Vegetables	117	56	61	83	31	52
Fruits and nuts	296	117	179	308	154	154
Industrial permanent crops	73	37	36	124	64	60
Other crops not classified elsewhere	1	1	1	3	2	1
Total	2,717	1,979	738	3,544	2,713	832
	%					
Cereals harvested for grain	72.5	82.2	46.2	72.6	74.1	65.8
Tubers and leguminous plants	5.7	3.8	10.7	5.8	5.8	6.0
Industrial temporary crops	4.0	3.4	5.6	4.0	3.3	7.2
Vegetables	4.3	2.8	8.3	4.7	3.3	11.1
Fruits and nuts	10.9	5.9	24.3	10.7	11.0	9.6
Industrial permanent crops	2.7	1.9	4.9	2.1	2.5	0.4
Other crops not classified elsewhere	0.0	0.1	0.1	0.1	0.1	0.0
Total	100	100	100	100	100	100

Source: NIS, 2015

In 2014, cereals for grain were harvested in total amount of 4,781,000 tons in wet season and 1,786,000 tons in dry season. It was the largest share (62.6%) of all crop production in Cambodia in term of quantity produced in wet season and 45.2% of all crop production in dry season. Moreover, 2,481,000 tons of tubers and leguminous plants were harvested, which equaled to 32.5% of all crops produced in wet season, and 1,809,000 tons were harvested, which equaled to 45.7% of all crops produced in dry season. Among

the 5 zones classified in Cambodia, Plain was the most important cereal production zone in terms of product quantity, which accounted for 1,498,000 tons and 1,237,000 tons in wet season and dry season, respectively. It was followed by Tonle Sap, which produced 2,113,0000 tons and 424,000 tons of cereals in wet and dry season, respectively.

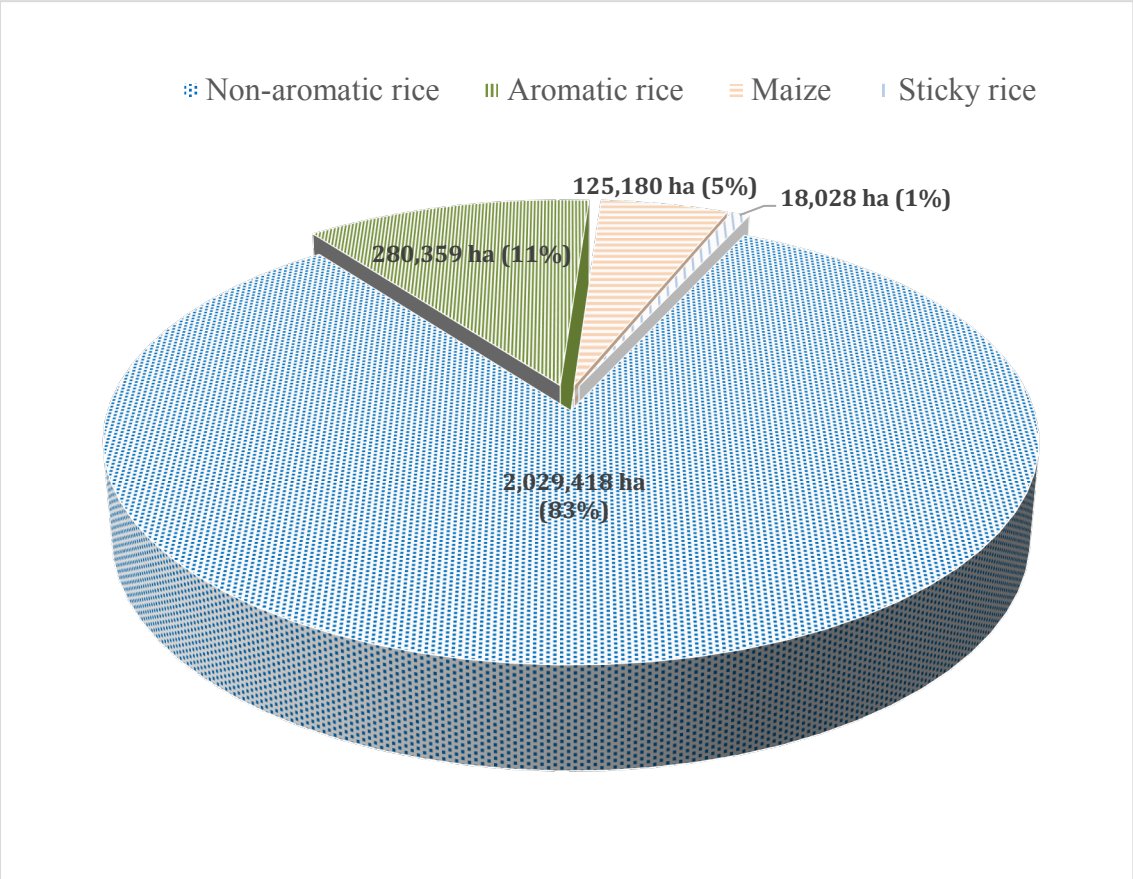
Table 1.7 Crop production by main group, season and zone in 2014.

Main group of crop production	Cambodia		Phnom Penh		Plain		Tonle Sap		Coastal		Plateau/ Mountain	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
	Thousand tons											
Cereals harvested for grain	4,781	1,786	32	18	1,498	1,237	2,113	424	317	33	820	75
Tubers and leguminous plants	2,481	1,809	0	0	667	754	1,334	622	2	1	478	433
Industrial temporary crops	87	51	0	0	28	24	41	19	2	3	16	6
Vegetables	32	54	2	4	21	32	6	14	1	1	2	3
Fruits and nuts	171	195	0	1	28	47	36	41	102	89	5	16
Industrial permanent crops	86	59	3	3	64	43	6	4	13	9	1	1
Other crops not classified elsewhere	1	0	0	0	1	0	0	0	0	0	0	0
	%											
Cereals harvested for grain	62.6	45.2	84.7	69.2	64.9	57.9	59.7	37.7	72.7	24.1	62.1	14.1
Tubers and leguminous plants	32.5	45.7	0.0	0.0	28.9	35.3	37.7	55.3	0.5	0.9	36.2	81.1
Industrial temporary crops	1.1	1.3	0.0	0.0	1.2	1.1	1.2	1.7	0.4	2.1	1.2	1.1
Vegetables	0.4	1.4	6.4	15.2	0.9	1.5	0.2	1.3	0.2	0.4	0.1	0.6
Fruits and nuts	2.2	4.9	0.7	5.5	1.2	2.2	1.0	3.7	23.4	65.9	0.3	2.9
Industrial permanent crops	1.1	1.5	8.2	10.1	2.8	2.0	0.2	0.4	2.9	6.5	0.1	0.1
Other crops not classified elsewhere	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: NIS, 2015

The two main cultivated crops classified in cereal and grain crops were rice and maize. 2.45 million ha of grain and cereal crops were cultivated during the CAC period, accounting to approximately 86% of the total number of land parcels used for temporary crops. Most importantly, rice amounted for 82% of all temporary crops grown on land parcels in Cambodia. Three types of rice were grown in Cambodia. They are non-aromatic rice, aromatic rice and glutinous (sticky) rice. Among these three types of rice, non-aromatic rice is the common one, cultivated over 2 million ha, followed by aromatic rice which was grown 280,359 ha.

Figure 1.5 Areas planted for major cereal and grain crops



Source: NIS, Census of Agriculture in Cambodia, 2013

Rice is still the most important crop for Cambodian rural livelihoods. Consequently, cultivated areas had been increased from 2,968,529 hectares in 2011 to 3,051,507 hectares in 2015. Also, harvested areas had been increased from 2,766,617 in 2011 to 3,025,630 hectares in 2015 while the paddy yield and production had fluctuated depending weather conditions. The average paddy yield was 3.085 tons per ha in 2015. Noticeably, rice surplus rose from 2,780,328 MT in 2011 to 2,975,809 MT in 2015 (MAFF, 2016).

Table 1.8 Rice productions in Cambodia 2010-2015

Descriptions	2011	2012	2013	2014	2015
Cultivated areas (ha)	2,968,529	3,007,545	3,052,420	3,055,507	3,051,412
Harvested areas (ha)	2,766,617	2,980,297	2,968,967	3,028,836	3,025,630
Yield (T/Ha)	3.173	3.117	3.163	3.079	3.085
Production (MT)	8,779,365	9,290,940	9,389,961	9,324,416	9,335,284
Rice surplus (MT)	2,780,328	3,031,017	3,090,452	3,013,783	2,975,809
Paddy surplus (MT)	4,344,263	4,735,964	4,828,832	4,709,036	4,649,702

Source: MAFF, 2015

During five-year period, the rice cultivation was increased both areas and total quantity because of farmers' improved farm management, improved cultivation techniques and rice high yield varieties. In 2015, despite of decrease of 0.13% in cultivated areas and 0.11% in harvested areas, total amount of rice still increased 0.12% comparing to 2014 as the yield increased 0.22% (MAFF, 2016).

Usually, the cultivated areas for seasonal crops fluctuated depending on kinds of crop and market price. The cultivated areas of crops (maize, cassava, mung bean and soy bean) significantly increased from 512,371 hectares in 2009 to 796,123 hectares in 2013. Among these crops, cultivated areas of maize grew from 206,058 hectares in 2009 to

239,748 hectares in 2013. In similar trends, cassava became the most popular crop, and its cultivated areas significantly increased from 160,326 hectares in 2009 to 421,375 hectares in 2013 while the cultivated areas of mung bean slightly increased from 49,599 hectares to just only 54,312 hectares in 2013. Unlike other crops, the cultivated areas of soybean slightly decreased from 96,388 hectares in 2009 to 80,688 hectares in 2013 (MAFF, 2014).

Table 1.9 Cultivated areas of four main crops in hectares

Commodities	2009	2010	2011	2012	2013
Maize	206,058	213,622	174,257	216,330	239,748
Cassava	160,326	206,226	391,714	361,854	421,375
Mung Bean	49,599	69,206	68,111	66,850	54,312
Soybean	96,388	103,198	70,584	71,337	80,688
Total	512,371	592,252	704,666	716,371	796,123

Source: MAFF, 2014

The cultivated areas of industrial and subsidiary crops were increased to 941,028 hectares in 2013 and the total production was increased from 9.9 million tons in 2011 to 10.54 million tons in 2013.

The cultivated areas of permanent crops were about 183,048 hectares in 2013. Therefore, the total cultivated areas for all kinds of crops were 4.51 million hectares (3.05 million hectares for paddy production, 0.94 million hectares for industrial and subsidiary crops, 0.33 million hectares for rubber plantation and 0.18 million hectares for permanent crops).

Table 1.10 Cultivated areas for all kinds of crops

Areas under all crops	2013	Remarks
Areas for rice crop	3,052,420	Wet and dry seasons
Areas for subsidiary and industrial crops	941,028	Maize, sesame, sugarcane, cassava, sweet potatoes, vegetable, all kinds of bean etc.
Areas for permanent crops	183,048	Oil palm, mangoes, banana, durian, coffee, orange, cashew, pepper and other fruits etc.
Areas for rubber plantation	328,771	
Total Areas (ha)	4,505,267	

Source: MAFF, 2014

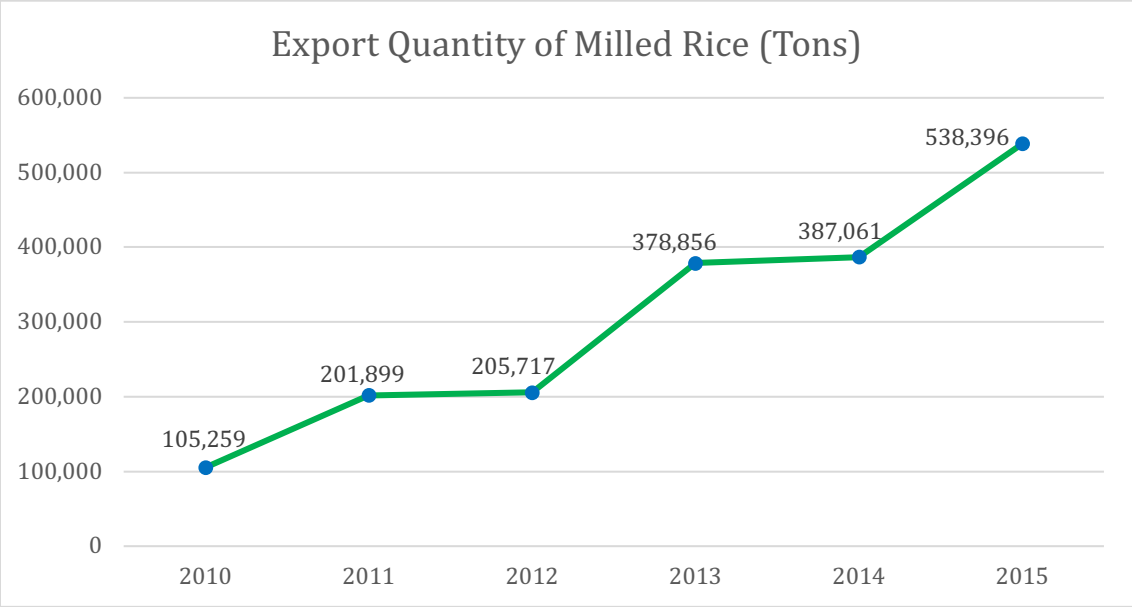
In 2010, Cambodia exported 136,854 tons of agricultural products, and the amount gradually increased to 680,457 tons in 2012, and rapidly increased to 3,659,908 tons. In 2015, 66 types of agricultural products were exported (only 47 types in 2014) to world markets in amount of 4,157,253 tons with 20% increase comparing to 2014.

Figure 1.6 Export of agricultural products 2010-2015 (in tons)

Source: MAFF, 2016

Milled rice was exported to 60 countries including 26 European countries, 3 ASEAN countries and other 30 countries from 2010 to 2015. Top 5 biggest markets of Cambodian milled rice were 1/ China (116,639 tons), 2/ France (75,277 tons), 3/ Poland (58,410 tons), 4/ Netherland (58,410 tons) and 5/ Malaysia (54,914 tons).

Figure 1.7 Export quantity of milled rice



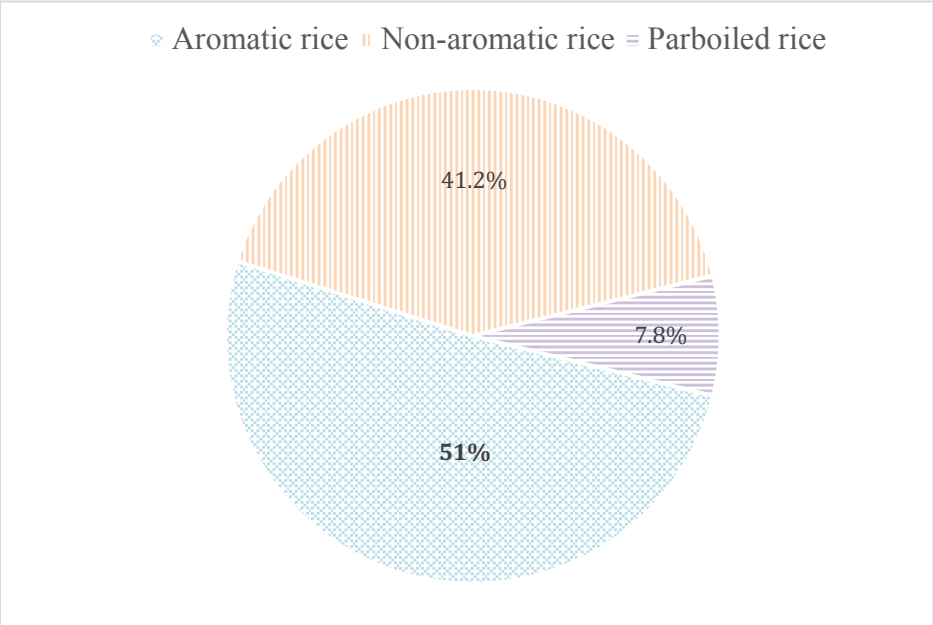
Source: MAFF, 2016

Cambodia exported 105,259 tons of milled rice in 2010. The export quantity was doubled to 201,899 tons in 2011, and slightly increased in 2012. The milled rice export was 538,396 tons, which increased by 151,334 tons (39.1%) comparing to 2014. In this export, this included aromatic rice of 274,671 tons (51%), non-aromatic rice of 221,862 tons and parboiled rice of 41,863 tons.

The export quantity of agricultural products to China was significantly increased. The total cassava export of 212,613 tons (including dried chip 149,412 tons, cassava flour

27,035 tons and cassava waste 36,166 tons), which was doubled in term of cassava export quantity of 119,597 tons in 2014.

Figure 1.8 Milled rice export by types



Source: MAFF, 2016

1.2.7. Livestock and poultry

Table 1.11 Number of households rearing livestock or poultry by zone in 2014 in thousands and percent

Number of households	Cambodia	Phnom Penh	Plain	Tonle Sap	Coastal	Plateau/ Mountain
Households rearing livestock or poultry	1,814	12	751	588	165	298
All households	3,261	369	1,223	998	234	437
Percent of all households	55.6	3.2	61.4	58.9	70.6	68.2

Source: NIS, 2015

Table 1.11 reveals the number of households having livestock or poultry by zone in 2014. Among 3,261,000 households in Cambodia, 1,814,000 households (55.6%) got involved with livestock or poultry raisings. In Phnom Penh, it shared the smallest amount (about 3%) while coastal zone shares the largest (70.6%).

Table 1.12 shows the number of livestock and poultry reared in Cambodia in 2014. Chicken shared the largest portion, which accounted for 21,381,000 heads, followed by ducks which accounted for 7,850,000 heads. The cattle and pigs accounted for 2,478,000 heads and 1,376,000 heads, respectively. Plain and Tonle Sap zones covered the greatest number of livestock and poultry, which accounted for 14,940,000 heads, and 10,730,000 heads, respectively.

Table 1.12 Number of livestock and poultry by zone in 2014 in thousands

Type of livestock and poultry	Cambodia	Phnom Penh	Plain	Tonle Sap	Coastal	Plateau/ Mountain
	Number					
Cattle	2,478	25	1,048	707	202	497
Buffalos	452	1	207	138	28	78
Horses, ponies	8	0	5	1	0	2
Pigs	1,376	9	632	423	129	183
Sheep	0	0	0	0	0	0
Goats	27	0	24	2	0	1
Chicken	21,381	75	8,460	7,278	2,505	3,062
Duck	7,850	2	4,546	2,179	819	305
Quail	1	0	1	0	0	0
Other	22	0	19	1	1	1
Total	33,594	112	14,940	10,730	3,683	4,128

Source: NIS, 2015

1.2.8. Aquaculture and fishery

Table 1.13 reveals the figure of households got involved with aquaculture and fisheries. In 2014, approximately 1,371,000 households or 55.6% of all households got involved with aquaculture and fisheries, and households in Plain Zone and Tonle Sap Zone shared most important aquaculture and fishery activities, which accounted for 510,000 households and 509,000 households, respectively.

Table 1.13 Number of households with fishing activities by zone in 2014 (in thousands and percent)

Number of households	Cambodia	Phnom Penh	Plain	Tonle Sap	Coastal	Plateau/ Mountain
Households with fishing activities	1,371	5	510	509	109	238
All households	3,261	369	1,223	998	234	437
Percent of all households	55.6	1.3	41.7	51.0	46.5	54.5

Source: NIS, 2015

1.2.9. Existing agricultural policy goals

The overall policy goal of Cambodian MAFF is to promote the agriculture growth rate around 5% annually by improving agricultural productivity, diversification and commercialization, promoting livestock and aquaculture, strongly focusing on sustainable protection and forest management.

To achieve this overall policy goal, Cambodian MAFF established 5 new programs.

- Program 1: Improving agricultural productivity, diversification and commercialization

To increase the productions of all kinds of crops around 10% per year through increasing agricultural research and extension with purpose of increasing crop yields, improving agricultural products, enhancing capacity of agricultural cooperatives by linking them with contract farming and improving effectiveness of management and sustainable land use.

- Program 2: Promoting livestock and aquaculture

To increase livestock around 3% per year by depending on effective agricultural research and extension, improving ability against animal disease, ensuring the safe and hygiene supplies of animals and meats, and increasing the exports.

- Program 3: Sustainable management of fishery resources

To protect and conserve fishery resources by eliminating all kinds of fishing crimes, enhancing management capability of 100 fishing communities and promoting aquaculture in the growth rate of around 15% per annum in order to ensure the sustainable fishery management and improve quality and safety of fishery products for local consumption and exports.

- Program 4: Sustainable management of forest and wild animals

To enhance the sustainable management of forests and wild animals through enforcing the implementation of laws on forest, promoting reforestation around 25,000 hectares per annum, creating forest and wild animal protected areas 50,000 hectares per annum and 32 forestry communities per annum.

- Program 5: Strengthening institutional capacity, enhancing efficiency of supporting services and human resource management

To increase the effectiveness of institution management, deliver better supporting services and enhance education and training capabilities for sustainable agricultural development (MAFF, 2016).

To respond to importance of agriculture in economy, the Royal Government of Cambodia and Cambodian MAFF decided to introduce programs to support agricultural cooperative activities in Cambodia. This is to rapidly increase agricultural production, promote crop diversification, create income generating activities through business development and also to explore suitable markets for selling all kinds of agricultural products produced by agricultural cooperative members as well as by the rural population as a whole (MAFF, 2008).

With the support from national and international development partners, the development of agricultural cooperatives has been focused and promoted to make easier agricultural development by linking it with private sectors in order to gain new technology, credit and stable food supply for local and international markets. Also, developing agricultural cooperatives into rural agricultural enterprises enhances the rural socio-economic conditions.

1.3. Agricultural cooperatives in Cambodia

1.3.1. History of agricultural cooperatives in Cambodia

Agricultural cooperatives in Cambodia were first established between 1950s and 1960s, and at that time, there were 512 agricultural cooperatives throughout the country, and they were under the control of Royal Office of Cambodian Cooperatives and supervised by the Cambodian MAFF. Among 512 cooperatives, 13 cooperatives were provincial credit cooperatives providing loans to their members. Moreover, there were 40

school cooperatives, 55 consumer cooperatives, 390 multi-purpose agricultural cooperatives and 14 specialized cooperatives specializing in producing rice, cotton and tobacco. The total business size of agricultural cooperatives in 1965 was USD 13 millions.

During the period of civil war between 1970 and 1975, the cooperatives vanished in Cambodia. Under the Pol Pot regime from 1975 to 1979, all people were forced to form collective cooperatives that were different from globally recognized cooperative concepts and principles regarding to ideology, management and concepts. The cooperatives were collectively run with activities leading to achieve political objectives of Pol Pot regime. There were no personal private properties, and all people were forced to work hard without sufficient food and relaxation and stay in the common houses built and controlled by Pol Pot regime.

After the fall of Pol Pot regime in 1979, rural people were formed as solidary groups by the regime of People Republic of Kampuchea for collectively producing agricultural products by using the limited resources such as labor, agricultural tools and animals remained from the Pol Pot regime. In spite of that, the solidary groups varnished when the government started providing land title programs in 1985.

A Royal Decree on the establishment and functioning of agricultural cooperatives in Cambodia was developed by the Cambodian government in 2001 and went into effect in the same year. Cambodian MAFF was assigned by the government to be responsible for promoting agricultural cooperatives in the purpose of helping rural population for better agricultural production and rural job opportunities, which enable them to have better socio-economic conditions and food supply. The Cambodian MAFF publicly and officially announced the promulgating of royal decree on establishment and functioning

of agricultural cooperatives in Cambodia in 2003 (MAFF, 2008). The law on Agricultural Cooperatives was currently enacted in 2013. Based on this law, the Cambodian MAFF is an institution having full competence to promote and support in order to register, operate and develop agricultural cooperatives (MAFF, 2013). The Cambodian MAFF is required to have a Department of Agricultural Cooperative Development under the control of the General Directorate of Agriculture (GDA), and the Cambodian MAFF is responsible for developing agricultural cooperatives in accordance with the spirit of district and provincial administration laws (MAFF, 2013). Prior to the existence of law on agricultural cooperatives, the Cambodian MAFF assigned the obligation of promoting agricultural cooperatives to the Department of Agricultural Extension. After 2003, a large number of agricultural cooperatives were founded and run with the technical supports at all levels (national, provincial and district levels). In addition to the technical supports, the legally founded agricultural cooperatives in accordance with the legal procedures also received some subsidies from the Cambodian MAFF regarding to capacity building and some financial supports as the start-up capital for their credit and agricultural input supply business. Nowadays, the Cambodian MAFF strongly focused on promoting agricultural cooperatives in the purpose of increasing agricultural production, promoting crop diversification and creating income-generating activities through business development. Agricultural cooperatives are very important since they help farmers improve their agricultural production and also obtain household income because farmers can get loan with lower interest rate comparing to private money lending agencies and individual money lenders in their villages. Furthermore, farmers can also get agricultural inputs such as seeds, fertilizers and other materials with lower prices comparing to private vendors. Moreover, members of agricultural cooperatives could also receive dividends got from

profits of the cooperatives in accordance with number of shares they own. Besides economic benefits, they also get social and cultural advantages (MAFF, 2008).

1.3.2. Definition of agricultural cooperatives in Cambodia

The Law on Agricultural Cooperatives in Cambodia was developed in order to make voluntarily participation of Cambodian citizens having main jobs in agricultural production, agribusiness, agro-industry or services relating to agricultural production in the purpose of establishing and developing agricultural cooperatives, which promotes socio-economic conditions and culture of members as well as to develop national economy.

Based on this law, agricultural cooperatives are private legal entities that were formed by a group of physical entities on volunteer basis to self-finance, self-control and democratically manage in order to expand agricultural productions, agro-industry, agribusiness or agriculture related services for social, economic and cultural enhancement of their members in accordance with basic principles of agricultural cooperatives. Those basic principles are voluntary and open membership, democratic member control, economic participation of members, autonomy and independence, education, training and information, cooperation among national and international cooperatives and concerns for community (MAFF, 2013).

According to Royal Decree on establishment and functioning of agricultural cooperatives, agricultural cooperatives are the business entities managed by their members based on democracy concepts, and their members contribute capital in the expectation of getting dividends and also being responsible for loss in proportion of number of shares they own (MAFF, 2008).

Based on law on agricultural cooperative, agricultural cooperatives to be registered must meet some criteria. First, they must have at least 15 members who are Cambodian older than 18 years old and accommodate in specific village, commune, Sangkat, town, district province or capital in Cambodia and have main job in agricultural production, agribusiness, agro-industry or any services related to agriculture. Second, the members have to contribute to the capital, and they must own at least 1 share. Third, the agricultural cooperative must have at least 1 business activity (MAFF, 2013).

1.3.3. Objectives of agricultural cooperatives in Cambodia

Agricultural cooperatives in Cambodia have main objectives as below:

- To provide credit services to their members
- To supply agricultural inputs such as fertilizers to their members and other farmers
- To trade agricultural products by buying and selling the products produced by members and non-member farmers
- To process agricultural products
- To provide farming services and drying and milling services to their members
- To produce and trade important agricultural products such as seeds and animals
- To provide agricultural techniques to their members
- To supply materials useful for daily consumption of members (MAFF, 2008).

1.3.4. Structure of existing agricultural cooperatives in Cambodia

The agricultural cooperatives are established to deal with many challenges, and they have many business activities; all agricultural cooperatives in Cambodia are multi-purposes (MAFF, 2008). According to the law on agricultural cooperatives, members of

board directors are always in odd number at least 3 depending on number of cooperative members and actual operation specified in the statute of agricultural cooperatives while members of monitoring committee are between 3 and 5. The board directors and monitoring committee are voted by the general assembly and have 5-year-mandate.

1.3.5. Education for leaders and members of agricultural cooperatives

The promotion team of agricultural cooperatives at all levels has provided capacity building trainings for agricultural cooperative leaders and members. This enables them to administer agricultural cooperatives and run their cooperative businesses. The provided trainings for agricultural cooperative leaders and members are related to the explanation of Royal Decree on the establishment and functioning of agricultural cooperatives, credit administration, business management of agricultural input supply, cooperative management, concepts of agricultural cooperatives (including principles, values and advantages), planning of business development, marketing, financial record, accounting, farming planning, capacity building for female cooperative leaders, and computer skills (MAFF, 2008).

1.3.6. Challenges in promoting and strengthening agricultural cooperatives

Nowadays, the agricultural cooperatives have faced many problems as below:

- Shortage of human resources having knowledge in agricultural cooperatives in both government sector and cooperative society
- The promotion institutions of agricultural cooperative are limited
- Limited knowledge in business management among agricultural cooperative leaders and auditors

- Insufficient infrastructure in agricultural cooperatives such as working office, paddy storage, rice mills, warehouses … for running business of agricultural cooperatives
- Lack of training centers to train and build capacity for leaders, staffs and members of newly established cooperatives
- Inability of farmers to buy shares to invest in the cooperatives
- Cambodian MAFF does not have much funds to support agricultural cooperatives
- Few donors support agricultural cooperatives in Cambodia
- Loans have not been directly provided to the cooperatives by financing institutions or banks (MAFF, 2008).

1.3.7. Business activities of agricultural cooperatives

Agricultural cooperatives have main business activities such as credit, saving, organic rice farming, paddy business, rice bank service, grocery store, animal feed production, animal raising and collective sale (pig and chicken), animal breeding, mushroom production, fertilizer business, black pepper supply and trading etc.

Credit services are the common cooperatives business activities because it is the most important reason to establish the cooperatives and keep it working. Farmers have limited accessibility to get loans from financing institutions such as banks or micro finance institutions since most of them do not have collateral or real estates to guarantee the loan. Furthermore, some agricultural cooperatives expand their business activities beyond credit provision such as saving, rice bank service, rice business, animal business, fertilizer business, etc. These activities respond to the needs of cooperative members.

Among business activities provided, the agricultural cooperatives could get a lot of benefits from paddy business and fertilizer business. However, because the capacity of

agricultural cooperatives is still limited, amount of business volumes is still small, and they have limited capital to buy and sell in paddy and fertilizer businesses.

Moreover, grocery store is also a popular business activity. The cooperatives run the store and share their dividends to their members in accordance with the number of shares members own. For animal business, the members individually raise animals, but the collective sale is done by the committee members who have skills in negotiating the prices with buyers/middlemen (Heifer, 2011).

1.3.8. Rights and obligations of agricultural cooperatives

Agricultural cooperatives have rights and obligations as below:

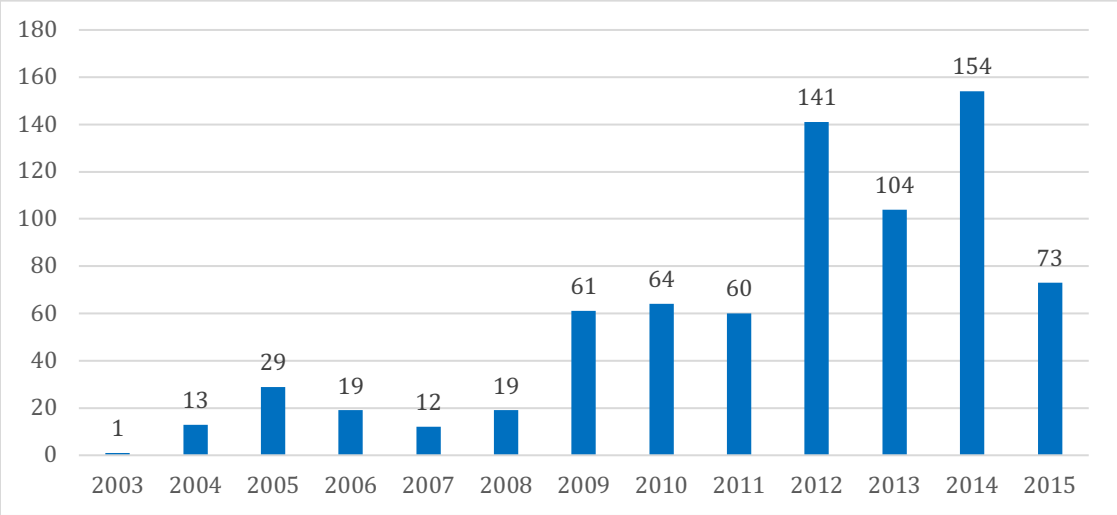
- Run business in agricultural production, agroindustry, agribusiness and other related services for the benefits of their members
- Work as the representatives of their members in signing and implementing the contracts with other private sectors or development partners
- Guarantee the rights of their members in achieving the cultural and socio-economic of agricultural cooperatives
- Provide trainings and technical assistances to enhance the capacity of their members and provide information in aim at promoting the participation of members in their agricultural cooperatives
- Submit proposal or receive financial or technical supports from government or other sources
- Be responsible for financial management, accounting, auditing, bookkeeping and capital increase as well as to manage the resources of agricultural cooperatives in accordance with existing legal framework

- Pay tax and other financial obligations as stated by laws and orders
- Implement tasks regarding objectives of the agricultural cooperatives
- Agricultural cooperatives have to keep documents or other records in their office or any places as stated by laws.
- Agricultural cooperatives have to keep the AC statute, internal regulations, registration certificate, list of membership which includes
    - Name and office address of agricultural cooperatives
    - Name, nationality, date of birth and address of members
    - Date of becoming the member of agricultural cooperatives
- List of shareholding members which includes the name and office address of agricultural cooperatives, and name of members holding share, price of share and number of shares.
- Annual financial balance of agricultural cooperatives
- Annual report of agricultural cooperatives
- Audit report of agricultural cooperatives
- All kinds of minutes and reports
- Other documents related to agricultural cooperatives as required by government or members (MAFF, 2015).

1.3.9. Current number of agricultural cooperatives in Cambodia

Starting from 1 in 2003, the number of agricultural cooperatives found per year fluctuated from 2004 to 2011. From 2012 to 2014, more than 100 agricultural cooperatives established annually. In 2015, MAFF officially registered 73 newly established agricultural cooperatives.

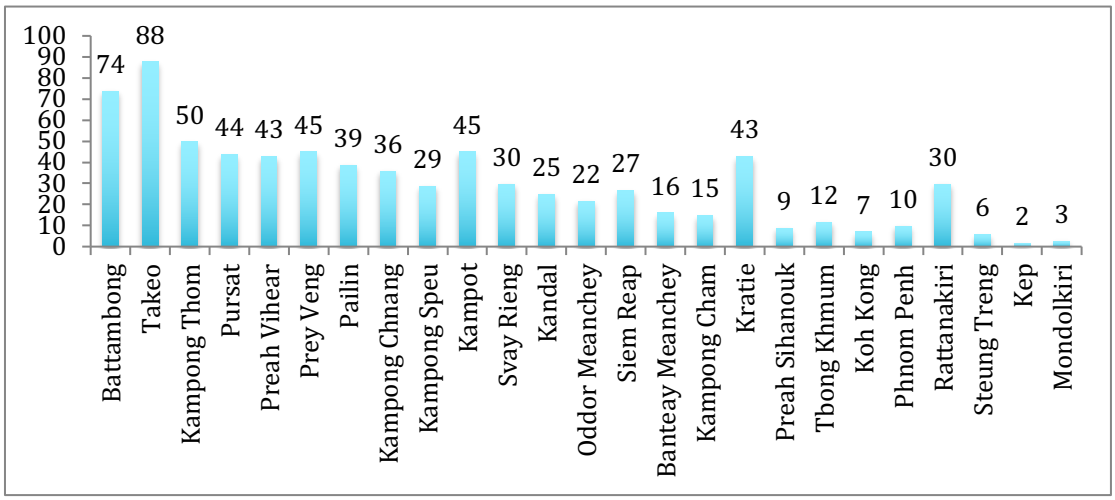
Figure 1.9 Number of agricultural cooperatives found in each year



Source: MAFF, 2016

As shown in Figure 1.10, Takeo, Battambong, Kampong Thom, Pursat, Preah Vihear, Kampot, Kratie and Prey Veng were the provinces having the largest number of agricultural cooperatives in 2015. In contrast, Steung Treng, Kep and Mondolkiri had few agricultural cooperatives since they are remote provinces with low population.

Figure 1.10 Distribution of agricultural cooperatives by provinces in 2015



Source: MAFF, 2016

1.4. Structure of the dissertation

This dissertation was organized into 5 chapters as described below. Chapter 1 provides background, overview of agriculture in Cambodia as well as general information related to agricultural cooperatives in Cambodia including the historical background, definition, principle, structure and objectives of agricultural cooperatives in Cambodia and structure of the dissertation. Chapter 2 describes the literature review on previous studies such as impacts of agricultural cooperatives in other countries and perception of success of agricultural cooperatives in Cambodia, justification and objectives of the study. Chapter 3 addresses the factors influencing on farmers' decision on becoming a member of agricultural cooperatives using Probit model and assess the impacts of membership on farmers' revenues from paddy, livestock and farm using propensity score matching techniques. Chapter 4 covers the effects of membership in agricultural cooperatives on farm households' food security and other determinants using instrumental variables. Lastly, chapter 5 gives the general conclusion, draws recommendations and states the limitation of the research.

Chapter 2

Literature Review

2.1. Previous studies

Regarding the factors influencing the membership in agricultural cooperatives, several studies have found that many factors influencing the farmers' participation in agricultural cooperatives. The results of previous studies indicate the following variables have significant influences: age (Karli *et al.,* 2006), education (Hao 2018; Karli *et al.,* 2006), gender of household head (Bernard & Spielman 2009; Abebaw & Haile 2013; Mayoux 1999), land holding (Fischer & Qaim 2012; Karli *et al.,* 2006; Ma & Abdulai 2016), access to information on the benefits of agricultural cooperatives (Debeb & Haile 2016) and off-farm job (Nugusse *et al.,* 2012).

Regarding functions of agricultural cooperatives, the production and market entry of smallholder farmers were seriously pressured by market imperfections such as missing or narrow markets, lack of access to information and high transaction costs in various developing countries (Alene *et al.*, 2008; Staal *et al.*, 1997). Agricultural cooperatives could help producers overcome some of these problems and make their agricultural production and market access better (Shiferaw *et al.*, 2009; Rao and Qaim 2011). The cooperatives market the agricultural products and jointly purchase the agricultural inputs, which result in reducing transaction costs in input purchase and output marketing. Lower transaction cost can insult in better market access and greater amount of marketed agricultural products. Moreover, the cooperatives can empower the bargaining powers of small producers against bigger buyers and input suppliers. This leads to lower input cost and producers can get better prices and greater revenue and income. Furthermore,

agricultural cooperatives can ease the dissemination of knowledges to their members as some of them offer agricultural trainings and information sharing. This contributes to better technology adoption and management, leading to better agricultural output, productivity and farm income (Verhofstadt and Maertens, 2014).

Several studies have been conducted to assess the impact of membership in agricultural cooperatives on farmers' welfare in various countries. Some of them found positive effects of membership in agricultural cooperatives on farmers' welfare while the others found no significant differences between members and non-members. For example, Hoken and Sun (2015) carried out a study on the effects of agricultural cooperatives on household income in China and showed that joining those rice producing agricultural cooperatives had no significant impacts on members in terms of net rice income. Maharjan and Fradejas (2006) did a research on backyard pig production in Philippines and found that members in agricultural cooperatives had greater income, leading to stronger purchasing power and saving for meeting the needs of farmers' households. Moreover, Ma and Abdulai (2016) conducted a research to see if the cooperatives membership improved household welfare for apple farmers in China, and they found that members in agricultural cooperatives had greater yields, net returns and household income. In a study on smallholder cooperatives and agricultural performance conducted by Verhofstadt and Maertens (2014) in Rwanda, the results showed that members in agricultural cooperatives had better adoption of modern inputs, boosted intensification, improved commercialization of agricultural products and higher revenue, labor productivity and farm income.

2.2. Perceptions of success in agricultural cooperatives in Cambodia

Hun *et al.* (2017) previously conducted a research titled "Factors Influencing Members' Perceptions of Success in Agricultural Cooperatives in Cambodia: A Case Study in Tram Kak District, Takeo Province". That study had 2 objectives: 1) to determine members' satisfaction regarding the degree of success in agricultural cooperatives based on certain indicators, and 2) to identify factors influencing the members' perceptions of success in agricultural cooperatives.

A data collection for that study was conducted in September and October 2014 in Tram Kak District, Takeo Province. 242 members randomly selected from 10 agricultural cooperatives in Tram Kak District were interviewed. Members' satisfaction regarding the degree of success in agricultural cooperatives was studied using descriptive statistics. 16 indicators were selected based on members' expectations of becoming members of agricultural cooperatives during a preliminary visit to the study areas. Degree of success in agricultural cooperatives was rated on five-point Likert scale ranging from 0 to 4 (0=least successful, 4=most successful).

Table 2.1 shows the perceptions of success of agricultural cooperatives based on selected indicators. They found that 81.40% of respondents strongly agreed that they got dividend from their agricultural cooperatives. Also, 76.03% of members responded strongly agreed that they had access to credit service while 82.64% strongly agreed that they reduced loans from outsiders at high interest rates. Further, 55.37% of respondents strongly agreed that it was easier to sell their agricultural cooperatives. 76.86% and 77.69% of them strongly agreed that they had access to marketing information and access to technical support respectively. Moreover, 50.83% of respondents strongly agreed that they had access to paddy rice for consumption when in need. Furthermore, 61.98% of

respondents strongly agreed that they had technical improvement in poultry raising while 54.96% and 45.04% strongly agreed that they had technical improvement in cow and pig raisings, respectively. Additionally, 95.45% and 91.32% of respondents, respectively, strongly agreed that they were satisfied with the services provided and the conflicts in the cooperatives were not the problem for them.

Table 2.1 Perceptions of success of the cooperatives based on selected indicators

No.	Selected indicators of success	Strongly disagree (%)	Disagree (%)	Neither agree or disagree (%)	Agree (%)	Strongly agree (%)
1	Dividend from agricultural cooperative	16.53	0.83	0.41	0.83	81.40
2	Reduced agricultural expenditure	31.82	4.55	8.26	35.95	19.42
3	Access to paddy rice for consumption when in need	38.02	4.13	4.55	2.48	50.83
4	Technical improvement for pig raising	34.71	5.37	5.79	9.09	45.04
5	Technical improvement for cow raising	31.40	3.72	5.37	4.55	54.96
6	Technical improvement for poultry raising	27.27	2.89	3.72	4.13	61.98
7	Access to fertilizers and pesticides with lower prices	42.56	2.48	11.57	1.65	41.74
8	Access to animal feeds and medicine with lower prices	63.22	6.61	25.21	1.65	3.31
9	Better prices for agricultural products	39.67	2.48	13.64	11.57	32.64
10	Ease of selling your products	29.34	1.65	11.16	2.48	55.37
11	Access to credit service	16.53	2.07	4.13	1.24	76.03
12	Reduced loans from outsiders with high interest rates	11.98	1.65	2.48	1.24	82.64
13	Conflicts between members and cooperative or among members are not problem	4.96	1.65	0.83	1.24	91.32
14	Satisfaction with services provided	1.65	0.83	0.83	1.24	95.45
15	Access to marketing information	17.77	0.00	2.48	2.89	76.86
16	Access to technical supports	19.83	0.00	0.83	1.65	77.69

Source: Hun *et al*. (2017)

Hun *et al.* (2017) found that members perceived revenue related indicators (e.g. dividend from agricultural cooperatives, ease of selling agricultural products and access

to marketing information) and food security related indicators (e.g. technical improvement in poultry, cow and pig raisings and access to paddy for consumption when in need) as among the most important ones of success in their agricultural cooperatives. In this study, we attempt to find out if agricultural cooperatives really have actual positive effects on farmers' revenues and food security. The objectives of this study are to assess the impacts of agricultural cooperatives on farmers' revenues and farm households' food security.

2.3. Justification of this research

Hun *et al.* (2017) previously conducted a study on members' perception of success in agricultural cooperatives in Cambodia, and they found that members perceived revenue related indicators (e.g. dividend from agricultural cooperatives, ease of selling agricultural products and access to marketing information) and food security related indicators (e.g. technical improvement in poultry, cow and pig raisings and access to paddy for consumption when in need) as among the most important ones of success in their agricultural cooperatives. Afolami *et al.* (2012) found no significant difference in yields between non-members and members of rice agricultural cooperatives in Nigeria. Hoken *et al.* (2015) also found no significant difference in net income between participants and non-participants in rice producing cooperatives in China. Agricultural cooperatives have been promoted in Cambodia since 2003; however, very limited studies have been conducted regarding the impact of membership in agricultural cooperatives on farmers' revenues and farm households' food security in Cambodia. Such studies are important to efficiently establish marketing power of the producers.

2.4. Objectives of the study

This study has two main objectives: 1) To assess the impacts of membership in agricultural cooperatives on farmers' revenues, and 2) To assess the impacts of membership in agricultural cooperatives on farm households' food security and other determinants.

This study has 3 specific objectives as below:

1) To identify factors influencing farmers' decision on membership in agricultural cooperatives

2) To assess the impacts of membership in agricultural cooperatives on farmers' revenues from paddy, livestock and farm

3) To assess the impacts of membership in agricultural cooperatives on farm households' food security and other determinants of food security.

Chapter 3

Impacts of Agricultural Cooperatives on Farmers' Revenues

3.1. Background of this chapter

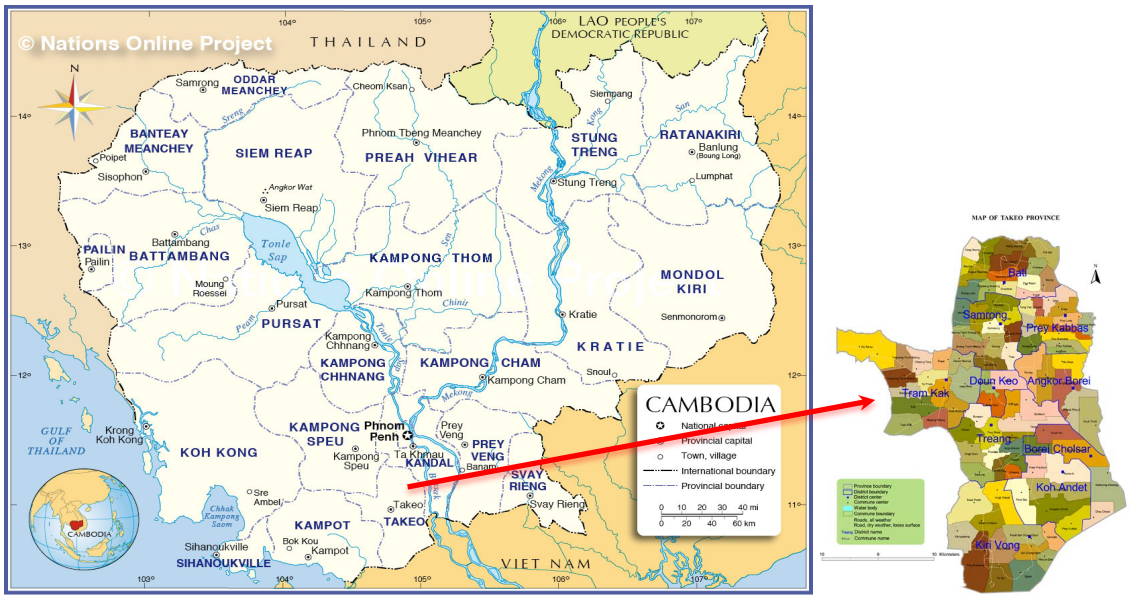
The purposes of promoting agricultural cooperatives are to improve the farmers' income through increasing productivity, diversifying agricultural production and marketing farmers' products. Since 2003, the Cambodian government through Ministry of Agriculture, Forestry and Fisheries has promoted the development of agricultural cooperatives, and the number of those agricultural cooperatives increased significantly in recent years. However, very limited studies have been conducted regarding the impact of membership in agricultural cooperatives on paddy yield, paddy revenue, livestock revenue and farm revenue in Cambodia. This chapter attempts to assess the impact of membership in agricultural cooperatives on farmers' revenues, and it has two specific objectives: 1) to identify factors influencing farmers' decision on membership in agricultural cooperatives, and 2) to identify the impact of being a member in agricultural cooperatives on farmers' revenues from paddy, livestock and farm.

3.2. Research methodology

3.2.1. Study site

Takeo Province is located in the southern part of Cambodia, and it is one of the most important paddy-producing provinces in the country. As one of the most important rice producing provinces in the country, the annual paddy harvest in this province can feed one quarter of Cambodia (USAID, 2010).

Figure 3.1 Administrative map of Cambodia and map of Takeo Province

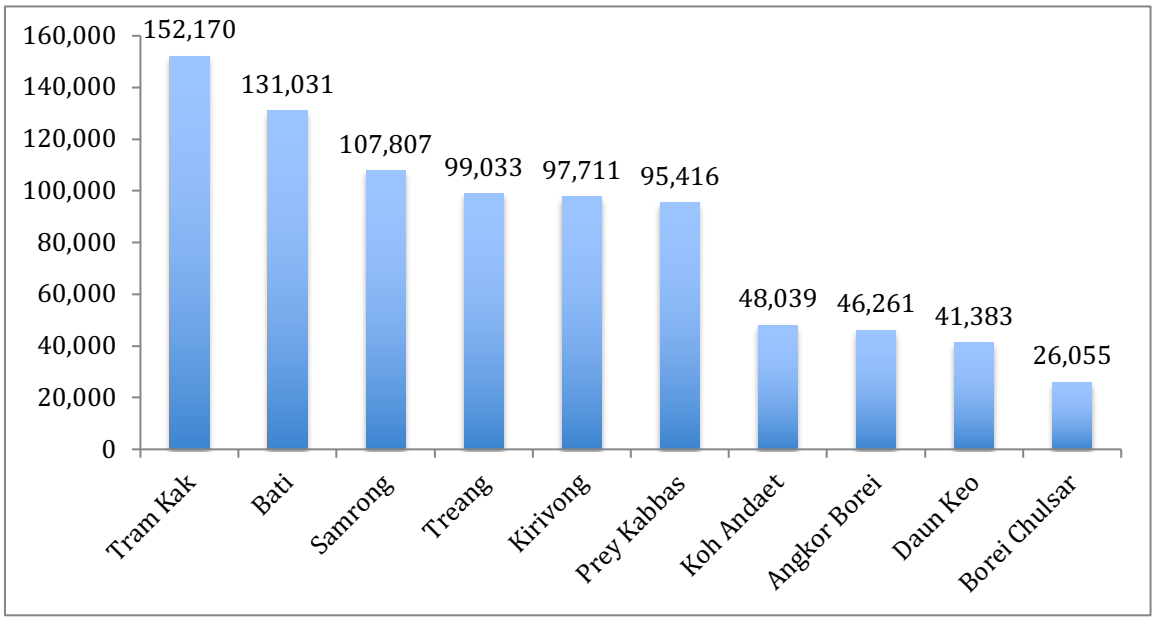


Source: Nations Online Project (2018) and Cambodia Visit (2018)

This province is roughly 87 Km away from Phnom Penh capital city if traveling by national road No. 3 and about 77 Km by national road No. 2. This province shares border with Kandal province, Kampot province, Kampong Speu province and Vietnam. It has 10 districts, 97 communes and 1,118 villages with 208,221 households, and the total population in this province is 991,947 (including 508,965 women). Approximately 90 percent of population gets involved in farming jobs such as paddy cultivation, plantation, fishing, aquaculture, business, crafts and other jobs. Its total area is 5,563 Km^2, and areas of its agricultural land are 249,000 hectares. Among these areas of agricultural land, rainy season paddy fields cover 170,000 hectares while the dry season paddy fields cover 75,000 hectares, and other crop fields covered about 4,000 hectares. The remaining areas are housing areas, lakes, ponds, canals, public infrastructures and other unoccupied areas. Geography and location of this province are suitable for agricultural production

especially for dry season paddy and livestock productions. Annual rainfall in 2013 in this province was 1,132 mm. (MAFF, 2014).

Figure 3.2 Population as of 2008 by districts in Takeo province



Source: National Institute of Statistics (NIS), Ministry of Planning, 2013

According to MAFF annual report 2016, this province has 88 agricultural cooperatives, the largest number of agricultural cooperatives among various provinces in Cambodia. Takeo Province has 10 districts and, based on data obtained from the Cambodian MAFF, Tram Kak District has the largest number of agricultural cooperatives in this province with a population of 152,170 (NIS, 2013). All agricultural cooperatives having paddy business in this district were selected. In addition, some of these agricultural cooperatives also had rice bank service, credit service, saving service, grocery stores and also provide some agricultural training such as paddy, livestock and other crop production training.

3.2.2. Data collection

The data collection was conducted in September and October 2016 in Tram Kak District, Takeo Province. A total of 242 farmers (99 members from 10 agricultural cooperatives and 143 non-members) were randomly selected and interviewed using face-to-face structured interviews. Qualitative interviews were also conducted with directors of those agricultural cooperatives in order to understand more about the situations and problems they have faced.

3.2.3. Empirical models

For the first objective, a probit model was used to identify factors influencing farmers' decision on membership in agricultural cooperatives. Age, gender, education of household head, household size, paddy land size, paddy sale, off-farm income, TV, car, contact with extension workers and access to a good road were used as independent variables (Table 3.1). For the second objective, the propensity score matching (PSM) using the single nearest neighbor matching was employed to assess the impact of being a member in agricultural cooperatives on paddy yield, paddy revenue per hectare, livestock and farm revenues per year (Table 3.1).

In order to acquire a realistic estimation of adoption impact, we needed to set a control group with similar attributes as much as possible similar to those of the treated group (Monteiro, 2010). According to Rosenbaum and Rubin (1983), PSM has become the common approach used in impact evaluation as it can control the observable characteristics of the control group as a resemblance of the treated group, that is to say it is a method that could establish a counterfactual condition and reduce possible selection bias involved with observable characteristics.

PSM is a two-step procedure (Becker & Ichino, 2002). In first step, the probit model is used for the decision to become a member of an agricultural cooperative, and this will provide a propensity score for each observation. Propensity scores of farmers were calculated by estimating the probability model in the probit model, specified as:

$$Y(1,0) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n \quad (1)$$

where, y is a dependent variable (1 = member of agricultural cooperative; 0 = non-member), β's are the regression coefficients to be estimated, and X's are independent variables to be explained. X_1 is the age of household head, X_2 is the gender of household head, X_3 is the years of education of household head, X_4 is the number of household members, X_5 is paddy land size, X_6 is paddy sale, X_7 is annual income of household head from off-farm job, X_8 is household having TV, X_9 is household having car, X_{10} is having contact with extension workers related to agricultural cooperatives, and X_{11} is access to good road in village (Table 3.1).

After estimating the probability model, we estimate the propensity score based on the following equation:

$$P_{score} = 1/[1 + e^{-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n)} \quad (2)$$

Where, $(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n)$ was used in the probit model as shown in Equation (1).

Propensity score was defined as the conditional probability of receiving treatment given a vector of observable covariates (Rosenbaum & Rubin, 1983). After the propensity score is estimated, each member of an agricultural cooperative was matched with non-members with similar propensity score values with the aim of estimating the average treatment effect on the treated (ATT), which is notated,

$$ATT = E(Y_1 - Y_0|x, D = 1) = E(Y_1|x, D = 1) - E(Y_0|x, D = 1) \quad (3)$$

where, D is an indicator variable equal to 1 if the farmer is a member, Y_1 is the members' outcomes, Y_0 is the non-members' outcomes, and x is a vector of the control variables. Outcome variables used this study are paddy yield, paddy revenue, livestock revenue and farm revenue (Table 3.1).

After matching, a balancing test is required to verify that the differences in the control variables between member group and non-member group have been eradicated, in which the matched comparison group could be regarded as a credible counterfactual (Ali & Abdulai, 2010). Even though there are many kinds of balancing tests, the most commonly adopted is the mean absolute standardized bias (MASB) method. Therefore, we used the MASB approach as recommended by Rosenbaum and Rubin (1983), in which the standardized difference should be smaller than 20% to prove the success in the matching procedure.

3.3. Description of data variables

Table 3.1 shows the variables used in this study, and it describes the variable names, definition and unit of each variable. Farmer status was used as the dependent variable while age, gender, education of household head, household size, paddy land size, paddy sale, annual income from off-farm jobs, TV, car, contact with extension workers and access to good road were used as independent variables in the probit model to identify factors influencing membership in agricultural cooperatives. Moreover, paddy yield, paddy revenue, livestock revenue and farm revenue were used as outcome variables in PSM.

Table 3.1 Definition of variables

Variables	Definition	Unit
Dependent variable (used in probit model)		
Farmer status	1 = Member of agricultural cooperative; 0 = non-member	
Independent variables (used in probit model)		
Age	Age of household head	Year
Gender	Gender of household head; 1 = male; 0 = female	Dummy
Education	Years of education of household head	Year
Household size	Number of household members	Number
Paddy land	Paddy land size	Hectare
Paddy sale	Farmers who sell their paddy = 1; 0 = otherwise	Dummy
Off-farm	Annual income of household head from off-farm job	US $
TV owned	Household having TV = 1; 0 = otherwise	Dummy
Car	Household having car = 1; 0 = otherwise	Dummy
Extension	Having contact with extension workers related to agricultural cooperatives = 1; 0 = otherwise	Dummy
Access to road	Access to good road in village = 1; 0 = otherwise	Dummy
Outcome variables (used in matching of propensity score)		
Paddy yield	Yield per hectare	Kg/ha
Paddy revenue	Total revenue from paddy per hectare	US $/ha
Livestock revenue	Total revenue from animals (pigs and poultry) per year	US $
Farm revenue	Total revenue from farm activities (paddy, crop, animal, aquaculture) per year	US $

3.4. Descriptive results before and after matching

Table 3.2 shows the characteristic differences between members and non-members before and after matching. Before matching, household size, paddy land size, paddy sale and contact with extension workers were significantly different between members and non-members. On average, household size of members was 4.68 while the household size of non-members was 3.83. Moreover, members had paddy land size of 0.97 hectare, and this is 0.19 hectare bigger than non-members. In addition, 82% of members sold their paddy, which was 19% higher than non-members. Based on the

unmatched results, 87% of members been in contact with extension workers compared to only 8% of non-members having had contact with extension workers. Outcome variables including paddy yield, paddy revenue, livestock revenue and farm revenue are also presented in Table 3.2. Livestock revenues of members was US$421.61 per year, which is US$132.88 significantly higher than non-members. Also, members got farm revenues of US$1,291.26 per year, US$322.83 statistically more than non-members. From simple comparison, results suggest that members obtained higher livestock revenue and farm revenue than non-members before matching. However, the differences in outcomes before matching may be caused by characteristics differences rather than being a member. It may lead to biased conclusion if we do not control these differences. Thus, we employed PSM to control these differences of characteristics in order to get unbiased results.

The mean absolute standardized bias was 17.1% and as Rosenbaum and Rubin (1983) suggested that the mean absolute standardized bias should be smaller than 20%, this confirms the success in the matching process. After matching, the differences between members and non-members were reduced. Only education and household size were still significant after we conducted matching process.

Table 3.2 Characteristic difference between members and non-members before and after matching

Variables	Before matching				After matching				% Bias
	Member Mean	Non-member Mean	Diff.	Tests[1]	Member Mean	Non-member Mean	Diff.	Tests[1]	
Age	46.86	47.02	-0.16	-0.09	46.86	46.07	0.80	0.53	6.0
Gender	0.89	0.90	-0.01	-0.15	0.89	0.93	-0.04	-0.99	-13.0
Education	5.93	5.41	0.52	1.28	5.93	4.32	1.61***	3.34	51.0
Household size	4.68	3.83	0.85***	4.61	4.68	3.80	0.88***	4.55	61.0
Paddy land	0.97	0.79	0.19***	2.84	0.97	0.85	0.12	1.53	22.1
Paddy sale	0.82	0.63	0.19***	3.17	0.82	0.83	-0.01	-0.19	-2.3
Off-farm	368.43	427.78	-59.35	0.57					
Log (off-farm)	1.02	1.17	-0.15	0.82	1.02	1.11	-0.09	-0.43	-6.3
TV owned	0.92	0.93	-0.01	-0.32	0.92	0.88	0.04	0.94	15.0
Car	0.02	0.03	-0.01	-0.38	0.02	0.03	-0.01	-0.45	-6.6
Extension	0.87	0.08	0.79***	12.36	0.87	0.87	0.00	0.00	0.0
Access to road	0.39	0.38	0.01	0.15	0.39	0.37	0.02	0.29	4.1
Paddy yield	2,889.08	2,956.46	-67.38	-1.17					
Paddy revenue	815.57	822.22	-6.65	-0.28					
Livest. revenue	421.61	288.73	132.88***	2.59	Mean absolute standardized bias = 17.1				
Farm revenue	1,291.26	968.43	322.83***	3.54					

Note. 1: *, **, *** significant at 10%, 5%, 1% respectively; We used t-test for mean comparison and z-test for proportion comparison; Diff. is difference; Livest. revenue is livestock revenue.

Source: Own survey (2016).

3.5. Determinants of membership in agricultural cooperatives

As the results of coefficients in the probit estimation could not be interpreted directly, the marginal effects of independent variables of becoming a member of agricultural cooperatives were used and are shown in Table 3.3, and the units of those marginal effects are the same as the units of measurement for the explanatory variables (Greene, 2013). According to the probit estimates in Table 3.3, paddy sale and having contact with extension workers are positively associated with the decision to become

members of agricultural cooperatives, while a male-headed household and off-farm income are negatively associated. For paddy sale, the probability of becoming a member in agricultural cooperatives of farmers who sold their paddy increases by 0.09 (holding all other variables constant) compared to farmers who did not sell their paddy. This is because they wanted to acquire rice-growing techniques and wanted to sell their paddy for better prices. Moreover, farmers who had been in contact with extension workers were more likely to join the cooperatives because they had got the information on the benefits of the cooperatives, and their probability of becoming a member of an agricultural cooperative increases by 0.46 holding all other variables constant. This result is in line with Debeb and Haile (2016), who found that access to information on the benefits of agricultural cooperatives encouraged farmers to join the cooperatives. For gender of household heads, the result of marginal effects shows that if the household heads were males, the probability of becoming a member of agricultural cooperatives decreased by 0.11 (holding all other variables constant) compared to female household heads. This may be due to the fact that male household heads mostly had off-farm jobs, so they did not want to join. On the other hand, female-headed households are generally poor, so they wanted to join the cooperative to get supports such as agricultural techniques and other services from the cooperatives. This is contrary to the finding of Bernard and Spielman (2009), and Abebaw and Haile (2013) who found that woman-headed households were less likely to join the cooperatives in Ethiopia. Also, Mayoux (1999) mentioned that females in Africa have a limited chance of joining in collective activities such as cooperatives. Based on the results of marginal effects, with one percent increase in off-farm income, the probability of becoming a member of agricultural cooperatives decreases by 0.06 (holding all other variables constant). Farmers who had higher off-farm

income were less likely to join the cooperatives because they were busy with off-farm jobs, and rice was not their main source of income. This is consistent with the finding of Nugusse, Huylenbroeck, and Buysse (2012), who found that households with special skills other than farming were less likely to join the cooperatives in Northern Ethiopia.

Table 3.3 Results of the probit model for factors influencing membership in agricultural cooperatives

Variables	Probit estimates		Marginal effects	
	Coef.	Std. Err.	Dy/dx	Std. Err.
Age	-4.49E-3	1.04E-2	6.77E-4	1.58E-3
Gender	-0.76*	0.41	-0.11*	6.09E-2
Education	2.99E-2	4.66E-2	4.51E-3	7.01E-3
Household size	4.79E-2	0.10	7.21E-3	1.50E-2
Paddy land	-0.25	0.27	-3.75E-2	4.02E-2
Paddy sale	0.61*	0.36	9.21E-2*	5.35E-2
Log(off-farm)	-0.37***	0.12	-5.63E-2***	1.73E-2
TV owned	7.54E-2	0.47	1.13E-2	7.07E-2
Car	0.35	0.69	5.33E-2	0.10
Extension	3.04***	0.33	0.46***	3.32E-2
Access to road	0.28	0.30	4.14E-2	4.54E-2
_cons	-1.07	0.88		
Log likelihood	-67.07			
LR Chi^2	193.29			
Pseudo R^2	0.59			

Note. *, **, *** significant at 10%, 5%, 1%, respectively.

Source: Own survey (2016).

3.6. Impacts of agricultural cooperatives on farmers' revenues

After matching, each member of the agricultural cooperatives was matched with non-members with similar propensity score values to estimate the average treatment effect for the treated (ATT) and average treatment effect for the untreated (ATU).

The results of propensity score matching in Table 3.4 show that before matching, on average, paddy yields of members and non-members are 2,889.08 Kg/ha and 2956.46 Kg/ha, and members and non-members have paddy revenues of US$815.57 and US$822.22 per hectare, respectively. However, there are no significant differences before and after matching. These results suggest that membership in agricultural cooperatives has no impact on paddy yield and revenue as there is no significant difference between members and non-members with and without the matching process. This may be due to the fact that the agricultural cooperatives have not provided sufficient training, and members did not actively attend those trainings that were provided. Furthermore, the cooperatives have failed to provide better prices compared to other traders as they have small equity capital and the capability of the board directors is limited. This result is consistent with Afolami *et al.* (2012), who also found no significant difference in yields between non-members and members of rice agricultural cooperatives in Nigeria. Similarly, Hoken and Su (2015) also found no significant difference in net income between participants and non-participants in rice-producing cooperatives in China. However, members could obtain more revenue from livestock by US$219.41 and from farm as a whole by US$403.42, respectively, than non-members. These results show that being a member have significantly positive impacts on livestock and farm revenue, according to ATT. The cooperatives provided training on livestock operation and encourage members to raise more livestock compared to non-members who have no or

fewer livestock, so this leads to positive impacts. But it is not significant according to ATU, therefore, there may be no significant impact of becoming a member in terms of livestock and farm revenues.

Table 3.4 Results of propensity score matching

Outcomes	Sample	Member	Non-member	Difference	S.E.	T-stat
Paddy yield	Unmatched	2,889.08	2,956.46	-67.38	57.38	-1.17
	ATT	2,889.08	2,944.68	-54.98	193.63	-0.28
	ATU	2,861.17	2,956.46	-95.30	158.89	-0.60
Paddy revenue	Unmatched	815.57	822.22	-6.65	23.96	-0.28
	ATT	815.57	818.07	-2.51	60.18	-0.04
	ATU	718.76	822.22	-103.45**	47.31	-2.19
Livestock revenue	Unmatched	421.61	288.73	132.88***	51.33	2.59
	ATT	421.61	202.19	219.41***	84.60	2.59
	ATU	299.08	288.73	10.36	74.16	0.14
Farm revenue	Unmatched	1,291.26	968.43	322.83***	91.16	3.54
	ATT	1,291.26	887.84	403.42*	214.20	1.88
	ATU	904.85	968.43	-63.59	290.33	-0.22

Note. *, **, *** significant at 10%, 5%, 1%, respectively; S.E. is standard error. ATT: average treatment effect for the treated; ATU: average treatment effect for the untreated.

Source: Own survey (2016)

3.7. Conclusion

In conclusion, farmers who sold their paddy and farmers who had contact with extension workers were more likely to join the cooperatives. Male farmers and higher off-farm-income farmers were less likely to join the cooperatives.

Agricultural cooperatives have no impact on paddy yield and paddy revenue, but there are positive impacts on livestock and farm revenues for members as they can

increase their livestock and other agricultural production when obtaining agricultural training from the cooperatives.

Chapter 4

Impacts of Agricultural Cooperatives on Farm Households' Food Security

4.1. Background of this chapter

Poverty in Cambodia was reduced noticeably from 50% in 2007 to 21% in 2011 (World Bank, 2015). About 80% of total population in Cambodia live in countryside (NIS, 2013), and most poverty occurs in rural areas (ADB, 2014). Over 60% of poverty alleviation were from agriculture sector (World Bank, 2015), and this sector provides food for daily consumption and raw material for industry and contributes over 30% to the GDP (MAFF, 2015). More poverty reduction will largely rely on the progress of agricultural sector because of its important role in labor force, value added and export, in particularly, farmers are among the poor (World Bank, 2015). Most people were lifted out of the poverty just by small margin, and a decrease in their income of USD 0.3 per day will push the poverty rate back to 40% (World Bank, 2015). This indicates that rural farm households' livelihood has not been much improved yet, raising the concern of rural food security. Agriculture sector is still considered as the priority sector to support economic growth, secure food security and promote rural economic development in aim to promote economic growth and poverty reduction in Cambodia (MAFF, 2016).

To ease the development of agricultural sector, agricultural cooperatives has been on attention to provide farmers with new agricultural techniques and credit service, and to ensure the stability of food supply in aim at improving rural socio-economic conditions (MAFF, 2016). However, very few studies have been conducted regarding effects of membership in agricultural cooperatives on food security.

4.2. Objectives of this chapter

This chapter attempts to identify the impacts of membership in agricultural cooperatives on farm households' food security and other factors influencing food security.

4.3. Data

Takeo province is one of the 25 provinces in Cambodia. This province is about 80 Km from Phnom Penh Capital City and it situates in the southern part of the country. This province is one of the biggest paddy producing province in the country, and this province alone produced 1.13 million tons out of 9.34 million tons of total paddy produced in Cambodia. As previously mentioned, Takeo province had 88 agricultural cooperatives, which was the highest number of agricultural cooperatives across the country (MAFF, 2016). Among the 10 districts in this province, Tram Kak has the highest number of agricultural cooperatives.

Data from interviewing 236 farmers including 99 members from 10 agricultural cooperatives and 137 non-members in Tram Kak District, Takeo Province in September and October 2016 were analyzed. The questionnaires used in that face-to-face structured interviews was designed to capture the information related to household characteristics, agricultural production, service provided by agricultural cooperatives and food security. In addition to interviews of farmers, we also carried on qualitative interviews with directors of those agricultural cooperatives in the purpose of understanding more about situations and challenges of those cooperatives.

4.4. Empirical models

To identify the impact of membership in agricultural cooperatives on food security, 2 Stage Least Squares (2SLS) Instrumental Variable approach was applied. According to Woodridge, J.M. (2013), the equations of 2SLS Instrumental Variable are as follow:

$$y_2 = \pi_0 + \pi_1 z_1 + \pi_2 z_2 + v_2 \qquad (4)$$

where y_2 is a dependent variable (1=member; 0=non-member), π's are the regression coefficients to be estimated, z_1 and z_2 are exogenous variables, and v_2 is the error term. After that, we apply second stage and our structural equation as below:

$$y_1 = \beta_0 + \beta_1 y_2 + \beta_2 z_1 + u_1 \qquad (5)$$

where y_1 is Household Dietary Diversity Score (HDDS), β's are the regression coefficients to be estimated, y_2 is the endogenous regressor, z_1 are exogenous variables, and u_1 is the error term.

Dietary diversity is a qualitative measurement of food intake which could express the accessibility of households to various food. It could also indicate the individuals' nutrient sufficiency. The dietary diversity scores are the sum of food groups which the individual or household has eaten in the last 24 hours (FAO, 2011). The dietary diversity scores target the individual, household and woman. According to Swindle & Bilinsky (2006) and FAO (2011), HDDS could be utilized as a proxy for household food security. The household dietary diversity score (HDDS) is used to capture economic ability of household accessing to various foods (FAO, 2011). Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (Hoddinott *et al.*, 2002). There are 12 food groups in HDDS such as cereals, white tubers and roots, vegetables, fruits, meat, eggs, fish and other seafood, legumes, nuts and seeds,

milk and milk products, oils and fats, sweets, and spice, condiments and beverages. The HDDS ranges from 0 to 12 (FAO, 2011).

4.5. Description of data variables

Table 4.1 presents the variables, definition and unit used in the research. Household Dietary Diversity Score was used as dependent variable in equation (5) while the farmer status (1=member; 0=otherwise) was used as dependent variable in equation (4). Age of household head, gender of household head, education of household head, household size, paddy sale, off-farm income, household income, TV, car, having contact with extension officers, access to good roads and livestock activity were used as independent variables.

Table 4.1 Definition of variables

Variables	Definition	Unit
HDDS	Household Dietary Diversity Score	
Farmer status	1=Member of agricultural cooperative; 0=non-member	
Age	Age of household head	Year
Gender	Gender of household head; 1=male; 0=female	Dummy
Education	Years of education of household head	Year
Household size	Number of household members	Number
Paddy land size	Total paddy land size	Hectare
Off-farm	Annual income of household head from off-farm job	U.S $
Household Income	Total annual income of household	U.S $
TV	Household having tv=1; 0=otherwise	Dummy
Car	Household having car=1; 0=otherwise	Dummy
Extension	Having contact with extension officers related to agricultural cooperatives=1; 0=otherwise	Dummy
Access to road	Access to good road in village=1; 0=otherwise	Dummy
Livestock	Households raising poultry and pigs=1; 0=otherwise	Dummy

4.6. Results and discussion

Table 4.2 presents the characteristic differences between members and non-members. There are no significant differences regarding age, gender, education, off-farm income, TV owned, car and access to good roads between member and non-members. However, on average, the household size of member group was 4.68 while the average household size of non-member groups was 3.84. On average, members had household income of US$4,014.71 per year, which was US$725 significantly higher than non-members. Moreover, 87% of member group were contacted with extension workers while only 8% of non-member group were in contacted with those workers. Furthermore, 99% of member group has involved with livestock activities such as pig and poultry raisings comparing to 93% of non-member group did.

Table 4.2 Characteristic difference between members and non-members

Variables	Member Mean	Non-member Mean	Difference	Tests[1]
Age	46.86	47.14	-0.28	-0.16
Gender	0.89	0.89	0.00	0.02
Education	5.93	5.47	0.46	1.08
Household size	4.68	3.84	0.84***	4.42
Paddy land size	0.97	0.79	0.18***	2.67
Off-farm	368.43	400.76	-32.33	-0.31
Household income	4,014.71	3,296.99	717.72**	1.93
TV	0.92	0.93	-0.01	-0.17
Car	0.03	0.02	0.01	0.45
Extension	0.87	0.08	0.79***	12.17
Access to road	0.39	0.41	-0.02	-0.25
Livestock	0.99	0.93	0.06**	2.30

Source: own survey (2016).

Note: *, **, *** significant at 10%, 5%, 1% respectively;

1: We used t-test for mean comparison and z-test for proportion comparison.

Table 4.3 shows the results of mean HDDS of members and non-members. On average, members have average HDDS of 7.06, which is 0.43 statistically higher comparing to non-members.

Table 4.3 Mean HDDS of members and non-members

HDDS	All sample	Member	Non-member	Difference	T-test
Mean	6.82	7.06	6.63	0.43***	3.26

Source: Own survey (2016)

Note: *, **, *** significant at 10%, 5%, 1% respectively

Table 4.4 shows the determinants of membership in agricultural cooperatives. Male household heads were less likely to become a member of agricultural cooperatives. Moreover, households with higher off-farm income were less likely to join the cooperatives. In contrast, farmers who had contacted the extension workers were more likely to become a member of agricultural cooperatives. Since these results were similarly to the results in Chapter 3, for more detail explanation of determinants of membership in agricultural cooperatives, please refer to Table 3.3 in Chapter 3.

Table 4.4 Determinants of membership in agricultural cooperatives

Member	Coef.	Std. Err.	z	P>z
Age	-3.85E-3	1.05E-2	-0.37	0.714
Gender	-0.76*	0.42	-1.82	0.068
Education	2.08E-2	4.57E-2	0.45	0.650
Household size	0.10	0.12	0.86	0.389
Paddy Land	7.16E-2	0.25	0.28	0.777
Off-farm	-0.92***	0.33	-2.78	0.005
TV	0.26	0.46	0.57	0.567
Car	7.73E-2	0.67	0.12	0.908
Extension	2.99***	0.32	9.38	0.000
Good road	8.17E-2	0.27	0.30	0.766
Livestock	0.51	0.90	0.57	0.568
Household income	6.04E-5	5.49E-5	-1.10	0.271
_cons	-1.49	1.23	-1.21	0.226
LR ratio Chi^2 (12)	184.91			
Pseudo R^2	0.58			

Source: Own survey (2016)

Note: Number of observations=233 and *, **, *** significant at 10%, 5%, 1%, respectively.

Prior to the second stage regression, tests for endogeneity, the power of the instruments and over-identifying restrictions of instruments were conducted. Table 4.5 shows the result of test of endogeneity. Durbin and Wu-Hausman tests use the null hypothesis that the variable being investigated could be treated as exogenous (StataCorp, 2013). These two tests are significant at 10% level, so it is not unreasonable to treat member as endogenous.

Table 4.5 Tests of endogeneity

Durbin (score) $chi^2(1)$	=	3.07406	(p	=	0.0796)
Wu-Hausman F(1,221)	=	2.95472	(p	=	0.0870)

Note: Ho: Variables are exogenous

Additionally, in Table 4.6 and Table 4.7, F-statistics F(3,220) equals 118.544, which exceeds the critical value of 13.91 (5% relative bias), so we would conclude that our instruments are not weak.

Table 4.6 First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq	Partial R-sq.	F(3,220)	Prob>F
Membership	0.6594	0.6409	0.6178	118.544	0.0000

Source: Own survey (2016)

Table 4.7 Critical value of first-stage regression

Ho: Instruments are weak

	5%	10%	20%	30%
2SLS relative bias	13.91	9.08	6.46	5.39
	10%	15%	20%	25%
2SLS Size of nominal 5% Wald test	22.30	12.83	9.54	7.80
LIML Size of nominal 5% Wald test	6.46	4.36	3.69	3.32

Source: Own survey (2016)

Moreover, the Sargan's and Basmann's tests for overidentify restrictions show no significance as shown in Table 4.6, so we could not reject the null hypothesis that our instruments are valid.

Table 4.8 Test of overidentifying restrictions

Sargan (score) chi2(2)	= 1.43841 (p = 0.4871)
Basmann chi2(2)	= 1.36659 (p = 0.5050)

Source: Own survey (2016)

Table 4.9 shows the results of 2SLS IV estimation. The membership in agricultural cooperatives positively influences the HDDS, and the results indicate members in agricultural cooperatives could have HDDS of 0.50 higher comparing to non-members. This is because agricultural cooperatives provided agricultural trainings, so that the members could consume the agricultural products they produced as food and sell them for revenue. Also, members could use credit service of agricultural cooperatives to purchase food, and they could use rice bank service as food or sell paddy they borrowed to purchase food. Moreover, livestock operation positively influenced the food security score.

Farm households with large paddy land had significantly higher HDDS because farmers with large paddy land could produce more food and generate more revenues. This is in line with Seng, K. (2016) who found that land area has positive influences on the household food security. Similarly, Feleke *et al.* (2005) and Mitiku *et al.* (2012) also found that farm size was positively associated with food security, and the likelihood of food security increases with the increase in farm size in Southern Ethiopia.

Additionally, household income positively associates with HDDS, and the results show that households having US$1,000 increase in household income had higher HDDS by 0.054. Similarly, this result is consistent with Esturk and Oren (2014) who found that households with higher income have better food security status comparing to lower-income households in Turkey.

Table 4.9 Results of 2SLS IV estimation

HDDS	Coef.	Std. Err.	z	P>z
Membership	0.50***	0.17	3.03	0.002
Age	7.30E-4	5.07E-3	0.14	0.886
Education	1.66E-2	2.15E-2	0.77	0.439
Household size	-3.68E-2	0.05	-0.70	0.486
Paddy land	0.24*	0.13	1.82	0.068
Household income	5.38E-5**	2.65E-5	2.03	0.042
TV	0.61**	0.24	2.55	0.011
Car	0.20	0.39	0.53	0.593
Access to road	0.25*	0.13	1.95	0.052
Livestock	0.50*	0.31	1.65	0.099
_cons	5.08	0.46	10.95	0.000
R^2	0.15			
Wald Chi^2 (10)	45.34			

Source: Own survey (2016).

Note: *, **, *** significant at 10%, 5%, 1%, respectively.

Farm households who owned TV had HDDS 0.61 higher than farmers who did not. This may be that because some agricultural production documentary and nutrition education programs were broadcasted on TV, farmers who owned TV had better nutrition knowledge and agricultural techniques, leading to higher HDDS.

With access to good roads, farm households have HDDS 0.25 higher comparing to farm households who do not. With good roads, farmers could easily go to do their off-farm job, to buy food or to find available food in their village.

Livestock operation positively influences the HDDS, and farm households with livestock operation had HDDS 0.50 greater than farm households who did not. Farmers can use those animals as food or sell for their income. This result is consistent with the findings of Abafita and Kim (2014) who found that livestock possession has significant positive influence on household food security. Similarly, Mitiku *et al.* (2012) also found that livestock size is positively associated with the probability of being food secure in

Southern Ethiopia. Furthermore, Beyene and Muche (2010) also found that households with larger livestock size are less vulnerable to food insecurity in Central Ethiopia.

4.7. Conclusion

In conclusion, membership in agricultural cooperatives has positive impact on farm households' food security. Also, household income positively associates with higher HDDS of farm households. Farmers who had access to good roads also had higher food security score. Moreover, farm households who had livestock operation had better food security score. Furthermore, farm households who own TV have better food security.

Chapter 5

General Conclusions and Recommendations

5.1. General conclusion and recommendations

In conclusion, farm households selling their paddy and having contact with extension workers were more likely to become members of agricultural cooperatives. Farm households with male head and/or higher off-farm income were less likely to join the cooperatives.

The cooperatives had no impacts on members' paddy yield. They had no impacts on members' paddy revenue, either because of limited marketing outlets and weak price negation power. They had positive impacts on members' livestock and farm revenues.

The cooperatives positively influenced food security in terms of HDDS. Agricultural land size, household income, owning TV, access to good roads and livestock operations positively influenced on the food security score.

According to the results summarized above, some recommendations could be drawn to improve farmers' revenues and food security. The government should promote more extension service, so the benefits of agricultural cooperatives could be disseminated to farmers more widely. The cooperatives should expand paddy markets and strengthen price negotiation power by increasing equity capital to procure more paddy from members, and by capacity-building of board directors in marketing expertise. Furthermore, farmers with livestock should be encouraged to join the cooperatives to increase their revenue and improve their food security because the cooperatives can provide good technical supports for livestock raisings. Also, the cooperatives should provide trainings on paddy production, so farmers with small paddy land size can increase

their paddy yield and improve their food security status. Moreover, the cooperatives should provide agricultural trainings for the livestock operation, so farmers can better operate to increase their household income. They can also afford to have a TV when the household income is improved, leading to better food security. Roads should be improved, so farmers could easily travel to do their off-farm jobs, transport their agricultural products, buy food or find available food in their village.

5.3. Limitation of the research

This research focused on impacts of agricultural cooperatives in Cambodia on farmers' revenues and food security in Cambodia by focusing only one district. The conclusion of this study could not be generalized for the whole country as there are many zones with different characteristics, which could result differently. In this study, we also faced challenges due to data limitation and difficulties to access to the trustful quantitative data because the availability of operation records of agricultural cooperatives in Cambodia is still limited.

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List of Publications

Papers published or accepted

1. Hun, S., Ito, S., Isoda, H., & Amekawa, Y. (2018). Impacts of Agricultural Cooperatives on Farmers' Revenues in Cambodia: A Case Study of Tram Kak District, Takeo Province, Journal of Agricultural Science, 10 (2), 82-88. https://doi.org/10.5539/jas.v10n2p82

2. Hun, S., Isoda, H., Amekawa, Y., & Ito, S. (2017). Factors Influencing Members' Perceptions of Success in Agricultural Cooperatives in Cambodia: A Case Study of Tram Kak District, Takeo Province, Journal of Economics and Sustainable Development, 8 (6), 1-6.

Paper in progress

3. Hun, S., Isoda, H., Ito, S. (2018). Impacts of Agricultural Cooperatives on Farm Households' Food Security in Cambodia: A Case Study of Tram Kak District, Takeo Province. (Ready to submit)

Presentations in conferences

1. Sereynithia Hun, Impacts of Agricultural Cooperatives on Farmers' Welfare in Cambodia: A Case Study of Tram Kak District, Takeo Province. The 8th International Symposium on East-Asian Agricultural Economics 2017. Kitakyushu, Japan, October 19, 2017.

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3. Sereynithia Hun, Factors Influencing Members' Perceptions of Success in Agricultural Cooperatives in Cambodia: A Case Study of Tram Kak District, Takeo Province, Presented in 9th Study Conference of the Food, Agricultural and Resource Economics Society of Japan. Kagoshima, Japan, September 20, 2015.

Appendix
Appendix 1 Questionnaire for Member of Agricultural Cooperative

Village: _____ Commune: _____ District: Tramkak Province: Takeo

Date: _ / _____ / 2016

1. General information of household

Is the household head answering this questionnaire?

[ ] Yes [ ] No, what is your relation to household head?

[ ] Spouse [ ] Parents [ ] Children [ ] Sibling

[ ] Other (specify _____)

Contact number of persons answering this questionnaire: _____

1.1 Name of household head: _____

1.2 Age of household head: _____

1.3 Gender of household head: [ ] Male [ ] Female

1.4 Years of formal schooling: _____

1.5 What is main occupation of household head? : [ ] Farmer [ ] Other (specify _____)

1.6 How many members are there in your family? _____

1.7 Family member information

Relationship with HH	Age	Gender	Schooling (years)	Occupation	Do they help in farming?	How many hours do they help per week?	Monthly salary/ income
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		

1.8 Housing condition: [ ] Thatched cottage [ ] Wooden house

[ ] Wood-brick house [ ] Brick house [ ] Other (specify _____)

1.9 What is the general road condition in your community?

[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable

[ ] Track unusable in certain periods of the year

[ ] Other (specify_____)

11. Do you have these stuffs in your house? [ ] Radio [ ] TV [ ] Motorcycle [ ] Car

2 Rice farming information

2.1 Total agricultural land size= _____ ha (excluding housing land)

2.2 Land size owned for rice cultivation _____ ha

How did you get this land?

[ ] Inherited Land size: _____ ha

[ ] Buy Land size: _____ ha

When did you buy? _____

How much was the price? _____

Have you paid all land cost or still paying installment?

[ ] Paid all land cost [ ] Still paying installments

If you are still paying installments, how much do you pay per month? _____

How many more months do you have to pay installments?
_____ Months

2.3 Amount of land rent for rice planting _____ha

2.4 Renting cost _____

2.5 Rice cultivation situation in 2015

Varieties	1. ……	2. ……	3. ……
Type of varieties	[ ] Early [ ] Medium [ ] Late	[ ] Early [ ] Medium [ ] Late	[ ] Early [ ] Medium [ ] Late
Source of varieties	[ ] Market [ ] Own self [ ] Cooperative [ ] Other:……	[ ] Market [ ] Own self [ ] Cooperative [ ] Other:…….	[ ] Market [ ] Own self [ ] Cooperative [ ] Other:……
Production areas (ha)			
Total production (Tons)			
How many land plots for this variety?			
Access to water supply	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you do it in dry season?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you plant anything before or after harvesting?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, please list it.	1. 2.	1. 2.	1. 2.
Is it your own or rent from others?	[ ] Own [ ] Rent	[ ] Own [ ] Rent	[ ] Own [ ] Rent
If rent, how much do you pay per year?			
Did you sell your harvested products?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If not, what purpose did you keep?			
Where did you sell your paddy rice?	[ ] Farm gate [ ] Rice mill [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Rice mill [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Rice mill [ ] Cooperative [ ] Other: ……
Paddy price per Kg? or per ton?			
Amount of paddy sold (Tons or Kg)			
Who did you sell to?	[ ] Cooperative [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Middleman [ ] NGO [ ] Other: ……
Did you have contract with them?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Have you ever negotiated the price?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you know the price in market when you sell it?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
How did you know?	[ ] Other farmers [ ] Media (Radio, TV) [ ] NGO [ ] Cooperative [ ] Other: ……	[ ] Other farmers [ ] Media (Radio, TV) [ ] NGO [ ] Cooperative	[ ] Other farmers [ ] Media (Radio, TV) [ ] NGO [ ] Cooperative

		[ ] Other: ……	[ ] Other: ……
What is the distance from your house to the nearest place where you can sell your paddy rice?			
What is the road situation to that nearest place?	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……

2.6 Production cost (PC) of rice

A. Nursery Preparation

Varieties	**1. .....**	**2. ……**	**3. .....……**
Season planted	[ ] Rainy season [ ] Dry season	[ ] Rainy season [ ] Dry season	[ ] Rainy season [ ] Dry season
How many kg of seeds did you use? (PC)			
If you buy, how much did it cost per kg? (PC)			
Did you apply fertilizer?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, amount of fertilizer used (kg) (PC)			
Cost of fertilizer (in currency) (PC)			
Did you use natural pesticide in nursery?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, how much did you spend? (PC)			
How did you prepare the nursery?	[ ] Manpower [ ] Animal power [ ] Machinery	[ ] Manpower [ ] Animal power [ ] Machinery	[ ] Manpower [ ] Animal power [ ] Machinery
Is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel you used? (PC)			
How much it cost per liter? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend for preparing nursery? (PC)			
How many people helped you? (PC)	Family … Hired……	Family …… Hired……	Family …….. Hired……..
If hiring, how much per day per person? (PC)			
How many days per week did you visit your nursery? (PC)			

B. Land preparation

Varieties	**1. .....**	**2. ……**	**3. .....……**
How did you prepare your fields?	[ ] Animal [ ] Two-wheel tractor [ ] Tractor	[ ] Animal [ ] Two-wheel tractor [ ] Tractor	[ ] Animal [ ] Two-wheel tractor [ ] Tractor
Is it your own or rent from others?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel did you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend for land preparation? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you flood the field by pumping water before land preparation?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Is it your own or rent from others?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many litters of fuel did you spend? (PC)			
If you rented, how much did you spend?			

C. Transplanting

Varieties	**1. .....**	**2. ……**	**3. .....……**
How many days did you spend on removing seedling? (PC)			
How many people helped you? (PC)	Family……. Hired……...	Family……. Hired……...	Family……. Hired……...
If hiring, how much per day per person? (PC)			
How many days did you spend on transplanting? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			

D. Maintaining and controlling

Varieties	**1. .....**	**2. ……**	**3. .....……**
How many times did you weed your field? (PC)			
How many days did you spend on weeding one time? (PC)			
How many people help you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you spray herbicide?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No

How much did it cost? (PC)			
How many days did you spend on spraying herbicide? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you apply fertilizer?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, amount of fertilizer used (kg) (PC)			
Cost of fertilizer (in currency) (PC)			
How many days did you spend on applying fertilizers? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you spray pesticide?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
How much did you spend on pesticide? (PC)			
How many days did you spend on spraying pesticide? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
How much did you use to control rat? (PC)			
How much did you use to control birds? (PC)			
How much did you use to control other pests? (PC)			
How many days did you spend on controlling those pests? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
How many times did you irrigate your fields? (PC)			
Do you own or rent pumping machine from others?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If you own, how many liters of fuel did you spend for one time? (PC)			
If you rented, how much you spend for one time? (PC)			
How many days did you spend for irrigating the fields for one time? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……

If hiring, how much per day per person? (PC)			
Did you spend on water fee? How much did you spend? (PC)			
How many days per week did you visit your fields? (PC)			
How many hours did you visit a day? (PC)			
How did you go to your fields?	[ ] Walking [ ] Bicycle [ ] Motorbike	[ ] Walking [ ] Bicycle [ ] Motorbike	[ ] Walking [ ] Bicycle [ ] Motorbike
If by motorbike, how many liters of fuel did you spend for one time? (PC) (Price/Litre=……)			

E. Post-harvest

Varieties	**1. .....**	**2. ……**	**3. .....……**
How did you harvest?	[ ] By hand [ ] By machinery	[ ] By hand [ ] By machinery	[ ] By hand [ ] By machinery
If machinery, is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend on harvesting? (PC)			
How many people helped you? (PC)	[ ] Family…… [ ] Hired ……..	[ ] Family…… [ ] Hired ……..	[ ] Family…… [ ] Hired ……
If hiring, how much per day per person? (PC)			
How did you transport paddy rice to your house?	[ ] Bicycle [ ] Cart [ ] Tractor [ ] Truck	[ ] Bicycle [ ] Cart [ ] Tractor [ ] Truck	[ ] Bicycle [ ] Cart [ ] Tractor [ ] Truck
Is it your own?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If you own, how many liters of fuel did you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend on transporting? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person?			
How did you thresh your paddy?	[ ] Hand [ ] Machine	[ ] Hand [ ] Machine	[ ] Hand [ ] Machine

If by machine, is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel did you spend? (PC)			
If rented, how much did you spend? (PC)			
How many days did you spend on threshing? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
How did you dry your paddy?	[ ] Traditional [ ] Machine	[ ] Traditional [ ] Machine	[ ] Traditional [ ] Machine
If by machine, is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend on drying?			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			

2.7 Tools and machineries to be used in rice production

Items (if farmer owned and used it, please check in the box)	☑	Quantities	Unit price	Bought year	How long can it be used?
Plough (traditional)					
Harrow (traditional)					
Two-wheel tractor					
Tractor					
Tractor equipment: …….....					
Pumping machine					
Pumping tube					
Transplanting tools: …….....					
Weeding tool: …….....					
Fertilizing tool: …….....					
Sprayer					
Plastic fence					
Other pest controlling tools:					

…….....					
Harvesting tools: …….....					
Harvesting machine					
Cart					
Truck					
Threshing tools: …….....					
Threshing machine					
Cleaning tools: …….....					
Tarpaulin					
Drying machine					
Sack					
Storage					

3 Livestock Situation in 2015

Animals	**Pig**	**Chicken**	**Duck**	**Cow**	**Other:……**
Number of heads					
Purpose of raising					
Number of animals sold and amount in kg					
Where did you sell your products?	[ ] Farm gate [ ] Market [ ]Cooperative [ ] Other: …	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……
Price per Kg?					
Who did you sell to?	[ ]Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ….	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……
Did you have contract with them?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Have you ever negotiated the price?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you know the price in market when you sell it?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
How did you know?	[ ] Other farmers [ ] Media [ ] NGO	[ ] Other farmers [ ] Media [ ] NGO [ ] Cooperative	[ ] Other farmers [ ] Media [ ] NGO [ ] Cooperative	[ ] Other farmers [ ] Media [ ] NGO [ ] Cooperative	[ ] Other farmers [ ] Media [ ] NGO [ ] Cooperative

	[ ]Cooperative [ ] Other: …	[ ] Other: ……	[ ] Other: ……	[ ] Other: …..	[ ] Other: …..
If you want to sell your products to the market, what is the distance to the nearest market that you can sell your products?					
What is the road situation to that nearest market?	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……..	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……..	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……..	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……

4 Other Farm and off-farm activities

4.1 Farming activities

Farm activities	Size	Unit	Period of doing?	Times per year	Are they in rice field	Income per year
Rice						
Vegetable 1. 2. 3. 4.		 Ha Ha Ha Ha			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	
Fruit tree 1. 2. 3. 4.		 Trees Trees Trees Trees			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	
Animal raising 1. 2. 3. 4.		 Heads Heads Heads Heads			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	
Aquaculture 1. 2. 3.		 Ha Ha Ha			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	

4.2 Do you have other job besides farming? [ ] Yes [ ] No

4.3 If you work as a labor in agriculture, what is the wage per day? _____

4.4 Income from off-farm activities

Off-farm activities	Tick appropriately	When you do it?	Income/month
1. Self-employment eg. Trading…			
2. Wage labor			
3. Other:……			
4. Other:……			

5 Agricultural Cooperative

5.1 Name of agricultural cooperative: _____ Date founded (year): _____

5.2 When did you join the cooperative? _____

5.3 Why did you join the cooperative?

[ ] Get paddy rice for consumption when lack of paddy rice
[ ] Access to credit
[ ] Access to farming techniques such as rice cultivation, vegetable cultivation…
[ ] Access to farm input such as fertilizers and pesticide
[ ] Access to marketing services for crops
[ ] Access to livestock techniques and livestock treatment services
[ ] Access to medicine for livestock
[ ] Access to livestock marketing
[ ] Network with other farmers
[ ] Other: (Specify) _____
_____

5.4 Did the NGO encourage you to become a member of agricultural cooperative? [ ] Yes [ ] No
If yes, name of NGO:_____

5.5 Did the government officer encourage you to become a member of agricultural cooperative? [ ] Yes [ ] No
If yes, name of institution: _____

5.6 Before becoming a member, did you have a close/good friend as a member of this cooperative? [ ] Yes [ ] No

5.7 Before becoming a member, did you have a close/good friend as a member of board directors?
[ ] Yes [ ] No

5.8 Activities of agricultural cooperative:

[ ] Credit
[ ] Saving
[ ] Rice bank
[ ] Rice business
[ ] Fertilizer business
[ ] Grocery
[ ] Livestock marketing what animals? (Specify) _____
[ ] Livestock technical extension what animals? (Specify) _____
[ ] Animal treatment services what animals? (Specify) _____
[ ] Crop marketing what crops? (Specify) _____
[ ] Crop technical extension what crops? (Specify) _____

[ ] Rice mill
[ ] Other: (specify:……)

5.9 Did you join all business activities? [ ] Yes [ ] No

5.10 Do you regularly join the meetings in 2015? [ ] Yes [ ] No

5.11 How many meetings did you join in 2015? _____

5.12 Did the cooperative provided technical trainings in 2015 for your agricultural production?
[ ] Yes; [ ] No

5.13 If yes, how many trainings did cooperative provide? _____

5.14 Do you know the cooperative gets any funds or supports from any institution? [ ] Yes [ ] No

5.15 If yes, what are they? [ ] Government [ ] NGO (specify……..)
[ ] Other (specify…….)

5.16 Did you use credit service from agricultural cooperative in 2015? [ ] Yes [ ] No

5.17 If yes, what are the purposes of credit use?
[ ] Agricultural production [ ] Household expenditure
[ ] Other: (specify) ……

5.18 Did you use rice bank service from agricultural cooperative in 2015? [ ] Yes [ ] No

5.19 If yes, what are the purposes of the use of rice bank service?
[ ] Food consumption [ ] Used as seed [ ] Sale
[ ] Other: (specify)……

5.20 Business size in agricultural cooperative in 2015

Business/ Service activities	Specific crop/ animal	Number of shares	Dividend	Business size			Cost	Net income
				Quantity (kg or ton)	Price per unit (kg or ton)	Total sale		
Marketing	Rice							
	Pig							
	Chicken							
	Duck							
	Cow							
	Other (specify)….							
	Other (specify)….							
	Other (specify)...							
Agricultural input supply	Fertilizer							
	Feed							
	Animal medicine							
	Seed							
	Other (specify)...							
	Other (specify)...							
	Other (specify)…							
Other (specify …….)								

Business/Service activities	Number of shares	Dividend	Initial amount borrowed/ saved	Duration of services in 2015	Interest rate per month or year	Total amount
Credit						
Saving						
Rice bank						
Other (specify……)						

5.21 Business activities/services used other than agricultural cooperative's

Activities	Specific crop/animal	Person/ Agency involved	Quantity (in kg or ton)	Price per kg	Total amount in currency
Marketing	Rice				
	Pig				
	Chicken				
	Duck				
	Cow				
	Other (specify)…..				
	Other (specify)…..				
	Other (specify)…..				
Agricultural input supply	Fertilizer				
	Feed				
	Animal medicine				
	Seed				
	Other (specify)…..				
	Other (specify)…..				
	Other (specify)…..				
Credit				(Interest rate)…...	
Saving				(Interest rate)…...	

6 Food Security

6.1 Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night at home. Start with the first food or drink of the morning.

Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned.

Breakfast	**Snack**	**Lunch**	**Snack**	**Dinner**	**Snack**

Note: include foods eaten by any members of the household, and **exclude foods purchased and eaten outside the home**.

Appendix 2 Questionnaire for Non-member of Agricultural Cooperatives

Village: _____ Commune: _____ District: Tramkak Province: Takeo

Date: _/_____ / 2016

1. General information of household

Is the household head answering this questionnaire?
[ ] Yes [ ] No, what is your relation to household head?
[ ] Spouse [ ] Parents [ ] Children [ ] Sibling
[ ] Other (specify _____)
Contact number of person answering this questionnaire: _____

1.1 Name of household head: _____
1.2 Age of household head: _____
1.3 Gender of household head: [ ] Male [ ] Female
1.4 Years of formal schooling: _____
1.5 What is main occupation of household head? : [ ] Farmer [ ] Other (specify _____)
1.6 How many members are there in your family? _____
1.7 Family member information

Relationship with HH	Age	Gender	Schooling (years)	Occupation	Do they help in farming?	How many hours do they help per week?	Monthly salary/ income
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		
		[ ] M; [ ] F			[ ] Y; [ ] N		

1.8 Housing condition: [ ] Thatched cottage [ ] Wooden house
[ ] Wood-brick house [ ] Brick house [ ] Other (specify _____)
1.9 What is the general road condition in your community?
[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable
[ ] Track unusable in certain periods of the year [ ] Other (specify _____)
1.10 Do you have these stuffs in your house? [ ] Radio [ ] TV
[ ] Motorcycle [ ] Car

2. Rice farming information

2.1 Total agricultural land size= _____ ha (excluding housing land)
2.2 Land size owned for rice cultivation _____ ha
How did you get this land?
[ ] Inherited Land size:_____ ha
[ ] Buy Land size:_____ ha
When did you buy? _____
How much was the price? _____
Have you paid all land cost or still paying installment?
[ ] Paid all land cost [ ] Still paying installments
If you are still paying installments, how much do you pay per month? _____
How many more months do you have to pay installments?
_____ Months

2.3 Amount of land rent for rice planting _____ ha

2.4 Renting cost _____

2.5 Rice cultivation situation in 2015

Varieties	1. ……	2. ……	3. ……
Type of varieties	[ ] Early [ ] Medium [ ] Late	[ ] Early [ ] Medium [ ] Late	[ ] Early [ ] Medium [ ] Late
Source of varieties	[ ] Market [ ] Own self [ ] Cooperative [ ] Other:……	[ ] Market [ ] Own self [ ] Cooperative [ ] Other:…….	[ ] Market [ ] Own self [ ] Cooperative [ ] Other:……
Production areas (ha)			
Total production (Tons)			
How many land plots for this variety?			
Access to water supply	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you do it in dry season?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you plant anything before or after harvesting?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, please list it.	1. 2.	1. 2.	1. 2.
Is it your own or rent from others?	[ ] Own [ ] Rent	[ ] Own [ ] Rent	[ ] Own [ ] Rent
If rent, how much do you pay per year?			
Did you sell your harvested products?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If not, what purpose did you keep?			
Where did you sell your paddy rice?	[ ] Farm gate [ ] Rice mill [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Rice mill [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Rice mill [ ] Cooperative [ ] Other: ……
Paddy price per Kg? or per ton?			
Amount of paddy sold (Tons or Kg)			
Who did you sell to?	[ ] Cooperative [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Middleman [ ] NGO [ ] Other: ……
Did you have contract with them?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Have you ever negotiated the price?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you know the price in market when you sell it?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
How did you know?	[ ] Other farmers [ ] Media (Radio, TV) [ ] NGO [ ] Cooperative [ ] Other: ……	[ ] Other farmers [ ] Media (Radio, TV) [ ] NGO [ ] Cooperative [ ] Other: ……	[ ] Other farmers [ ] Media (Radio, TV) [ ] NGO [ ] Cooperative [ ] Other: ……

What is the distance from your house to the nearest place where you can sell your paddy rice?			
What is the road situation to that nearest place?	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……

2.6 Production cost (PC) of rice

A. Nursery Preparation

Varieties	**1. .....**	**2. ……**	**3. .....……**
Season planted	[ ] Rainy season [ ] Dry season	[ ] Rainy season [ ] Dry season	[ ] Rainy season [ ] Dry season
How many kg of seeds did you use? (PC)			
If you buy, how much did it cost per kg? (PC)			
Did you apply fertilizer?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, amount of fertilizer used (kg) (PC)			
Cost of fertilizer (in currency) (PC)			
Did you use natural pesticide in nursery?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, how much did you spend? (PC)			
How did you prepare the nursery?	[ ] Manpower [ ] Animal power [ ] Machinery	[ ] Manpower [ ] Animal power [ ] Machinery	[ ] Manpower [ ] Animal power [ ] Machinery
Is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel you used? (PC)			
How much it cost per liter? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend for preparing nursery? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …….. Hired……..
If hiring, how much per day per person? (PC)			
How many days per week did you visit your nursery? (PC)			

B. Land preparation

Varieties	**1. .....**	**2. ……**	**3. .....……**
How did you prepare your fields?	[ ] Animal [ ] Two-wheel tractor [ ] Tractor	[ ] Animal [ ] Two-wheel tractor [ ] Tractor	[ ] Animal [ ] Two-wheel tractor [ ] Tractor
Is it your own or rent from others?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel did you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend for land preparation? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you flood the field by pumping water before land preparation?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Is it your own or rent from others?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many litters of fuel did you spend? (PC)			
If you rented, how much did you spend?			

C. Transplanting

Varieties	**1. .....**	**2. ……**	**3. .....……**
How many days did you spend on removing seedling? (PC)			
How many people helped you? (PC)	Family……. Hired……...	Family……. Hired……...	Family……. Hired……...
If hiring, how much per day per person? (PC)			
How many days did you spend on transplanting? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			

D. Maintaining and controlling

Varieties	**1. .....**	**2. ……**	**3. .....……**
How many times did you weed your field? (PC)			
How many days did you spend on weeding one time? (PC)			
How many people help you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you spray herbicide?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No

How much did it cost? (PC)			
How many days did you spend on spraying herbicide? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you apply fertilizer?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If yes, amount of fertilizer used (kg) (PC)			
Cost of fertilizer (in currency) (PC)			
How many days did you spend on applying fertilizers? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
Did you spray pesticide?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
How much did you spend on pesticide? (PC)			
How many days did you spend on spraying pesticide? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
How much did you use to control rat? (PC)			
How much did you use to control birds? (PC)			
How much did you use to control other pests? (PC)			
How many days did you spend on controlling those pests? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
How many times did you irrigate your fields? (PC)			
Do you own or rent pumping machine from others?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If you own, how many liters of fuel did you spend for one time? (PC)			
If you rented, how much you spend for one time? (PC)			
How many days did you spend for irrigating the fields for one time? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……

If hiring, how much per day per person? (PC)			
Did you spend on water fee? How much did you spend? (PC)			
How many days per week did you visit your fields? (PC)			
How many hours did you visit a day? (PC)			
How did you go to your fields?	[ ] Walking [ ] Bicycle [ ] Motorbike	[ ] Walking [ ] Bicycle [ ] Motorbike	[ ] Walking [ ] Bicycle [ ] Motorbike
If by motorbike, how many liters of fuel did you spend for one time? (PC) (Price/Litre=……)			

E. Post-harvest

Varieties	**1. .....**	**2. ……**	**3. .....……**
How did you harvest?	[ ] By hand [ ] By machinery	[ ] By hand [ ] By machinery	[ ] By hand [ ] By machinery
If machinery, is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend on harvesting? (PC)			
How many people helped you? (PC)	[ ] Family…… [ ] Hired ……..	[ ] Family…… [ ] Hired ……..	[ ] Family…… [ ] Hired ……
If hiring, how much per day per person? (PC)			
How did you transport paddy rice to your house?	[ ] Bicycle [ ] Cart [ ] Tractor [ ] Truck	[ ] Bicycle [ ] Cart [ ] Tractor [ ] Truck	[ ] Bicycle [ ] Cart [ ] Tractor [ ] Truck
Is it your own?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
If you own, how many liters of fuel did you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend on transporting? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person?			
How did you thresh your paddy?	[ ] Hand [ ] Machine	[ ] Hand [ ] Machine	[ ] Hand [ ] Machine

If by machine, is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel did you spend? (PC)			
If rented, how much did you spend? (PC)			
How many days did you spend on threshing? (PC)			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			
How did you dry your paddy?	[ ] Traditional [ ] Machine	[ ] Traditional [ ] Machine	[ ] Traditional [ ] Machine
If by machine, is it your own?	[ ] My own [ ] Rent	[ ] My own [ ] Rent	[ ] My own [ ] Rent
If your own, how many liters of fuel you spend? (PC)			
If you rented, how much did you spend? (PC)			
How many days did you spend on drying?			
How many people helped you? (PC)	Family …… Hired……	Family …… Hired……	Family …… Hired……
If hiring, how much per day per person? (PC)			

2.7 Tools and machineries to be used in rice production

Items (if farmer owned and used it, please check in the box)	☑	Quantities	Unit price	Bought year	How long can it be used?
Plough (traditional)					
Harrow (traditional)					
Two-wheel tractor					
Tractor					
Tractor equipment: …….....					
Pumping machine					
Pumping tube					
Transplanting tools: …….....					
Weeding tool: …….....					
Fertilizing tool: …….....					
Sprayer					
Plastic fence					

Other pest controlling tools: …….....					
Harvesting tools: …….....					
Harvesting machine					
Cart					
Truck					
Threshing tools: …….....					
Threshing machine					
Cleaning tools: …….....					
Tarpaulin					
Drying machine					
Sack					
Storage					

3 Livestock Situation in 2015

Animals	**Pig**	**Chicken**	**Duck**	**Cow**	**Other:……**
Number of heads					
Purpose of raising					
Number of animals sold and amount in kg					
Where did you sell your products?	[ ] Farm gate [ ] Market [ ]Cooperative [ ] Other: …	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……	[ ] Farm gate [ ] Market [ ] Cooperative [ ] Other: ……
Price per Kg?					
Who did you sell to?	[ ]Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ….	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……	[ ] Cooperative [ ] Consumer [ ] Middleman [ ] NGO [ ] Other: ……
Did you have contract with them?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Have you ever negotiated the price?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
Did you know the price in market when you sell it?	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No	[ ] Yes [ ] No
How did you know?	[ ] Other farmers [ ] Media	[ ] Other farmers [ ] Media [ ] NGO	[ ] Other farmers [ ] Media [ ] NGO	[ ] Other farmers [ ] Media [ ] NGO	[ ] Other farmers [ ] Media [ ] NGO

	[ ] NGO [ ]Cooperative [ ] Other: …	[ ] Cooperative [ ] Other: ……	[ ] Cooperative [ ] Other: ……	[ ] Cooperative [ ] Other: …..	[ ] Cooperative [ ] Other: …..
If you want to sell your products to the market, what is the distance to the nearest market that you can sell your products?					
What is the road situation to that nearest market?	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……..	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……..	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……..	[ ] Asphalt [ ] Track in good shape all year round [ ] Track hardly usable [ ] Track unusable in certain periods of year [ ] Other:……

4 Other Farm and off-farm activities

4.1 Farming activities

Farm activities	Size	Unit	Period of doing?	Times per year	Are they in rice field	Income per year
Rice						
Vegetable 1. 2. 3. 4.		 Ha Ha Ha Ha			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	
Fruit tree 1. 2. 3. 4.		 Trees Trees Trees Trees			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	
Animal raising 1. 2. 3. 4.		 Heads Heads Heads Heads			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	
Aquaculture 1. 2. 3.		 Ha Ha Ha			 [ ] Yes[ ] No [ ] Yes[ ] No [ ] Yes[ ] No	

4.2 Do you have other job besides farming? [ ] Yes [ ] No

4.3 If you work as a labor in agriculture, what is the wage per day? _____

4.4 Income from off-farm activities

Off-farm activities	Tick appropriately	When you do it?	Income/month
1.			
2.			

5. Sale of agricultural products in 2015

5.1 Are there any agricultural cooperatives in your village? [ ] Yes [ ] No

5.2 If there is, why don't you join them? _____

5.3 Are there any NGOs support/encourage you to become a member of agricultural cooperatives? [ ] Yes [ ] No If yes, what NGO? _____

5.4 Are there any governmental agencies support/encourage you to become a member of agricultural cooperatives? [ ] Yes [ ] No If yes, what agency? _____

5.5 Do you have any close friends who are members of agricultural cooperatives? [ ] Yes [ ] No

5.6 Do you have any close friends who are committee members of agricultural cooperatives? [ ] Yes [ ] No

Activities	**Specific crop/animal**	**Person/ Agency involved**	**Quantity (in kg or ton)**	**Price per kg**	**Total amount in currency**
Marketing	Rice				
	Pig				
	Chicken				
	Duck				
	Cow				
	Other (specify)…..				
Agricultural input supply	Fertilizer				
	Feed				
	Animal medicine				
	Seed				
	Other (specify)…..				
Other					

Business/Service activities	**Involving agencies**	**Initial amount borrowed/ saved**	**Duration of services in 2015**	**Interest rate per month or year**	**Total amount**
Credit					
Saving					
Rice bank					
Other (specify……)					

6. Food Security

6.1 Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night at home. Start with the first food or drink of the morning.
Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned.

Breakfast	**Snack**	**Lunch**	**Snack**	**Dinner**	**Snack**

Note: include foods eaten by any members of the household, and **exclude foods purchased and eaten outside the home**.

Impacts of Agricultural Cooperatives on Farmers' Revenues and Farm Households' Food Security in Cambodia:
A Case Study of Tram Kak District, Takeo Province

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Chapter 1: Introduction

Presentation Outline

1.1. A history of agricultural cooperatives in Cambodia

- The population of Cambodia was estimated at 14.68 million in 2013 (NIS, 2013). Among the total 3.16 million households, 2.5 million households lived in rural areas (ADB, 2014). Agriculture shared more than 30% of the gross domestic product (GDP), and it employed approximately 45% of the total workforce in 2014 (MAFF, 2016).

1.1. A history of agricultural cooperatives in Cambodia (cont.1)

- Due to the significance of agriculture in Cambodia, the Ministry of Agriculture, Forestry and Fisheries has initiated programs to promote agricultural cooperative movement in the country. These programs are intended to boost agricultural production, diversify crop production, create income-generating activities through business development and also expand markets for commercializing all kinds of agricultural products produced by cooperative members (MAFF, 2008).
- Between 2003 and 2015, as many as 750 agricultural cooperatives were established and registered at the Ministry of Agriculture, Forestry and Fisheries (MAFF, 2016).

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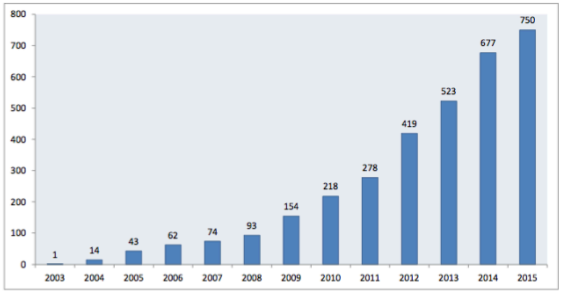
1.1. A history of agricultural cooperatives in Cambodia (cont.2)

Figure 1.1. Number of agricultural cooperatives in Cambodia from 2003 to 2015



Source: MAFF (2016)

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1.4. Structure of dissertation

Chapter 1: Introduction

Chapter 2: Background, literature reviews, justification and objectives

Chapter 3: Impacts of agricultural cooperatives on farmers' revenues

Chapter 4: Impacts of agricultural cooperatives on farm households' food security

Chapter 5: General conclusions and recommendations

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1.4. Structure of dissertation

- **Chapter 1** provides introduction and a history of agricultural cooperatives in Cambodia.
- **Chapter 2** describes background on overview of agriculture in Cambodia as well as general information related to agricultural cooperatives including the historical background, definition, principle, structure and objectives of agricultural cooperatives in Cambodia, and provides a literature review of existing studies such as impacts of agricultural cooperatives in other countries and perception of success of agricultural cooperatives in Cambodia and worldwide, and finally states the justification of this study.
- **Chapter 3** addresses the factors influencing farmers' decision on becoming a member of agricultural cooperatives using Probit model and assess the impacts of membership on farmers' revenues from paddy, livestock and farm using propensity score matching techniques.
- **Chapter 4** covers the impacts of membership in agricultural cooperatives on farm households' food security and other determinants using instrumental variables.
- **Chapter 5** gives the general conclusion, draws recommendations and states the limitation of the research.

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Chapter 2: Background, Literature Reviews, Justification and Objectives

2.3. Justification of this research

- Hun *et al*., (2017) conducted a study on members' perception of success in agricultural cooperatives in Cambodia, and they found that the cooperative members perceived revenue related indicators (e.g. dividend from agricultural cooperatives, ease of selling agricultural products and access to marketing information) and food security related indicators (e.g. technical improvement in poultry, cow and pig raisings, and access to paddy for consumption when in need) as among the most important ones of success in their agricultural cooperatives. Afolami *et al.*, (2012) found no significant difference in yields between non-members and members of rice agricultural cooperatives in Nigeria. Hoken *et al.*, (2015) also found no significant difference in net income between participants and non-participants in rice producing cooperatives in China.
- However, very limited studies have been conducted regarding the impacts of membership in agricultural cooperatives on farmers' revenues and farm households' food security in Cambodia. Such studies are important to efficiently establish marketing power of the producers.

2.4. Main objectives

1. To assess the impacts of membership in agricultural cooperatives on farmers' revenues
2. To assess the impacts of membership in agricultural cooperatives on farm households' food security and other determinants.

Specific objectives

1. To identify factors influencing farmers' decision on membership in agricultural cooperatives
2. To assess impacts of membership in agricultural cooperatives on farmers' revenues from paddy, livestock and farm
3. To assess impacts of membership in agricultural cooperatives on farm households' food security and other determinants of food security

Chapter 3: Impacts of Agricultural Cooperatives on Farmers' Revenues in Cambodia

--A Case Study of Tram Kak District, Takeo Province--

3.1. Research Objectives

Objective 1:

- To identify factors influencing membership in agricultural cooperatives

Objective 2:

- To assess the impacts of membership in agricultural cooperatives on farmers' paddy revenue, yields, and livestock and farm revenues

3.2. Research Methodology

Study Area

- Tram Kak district, Takeo province

Sample Size

- 242 households (99 members and 143 non-members) were randomly selected

Period of Data Collection

- September and October 2016

Data Collection Method

- Face-to-face structured interviews with members and non-members

3.2. Research Methodology (cont.1)

Figure 3.1 Administrative map of Cambodia and map of Takeo province

Source: Nations Online Project, Administrative Map of Cambodia

3.2. Research Methodology (cont.2)

Objective 1: Probit model

Probit model (Becker *et al.*, 2002)

$$Y(1,0) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_n X_n$$

where,

Y is a dependent variable (1=member ; 0=non-member)

β's are the regression coefficients to be estimated

X's are independent variables

3.2. Research Methodology (cont.3)

- **Objective 2:** Propensity Score Matching using single nearest neighbor matching

$$ATT = E(Y_1 - Y_0|x, D = 1) = E(Y_1|x, D = 1) - E(Y_0|x, D = 1)$$

where,

D is an indicator variable equal to 1 if the farmer is a member

x's are control variables

Y_1 are the members' outcomes

Y_0 are the non-members' outcomes

Outcome variables used this study are paddy yield, paddy revenue, livestock revenue and farm revenue

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3.2.Research Methodology (cont.4)

Table 3.1 Definition of variables

Variables	Definition	Unit
Dependent variable (used in probit model)		
Farmer status	1 = Member of agricultural cooperative; 0 = non-member	
Independent variables (used in probit model)		
Age	Age of household head	Year
Gender	Gender of household head; 1 = male; 0 = female	Dummy
Education	Years of education of household head	Year
Household size	Number of household members	Number
Paddy land	Paddy land size	Hectare
Paddy sale	Farmers who sell their paddy = 1; 0 = otherwise	Dummy
Off-farm	Annual income of household head from off-farm job	US $
TV owned	Household having TV = 1; 0 = otherwise	Dummy
Car	Household having car = 1; 0 = otherwise	Dummy
Extension	Having contact with extension workers related to agricultural cooperatives = 1; 0 = otherwise	Dummy
Access to road	Access to good road in village = 1; 0 = otherwise	Dummy
Outcome variables (used in matching of propensity score)		
Paddy yield	Yield per hectare	Kg/ha
Paddy revenue	Total revenue from paddy per hectare	US $/ha
Livestock revenue	Total revenue from animals (pigs and poultry) per year	US $
Farm revenue	Total revenue from farm activities (paddy, crop, animal, aquaculture) per year	US $

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3.3. Results – Descriptive Results

Table 3.2 Characteristic difference between members and non-members before and after matching

Variables	Before matching				After matching			
	Member Mean	Non-member Mean	Difference	Tests[1]	Member Mean	Non-member Mean	Difference	Tests[1]
Age	46.86	47.02	-0.16	-0.09	46.86	46.07	0.80	0.53
Gender	0.89	0.90	-0.01	-0.15	0.89	0.93	-0.04	-0.99
Education	5.93	5.41	0.52	1.28	5.93	4.32	1.61***	3.34
Household size	4.68	3.83	0.85***	4.61	4.68	3.80	0.88***	4.55
Paddy land	0.97	0.79	0.19***	2.84	0.97	0.85	0.12	1.53
Paddy sale	0.82	0.63	0.19***	3.17	0.82	0.83	-0.01	-0.19
Off-farm	368.43	427.78	-59.35	0.57				
Log(off-farm)	1.02	1.17	-0.15	0.82	1.02	1.11	-0.09	-0.43
TV owned	0.92	0.93	-0.01	-0.32	0.92	0.88	0.04	0.94
Car	0.02	0.03	-0.01	-0.38	0.02	0.03	-0.01	-0.45
Extension	0.87	0.08	0.79***	12.36	0.87	0.87	0.00	0.00
Access to road	0.39	0.38	0.01	0.15	0.39	0.37	0.02	0.29

Source: own survey (2016)

Note: Mean bias= 17.1%. Number of observations=242; *, **, *** significant at 10%, 5%, 1% respectively; 1: We use t-test for mean comparison and z-test for proportion comparison

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3.3. Results – Determining factors

Table 3.3 Results of probit model for factors influencing membership in agricultural cooperatives

Variables	Probit estimates		Marginal effects	
	Coef.	Std. Err.	Dy/dx	Std. Err.
Age	-4.49E-3	1.04E-2	6.77E-4	1.58E-3
Gender	-0.76*	0.41	-0.11*	6.09E-2
Education	2.99E-2	4.66E-2	4.51E-3	7.01E-3
Household size	4.79E-2	0.10	7.21E-3	1.50E-2
Paddy land	-0.25	0.27	-3.75E-2	4.02E-2
Paddy sale	0.61*	0.36	9.21E-2*	5.35E-2
Log(off-farm)	-0.37***	0.12	-5.63E-2***	1.73E-2
TV owned	7.54E-2	0.47	1.13E-2	7.07E-2
Car	0.35	0.69	5.33E-2	0.10
Extension	3.04***	0.33	0.46***	3.32E-2
Access to road	0.28	0.30	4.14E-2	4.54E-2
_cons	-1.07	0.88		
Log likelihood	-67.07			
LR Chi^2	193.29			
Pseudo R^2	0.59			

Source: Own survey (2016)

Note: Number of observations=242; *, **, *** significant at 10%, 5%, 1% respectively

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3.3. Results – Determining factors (Cont.1)

- According to the probit estimates, **paddy sale** and having contact with **extension workers** are positively associated with the decision to become members of agricultural cooperatives, while a **male-headed household (gender)** and **off-farm income** are negatively associated.
- **Paddy sale**: the probability of becoming a member in agricultural cooperatives of farmers who sold their paddy increases by 0.092 (holding all other variables constant) compared to farmers who did not sell their paddy.

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3.3. Results – Determining factors (Cont.2)

- **Contact with extension workers**: farmers who had been in contact with extension workers were more likely to join the cooperatives because they had got the information on the benefits of the cooperatives, and their probability of becoming a member of an agricultural cooperative increases by 0.46 holding all other variables constant. This result is in line with Debeb *et al.*, (2016), who found that access to information on the benefits of agricultural cooperatives encouraged farmers to join the cooperatives in Ethiopia.

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3.3. Results – Determining factors (Cont.3)

- **Gender**: If the household heads were males, the probability of becoming a member of agricultural cooperatives decreased by 0.11 (holding all other variables constant) compared to female household heads. This is contrary to the finding of Bernard *et al.*, (2009), and Abebaw *et al.*, (2013) who found that woman-headed households were less likely to join the cooperatives in Ethiopia. Also, Mayoux (1999) mentioned that females in Africa have a limited chance of joining in collective activities such as cooperatives.
- **Off-farm income**: one percent increase in off-farm income, the probability of becoming a member of agricultural cooperatives decreases by 0.056 (holding all other variables constant). Farmers who had higher off-farm income were less likely to join the cooperatives because they were busy with off-farm jobs, and rice was not their main source of income. This is consistent with the finding of Nugusse *et al.,* (2012), who found that households with special skills other than farming were less likely to join the cooperatives in Northern Ethiopia.

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3.4. Result-Propensity Score Matching

Table 3.4 Results of Propensity Score Matching

Outcomes	Sample	Member	Non-member	Difference	S.E.	T-stat
Paddy yield	Unmatched	2,889.08	2,956.46	-67.38	57.38	-1.17
	ATT	2,889.08	2,944.68	-54.98	193.63	-0.28
	ATU	2,861.17	2,956.46	-95.30	158.89	-0.60
Paddy revenue	Unmatched	815.57	822.22	-6.65	23.96	-0.28
	ATT	815.57	818.07	-2.51	60.18	-0.04
	ATU	718.76	822.22	-103.45**	47.31	-2.19
Livestock revenue	Unmatched	421.61	288.73	132.88***	51.33	2.59
	ATT	421.61	202.19	219.41***	84.60	2.59
	ATU	299.08	288.73	10.36	74.16	0.14
Farm revenue	Unmatched	1,291.26	968.43	322.83***	91.16	3.54
	ATT	1,291.26	887.84	403.42*	214.20	1.88
	ATU	904.85	968.43	-63.59	290.33	-0.22

Source: own-survey (2016)
Note: Mean bias= 17.1%. *, **, *** significant at 10%, 5%, 1% respectively
ATT: Average Treatment Effect on Treated, ATU: Average Treatment Effect on Untreated

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3.4. Result-Propensity Score Matching (cont.1)

- The results of the propensity score matching suggest membership in agricultural cooperatives has no impact on paddy yield and revenue because there is no significant difference between members and non-members with and without matching process. This is due to the fact that the cooperatives have not provided sufficient trainings, and members did not actively attend the trainings. Furthermore, the cooperatives fail to provide better prices comparing to other traders. Afolami *et al.*, (2012) also found no significant difference in yields between non-members and members of rice agricultural cooperatives in Nigeria. Similarly, Hoken *et al.*, (2015) also found no significant difference in net income between participants and non-participants in rice producing cooperatives in China.

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3.4. Result-Propensity Score Matching (cont.2)

- However, members could obtain more revenue from livestock by US$219.41 and from farm as a whole by US$403.42, respectively, than non-members. These results show that being a member have significantly positive impacts on livestock and farm revenue, according to ATT. The cooperatives provided training on livestock operation and encourage members to raise more livestock, so this leads to positive impacts. But it is not significant according to ATU; therefore, there may be no significant impact of becoming a member in terms of livestock and farm revenues.

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3.5. Conclusion

Objective 1:

- Farmers who sold their paddy and who contacted extension workers are more likely to join the cooperatives.
- Male farmers and higher off-farm income farmers are less likely to join the cooperatives.

Objective 2:

- Agricultural cooperatives have no impact on paddy yield and paddy revenue.
- There are positive impacts on livestock and farm revenues for member group .

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Chapter 4: Impact of Agricultural Cooperatives on Farm Households' Food Security in Tram Kak District, Takeo Province, Cambodia

Objective: To identify impact of membership in agricultural cooperatives on farm households' food security and other factors influencing food security

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4.1. Research Methodology

Instrumental Variables (IV) Estimation (Wooldridge, 2013)

$$y_1 = \beta_0 + \beta_1 y_2 + \beta_2 z_1 + u_1 \quad (1)$$

where,
y_1 is Household Dietary Diversity Score (HDDS)
β's are the regression coefficients to be estimated
y_2 is described in equation 2
z_1 is explanatory variables
u_1 is the error term

$$y_2 = \pi_0 + \pi_1 z_1 + \pi_2 z_2 + v_2 \quad (2)$$

where,
y_2 is a dependent variable (1=member ; 0=non-member)
z_2 is explanatory variables
v_2 is the error term

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4.1. Research Methodology (cont.1)

Table 4.1 Definition of variables

Variables	Definition	Unit
HDDS	Household Dietary Diversity Score	
Farmer status	1=Member of agricultural cooperative; 0=non-member	
Age	Age of household head	Year
Gender	Gender of household head; 1=male; 0=female	Dummy
Education	Years of education of household head	Year
Household size	Number of household members	Number
Paddy land size	Total paddy land size	Hectare
Off-farm	Annual income of household head from off-farm job	U.S $
Household Income	Total annual income of household	U.S $
TV	Household having tv=1; 0=otherwise	Dummy
Car	Household having car=1; 0=otherwise	Dummy
Extension	Having contact with extension officers related to agricultural cooperatives=1; 0=otherwise	Dummy
Access to road	Access to good road in village=1; 0=otherwise	Dummy
Livestock	Raising poultry and pigs=1; 0=otherwise	Dummy

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4.1 Research Methodology (cont.2)

- Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individuals. The dietary diversity scores consist of a simple count of food groups that a household or an individual has consumed over the preceding 24 hours (FAO, 2011).
- The household dietary diversity score (HDDS) is meant to reflect, in a snapshot form, the economic ability of a household to access to a variety of foods (FAO, 2011). Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (Hoddinott *et al.*, 2002).
- There are 12 food groups in HDDS, and HDDS ranges from 0 to 12.

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4.2. Results

Table 4.2 Characteristic difference between members and non-members

Variables	Member Mean	Non-member Mean	Difference	Tests[1]
Age	46.86	47.14	-0.28	-0.16
Gender	0.89	0.89	0.00	0.02
Education	5.93	5.47	0.46	1.08
Household size	4.68	3.84	0.84***	4.42
Paddy land size	0.97	0.79	0.18***	2.67
Off-farm	368.43	400.76	-32.33	-0.31
Household income	4,014.71	3296.99	717.72**	1.93
TV	0.92	0.93	-0.01	-0.17
Car	0.03	0.02	0.01	0.45
Extension	0.87	0.08	0.79***	12.17
Access to road	0.39	0.41	-0.02	-0.25
Livestock	0.99	0.93	0.06**	2.30
HDDS	7.06	6.63	0.43***	3.26

Source: own survey (2016)
Note: Number of observations = 233; *, **, *** significant at 10%, 5%, 1% respectively; 1: We use t-test for mean comparison and z-test for proportion comparison

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4.2. Results (cont.1)

Table 4.4 Determinants of membership in agricultural cooperatives

Member	Coef.	Std. Err.	z	P>z
Age	-3.85E-3	1.05E-2	-0.37	0.714
Gender	-0.76*	0.42	-1.82	0.068
Education	2.08E-2	4.57E-2	0.45	0.650
Household size	0.10	0.12	0.86	0.389
Paddy Land	7.16E-2	0.25	0.28	0.777
Off-farm	-0.92***	0.33	-2.78	0.005
TV	0.26	0.46	0.57	0.567
Car	7.73E-2	0.67	0.12	0.908
Extension	2.99***	0.32	9.38	0.000
Good road	8.17E-2	0.27	0.30	0.766
Livestock	0.51	0.90	0.57	0.568
Household income	6.04E-5	5.49E-5	-1.10	0.271
_cons	-1.49	1.23	-1.21	0.226
LR ratio Chi^2 (12)	184.91			
Pseudo R^2	0.58			

Source: own survey (2016)

Note: Number of observations=233 and *, **, *** significant at 10%, 5%, 1% respectively; 1: We use t-test for mean comparison and z-test for proportion comparison

4.2. Results (cont.2)

- Male household heads were less likely to become a member of agricultural cooperatives. Moreover, households with higher off-farm income were less likely to join the cooperatives. In contrast, farmers who had contacted the extension workers were more likely to become a member of agricultural cooperatives.

4.2. Results (cont.3)

Prior to the second stage regression, tests for endogeneity and over-identifying restrictions of instruments were conducted.

Table 4.5 Test of endogeneity

Durbin (score) $chi^2(1)$	=	3.0741	(p =	0.0796)
Wu-Hausman F(1,221)	=	2.9547	(p =	0.0870)

Durbin and Wu-Hausman tests use the null hypothesis that the variable being investigated could be treated as exogenous (StataCorp, 2013). These two tests are significant at 10% level, so it is not unreasonable to treat membership as endogenous.

4.2. Results (cont.4)

Table 4.6 Test of overidentifying restrictions

Sargan (score) chi2(2)	=	1.4384	(p =	0.4871)
Basmann chi2(2)	=	1.3666	(p =	0.5050)

Sargan's and Basmann's tests for overidentifying restrictions show no significance, so we could not reject the null hypothesis that our instruments are valid.

4.2. Results (cont.5)

Table 4.7 Results of 2SLS IV estimation

HDDS	Coef.	Std. Err.	z	P>z
Membership	0.50***	0.17	3.03	0.002
Age	7.30E-4	5.07E-3	0.14	0.886
Education	1.66E-2	2.15E-2	0.77	0.439
Household size	-3.68E-2	0.05	-0.70	0.486
Paddy land	0.24*	0.13	1.82	0.068
Household income	5.38E-5**	2.65E-5	2.03	0.042
TV	0.61**	0.24	2.55	0.011
Car	0.20	0.39	0.53	0.593
Access to road	0.25*	0.13	1.95	0.052
Livestock	0.50*	0.31	1.65	0.099
_cons	5.08	0.46	10.95	0.000
R^2	0.15			
Wald Chi^2 (10)	45.34			

Source: own survey (2016)

Note: Number of observations=233 and *, **, *** significant at 10%, 5%, 1% respectively;

1: We use t-test for mean comparison and z-test for proportion comparison

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4.2. Results (cont.6)

- The membership in agricultural cooperatives positively influences the HDDS, and the results indicate members in agricultural cooperatives could have HDDS 0.50 higher comparing to non-members. This is because agricultural cooperatives provided agricultural trainings, so that the members could consume the agricultural products they produced as food and sell them for revenue. Also, members could use credit service of agricultural cooperatives to purchase food or invest in agricultural production, and they could use rice bank service as food or sell paddy they borrowed to purchase food. Moreover, livestock operation positively influenced the food security score.

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4.2. Results (cont.7)

- Farm households with large paddy land had significantly higher HDDS because farmers with large paddy land could produce more food and generate more revenue. This is in line with Seng, K. (2016) who found that land area has positive influences on the household food security. Similarly, Feleke *et al.,* (2005) and Mitiku *et al.*, (2012) also found that farm size was positively associated with food security, and the likelihood of food security increases with the increase in farm size in Southern Ethiopia.

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4.2. Results (cont.8)

- Household income positively associates with HDDS, and the results show that if households having US$1,000 more in household income, then its HDDS increases by 0.054. Similarly, this result is consistent with Esturk and Oren (2014) who found that households with higher income have better food security status comparing to lower-income household in Turkey.

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4.2. Results (cont.9)

- Farm households who owned TV had HDDS 0.61 higher than farmers who did not. This may be that because some agricultural production documentary and nutrition education programs are broadcasted on TV, farmers who own TV may have better nutrition knowledge and agricultural techniques, leading to higher HDDS.
- With access to good roads, farm households have HDDS 0.25 higher comparing to farm households who do not. With good roads, farmers could easily go to do their off-farm job, to buy food or to find available food in their village.

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4.2. Results (cont.10)

- Livestock operation positively influences the HDDS, and farm households with livestock raising had HDDS 0.50 greater than farm households who did not. Farmers can use those animals as food or sell for their revenue. This result is consistent with the findings of Abafita and Kim (2014) who found that livestock possession has significant positive influence on household food security. Similarly, Mitiku *et al*., (2012) also found that livestock size is positively associated with the probability of being food secure in Southern Ethiopia. Furthermore, Beyene and Muche (2010) also found that households with larger livestock size are less vulnerable to food insecurity in Central Ethiopia.

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4.3. Conclusion

- Membership in agricultural cooperatives has positive impact on farm households' food security.
- Household income positively associates with higher HDDS of farm households.
- Farmers who had access to good roads also had higher food security score.
- Farm households who had livestock operation had better food security score.
- Farm households having TV had better food security.

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Chapter 5: General Conclusions and Recommendations

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5.1. General Conclusion

As for Specific Objective 1 (#11)

1-1 Farm households selling their paddy and having contact with extension workers were more likely to become members of agricultural cooperatives.

1-2 Farm households with male head and/or higher off-farm income were less likely to join the cooperatives.

As for Specific Objective 2

2-1 The cooperatives had no impacts on members' paddy yield.

2-2 They had no impacts on members' paddy revenue, either because of limited marketing outlets and weak price negotiation power.

2-3 They had positive impacts on members' livestock and farm revenues.

As for Specific Objective 3

3-1 The cooperatives positively influenced food security in terms of HDDS.

3-2 Agricultural land size, household income, owning TV, access to good roads and livestock operations positively influenced on the food security score.

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5.2. Recommendations

A. The government should promote more extension service to all farmers, so the benefits of agricultural cooperatives could be disseminated to farmers more widely. ⟸ (1-1)

B. The cooperatives should expand paddy markets and strengthen price negotiation power by increasing equity capital to procure more paddy from members, and by capacity-building of board directors in marketing expertise. ⟸ (2-1)

C. Farmers with livestock should be encouraged to join the cooperatives to increase their revenue and improve their food security because the cooperatives can provide good technical supports for livestock raisings. ⟸ (2-3, 3-1, 3-2)

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5.2. Recommendations (cont.1)

D. The cooperatives should provide trainings on paddy production, so farmers with small paddy land size can increase their paddy yield and improve their food security status. ⟸ (3-2)

E. The cooperatives should provide agricultural trainings for the livestock operation, so farmers can better operate to increase their household income. They can also afford to have a TV when the household income is improved, leading to better food security. ⟸ (3-2)

F. Roads should be improved, so farmers could easily travel to do their off-farm jobs, transport their agricultural products, buy food or find available food in their village. ⟸ (3-2)

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