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Value chain analysis of the rice-based agricultural systems in Kampong Thom province, Cambodia

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Declaration

I hereby declaration that the M.Sc. thesis entitled "**Value chain analysis of the rice-based agricultural systems in Kampong Thom province, Cambodia**" has been written by me independently and all the resources have been quoted and stated in the references.

In Prague, 1st September 2015

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Abstract

Cambodia is one of the rice exporters in Southeast Asia. With the expectation of the Royal Government of Cambodia policy to export one million tons of milled rice by 2015, Cambodian farmers need to increase rice productivity significantly. However, in combination with the dependency on inputs from neighbouring countries - particularly Vietnam and Thailand - they sell only unprocessed paddy rice back to input suppliers and intermediaries, which export it illegally to Vietnam. Therefore, this study was conducted in order to examine how the rice value chain works in the central region of Cambodia, which factors affect it, and how the current dependency on agriculture input providers and middlemen from neighbour counties benefits or harms Cambodian rice producers and traditional systems of rice cultivation. The value chain analysis approach was used to capture the current situation, the main challenges and the potential of rice cultivation, trade and export. All types of key player in the rice value chain were interviewed starting from agriculture input suppliers, rice producers, collectors, millers, wholesalers and retailers. 270 rice producers in three villages in Kampong Thom province were selected to be interviewed individually with structured questionnaire. Other key players in rice market channel were selected by snow-ball sampling method. The result indicates the growing dependency of local farmers on Thai and Vietnamese inputs and selling channels. Most of the farmers have recently adopted IR504 rice variety which was introduced by Vietnam. At the moment the recent arrangement of the rice value chain benefits them economically. However, it contradicts the Cambodian government rice development policy and it might create a negative impact on social, economic and environmental issues in region in the long run.

Key words: *rice ecosystem, value chain, economic evaluation, rice export policies, Cambodia*

Abstrakt

Kambodža je jedním z exportérů rýže v Jihovýchodní Asii. Při předpokladu kambodžské královské vládní politiky, který je vyvézt milion tun omleté rýže za rok 2015, kambodžští farmáři budou muset výrazně zvýšit produktivitu rýže. Ačkoliv, v kombinaci se závislostí na vstupech ze sousedních zemí – jmenovitě Vietnamu a Thajska – farmáři prodávají pouze nezpracovanou neloupanou rýži zpět dodavatelům vstupů a zprostředkovatelům, kteří ji nelegálně exportují do Vietnamu. Tudíž, tato studie byla vypracována, aby prozkoumala, jak funguje hodnotový řetěz rýže v centrálním regionu v Kambodži, jaké faktory ho ovlivňují, a jaký užitek či jaké negativní dopady na Kambodžské pěstitele rýže a její tradiční systém pěstování má závislost na poskytovatelích zemědělských vstupů a prostředníků ze sousedních zemí. Přístup analýzy hodnotového řetězu byl použit k zachycení současného stavu, hlavních výzev a potenciálu pro pěstování rýže, jejímu exportu a obchodu. Se všemi klíčovými hráči v tomto řetězu bylo učiněno interview, počínaje dodavateli zemědělských vstupů, pěstiteli rýže, výběrčími, mlynáři, velkoobchodníky i maloobchodníky. 270 producentů rýže v třech vesnicích v provincii Kampong Thom byli vybráni k osobnímu rozhovoru se strukturovaným dotazníkem. Ostatní klíčoví hráči v obchodu s rýží byli vybráni metodou výběru vzorku známou jako sněhová koule. Výsledky naznačují rostoucí závislost místních farmářů na thajských a vietnamských vstupech a obchodních strukturách. Většina farmářů v poslední době adoptovala rýžovou odrůdu IR504, která byla zavedena Vietnamem. Momentálně však farmářům současné ustanovení hodnotového řetězu rýže ekonomicky vyhovuje. Nicméně, tato skutečnost je v rozporu s kambodžskou vládní politikou pro rozvoj rýže a může mít negativní dopad na sociální, ekonomické a environmentální záležitosti v regionu v dlouhodobém horizontu.

Klíčová slova: ekosystém rýže, hodnotový řetěz, ekonomické zhodnocení, exportní politiky rýže, Kambodža

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Abbreviations

ADB	:	Asian Development Bank
AMIS	:	Agricultural Market Information System
AMO	:	Agricultural Marketing Office
AsiaDHRRA	:	Asian Partnership for Development of Human Resources in Rural Asia
Avg.	:	Average
CARDI	:	Cambodian Agricultural Research and Development Institute
CAMIP	:	Cambodian Agricultural Market Information Project
CIDA	:	Canadian International Development Agency
FAO	:	Food and Agriculture Organization
FGD	:	Focus Group Discussion
FOs	:	Farmer Organizations
GDP	:	Gross Domestic Product
h	:	Hectare
ILO	:	International Labour Organization
MAFF	:	Ministry of Agriculture, Fisheries and Forestry
M4P	:	Making Market Work Better for the Poor
NGOs	:	Non-government Organizations
NIS	:	National Institute of Statistic of Cambodia
NTFP	:	Non-timber Forest Product
PDA	:	Provincial Department of Agriculture
PRA	:	Participatory Rural Appraisal
RGC	:	Royal Government of Cambodia
SMS	:	Short Message Service
UN	:	United Nation
VCA	:	Value Chain Analysis

1. Introduction

Rice (*Oryza sativa* L.) is the main staple food crop for over half of the population (Biselli et al., 2014) and more than 90 percent of rice is consumed in Asia, where it is a staple food for a majority of the population including the region's 560 million hungry people (Mohanty, 2013). Rice provides alot of benefits and nutrients to human body and animal (Organic & Facts, 2015). By-product from paddy rice is considered as new sources of renewable energy in the future (Shackley et al., 2012). Rice not only ensure food security in the world but also help poor farmers in rural area to leave from poverty. Nevertheless, rice production system cosumes a lot of water and contributes signifucantly to increase the number of greenhouse gasses. Currently, impact of climate change caused by increasing greenhouse gasses emission is influencing on rice production leading to decreasing rice cultivation land productivity (Kawasaki et al., 2011).

Rice has been grown in Cambodia for at least 2,000 years, possibly longer in case of upland rice. According to historian, rice-growing technologies may have been exported into Cambodia along trade routes from India and irrigated rice production technologies were introduced 1,500 years ago. In prehistory of Cambodia, rice production system was integrated into their existing system of land use including slash and burn agriculture, livestock raising, fishing and hunting, and gathering wild fruit. There are many kinds of rice varieties growing in different ecosystems existing in Cambodia (Nesbitt, 1997).

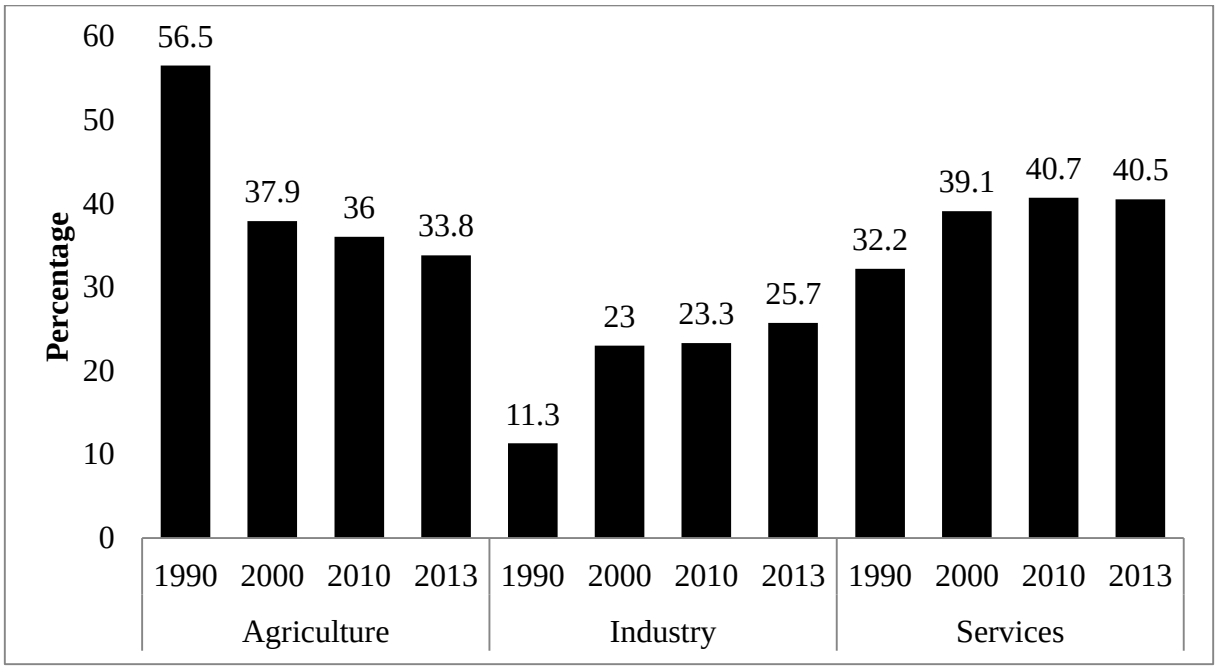
In Cambodia, rice is the staple crop which people cosume nearly everyday at least two times per day. The annual consumption per capita per year is around 143 kg which is higher than world rice consumption per capita per year (Wang et al., 2012). More than 70 percent of total population of 13.5 million people is engaged in agriculture (largely rice cultivation) for their livelihood (NIS, 2008). Nowadays, Cambodia is an emerging rice exporter in Southeast Asia (UNDP, 2013). In the agricultural policies of the Cambodian government, rice is seen as white gold and a strategic crop to alleviate poverty and ensure food security (RGC, 2010). The value chain analysis approach was used in this research topic to capture the current situation, the main challenges and the potentiality of rice cultivation, trade and export, and examine how the rice value chain works in the central region of Cambodia, which factors affect it, and how the current dependency on agriculture input providers and middlemen from neighbour counties benefits or harms Cambodian rice producers and traditional systems of rice cultivation.

2. Literature review

2.1. Agriculture Overview in Cambodia

In GDP composition of Cambodia in 2013, agriculture sector accounts for 33.8 percent which is lower than 2010 (36 percent) (ADB, 2014). Royal Government of Cambodia has given top priority to agriculture in development strategy plan since 1993. In addition to rice growing, most of rural farmers grow other cash crops such as cassava, cashew, maize, and bean, as well as livestock and raising poultry (chicken, ducks) to supplement daily subsistence and household income.

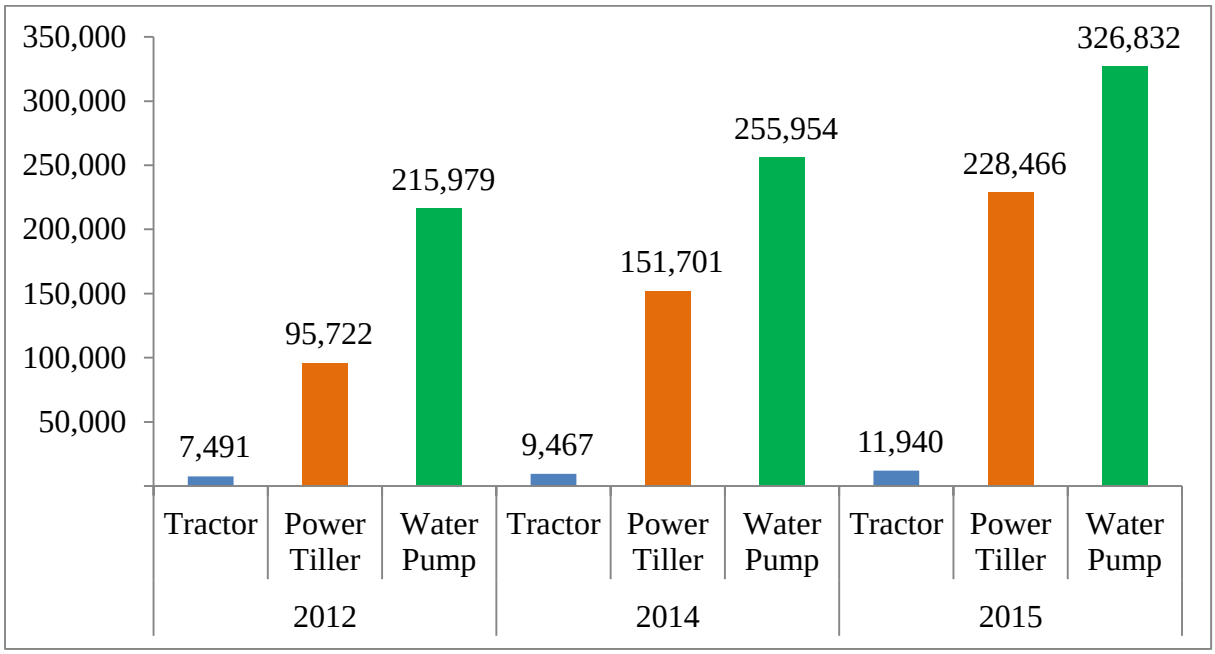
Figure 1: Agriculture, Industry and Services Value Added computed as a share of GDP



Source: (ADB, 2014)

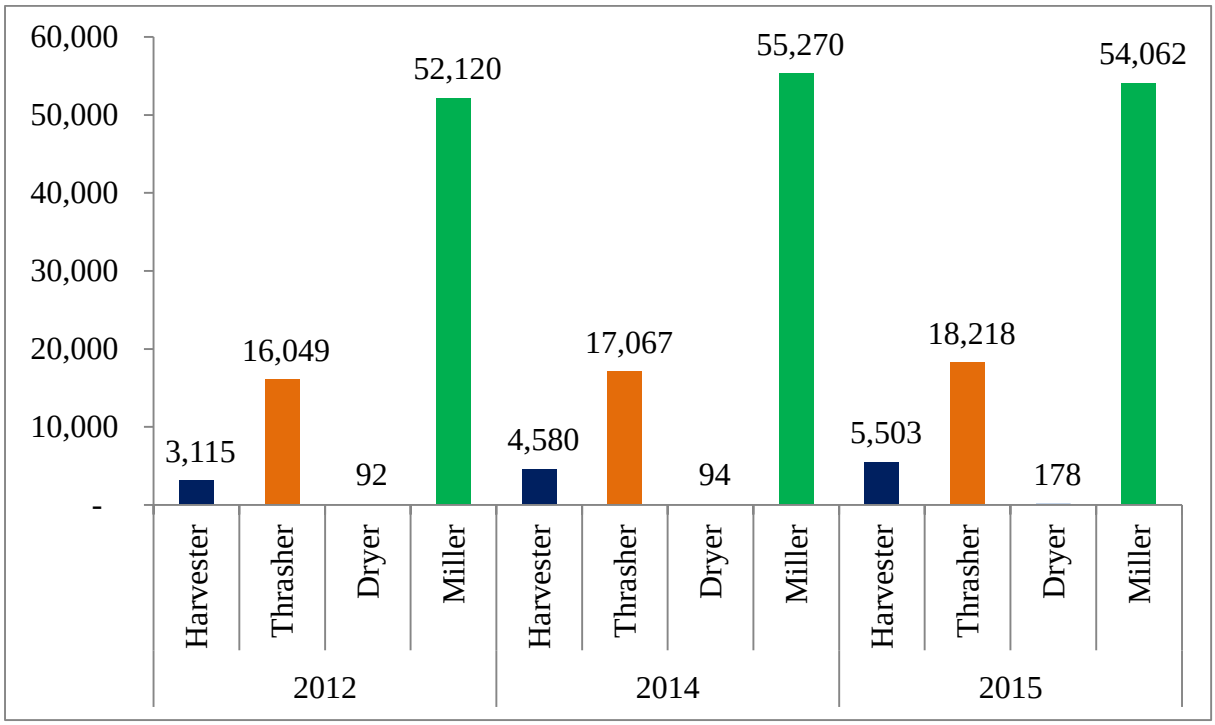
Recently, mechanization or farm equipment are modernizing from traditional and hand tool and animal power to two-wheel (hand) tractors, four-wheel tractors, thresher, and harvester. However, conventional agricultural techniques and seeds are still widely used and production is predominantly rainfall dependent.

Figure 2: Number of tractor, power tiller and water pump in Cambodia



Source: (MAFF, 2015)

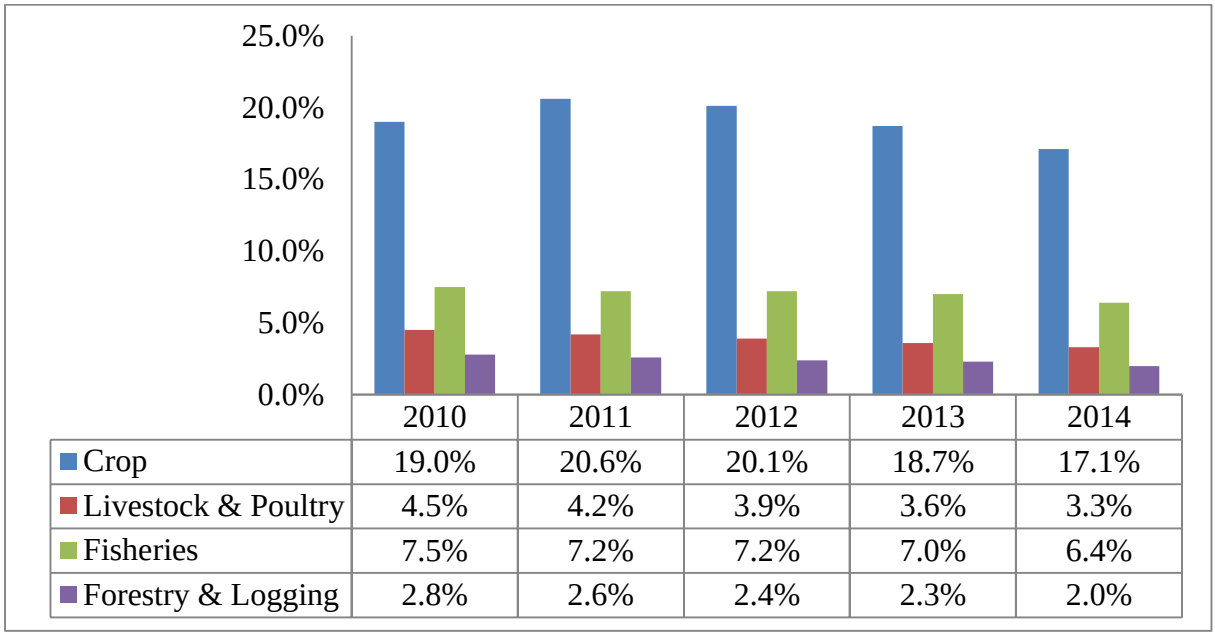
Figure 3: Number of harvester, thrasher, dryer and miller in Cambodia



Source: (MAFF, 2015)

Fishery and forestry also play important role in contributing to agricultural development and economic growth. Forest provides great value in tern of ecosystem services to local communities. Beside timber product, many types of non-timber forest products are provided by forest for local subsistence such as construction materials, bamboo, rattan, traditional medicine, wild vegetable, honey ....etc. After rice, fishery sector is considered the second most important contribution around 70 – 75 percent of national diet. In central low land of Cambodia, there is a big reservoir, Tole Sap, providing much water and fresh fish for Cambodian. The Tonle Sap Lake and Mekong River are home to many inland fish species and richness of aquatic lives, intimately linked to the flood areas around the lake, flooded forest and the water flow regime of the Mekong. There are about 500 to 1,200 fish species in Tonle Sap Lake and Mekong River Basin in Cambodia. Cambodia's fresh capture fisheries rank as the fourth most productive in the world after China, India and Bangladesh with an annual production between 300,000 and 450,000 tones. Small scale fishing recognized as primarily a subsistence activity is estimated to account for 60% of total in land fishery production. In land fisheries are very important component of rural economic growth and key to improve local livelihood in Cambodia. Fish is a staple diet for local people along with rice. It forms the basis of food security. The households of more than 72% of the population depend on agriculture and fisheries (NIS, 2008). More than 80% of the total animal protein in the Cambodian diet is estimated to come from fish and other aquatic animals, especially from inland water such as: rice fields, rivers, streams, community ponds and natural lakes.

Figure 4: Share of Sub-Agriculture Sector in GDP 2010-2014 (Current Prices)



	2010	2011	2012	2013	2014
Crop	19.0%	20.6%	20.1%	18.7%	17.1%
Livestock & Poultry	4.5%	4.2%	3.9%	3.6%	3.3%
Fisheries	7.5%	7.2%	7.2%	7.0%	6.4%
Forestry & Logging	2.8%	2.6%	2.4%	2.3%	2.0%

Source: (MAFF, 2015)

2.1.1. Agricultural Extension Services in Cambodia

Agriculture extension service program in Cambodia started before 1970s with an aim to transfer improved technology to farmers in rural areas including vegetable, rice and livestock production. There were many several methods to disseminate and transfer new technologies and information used by technical staffs, extension officers, and mass media communication such as radio and television, but the extension system was stopped during Khmer Rouge regime from 1975 to 1979. Extension services were started again after 1979 carried out by technical department of Ministry of Agriculture through target areas of research station and agricultural development centers. A committee for development extension materials (scripts for radio and television programs, booklets and posters) and provincial and district department of agriculture officers was established by Ministry of Agriculture to disseminate new agricultural technique and information to farmers in 1980 (Mak, 2012). To improve and support agricultural extension services, Ministry of Agriculture have cooperated closely with both NGOs and private sectors (Touch, 2000).

Table 1: Number of extension service workers in Cambodia

Types of extension staff according to gender	**Male**	**Female**
Senior Management Staff	46	12
Subject Matter Specialists (SMS)	49	17
Field Level Extension Staff	1,000	120
Total Extension Staff: 1,244	**1,095**	**149**

Source: (Nnoung et al., 2011)

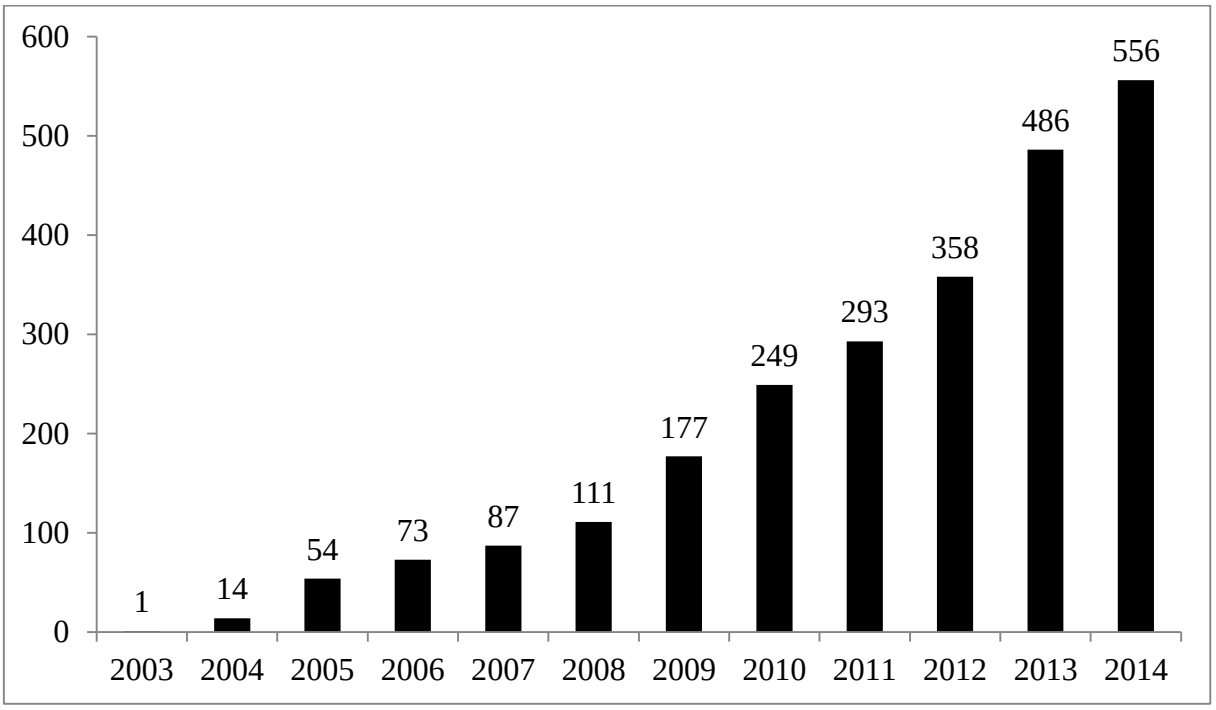
In 2014, the number of extension service workers was increased approximately to 30,856 people (female 45.5%) including agricultural technicians, agricultural extension workers, commune officers, and farmers. Among 9,640 farmers across the country who have been trained, 846 people become commune extension workers and the rest become village extension workers (MAFF, 2015).

2.1.2. Farmer Organization Development in Cambodia

Farmer Organization (FOs) development is essential for the poverty allevation, empoverment and advancement of agriculture producers and poor rural people. FOs are the nearest and often only institutes which provide essentail goods and services to poor rural people and help them to break down the poverty cycle. Government and development agencies can create more appropriate and suitable rural and agricultural development programes and policies to identify and benefit poor and small farmers effectively by working with supporting FOs in the planing, designing, and implementation of rural and agricultural programes and policies. Small scale farmers can increase their bargaining power, reduce transection cost for accessing inputs and transportation, facilitate processing and marketing of agricultural products, and empower financial resources (group saving) through organizing FOs (SARD, 2007).

In Cambodia, RGC cooperate with national and international development partners. The agricultural cooperation development is being promoted in order to enable organized agricultural production in partnership with private sector to ensure better access to technology and credit, and stable supply of products to both domestic and external markets. In the future RGC aim to transform the agricultural cooperation into rural economic enterprises playing a crucial role in rural socio-economic development (MAFF, 2015).

Figure 5: Agricultural cooperatives in Cambodia



Source: (MAFF, 2015)

2.1.3. Agricultural market information system in Cambodia

Market information system is really important for agricultural development and small-scale producer and trader who typically have limited access to, and understand of market information and analysis. Reliable market information can help to ensure competitiveness, transparency and more equitable sharing of benefit between market participants. For small scale producers and traders, AMIS helps to improve their understanding of market opportunities and options, and strengthen their bargaining position in the market. Government can take appropriate policy decision to support agricultural growth and enhanced food security based on reliable agricultural market information.

Cambodia Agricultural Market Information System (AMIS) is operated by Agricultural Marketing Office (AMO) at Ministry of Agriculture Fisheries and Forestry (MAFF) with two main functions: (1) to provide timely and reliable market information to allow supply chain participants to take appropriate production, marketing and related decision and (2) to help producers, traders and others to understand effectively of using this information for making better decision to support agricultural development and growth. AMIS processed by Short Message Service (SMS) is a government-owned and user-friendly system allowing farmers and traders across the country to exchange and access prices of selected agricultural commodities sold in the market through their mobile phones.

It is developed in 2008 as a web-based data management system with support from the Canadian international Development Agency (CIDA) through the Cambodian Agricultural Market Information Project (CAMIP). It records and transmits wholesaler prices of selected agricultural commodities included wholesaler price paid by traders to purchase goods directly from farmer, as well as the selling prices charged by traders. This system also provides the information about trader interested in purchasing commodities in specific market including market requirement, price differentiation by grade, information on pests and diseases, as well as production advice, weather advisories, and early warnings (Agricultural Marketing Office, 2010).

Figure 6: Agricultural information system framework in Cambodia

Source: (FAO, 2012)

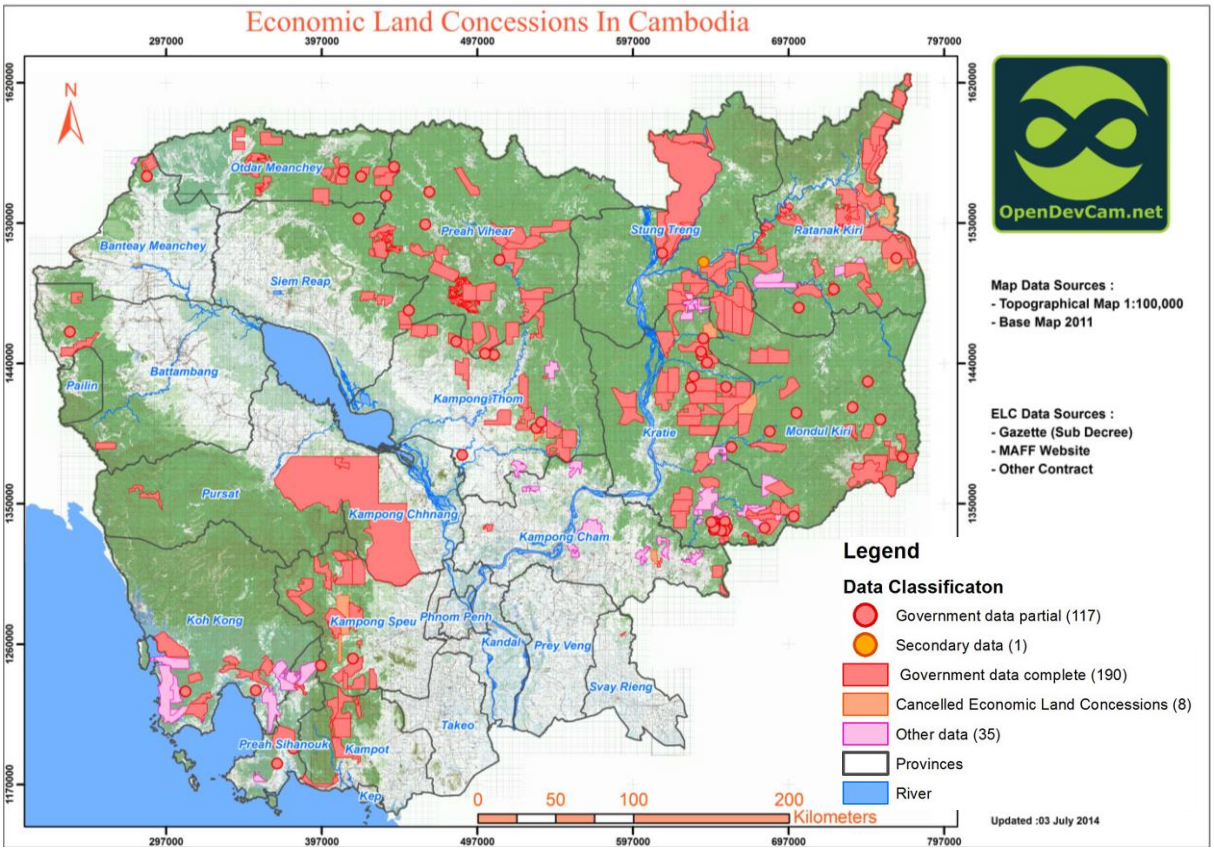
2.1.4. Investment in Agriculture Sector

Foreign direct investment has played a crucial role to improve agriculture sector in Cambodia. RGC attracts and encourages private investment (domestic and foreign investors) to develop intensive and diversified agro-industry with contributing the rural job creation, promoting export of agricultural products for national income and economic development, and increasing the living standard through providing economic land concession (MAFF, 2015). By the law, foreigner cannot own land in Cambodia. Therefore, the government offers three types of land concessions (social, economic and development or exploitation land concession) to domestic and foreign investors. Development or exploitation land concession is included mining, port, airport, industrial development, and fishing concession. In the case of social land concession, beneficiary can build residential constructions and cultivate state land for subsistence. For economic land concession, the government allows beneficiary to clear the land for industrial or agricultural exploitation. Economic land concession can be granted by MAFF with maximum of 10,000 hectares, and no more than 99 years. Rubber, cassava, sugarcane, teak, acacia and pistachio crops are strongly interested by foreign investors (MAFF, 2015; Hem, 2013).

From 2014, 121 companies have been contracted with MAFF operated in 18 provinces with total land about 1.3 million hectares in which 811,266 hectares are exploited-production area. The clearing land is around 324,667 hectares and cultivated agro-industrial crop land is about 288,788 hectares. Providing economic land concession absorbed total labor force of 53,677 including 12,813 of Khmer staffs, 14,569 permanent laborers, 24,516 temporary laborer, and 1,779 foreign technical staffs and experts (MAFF, 2015).

However, many problems are appearing because of lack of consultation with local community and encroachments on land are influencing on traditional livelihoods, displacement, environment, employment, and labor conditions. Local communities are threatened by violence and intimidation from the government and private investors. The encroachment of concession upon forested areas strongly affect on local communities depending non-timber forest products (NTFP). They are removed from their settlement and changed their traditional livelihood (UN, 2007).

Figure 7: Economic land concession in Cambodia

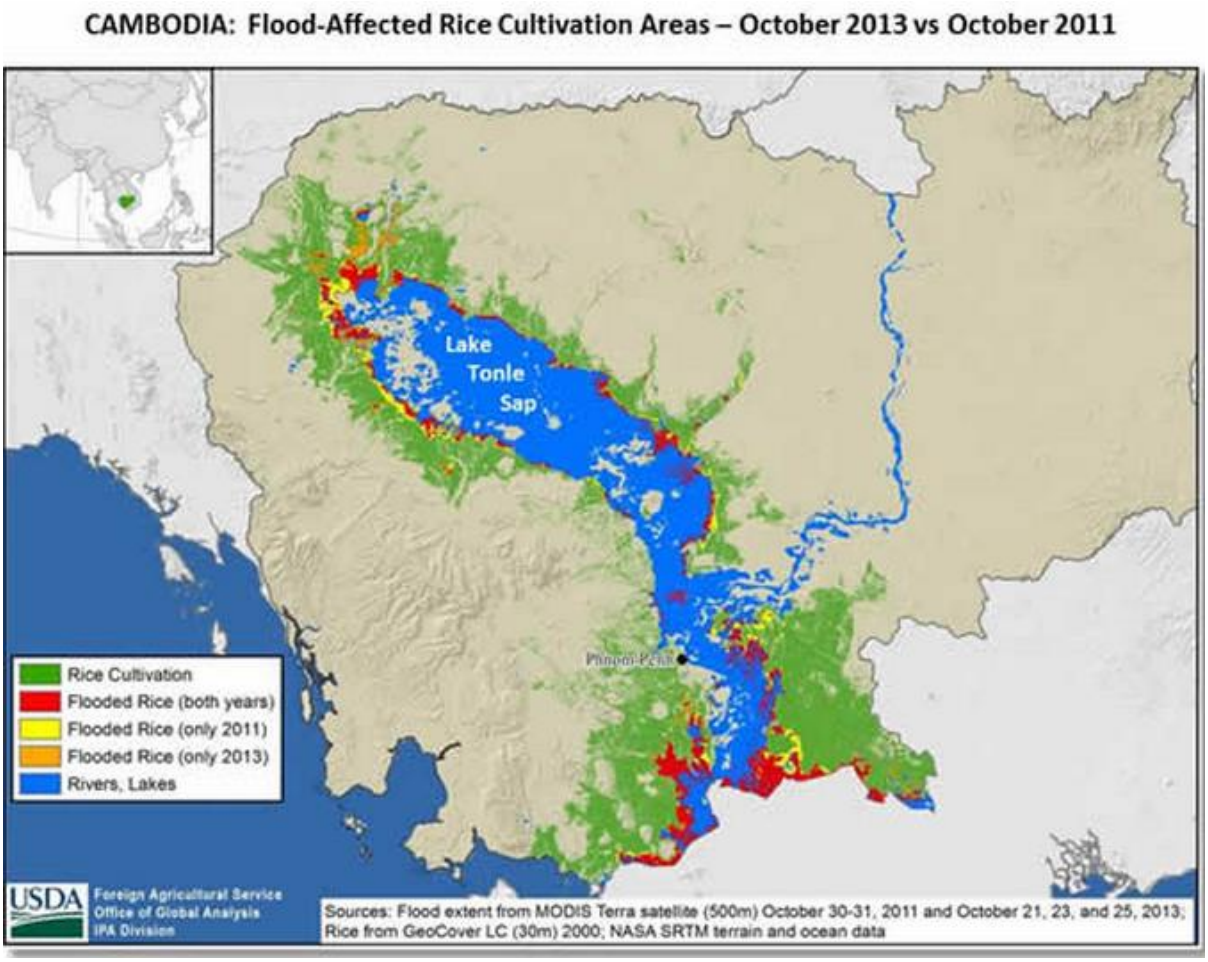


Source: (OpenDevelopment, 2014)

2.2. Rice Ecosystem in Cambodia

Cambodia is located between latitudes 10^{o} and 15^{o} north, and longitudes 102^{o} and 108^{o} east. The country is nearly surrounded by two mountain lines (Krovanj and Dorng Reak) which protect Cambodia from heavy storm. Landscape of the country is devided into 4 different types: mountain, upland, lowland and costal area. Rice is mostly grown on lowland located in central of the country which is large plain supporting the Tonle Sap "Great Lake", the largest fresh water lake in South-east Asia and accompanying river complex, the lower Mekong river flood plain, and the Bassac river plain. The climate is dominated by the annual monsoon cycle. There are two main seasons: dry and wet in the country. Dry season starts from November to May and wet season starts from June to Octorber. Rice is grown in both dry and wet seasons. The temperature is always changed seasonally and regionally. From 1991 to 2000, the temperature raised more than 38^{o}C, the minimum is around 22^{o}C and the average is 27^{o}C, and the warmest month is April. The average of wind speed is 2 meters per second and the annual evaporation is from 2,000 to 2,200 mm (Ministry of Environment, 2009).

Figure 8: Rice ecosystem affected by flood in Cambodia



2.2.1. Rice ecosystem in wet season (rainfed rice ecosystem)

In wet season, rice is grown on different landscapes divided into three main different rice ecosystem: Upland rice, Rain-fed low land rice, and Floating or Deep water rice ecosystem. Rain-fed low land rice ecosystem is divided into three sub-rice ecosystems based on life of production: Early duration maturity, Medium duration maturity, and Long duration maturity rice. In this season, rice can be grown both photoperiod sensitivity and insensitivity (Nesbitt, 1997; CARDI, 2007).

2.2.1.1. Upland rice

Rice is mostly grown on upland and slope of the mountain mountain by indigenous people. It is uasually depend on rain and cultivated in the forest. Farmer cut and burn the forest to cultivate rice. They give up the rice field after growing for 2 to 5 years and find new rice field (Shifting Cultivation). It is traditional livelihood of indigenous people. Farmer's household has usually 1 to 2 rice fields with size is from 0.1 to 3 hectares, and the distance is from 1 to 10 km from their house. In this rice production, land preparation is started from Fabruary to April, cultivation start in June without plowing, and farmer harvest rice during September until December depending on varieties and photo period sensitivity or insensitivity. For cultivation, farmer use direct seeding technique. The yield of this rice production is from 1.6 to 1.8 tonnes per hectare (Nesbitt, 1997; CARDI, 2007).

2.2.1.2. Rain-fed low land rice

2.2.1.2.1. Early duration maturity rice

Early duration maturity rice is a type of Photoperiod Insensitive variety with life of production is not loger than 120 days. It is mostly grown on large low land plain in central region of the coutry. This rice production starts from May and finish in Octorber. Farmers cultivate this rice production not further than 1km from their house. It can be cultivated on rice field with level of water is from 0 to 0.15 meters. Farmer can apply both trasplanting and direct seeding technique. The yield is from 3.5 to 6 tonnes per hectare depending on the varieties (Nesbitt, 1997; CARDI, 2007).

2.2.1.2.2. Medium duration maturity rice

Medium duration maturity can be both photoperiod sensitive and insensitive rice varieties with life of production is longer than early duration maturity rice from 120 to 150 days after sowing. It is mostly grown on large low land plain in central region of the coutry. This rice production start from May and finish in November. The distance of this rice production is further than early duration maturity rice from village. It can be cultivated on rice field with level of water is higher than early duration maturity rice production from 0.1 to 0.3 meters. Farmers can apply both trasplanting and direct seeding technique. The yield is from 2.5 to 6 tonnes per hectare depending on the varieties (Nesbitt, 1997; CARDI, 2007).

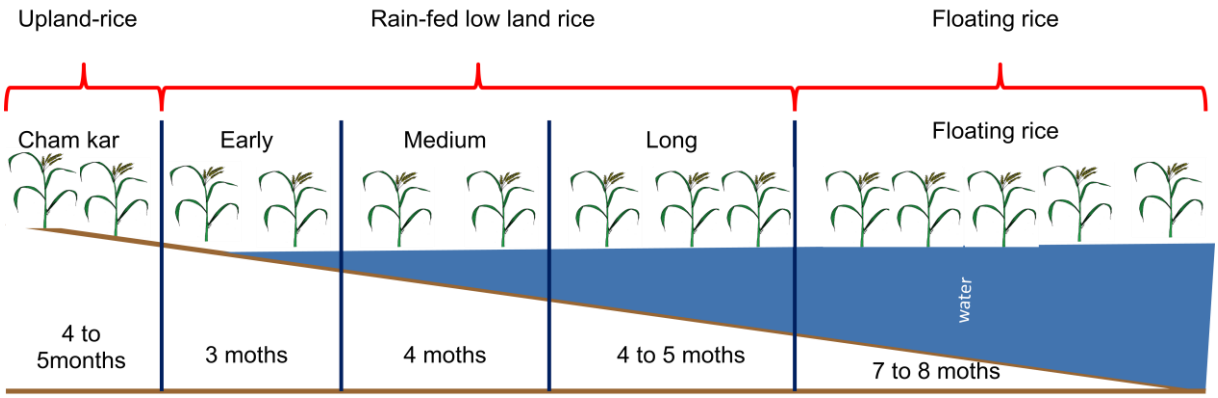
2.2.1.2.3. Long duration maturity rice

Long duration maturity rice can be only photoperiod sensitive rice variety with life of production is more than 150 days longer than medium duration maturity rice. It is mostly grown on large low land plain in central region of the coutry. This rice production starts from the end of April and harvest in December. From the village, the distance of this rice field production is further than medium duration maturity rice. It can be cultivated on rice field with level of water is higher than medium duration maturity rice production from 0.8 to 0.9 meters. Farmers can apply both trasplanting and direct seeding technique. The yield is from 2.5 to 5 tonnes per hectare depending on the varieties (Nesbitt, 1997; CARDI, 2007).

2.2.1.3. Floating or Deep water rice ecosystem

Floating rice is mostly cultivated around the lakes or rivers in flooded forests where level of water is high. Rice varieties used to grow on this rice ecosystem are photoperiod sensitivity and resistance to high level of flood. It can grow where level of flood is up to 4 meters, and the life of production is around from 8 to 9 months longer than the others. Floating rice field is far from the village and next to the lakes or rivers. Farmers start to prepare land at the begining of April and sow from the end of April to May when the rain start, and usually harvest from December to February. This type of rice production mainly depends on rain and level of flood. It is resistant to high level of flood, but if the flood comes too fast with high level, it might be demaged. Usually, farmers use direct seeding technique to cultivate without using chemical fertilizer and pesticide. Therefore, the cost of production is low. The yield of this rice production is from 2 to 4.5 tonnes per hectare depending on the varieties. Nowadays, this type of rice production is being replaced by recession rice production because of extremely flood, low yield and demage from wild animals (Nesbitt, 1997; CARDI, 2007).

Figure 9: Rice ecosystem in rainy season in Cambodia



2.2.2. Rice Ecosystem in dry season

Currently, dry season rice production is expanding from year to year. Photoperiod insensitive rice varieties are used to cultivate in dry season. This type of rice production provides higher yiled (3.5 to 6 tonnes perhectare), and it is able to adapt to climate change. Life of production is short (less than 120 days after sowing), and it can be practiced on upland, lowland and floating rice field in dry season. Nevertheless, dry season rice production require high amount of water to irrigate because of no rain in dry season, chemical fertilizer, pesticide and weed control. Cambodian Agricultural and Development Institute (CARDI) divided dry season rice production into two different types (irrigated and recession rice production) (Nesbitt, 1997; CARDI, 2007).

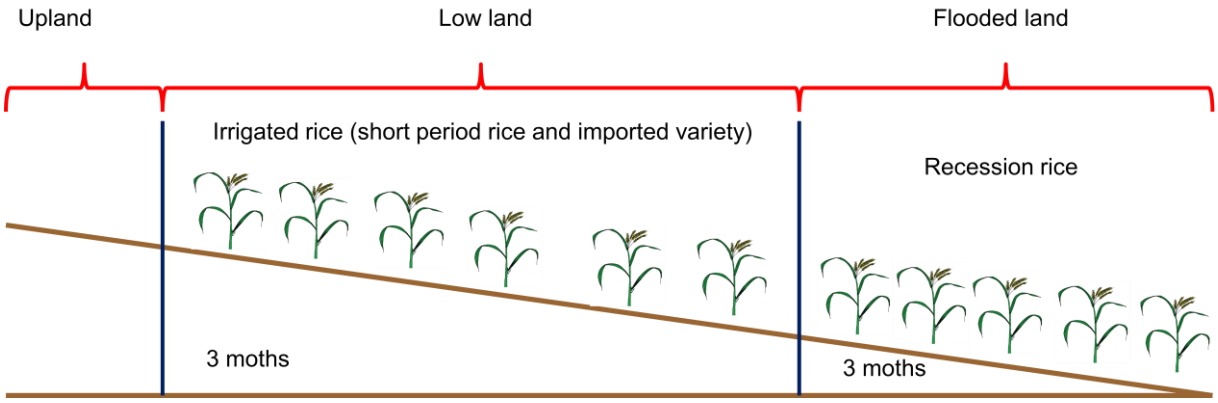
1.1.1.1. Irrigated rice

Irrigated rice production is mostly cultivated on rain-fed low land rice field in dry season where there are good irrigation system providing enough water to irrigate rice field. Farmers can cultivate after they harvest rain-fed low land rice production. In some areas, farmer could cultivate twice in dry season when irrigation system provide enough water to irrigate (Nesbitt, 1997; CARDI, 2007).

1.1.1.2. Recession rice

Usually, recession rice production is grown on floating rice field and river bank in dry season. Nowadays, farmers are giving up floating rice production and adopting recession rice production. Farmers can cultivate this rice production is only one time per year. Farmers start to prepare land before flood come from April to June, and they plow recession rice field again and sow from November to January when the flood go down (Nesbitt, 1997; CARDI, 2007).

Figure 10: Rice ecosystem in dry season in Cambodia

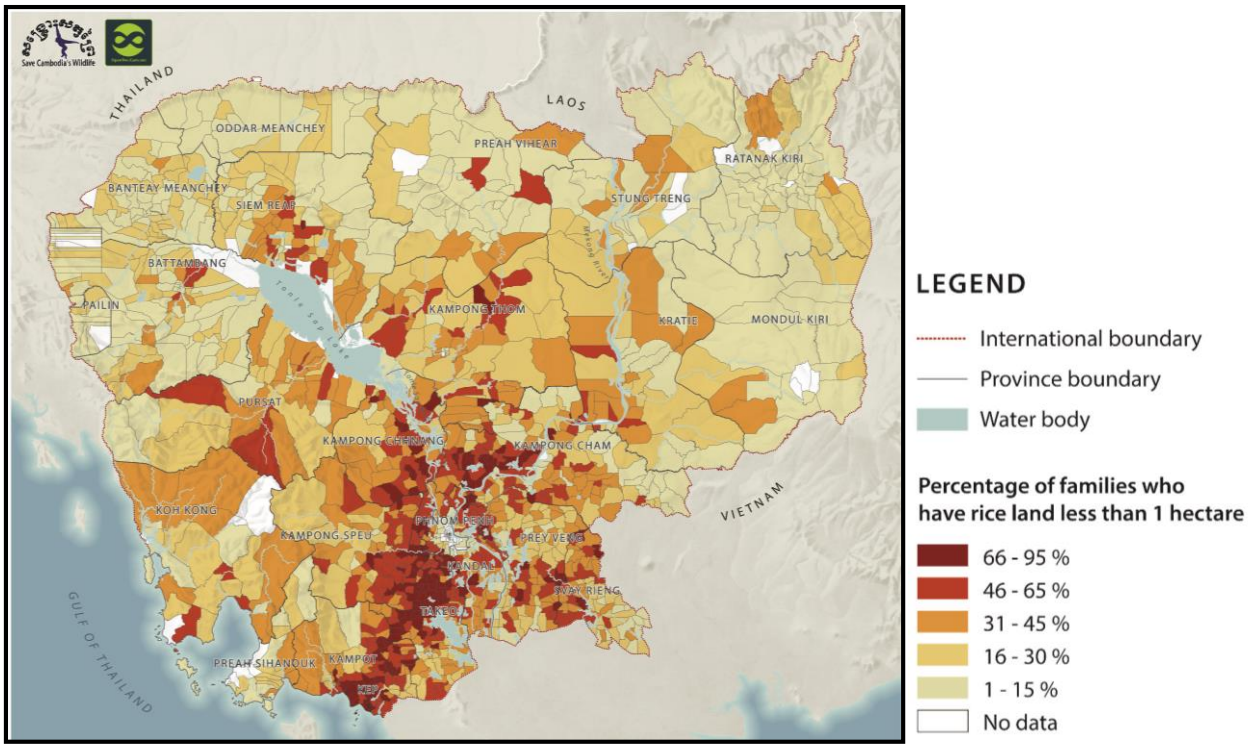


2.3. Rice Production in Cambodia

The basic rice ecosystem in Cambodia is lowland rice representing 79.3% of total production. Dry season rice, floating rice, and upland rice, which are located around Tonle Sap Lake, represent 15.9%, 3.3%, and 1.9% respectively (MAFF, 2013; CARDI, 2007). According to MAFF's report of 2013, the yield of dry season rice is higher than that of rainy season rice (rain-fed rice) (MAFF, 2014), yet the total cost of dry season rice is higher than that of rainy season rice because farmers spend more money on agricultural inputs. Currently, dry season rice production demands additional inputs such as chemical fertilizer, pesticide, herbicide, gasoline, and modern equipment, which are imported from neighbouring countries (Vietnam and Thailand). Farmers changing from conventional practices to more intensive practices are thus increasing the cost of production (Keo, 2012; CAVAC, 2010).

Currently, due to investment in the construction of irrigation systems, better seed selection, increased fertilizer supply and improved growing techniques, there is an expansion of cultivated land, rice intensification and finally rice yield, which is increasing year on year. According to MAFF (2014), average rice yield had increased by 38.89% from 2004 to 2008 (from 1.977 to 2.746 tonnes per hectare) and 15.18% from 2008 to 2013. Yet, rice yield decrease 2.02% in 2014 if we compare to 2013 (MAFF, 2015).

Figure 11: Rice field distribution



Source: (OpenDevelopment, 2011)

Table 2: Paddy rice production in Cambodia (2004-2014)

Year	Harvested area (ha)	Yield (T/ha)	Total paddy rice product (T)	Surplus paddy rice[1] (T)
2004	2,109,050	1.977	4,170,284	650,184
2005	2,414,455	2.479	5,986,179	2,061,830
2006	2,516,415	2.489	6,264,123	2,240,438
2007	2,566,952	2.621	6,727,127	2,577,562
2008	2,613,363	2.746	7,175,473	3,164,114
2009	2,674,603	2.836	7,585,870	3,507,185
2010	2,777,323	2.970	8,249,452	3,932,425
2011	2,766,617	3.173	8,779,365	4,344,263
2012	2,980,297	3.117	9,290,940	4,735,964
2013	2,968,967	3.163	9,389,961	4,828,832
2014	3,028,836	3.079	9,324,416	4,709,036

Source: (MAFF, 2014, 2015)

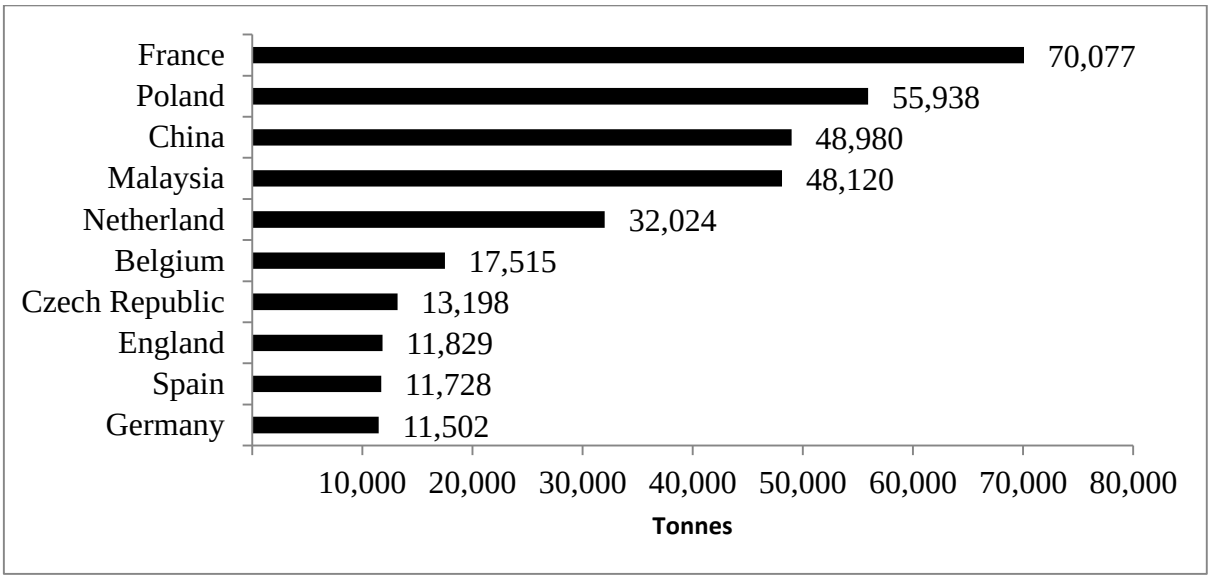
2.4. Milled Rice Export in Cambodia

After the civil war in 70-ies and 80-ies, Cambodia has turned from a net rice importer into an exporter; nevertheless it has always been a small rice exporter in the region compared to neighbouring countries (Vietnam and Thailand). Cambodia exported 5.6 thousand tons of rice in 1996 while Thailand exported 5,442 thousand tons and Vietnam exported 3,003 thousand tons (FAO, 2014). However, in addition to the official figures, approximately one-third of paddy rice was allegedly sold by Cambodian farmers into Vietnam and Thailand unofficially (Yu & Diao, 2011; Ly, et al., 2012; UNDP, 2013). This fact decreases the reliability of official statistics. At the same time, as we shall claim further, it decreases the potential benefits to Cambodian rice farmers.

[1]The remaining amount of rice is potentially for sale after consumption

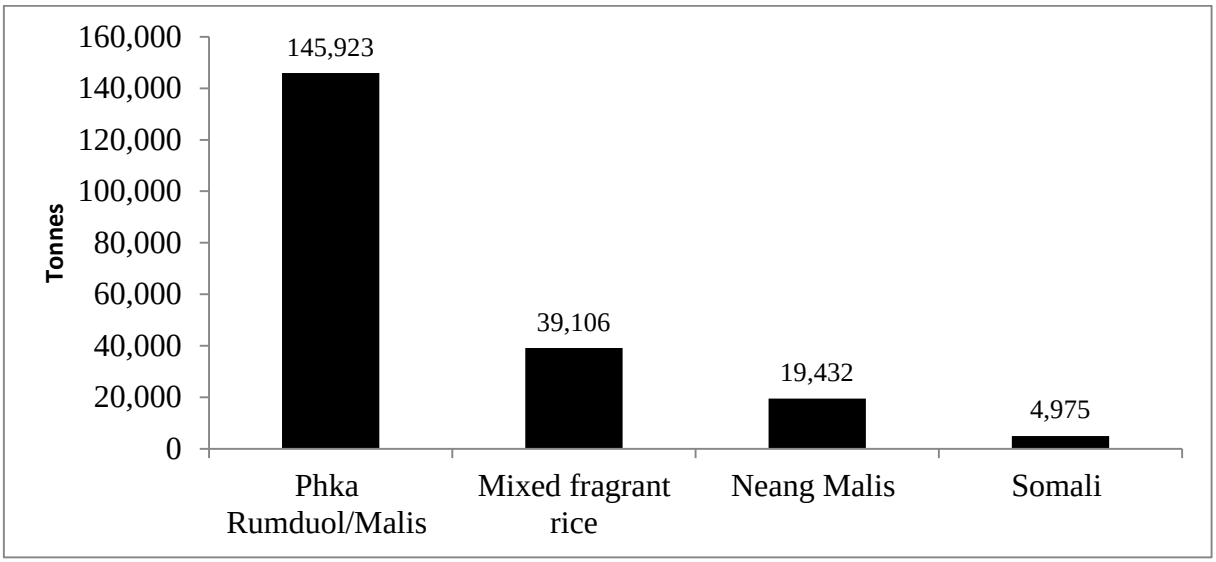
In 2014, Cambodia could export milled rice only 387,061tons (mixed white rice is 157,417 tons, fragrant rice is 210,594 tons, and parboiled rice 19,050 tons), increased by 2.2% compared with 2013 while surplus paddy rice was 4,709,036 tonnes. Cambodia exported rice to 59 countries in 2014, most of which are the European countries. The top 10 market destinations for Cambodian rice include France, Poland, China, Malaysia, Netherland, Belgium, Czech Republic, England , Spain and Germany. Main fragrant rice exported were Phka Rumduol/Malis, mixed fragrant rice, Neang Malis, Somali. Phka Rumduol has won the world's best rice three years in a row, starting in 2012-2014 (MAFF, 2015).

Figure 12: Countries importing milled rice from Cambodia



Source: (MAFF, 2015)

Figure 13: Type of milled rice export from Cambodia



Source: (MAFF, 2015)

The Royal Government of Cambodia (RGC) in line with its document "*The promotion of paddy rice production and the export of milled rice policy, 2010"* planned to be the new leading rice exporter in the region and wishes to export milled rice at 3 to 4 million tons per year. If Cambodia wants to export 3 to 4 million tons of milled rice, the country must produce paddy rice at the level of at least 10 to 11 million tons. Increasing paddy rice production and milled rice export can help to contribute to Cambodia's economic growth in addition to the traditional garment industries. Compared to the garment sector which is used to be a vulnerable sector during economic and financial crisis (ILO, 2010), rice can assure more stable gross export and added value generated in the supply chain including higher rural employment (RGC, 2010).

In order to support the implementation of policies in accordance with the plan on rice production, improvement and export, MAFF introduced 10 rice varieties developed by the Cambodian Agricultural Research Development Institution. Three photoperiod insensitive rice varieties (IR66, Chul'sa and Senpidour) were introduced to farmers for cultivation in the dry season and early rainy season. Phkarumduol, Phkarumdeng, Phkaromeat and Phkarchan Sensor were introduced to farmers for cultivation in medium maturity rice production. Riang Chey, Car4 and Car6 were induced to farmers for growing in late rice production systems (MAFF, 2011).

The achievement of the government policy goal for stable milled rice export is a daunting task. Besides low productivity, Cambodian farmers are facing other problems such as climate change - extreme flooding and drought in all regions of Cambodia (Chhinh & Poch, 2012). According to MAFF (2015), in 2014 total affected area is 198,866 hectares (drought 116,129 hectares, flood 81,083 hectares and pest 1,654 hectares) and total damaged area is 45,940 hectares (drought 20,289 hectares, flood 24,100 hectares, and pest 1,551 hectares).

Table 3: Quantity of exported Cambodian Milled Rice (by months of 2009-2014, in tonnes)

Year / Month	2009	2010	2011	2012	2013	2014
January	360	10,012	6,798	9,703	25,726	**21,536**
February	792	13,644	5,089	14,417	24,089	**27,037**
March	1,248	5,062	12,534	12,310	45,413	**35,757**
April	664	17,287	17,946	15,036	23,276	**35,961**
May	399	5,499	20,520	13,115	28,350	**27,971**
June	316	4,274	17,990	13,426	29,105	**29,666**
July	226	15,030	12,703	20,527	31,411	**26,060**
August	673	5,997	20,404	15,530	29,358	**29,871**
September	956	4,744	14,384	15,169	29,395	**35,511**
October	2,964	6,078	19,067	16,967	28,031	**35,418**
November	1,690	7,988	9,559	25,189	37,855	**31,137**
December	2,325	9,645	44,905	34,328	46,847	**51,136**
Total	**12,613**	**105,259**	**201,899**	**205,717**	**378,857**	**387,061**

Source: (Oryza, 2015; Signature of Asia, 2015; MAFF, 2015)

At the same time Cambodia virtually depends on imported agriculture inputs from neighbouring countries (Vietnam and Thailand) and those countries collect paddy rice illegally then export it as milled rice (RGC, 2010). Farmers might be not able to compete with farmers from neighbouring countries and RGC has difficulty achieving the desired amounts of milled rice for export. In 2014, MAFF granted permits to 182 companies to import agricultural inputs as follows: agricultural chemicals: 27,017 tons and 497,788 litters, fertilizers is 912,595 tons and 190,000 litters, animal feeds and additives are 720,056 tons, raw material for production of animal feed is 354,580 tons, and crop seed: 6,396 tons (MAFF, 2015).

2.5. Agriculture product value chain

Value chain is a complex range of activities involved by various actors to bring raw materials through a chain to the sale of the final product (M4P, 2008). Value chain analysis approach is widely used to investigate the full range of activities that are required to bring a product (good and service) from supply side through the different phases of production to delivery to final consumers and disposal after use (M4P, 2008; EASYpol, 2013; (Kaplinsky et al., 2000). It is used in development project and/or assessment of investment opportunities. Recently, it has been adopted by industry, researchers, and development agency to understand the political economy of exiting production system (Neilson, 2008). Value chain analysis can help poor farmer or small producer gain more benefit from market development in a number of ways by providing them with better income or employment security through market participation, and it is important tool for local policy and decision makers to understand better on how market should be organized and/or the role they can play as decision makers to facilitate the development of value chain and improve the position of poor farmers or small producers within the value chain (M4P, 2008). Currently, value chain analysis approach is applied to agriculture products (rice, coffee, fish...etc) (El-Sayed et al., 2015; Neilson, 2008; Minten et al., 2012). Four aspects of value chain analysis of agriculture are particularly important.

Firstly, mapping value chain is a part of value chain analysis tool used to identify actors participating systematically in production, distribution, marketing and sales of a particular product, and assess characteristic of all actors, cost structure and profit, flow of product and raw material, employment characteristic and volume of domestic and foreign sale. Data can be collected by a combination of focus group discussion (FGD), primary survey work, participatory rural appraisals (PRAs), informal interview and secondary data. Secondly, value chain analysis is used to identify the distribution of benefits of all actors in the chain through measuring margin and profit within the chain, and it is possible to determine who benefit from the chain. Thirdly, value chain analysis can examine the role of upgrading within the chain which help producer to gain higher value of product through involving in improvement of product quality and diversification in the product line or product design. Finally, value chain analysis can show up the role of governance in the value chain which refers to the structure of relationships and coordination mechanism exiting between actors in the value chain (M4P, 2008).

2.6. Value chain analysis applied on agriculture product in Cambodia

Asian Partnership for the Development of Human Resources in Rural Asia (AsiaDHRRA) conducted value chain research on chicken product in Cambodia applying both primary and secondary data collection methods. Primary data was collected from chicken producer group by focus group discussion from three provinces in Cambodia. In the whole value chain of chicken product, cost and prices of the product were collected from middlemen, wholesalers, food processors, retailer and consumer. Mapping value chain was applied to identify key players' role and product flow in the whole value chain of chicken product. Cost and prices of chicken product were calculated for all actors played role in the value chain, and technologies, enabling environment rules, regulations and policies were also illustrated in value chain analysis. In the research, value chain analysis is also used to highlight the role of government and supporting from NGOs and private sector in the whole value chain as well (AsiaDHRRA, 2008).

3. Aims of the thesis

Three main research objectives are derived from the main research problem – in order to evaluate how the rice market works in the selected study area:

- To compare costs and margins between the local and introduced rice varieties (IR 504) in the rice production system (comparing total income, cost and net return between local and introduced varieties).

- To describe the local market value chain for each type of rice production (defining key actors in the rice market channel, identifying activities related to transaction costs)

- To identify key factors affecting the rice production systems (identifying the influence of the Vietnamese market middlemen and other constraints which farmers are facing).

Research Question:

Does the current dependence on agricultural input providers and intermediaries from neighbouring countries benefit Cambodian rice producer?

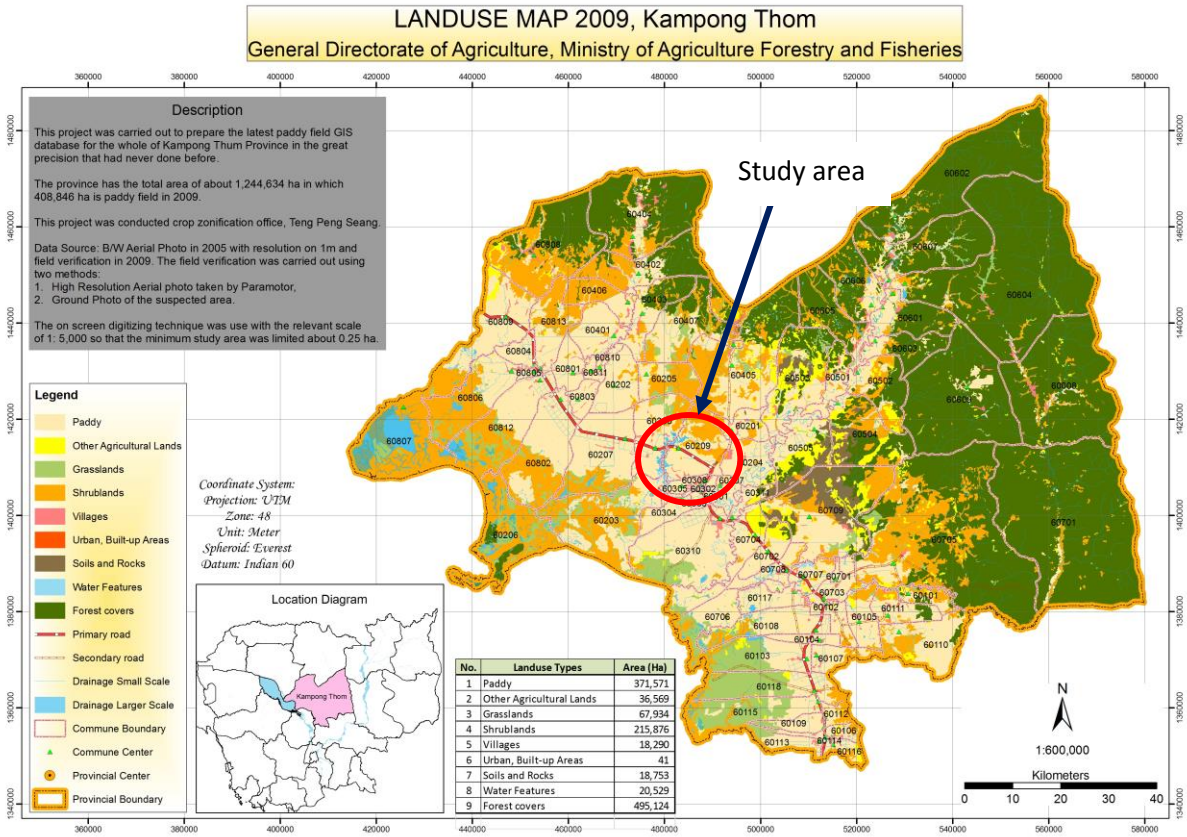
4. Research Methodology

In order to capture the current situation, the main challenges and the potential for rice cultivation, trade and export, we use a Value Chain Analysis (VCA) approach. VCA is used for the assessment of a portion of an economic system where upstream agents in production and distribution processes are linked to downstream partners by technical, territorial, economic, institutional and social relationships (EASYPol, 2013). It has been used several times for similar studies; see for example (Minten et al., 2012; Graef et al., 2014). In this research VCA is used to see how rice was produced, processed and ultimately marketed to the consumers and how production and trade can be enhanced for the primary benefit of the Cambodian producers

4.1. Study site selection

For up-stream producers in the value chain, the research was conducted in Kampong Svay district in Kampong Thom province, a central region of Cambodia located in low-land zone next to the great Tonle Sap Lake. In Kampong Thom province, the landscape is divided into two main parts by national road number 6 - into an upland area located above the national road growing industrial crops such rubber and fruit trees, while the area below the national road is low-land area next to the great Tole Sap lake, which has high potential for the cultivation of many types of rice. The selected district has the largest rice plantation surface in the province and all types of rice production existed in the 11 communes located there (Chey, Damrei Slab, Kampong Kou, Kampong Svay, Nipechr, Phat Sanday, San Kor, Tbaeng, Trapeang Ruesse, Kdei Doung and Prey Kuy. Tbaeng commune, where the majority of people are growing rice, was selected for this study. There are 15 villages in this commune (Trach, Ta Ream, Ruessei Cheah, Pou, Prey Pras, Boeng Andaeng, Ta Am, Tbaeng Ka, Tbaeng Kha, Ba Kong, Tram Khla, Srangae, Ou Ambaeng, Phlong and Chheu Teal). Only three villages (Ba Kong, Ta Ream and Ruessei Cheah) are divided by national road 6 where farmers are growing rice on both sides (below and above part of the national road 6). The total number of households growing rice in these three villages is 885 households (Provincial Department of Planing, 2013). Provincial and district rice markets were selected in order to study the value chain and rice distribution channels.

Figure 14: Map of selected study area



Source: (General Directorate of Agriculture, 2009)

4.2. Data collection

Data collection was organized in August 2014. As a first step, the supply side (rice production) was studied with the purpose of the identification of the main inputs and outputs of the production systems to calculate the costs and margins of each type of local rice production system and to determine the main activities and constraints in production. Second, the rice market in the province and across the border of the province was investigated. The value chain mapping method was applied throughout the whole province in order to describe the behaviour of various stakeholders. It served as a basis for an inventory of market players as well as an analysis of the opportunities and constraints at the value chain level. A flow chart method of visualization was used in order to identify the main market players, to get an overview of what is happening in the target sector and to organize data and information illustrating cost factors, profits, and prices etc (Herr et al., 2009; M4P, 2008).

Quantitative data was collected at a producer level by individual interview based on structured questionnaire. The targeted respondents were the head of the household regardless of being male or female. The questionnaire contained information on the size of a rice farm's production, the farmer's household profile (labour in family, education of head of family, age and main job of farmer...etc), the identification of agricultural inputs in different forms of rice production, the output product and operational activities in each rice product system in order to calculate costs and margins and make a comparison between modern varieties introduced from Vietnam and traditional varieties of rice.

The 270 households growing rice were selected according to a simplified formula for proportion. Yamane (1967) providing a simplified formula to calculate sample size

$$n = \frac{N}{(1 + Ne^2)} = \frac{828}{1 + 828(0.05)^2} = 270\ households$$

Where: n = sample size;
N = total of number household growing rice in the area
e = desired margin of error (5%)

Sample selection by villages:

$$n_i = \frac{n.N_i}{N}$$

Where: n = sample size;
N = total number of household growing rice in the area
n_i= sample size in each village
N_i= Total number of households in each village

Selecting respondents for interview was not a totally random process. 270 households living along both sides of national road 6 were selected using a convenient sampling method to interview people individually using structured questionnaire.

In the market channel, all types of key players involved in the rice market channel in the region were interviewed to identify their roles and specific activities in the rice value chain. They were selected by the snowball sampling method which is used to collect data on opinions and attitudes from non-representative and non-random or non-probability respondents in rice market channel (Katz, 2006). Semi-structured interview and observation were used for this purpose in order to find out in-depth information related to problems in production and the interaction of each market player in the market channel.

Table 4: Description of respondents

Type of respondent	Characteristic	Number of respondent
Producer	finite[2]	270
Village input supplier	infinite[3]	4
Key informant (local authority, NGOs staffs, PDA)	infinite	6
Village collector	infinite	2
Wholesaler	infinite	2
Village miller	infinite	4
Large scale miller	infinite	2
Retailer	infinite	4
Total		294

4.3. Data analysis

Both descriptive and inferential statistics were used to analyze the data obtained from the survey. The descriptive statistics included calculating frequency counts, the mean and percentages, while the inferential statistics included costs and returns comparisons. In economic evaluation among types of rice productions, One-way ANOVA (Duncan) was used in the SPSS program (Version 20) to compare the mean of population of more than two groups (Taylor, 2007). All types of agriculture input costs and the total benefit of selling the paddy rice product were compared for different types of rice production.

- Total Return (TR)= $P \times Y$
- Total variable cost (TVC) = $VC_1 + VC_2 + VC_3 + VC_4 + VC_5 + VC_6$
- Variable cost per unit (Riel/kg) = TVC/Y
- Gross margin = total return - TVC
- Total net return = TR – (TVC + Total Fixed cost)

Note: TR = Total Return/Value of Production ; P = Price of Paddy Rice; Y = Yield;
TVC = Total Variable Cost; VC_1 = Seed, VC_2 = Chemical Fertilizer, VC_3 = Pesticide, VC_4 = Fuel, VC_5 = Herbicide, VC_6 = Labor

[2] We are able to determine the total number of households of farmer growing rice in the study area
[3] We cannot find the total number of key actors in the rice market channel and key informants in the region

5. Results

Currently, various actors work in the rice value chain in the study area. If we start with the rice producer, they buy agricultural inputs from village or provincial input suppliers. The inputs are imported from neighbouring countries (seeds, chemical fertilizer, herbicide and pesticide are mainly from Vietnam and agricultural machineries mainly from Thailand). The farmer sells their paddy rice to a collector or directly to a miller. The local paddy rice collector brings paddy rice for sale to a miller, a Vietnamese paddy rice collector or Vietnamese wholesaler at the Vietnam border. Millers also buy paddy rice from collectors or directly from farmers and process paddy rice into milled rice product, pack it and sell it to provincial and city wholesalers and local distributors (district retailers), or middlemen who export the rice to Thailand. As to the part of production which is processed in the region, by-products from milling paddy rice (rice bran and broken rice) are sold to local animal farms, other distributors or Vietnamese rice collectors. Rice husk as a waste from processing is sold to the electricity provider in the region. Wholesaler and retailer play crucial role for distribution of the milled rice product to final consumers. Beside these main actors in the rice value chain, there are also other external stakeholders like Provincial Department of Agriculture, various NGOs, and banks or microfinance institutions in the region.

5.1. Role of input suppliers

There are two different kinds of input suppliers - village and provincial levels playing a crucial role in supplying agricultural inputs to rice farmers. Provincial input suppliers sell directly to village input suppliers and large scale farmers. Then village input suppliers sell to small scale farmers. Farmers need to pay interest for delayed payment after harvesting. Normally, this takes 3 months with an interest rate of 12.5%. Based on research results, 40% of producers favoured concluding these transactions with a local input supplier since it is less complicated than asking for a loan from a local bank or micro finance institution. Input suppliers also provide technical support and introduce new inputs to rice producers. Around 80% of agriculture inputs (chemical fertilizer, pesticide, herbicide and seed) are imported from Vietnam.

Figure 15: Agriculture input supplier in village

5.2. Rice producers (farmers)

5.2.1. Characteristic of rice producers (farmers)

Table 5 presents a descriptive statistic of the rice producer. More than half of the total household respondents were female. The average age of rice farmers is around 42. The majority of the respondents did not continue their education at high school level and only a few of them have a university degree. Among the reasons which prevent them from continuation of their studies were the civil war, distance to the nearest school, potential violence on the way to school, and lack of family support. Cultivating rice is the main source of income for most of the households, providing food and generating income. The household has 5 members on average with 3 female members. Farmers have around 22 years' experience cultivating rice. The main channel of transfer of know-how to re-rice cultivation was from parents and others neighbouring farmers. Respondents do not cultivate only one type of rice.

Table 5: Characteristic of rice producers

	Village name		
	Bakorng	Taream	Resey Chass
Sample size	84	105	81
Respondent info.			
Female (%)	51	57	54
Average age (standard deviation)			
Male	46 ±13	45±12	40±12
Female	41±13	42±10	39±12
Education (%)			
No formal education	2	12	9
Primary school	56	57	53
Secondary school	32	27	27
High school	9	3	11
University	1	1	0
Main income (%)			
Cultivate rice	91	92	94
NGOs staff	1	0	0
Governmental staff	1	1	0
Worker	0	1	2
Raising animal	1	1	2
Own-business	4	2	1
Others	1	4	0
Average household size	5±1.6	5±1.6	5±1.7
Female	3±1.1	2±1.0	3±1.1
Experiences with growing rice (year)	23±13	23±11	21±10

For the last 4 years farmers have preferred growing IR 504 (early photoperiod-insensitive rice variety), introduced from Vietnam, which is cultivated in the rainy season in May and harvested in August, to local rice; the production is shorter (85 days) and the yield is higher (for detail see Table 5), according to officers of the Provincial Department of Agriculture and the chiefs of villages. In the study area, IR 504 can be grown in early, irrigated and recession rice production systems and also at different time and in different environments. Irrigated and recession rice are cultivated in low-land (flood plain areas) in the dry season. However, other farmers still cultivate photoperiod sensitive rice varieties such as Phka Rumduol (medium rice introduced by RGC), Neang Kong (late rice) and Porpeay (floating rice), due to their having a better taste than IR 504.

Table 6: Descriptive statistics of rice producer

	Varieties	Period (day)	Village name		
			Bakorng	Taream	Resey Chass
Sample size	-	-	84	105	81
Rice production (%)					
Early rice	IR 504	85-90	44	51	85
Medium rice	Phka Rumduol	120-150	53	57	9
Late rice	Neang Kong	150-160	26	31	6
Floating rice	Porpeay	180-210	42	47	15
Irrigated rice	IR 504	85-90	5	4	2
Recession rice	IR 504	85-90	32	38	60

Early, irrigated and medium rice are cultivated next to villages, while late rice is grown far away from the village until great lake. Floating and recession rice are grown in deep water (flooded areas). For growing recession rice, farmers must clear the flooded forest, prepare land and build a good irrigation system.

Figure 16: Farmer collect dried paddy rice to keep as seed for next IR 504 rice production

Table 7 presents the land characteristics of rice production in the study area. It reveals that land size distribution of rice production per household is very variable. The median value of total rice field holdings by farmers is around 3 hectares per household. For types of rice production, the standard deviation of recession rice size of holding is very high because it is not distributed equally to small scale farmers and it is determined by cutting down the flooded forest fields around the great Tonle Sap Lake.

Table 7: Land holding characteristic

Rice farm size (ha)	N=270	Mean	Median	SD
		6.07	3.00	8.41
Rice farm size by different productions (ha)				
Early rice	59%	2.16	1.50	3.09
Medium duration maturity rice	41%	1.55	1.00	1.93
Late rice	22%	1.14	1.00	0.85
Floating rice	36%	2.23	2.00	1.49
Irrigated rice	4%	2.21	1.00	3.19
Recession rice	43%	7.00	3.00	10.55

5.2.2. Paddy rice production

Farmers buy seeds from neighbours or seed producing farmers for growing local varieties and buy IR 504 from input suppliers. After harvest, IR 504 cannot be kept for growing the next year, since that would decrease the yield. 4% of farmers buy seeds directly from Vietnam at a price of 4,000 rile/kg and cultivate it in rainy season in small fields of around 1 hectare. They can use all the harvested rice as seed in recession rice production or sell it to other farmers at a price of 1,000 to 1,200 riel/kg,

Different rice ecosystems have different times to start and to prepare land but the techniques of operation are similar. In the study area, farmers start to prepare land for early rice in May, medium and late rice in June and July, floating rice in April, recession rice in December and January and irrigated rice in February and March. Most of farmers use direct seeding or broadcasting technique for all kinds of rice production. Two years ago some farmers started using the transplantation technique to grow rice but recently they have stopped since it requires a number of labours and the cost of a man/day (10,000 to 15,000[4] riel) is higher than with the direct seeding technique. The research discovered that around 63% of the respondents do not have enough labour to work in the rice fields. 98% of them hire external labour and 2% ask their neighbours for help. Most farmers hire harvesting machines from rich or large scale farmers for harvesting. 12 percent of respondents sold all paddy rice, 75% sold some paddy rice and keep some for their own consumption and 13 % produce rice just for their own consumption. Of rice producers, approximately 94% sell paddy rice immediately after the harvest because they lack storage space and have to pay back loans to banks or micro finance institutions (MFI) and input suppliers, while only 6% of rice producers keep and sell paddy rice in the next rice cultivation period - since selling immediately realises a cheaper price. Location of sale: 93% of rice producers bring their product from the farm and sale it at home, 5% sell at the farm gate and the rest transport it to the miller using their hand tractors. There are significant differences in the price of different types of paddy rice (Sig.=0.000) based on ANOVA (see table7: analysis of price of rice sale from producers). Remarkably, there is no significant difference among early, irrigated, recession and floating rice because those varieties are not good quality (hard, not tasty...) and their price is around 791 to 818 riel[5]/kg. The price of medium rice is the highest price of all types of rice - around 1,080

[4] 10,000 to 15,000riel = 2.5 to 3.75 USD
[5] 791 to 818 riel = 0.19 to 0.20 USD

riel[6]/kg because it has good flavour; it is soft and tasty according to respondents. The price of late rice is around 924 riel[7]/kg.

5.2.3. Economic evaluation of local rice production systems

Different types of rice cultivation provide a different economic mix of benefits. Not all rice production achieves a positive gross margin - 3.8% of early rice producers, 6.3% of medium rice producers, 6.8% of late rice producers, 1% of floating rice producers and 9.6% of recession rice producers end up with a negative gross margin. There are deeply significant differences between rice production in the paddy rice yield, paddy rice price, gross income (value of production per hectare), cost of seed, cost of chemical fertilizer and pesticide, gross income and total variable costs (Sig = 0.000 < 0.01). Recession rice grown next to the lake or at higher levels of the flood area in the dry season provides significantly higher yield than other rice production systems. There are no significant differences in rice yield of rain-feed rice production using local varieties (medium, late and floating rice).

According to table7, IR 504 has a significantly higher yield than that of local varieties (Phkarumduol, Neangkong and Porpeay), but IR 504 grown in an irrigated rice ecosystem provides significantly less yield than in the rainy and recession rice ecosystems. Total variable cost and gross income per hectare of the recession rice ecosystem is higher compared to other rice ecosystems. Statistically, the spend on IR 504 in terms of total variable cost is significantly higher than on local varieties. Remarkably, there are no significant differences between the different types of rice production in terms of variable costs per unit (Sig. = 0.265 > 0.05) but there is a deeply significant difference between the different types of rice production in terms of gross income per unit (Sig. = 0.000 <0.01). Gross margin per unit of medium rice is relatively high compared to that of other forms of rice production while the lowest gross margin is on recession rice production.

[6] 1,080 riel = 0.27 USD (4,000 riel = 1USD)
[7] 924riel = 0.23 USD

Table 8: Economic evaluation of rice production (Currency Note: 1USD = 4,000 riel)

Rice production	IR 504	Local varieties			IR 504		Sig.
	Early	Medium	Late	Floating	Irrigated	Recession	
Number of case	160	112	59	97	10	116	
Avg. farm size (h)	2.16	1.55	1.14	2.23	2.21	7.00	
Avg. value of production (Riel/h)	2,838,700^{c}	2,055,300^{b}	1,459,200^{a}	1,354,400^{a}	2,838,700^{b}	3,308,800^{d}	0.000
Price (Riel/kg)	818^{a}	1,080^{b}	924^{c}	804^{a}	818^{a}	791^{a}	0.000
Yield (kg/h)	3,466^{a}	1,895^{b}	1,692^{b}	1,563^{b}	2,677^{c}	4,317^{d}	0.000
Avg.variable cost (Riel/h)							
Seed	254,400^{a}	177,900^{b}	128,900^{c}	124,400^{c}	217,100^{d}	270,900^{a}	0.000
Chemical Fertilizer	548,000^{a}	271,600^{b}	267,600^{b}	146,000^{c}	494,200^{a}	577,900^{a}	0.000
Pesticide	64,300^{a}	40,800^{a}	40,400^{a}	37,200^{a}	58,900^{a}	96,600^{b}	0.000
Herbicide	34,300	41,400	31,400	109,900	17,500	26,300	
Fuel	156,400	127,000	135,600	81,700	179,200	247,100	
Labour	346,400	325,900	157,700	361,000	241,100	390,600	
Avg. total variable cost	1,275,000^{c}	848,000^{b}	568,800^{a}	653,800^{a}	1,172,100^{c}	1,499,600^{d}	0.000
Avg. variable cost per unit (Riel/kg)	404	497	417	426	475	483	0.265
Avg. gross margin (Riel/h)	1,566,945^{cd}	1,217,300^{bc}	897,900^{ab}	710,300^{a}	1,051,500^{ab}	1,815,400^{d}	0.000
Avg. gross income per unit (Riel/kg)	414^{abc}	584^{c}	517^{bc}	383^{ab}	346^{ab}	318^{a}	0.000
Avg. total Fixed cost (Riel/h)	205,400^{c}	185,500^{a}	185,600^{a}	197,800^{b}	215,400^{d}	225,200^{e}	0.000
Avg. net return (Riel/h)	1,358,400^{cd}	1,021,800^{bc}	704,800^{ab}	502,700^{a}	823,200^{ab}	1,572,900^{d}	0.000

Note: - a, b, c, e and d represent notation to compare between groups, and the different letters show significant differences between groups (derived from the Duncan table)

5.3. Paddy rice collector

Paddy rice collectors play the main role in buying paddy rice from rice producers. There are two different kinds of paddy rice collectors - village collectors and regional paddy rice collectors who come from other provinces. In the study area there were 4 to 5 paddy rice collectors who lived in the village but when the harvest started, many paddy rice collectors from other provinces came and bought paddy rice from the producers. However, they also cooperated with the local paddy rice collectors. The collectors had large trucks and bought paddy rice at the rice producer's house and at the paddy fields whenever farmers called them. The collectors were able to transport 23 to 28 tons of paddy rice with labour costs of 20 riel/kg. Local collectors usually transport paddy rice from the village to a Vietnamese wholesaler on the border but sometimes they sold paddy rice to a local miller. The distance from the village to the Vietnam border is around 300 kilometres and collectors use 300 litres of diesel to transport paddy rice from the village to the Vietnam border and get back. Collectors normally get 70 to 100 riel/kg for paddy rice from the Vietnamese wholesaler. During harvest time they can transport 10 trucks per month to the Vietnam border and 4 to 5 trucks per month at the end of harvest time. The collector is also supported by the Vietnamese wholesaler through informal contracts; they provide financial support to the collector to buy and bring paddy rice for them when the collector doesn't have enough money to run their business. The price of paddy rice is not stable and always goes up and down. For this reason collectors sometimes sell to the local miller and the Vietnamese paddy rice collector. Around 90% of IR 504 paddy rice collected by collectors is exported to Vietnam.

Figure 17: Paddy rice collector come to collect paddy rice from farmer

5.4. Millers

5.4.1. The village miller (small scale)

Village millers are small scale millers providing milling services to rice producers in the village to obtain money or rice bran and also produce milled rice for selling to district and provincial retailers. They invest approximately 1,200 USD to buy a miller machine and have it installed. The capacity of a village miller to process paddy rice is approximately 4 to 5 tons per day. In the rice milling process, 100kg of paddy rice is turned into 60 to 63kg of milled rice, 15kg of rice bran, 5 to 6kg of rice husk and 20 to 23kg of broken rice. The village miller sells milled rice at different prices according to the type of rice. Milled rice made from medium rice (Rumdoul) is sold at the highest price around 2,200 to 2,600 riel/kg and 1,200 riel/kg in the form of broken rice. Mixed rice (late and floating rice) and early rice (the introduced variety) prices are around 1,500 riel/kg and 1,000 to 1,200 riel for broken rice. Normally, the price of rice husk and rice bran is around 20riel/kg and 800riel/kg respectively. Village millers pay 108,000 riel/100kg to buy medium paddy rice; after milling they can get 180,100 riel from the sale of the milled rice and by-products, but if they process mixed rice and the introduced variety they spend 90,000riel/100kg for paddy rice and receive 124,100 riel, less than for medium rice.

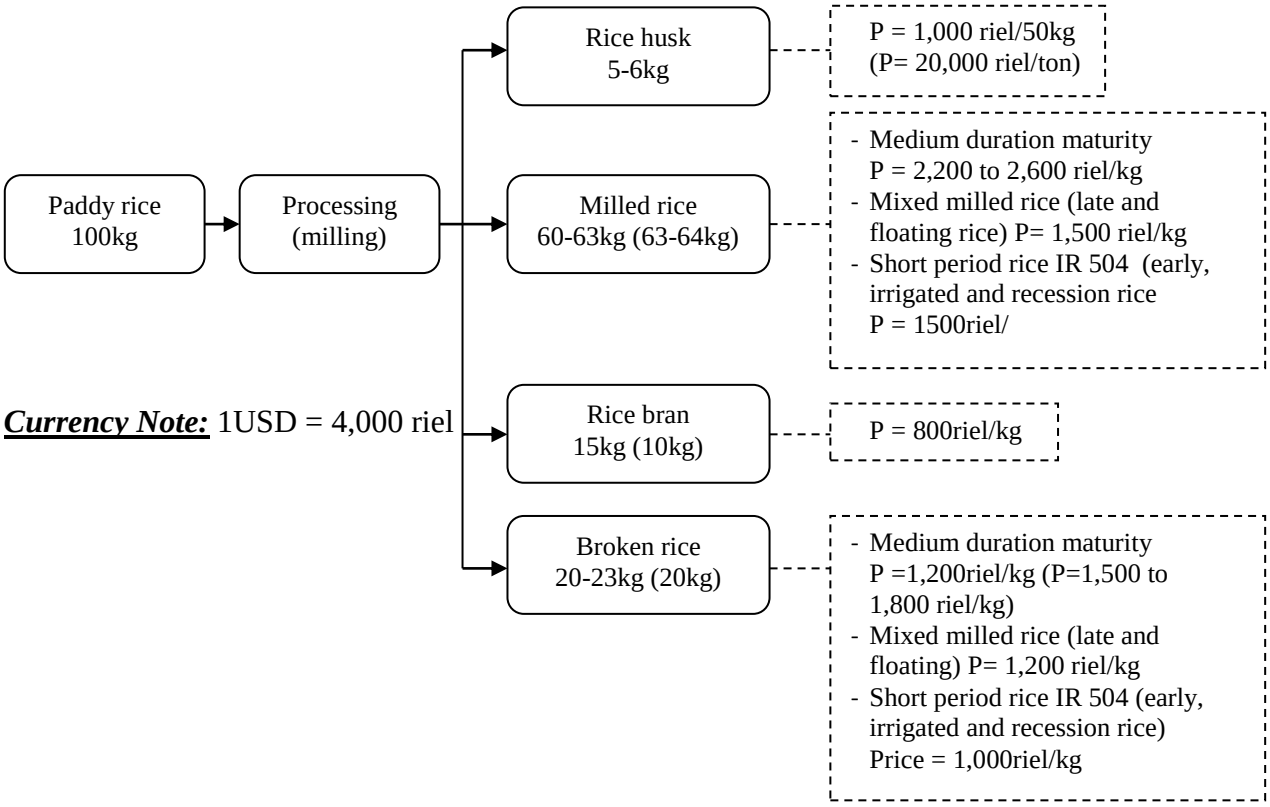
Figure 18: Village miller's rice milling machine

5.4.2. Large scale millers

Large scale millers sell milled rice getting added value and optimal technology operation for the same price as a village miller, but also at different prices due to the different varieties of rice, mostly to district distributors, provincial wholesalers (60 km) and wholesalers in the Phnom Penh (200 km), to middlemen for Thailand and to a few export companies from the city that require good rice quality and also paddy rice for Vietnam, rice husks (5 USD/Ton) to the electricity company and other by-products (rice bran and broken rice) for local animal farms, middlemen and Vietnam. The medium broken rice price is the highest. Currently, millers are facing some problems with low demand for milled rice because Thailand stopped importing milled rice and domestic demand is low. Moreover, milled rice has difficulties meeting the quality requirements of milled rice exporters. There are improvements in new technology and modern equipment that can produce approximately 40 tons of milled rice per day. From the milling of 100kg of paddy rice, it is possible to get 63 to 64kg of milled rice, 10kg of rice bran, 5 to 6kg of rice husks and 20kg of broken rice. Millers spend 108,000 riel/100 kg of medium paddy rice, then get a return of 185,700 riel, but if they process 100kg of mixed and IR 504 paddy rice, they get similar sums to village millers. Due to domestic demand, they would rather process local varieties of paddy rice than IR 504.

Figure 19: Large scale miller in the region

Figure 20: Product changes after milling and value added in small and large scale milling

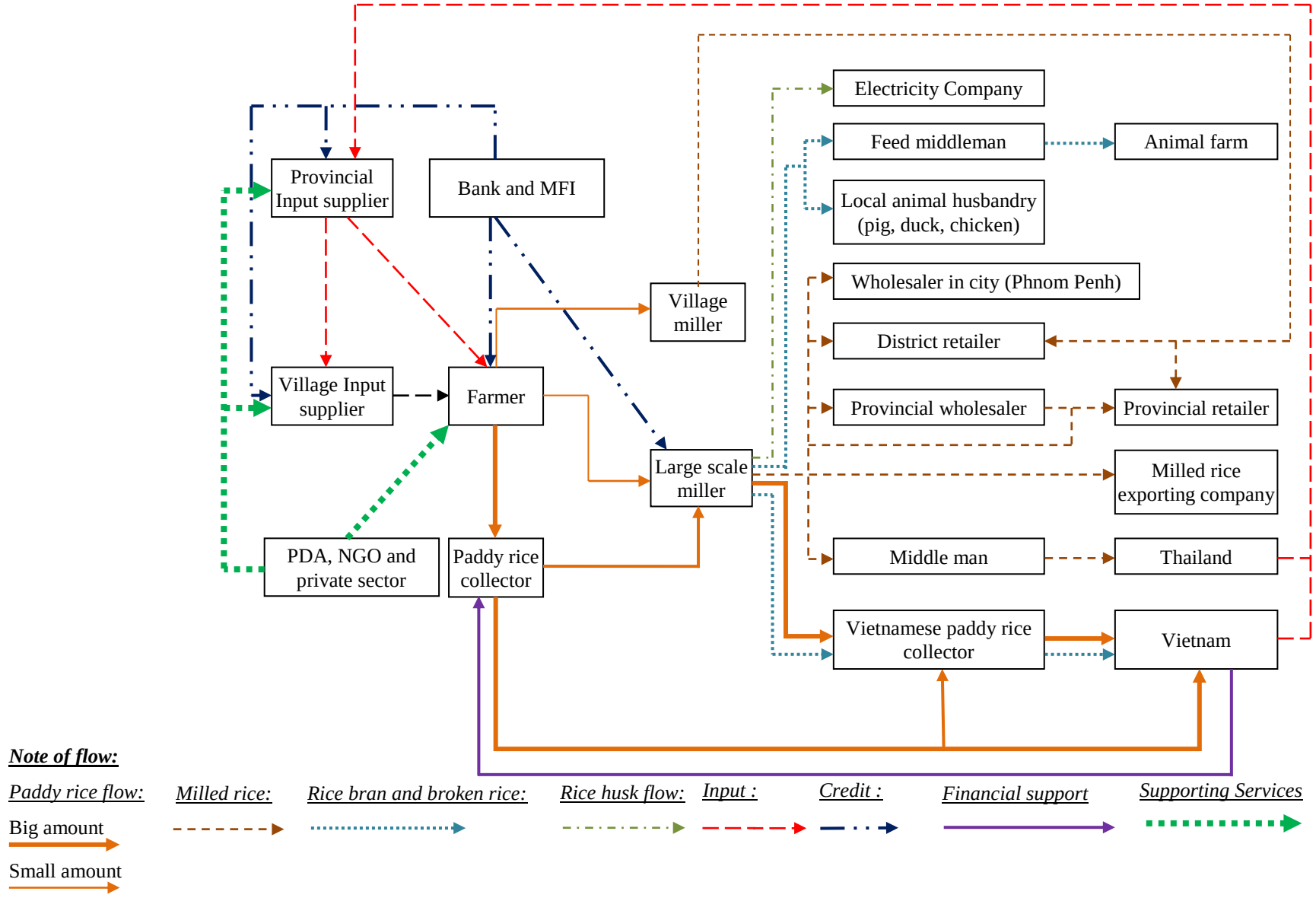


Note: The value in parenthesis represents the large scale miller

5.5. Wholesalers and distributors

Provincial wholesalers order more than 5 tonnes of milled rice from millers who are responsible for transport at a distance of 60 km. Wholesalers sell with a margin of 100 to 200 riel/kg to retailers in the province who distribute the product to the final consumers. In some cases, retailers contact the millers directly to get a good price or contact district retailers to buy milled rice directly from the millers. If the final consumers buy in large amounts (1 bag = 50kg), they can get a discount price. Currently, provincial retailers obtain a profit of 100 to 200 riel/kg of milled rice but retailers who buy directly from millers have more competitive advantages and get higher profits.

Figure 21: The whole rice value chain mapping in the region

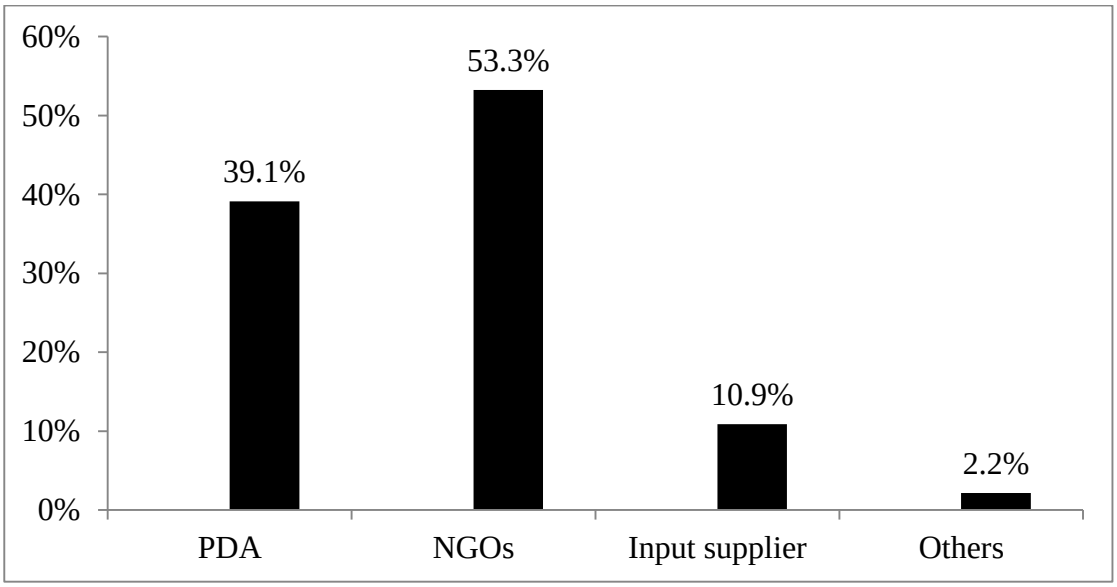


5.6. Business environment

5.6.1. Rice value chain support

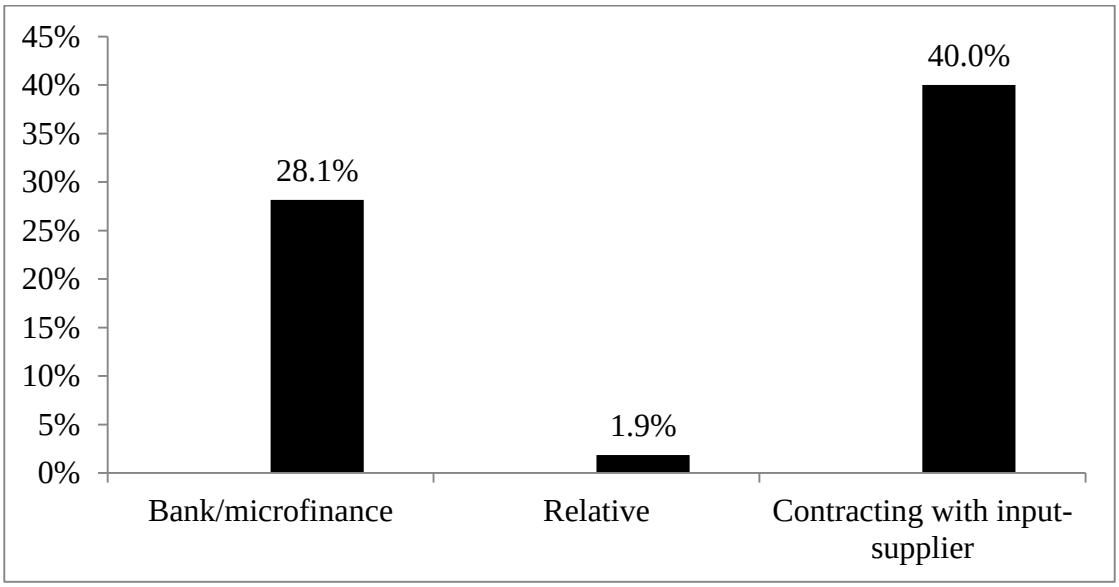
In the rice value chain in the region, rice production is supported by the public, NGOs and the private sector. The public sector (The Provincial Department of Agriculture) provides extension services in rice cultivation. This includes step by step support for rice production (land preparation, use of agricultural inputs, weed control and harvesting) supported by a project of the Asia Development Bank. NGOs (CAVAC, CEDAC, USAID... etc) are implementing agricultural development projects which focus on yield improvement, agricultural adaptation to climate change, sustainable agriculture and value added enhancements.

Figure 22: Supporting on rice production



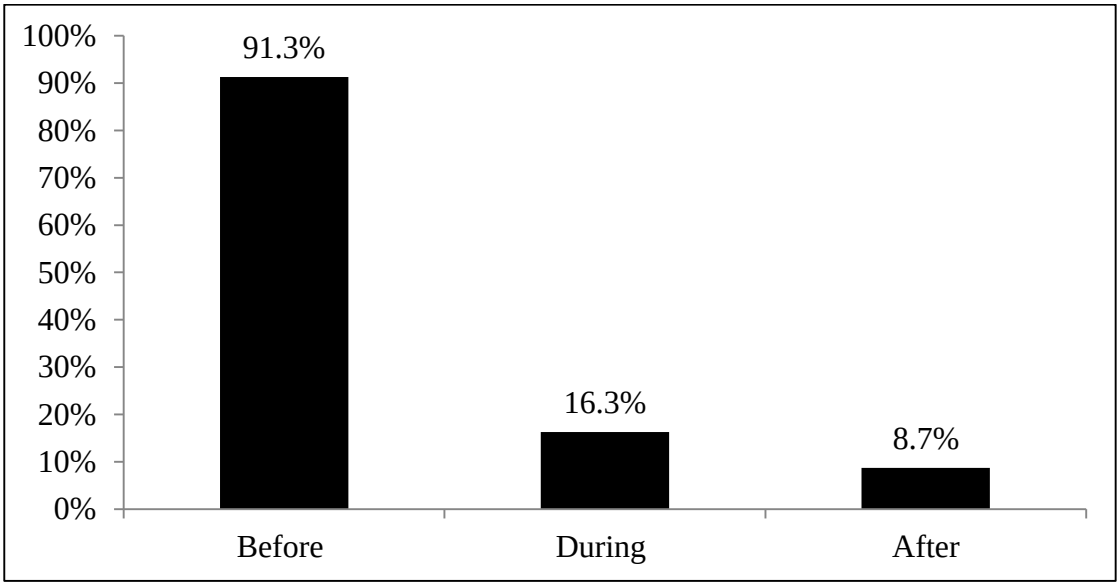
The private sector, Agriculture Input Companies, are introducing new agricultural inputs (pesticides, herbicides, machinery, seed and so on), and local banks and microfinance institutions (MFI) are providing credit to local input suppliers, producers and millers. According to our research results, 28.1% of total respondents (producers) and millers are using loans from local banks and MFIs. On average, the amount of money borrowed from local banks and MFIs is around 8,000,000 riel, the interest rate is around 2.1% per month and the producer pays back the loan in around 9 months.

Figure 23: Sources of money for rice production



In the province, the PDA cooperate with NGOs and agricultural input companies to gather all local input suppliers in the region and provide training on how to use agricultural inputs and provide solutions when farmers face problems with disease, weeds and soil fertility. Producers are also involved in training and supported by these sectors. However, only 33 percent of rice producers received support from these stakeholders with 50 percent of these receiving supports from NGOs, 37 percent from the PDA and the rest from input suppliers. Of the farmers 91% were supported before, 16% during and 8.7% after rice cultivation.

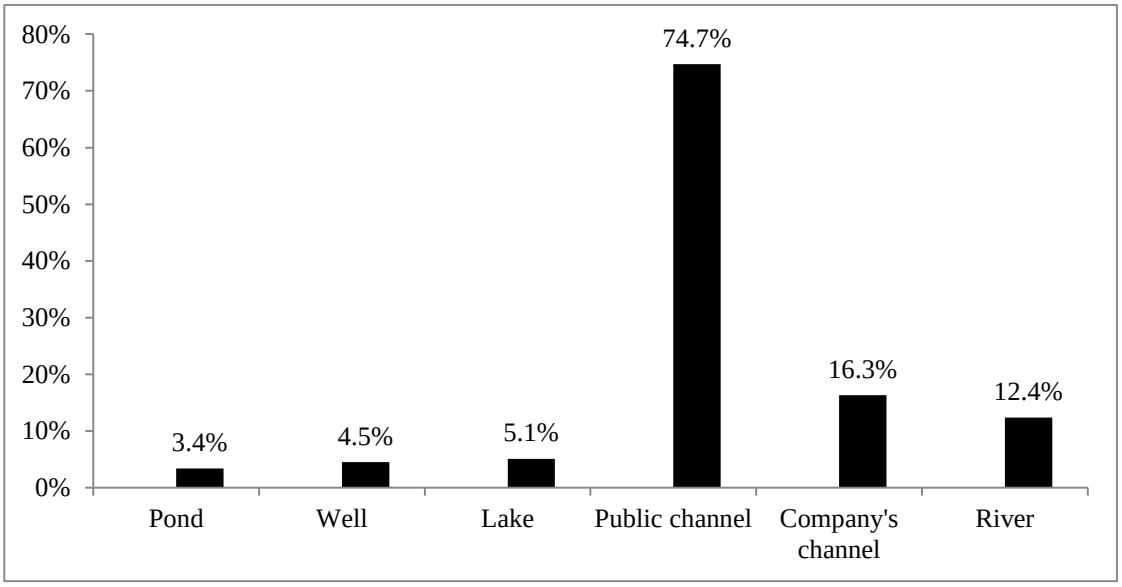
Figure 24: Supporting time of rice production



5.6.2. Constraints in rice production and role of Vietnamese wholesalers

Farmers who cultivate rainy season rice depend mostly on rainfall, sometimes public irrigation canals created by the government and other natural water sources (rivers, ponds and lakes) when the rainfall is not enough. However, the main constraint comes in the dry season when the public canals do not have enough water and conflicts occur between up-stream and down-stream farmers. Recently there was an attempt by the local authority to ameliorate the situation through fund raising from farmers and create groups to collect money from members and maintain access to irrigation.

Figure 25: Sources of water for rice production



During rice production, farmers must deal with insects and natural disasters which affect the yield. 91 % of rice producers have problems with insects, birds, and mice, 75% with natural disasters (64% with flood and 35% with drought last year) which occur nearly every year. This gets worse whenever there are outbreaks of new diseases and insects.

Figure 26: Types of insect and animal damage rice production

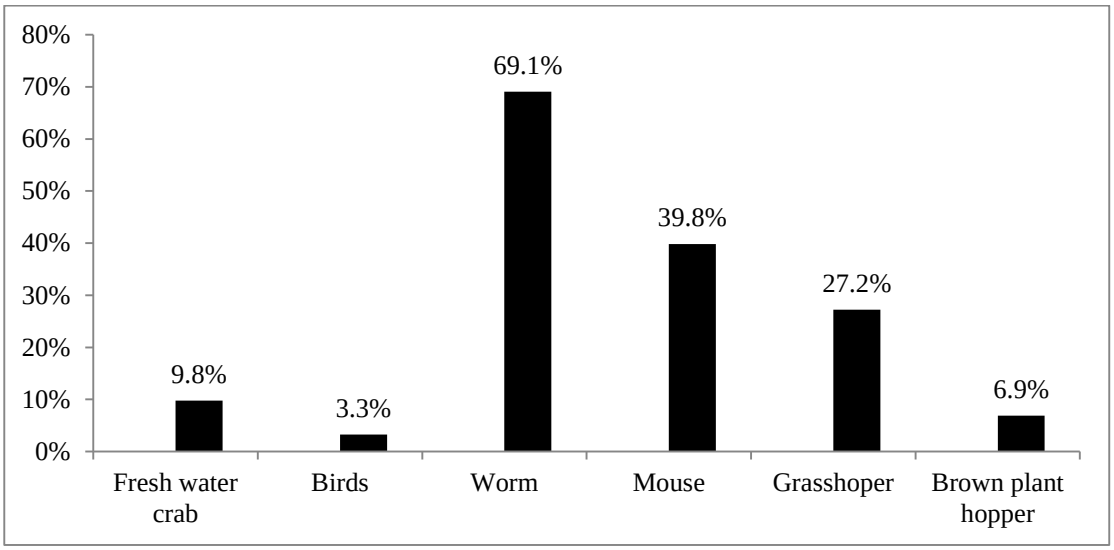
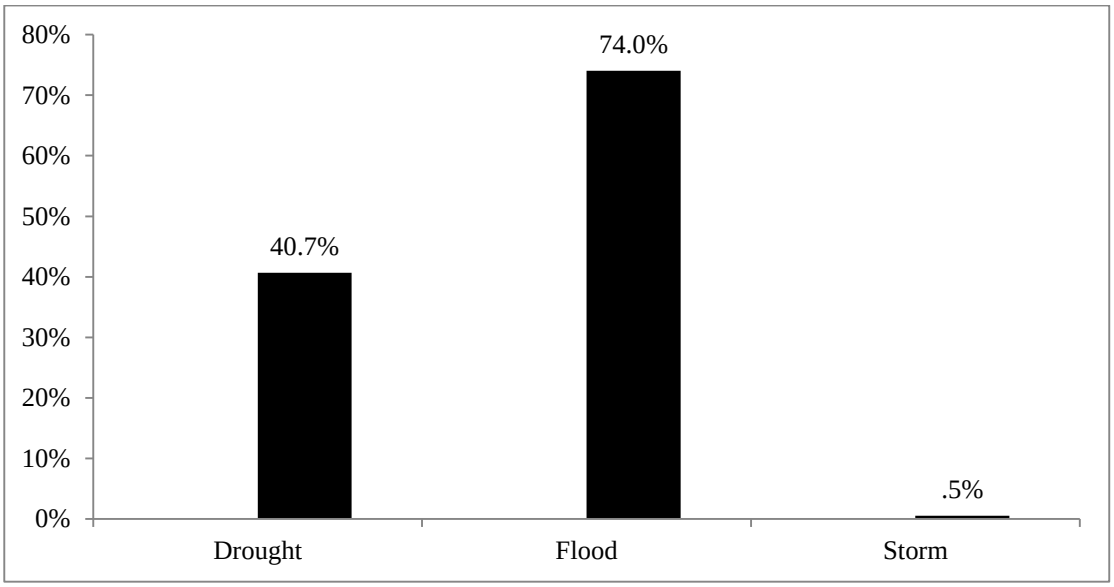


Figure 27: Types of natural disaster affect on rice production



Vietnamese wholesalers at the border wield considerable influence over the local millers. They provide loans with free interest to local rice collectors to buy all wet and dry paddy rice, mainly IR 504, with low requirements. Hence, collectors prefer to sell paddy rice to them than to the local millers. The local paddy rice price is dominated by Vietnamese wholesalers. The price in the region increases when more rice collectors come to buy.

6. Discussion

Dependence on agricultural inputs and intermediaries from neighbouring countries has both negative and positive impacts. From an economic point of view, Cambodian rice producers significantly benefit from adopting IR 504 and at the same time they can improve rice cultivation knowledge through better access to agriculture extension. Input suppliers obtain greater benefit when an increase in a number of fields planted with IR 504 rice leads to higher demand for agricultural inputs. On the other hand, most of IR 504 paddy rice is exported to Vietnam without any registration at the border. The increasing adoption of IR 504 among Cambodian farmers leads to a loss of added value from processing, lower job opportunities for local people and limited by-products supplied as feed to other agricultural activities in the region. Rice husk might be a new source of renewable energy which can be used to produce electricity. Research indicates that in order to produce 1 kWh of power, 1.6 – 1.8 kg of husk is required (Shackley et al., 2012). At the same time, the Governmental ***Export of Milled Rice Policy*** will be not achieved if rice producers do not adopt the 10 varieties of rice introduced by RGC for exporting as milled rice to the international market, when rice producers prefer the IR 504 variety.

According to our economic evaluation, rice producers spend significantly higher amounts of money on chemical fertilizer and pesticide in IR 504 rice production than for local varieties. From the point of view of the environment, adopting IR 504 might increase the pollution caused by rice production. Chemical pesticide and inorganic fertilizer in rice production have a negative impact on soil and water quality and biodiversity (McLaughlin et al., 1995; T. Agbohessi et al., 2015; S. McKnight et al., 2015). This is supported by the fact that most of the rice fields are around the Tonle Sap Lake (great lake) with a rich biodiversity. Increased use of pesticide might also impact human health (Mumtaz et al., 2015). According to our observations, most of the rice producers would prefer to consume local varieties rather than IR 504. Widespread production of IR 504 rice leads to increased water demand and conflicts over water. The traditional local rice varieties will be lost when IR 504 expands and the knowledge needed to cultivate those varieties will disappear as well. According to (Jian et al., 2011), it was found that traditional varieties are more resistant to disease and insect pests than any hybrid variety when grown in the same ecosystem without using pesticide, and traditional varieties are also important for the conservation of aquatic biodiversity.

This research maybe not able to represent the whole value chain in the region, because the number of respondents in the rice market channel (key players in the market) is rather small, but it can serve as a case study as to how the rice market channels work in the region. Currently, Vietnamese wholesalers have recently built a strong relationship with local rice collectors to gather IR 504 paddy rice in the region. The rice producer benefits from a competitive price when both local and Vietnamese rice collectors come and buy paddy rice. However, more and more the price of IR 504 paddy rice is influenced by Vietnamese wholesalers at the border alone. The price will go down again if the Vietnamese wholesalers stop buying it, since IR 504 is not in the list of 10 rice varieties which RGC supports in order to help farmers to export and since local people do not want to include it in their diet. In the future, Cambodian rice producers will be at high risk if the agricultural trade policy of neighbouring (Vietnam) is changed. For example, Thailand implemented a new rice price policy in 2001 under which local farmers were able to get a fixed minimum price for their rice, which was slightly higher than the market price (Forssell, 2008). Since then, in order to protect this minimum price of rice the Royal Government of Thailand stop importing paddy or milled rice from Cambodia.

7. Conclusions

Our research results demonstrate that dependence on agricultural inputs and intermediaries from neighbouring countries benefits rice producers in the region in the short run, but exporting unprocessed paddy rice to neighbouring countries might lead to the loss of Cambodian social and economic benefits, and former agro-biodiversity in the longer term. Farmers adopting IR 504 get significantly higher yield and net return than for local varieties, but at the same time they must invest at a significantly higher cost. The advantage of IR 504 is its shorter period of production than local varieties, plus it can be cultivated in both rainy and dry seasons whenever there is enough water for irrigation. In the study area, IR 504 can be used to grow in the dry season to replace floating rice (low yield and low quality in terms of taste) which is grown in the rainy season and always damaged by floods. Even though IR 504 provides higher yield and better net income in the region, some producers continue to use local varieties such as Phka Rumdoul (introduced by RGC), Neang Kong and Porpeay (traditional variety). Phka Rumdoul (the local variety cultivated in medium rice production) also provides high net income and best quality in the region especially in terms of the taste preferences of local farmers. However, producers tend to drop local varieties which have lower yield and net return for IR 504 at the moment they secure sufficient sources of water. But most of the rice cultivation in the study area still depends on public irrigation which has not enough of water in the dry season to fully supply IR 504. With regard to input suppliers and collectors, they clearly gain more benefits when producers switch to IR 504. Frequent informal contracts between input suppliers and small scale producers play a crucial role in supporting small scale production of IR 504 in the region.

All the players in the rice value chain in the region work closely together. Most agricultural inputs for IR 504 rice production are imported from neighbouring countries. Input suppliers play the main role not only in the distribution of agricultural inputs to producers but also in technical support and extension. The input suppliers can gain more benefit if producers switch to IR 504 not only from selling their products but also from the high interest on deferred payments from producers. On the other hand, under this new system small scale producers are able to produce even if they don't have enough cash to buy agricultural inputs. IR 504 also brings more intensive agricultural knowledge to rice producers. Farmers have to change from the traditional practices applied in local varieties to more intensive know-how when they adopt IR 504.

Price setting for paddy rice is more and more dominated by Vietnamese wholesalers and large amounts of paddy rice collected by local rice collectors are exported to Vietnam. Vietnamese wholesalers at the border can collect all the paddy rice in the region through local collectors. They provide loans with free interest to local rice collectors. The quality demand is lower than for local millers, therefore local rice collectors also tend to collect paddy rice in the region in order to sale it to Vietnamese wholesalers rather than to the local miller when they get these incentives and promotions from Vietnamese wholesalers. Therefore, Vietnam wholesalers can collect all kinds of paddy rice faster than local millers. Local millers only gain more benefits if the producers cultivate Phka Romdoul (a local variety).

Natural disasters, insects and disease continue to be the main obstacles to increased yield of rice. Besides this, new water conflicts between rice producers up and down stream of public irrigation arise whenever the use of IR 504, as a more water-demanding crop, expands. Lack of infrastructure (road and irrigation) leads to higher production costs, when public irrigation has not enough water for this new type of production. This means that all local producers also need to buy water from private irrigation companies and spend more money on its tricky transportation.

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