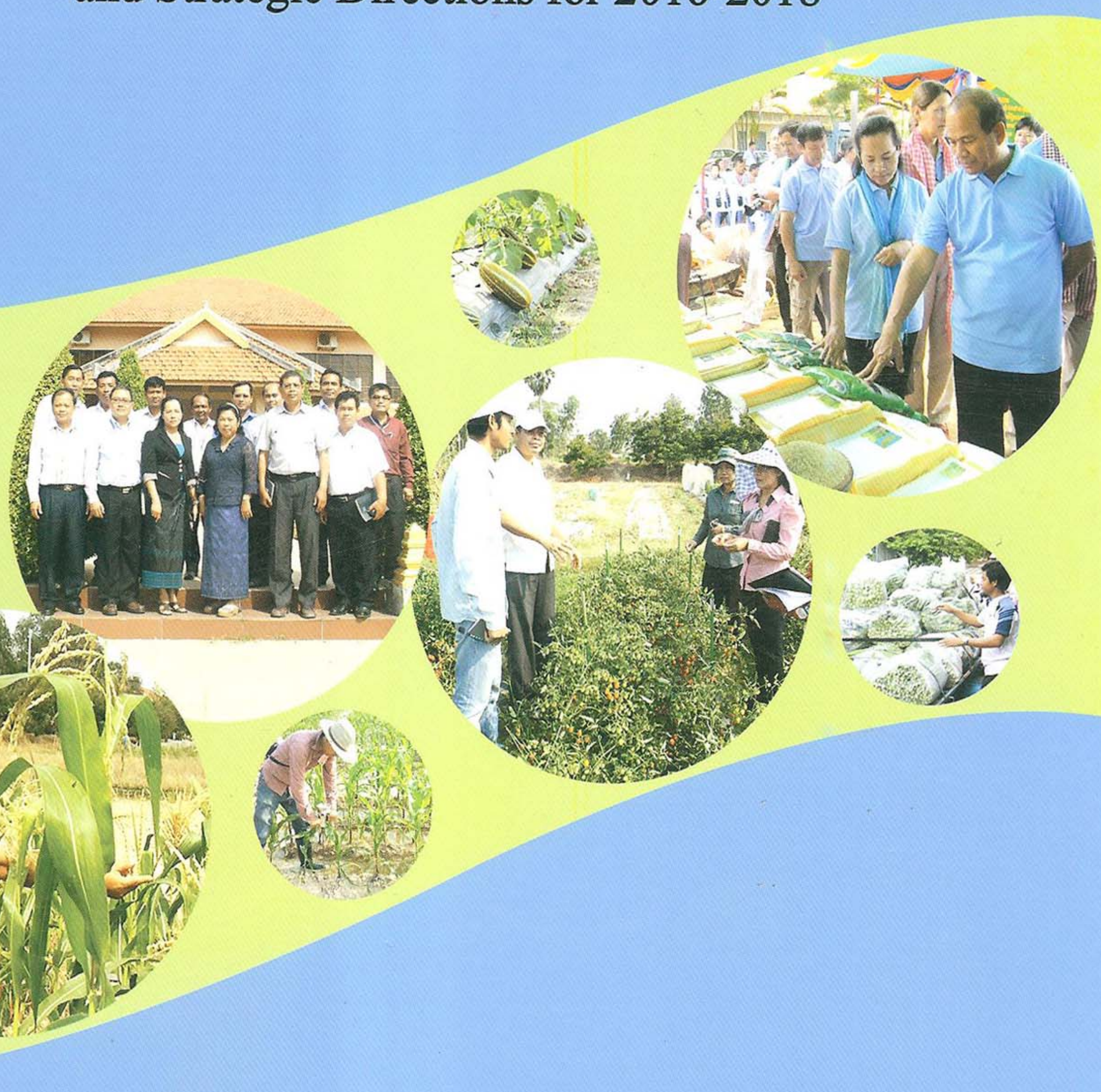
Cambodian Agricultural Research and Development Institute

Summary Report on
Main Achievements of Research and Agricultural Technology Development in 2015 and Strategic Directions for 2016-2018



Research ➡ Extension ➡ Production ➡ Marketing

Foreword

The Cambodian Agricultural Research and Development Institute (CARDI) is a semi-autonomous, leading agricultural research institute under the jurisdiction of the Ministry of Agriculture, Forestry and Fisheries (MAFF) as a Technical Supervisor; and the Ministry of Economics and Finance (MEF) as a Financial Supervisor. CARDI is managed by Board of Directors (BOD), and executed by a Director with a few Deputy Directors as Assistant. CARDI's mission is to increase agricultural crop productivity, improve crop diversification, and ensure environmental sustainability and stability of rural livelihoods through partnership in agricultural research, and technology utilization. CARDI has developed and released high quality crop varieties and seeds, while a range of other programs have improved all aspects of crop diversification and crop improvement, growing, cultivation and harvesting. It has a track record of research excellence in developing Cambodia's capacity in rice production and will continue to diversify its capability, particularly in non-rice areas, to assist with the broader development of Cambodia's agriculture.

CARDI is delighted to present its Annual Report for 2015, a Summary Edition, as its commitment in implementation of the Agricultural Sector Strategic Development Plan, 2014-2018. The report highlights key findings and achievements made in 2015 as the outcomes of research implemented by CARDI's Research Offices including Plant Breeding, Soil and Water Sciences, Plant Protection, Agricultural Engineering, Socio-Economic Science, Agronomy and Farming Systems, and Training and Information Centre.

This report was produced under the leadership of CARDI's BOD and with strong support and guidance from MAFF and MEF. Our research and development work was carried out in close cooperation with a number of stakeholders including: Government Officers from National to Sub-National levels including officials and technical staff of the Provincial Departments of Agriculture (PDAs), specialized departments of MAFF mainly General Directorate of Agriculture and royal University of Agriculture, UN agencies, OIs, NGOs, and a number of international research and/or educational institutions such as ACIAR, IRRI, CSIRO, University of Queensland, Murdoch University, Charles Sturt University, University of South Australia, University of Western Sydney, New South Wales DPI, Tamworth Agricultural Institute, RDA, KOPIA-Cambodia NIAS, YAAS, Bioversity International, MJP, and last but not least the Cambodian farmers.

This report will serve a wide range of users who are interested in agricultural research and development in Cambodia including politicians, policy makers, researchers, extension workers, lecturers, students, and even farmers. For CARDI itself, the report provides an important incentive for its leaders and staff to continue its mission on agricultural research and technology transfer in Cambodia.

I am convinced that this report is a useful source of information for any users.

Phnom Penh, 25 March 2016

Ouk Makara, Ph. D

Director

Table of Contents

1. Introduction

In the 5th Legislature, the Royal Government of Cambodia has set four strategic objectives to promote agricultural growth: (1) Enhancing agricultural productivity, diversification, and commercialization; (2) Enhancing animal production and aquaculture; (3) Increasing efforts on land reforms, mine clearing, and UXOs; (4) Managing natural resources in a sustainable manner through agricultural modernization with new context and more progressive approach in order to transform agriculture from subsistence-oriented to business-oriented production which involves utilization of new technology and techniques, mechanization, and irrigation facilities for increasing crop productivity and diversification, and other agricultural commodities including animal production and aquaculture.

In response to the Royal Government's strategic objectives, the Ministry of Agriculture, Forestry and Fisheries (MAFF) has developed its strategic development plan, called Agricultural Strategic Development Plan (ASDP) for 2014-2018. ASDP2014-2018 has an overall goal to achieve agricultural growth around 5% per annum by implementing 5 key Programs as follows: Program 1- Enhancing agricultural productivity, diversification and commercialization; Program 2- Enhancing animal health and production; Program 3- Ensuring sustainable management of natural resources; Program 4- Ensuring sustainable management of forest resources and wild life; and Program 5- Strengthening institutions including their capacity, services, and human resources development.

In MAFF's ASDP 2014-2018, the Cambodian Agricultural Research and Development Institute (CARDI) involves with implementation of Program 1 aiming at increasing the growth of crop production about 10% per annum through enhancing agricultural research and extension services that lead to increased crop yields and quality, strengthening capacity of agricultural cooperatives in relation to implementing contracted farming, and enhancing the sustainable use and management of soil resources. Program 1 has 20 Subprograms in which CARDI has been implementing 3 Subprograms as follows: **Subprogram 1.18**- Research on increased agricultural crop productivity; **Subprogram 1.19**- Research on increased agricultural crop diversification and technology transfer; and **Subprogram 1.20**- Enhancing the effectiveness of supporting services and human resources development for research.

This report highlights key results of CARDI's research and development indicators projected in 2015 under MAFF's ASDP 2014-2018.

2. Summary achievements in response to indicators in ASDP 2014-2018

Under technical supervision by MAFF, financial supervision by Ministry of Finance and Economic, and leadership of Board of Director; as well as in good collaboration with related departments and all provincial agricultural departments under MAFF, international research institutions, NGOs and especially with farmers; CARDI has fruitfully achieved 2 year results as indicate in ASDP2014-2018 (Table 1).

Table 1. Results in response to predicted indicators in ASDP 2014-2018

Indicators of results	Unit	2014		2015		Yearly predicted		
		Predicted	Achieved	Predicted	Achieved	2016	2017	2018
Subprogram 1.18. Research on increased agricultural crop productivity								
1. Additional collected sample of crops	sample	100	391	100	324	100	100	100
2. Crop variety released	variety	2	0	1	4	2	1	3
3. New technology developed	number	7	8	6	6	7	10	9
Subprogram 1.19. Research on increased agricultural crop diversification and technology transfer								
1. Technology package for diversification	number	2	1	1	1	1	1	1
2. Increased area using CARDI technology	%	2	2	2	2	2	2	2
3. Quality seed produced	ton	50	102	55	75	55	60	60
Subprogram 1.20. Enhancing the effectiveness of supporting services and human resources development for research								
1. Staff and others have been trained and educated	opportunity	105	781	105	686	105	105	105
2. Published paper and document	number	2	14	3	9	5	6	7
3. Increased effectiveness of supporting to economy	%	2	2	2	2	2	2	2

3. Achievements of research, technology development and transfer in 2015

Implementing its mandate and under guiedlines of ASDP2014-2018 to achieve Rectangular Strategy Phase III of the Royal Goverment of Cambodia, CARDI continues to (1) develop new crop varieties, (2) soil and nutrient management, (3) cultural technology for cropping systems, (4) crop protection from pests, (5) pre and post harvest technology, (6) agricultural socio-economic analysis, and (7) training, extension of technology knowledges and agricultural information. In general, a total of 110 types of experiment were conducted at 710 sites, different types of surveys and training courses have been conducted and achieved good results accordance to objectives and predicted indicators in all three Subprograms as the following:

3.1. Sub-Program 1.18. Research on increased agricultural crop productivity

This Subprogram aims to promote research technology and high productivity crop varieties with tolerance to abiotic and biotic stresses for ensuring sustainability of genetic resources for food and agriculture with 9 main achievements as below:

- **Germplasm conservation:** Letter of agreement for a long-term conservation of crop germplasm at the Rural Development Administration (RDA) was signed, and sent a duplication of 217 rice accessions for a long-term storage in the gene bank of the Republic of Korea. Meanwhile, 324 samples of other crops germplasm have been collected, in those, nearly 100 samples of melon and chilli have been evaluated. By the end of 2015, a total of 33

types of crop germplasm with 7,900 accessions/samples, including 6,645 rice accessions/samples and other 32 crops altogether have 1,255 accessions/samples have been conserved in the genebank at CARDI for the development of crop germplasm. Meanwhile, a duplicated 2,557 and 217 rice accessions are long-term conserved in IRRI and RDA genebank, respectively.

- **New crop variety released**: Aside from rice varieties of Phka Rumduol Prang, CAR14 and glutinous maize CM1 that were released in early 2015 and reported in early report, CARDI has also released a new rice variety named CAR15, which is an early maturing incensitive variety, originated from IRRI (IR04N155). The life cycle of this variety is 100 days in average with its plant height of 1.0m, the length of white rice is 0.7mm, grain width is 2.1mm, amylose content is 21.6% and average yield in dry and wet seasons is 4.0 t/ha. This variety is moderately resistant to brown panthoppers (BPH). The yield potential of CAR15 is up to 7.4 t/ha. Thus, in 2015, CARDI released 4 new crop varieties.
- **Pesticide to control brown plant hopper (BPH):** Results obtained from testing four types of pesticides (Table 2) indicate that APATA killed BPH by 93% and reduced hatchig rate similar to OSHIN20WP to 33% (Figure 1). However, APATA application should be used in rotation with OSHIN20WP from time to time to maintain the pesticide effectiveness and reduce BPHs resistant to the pesticide application.

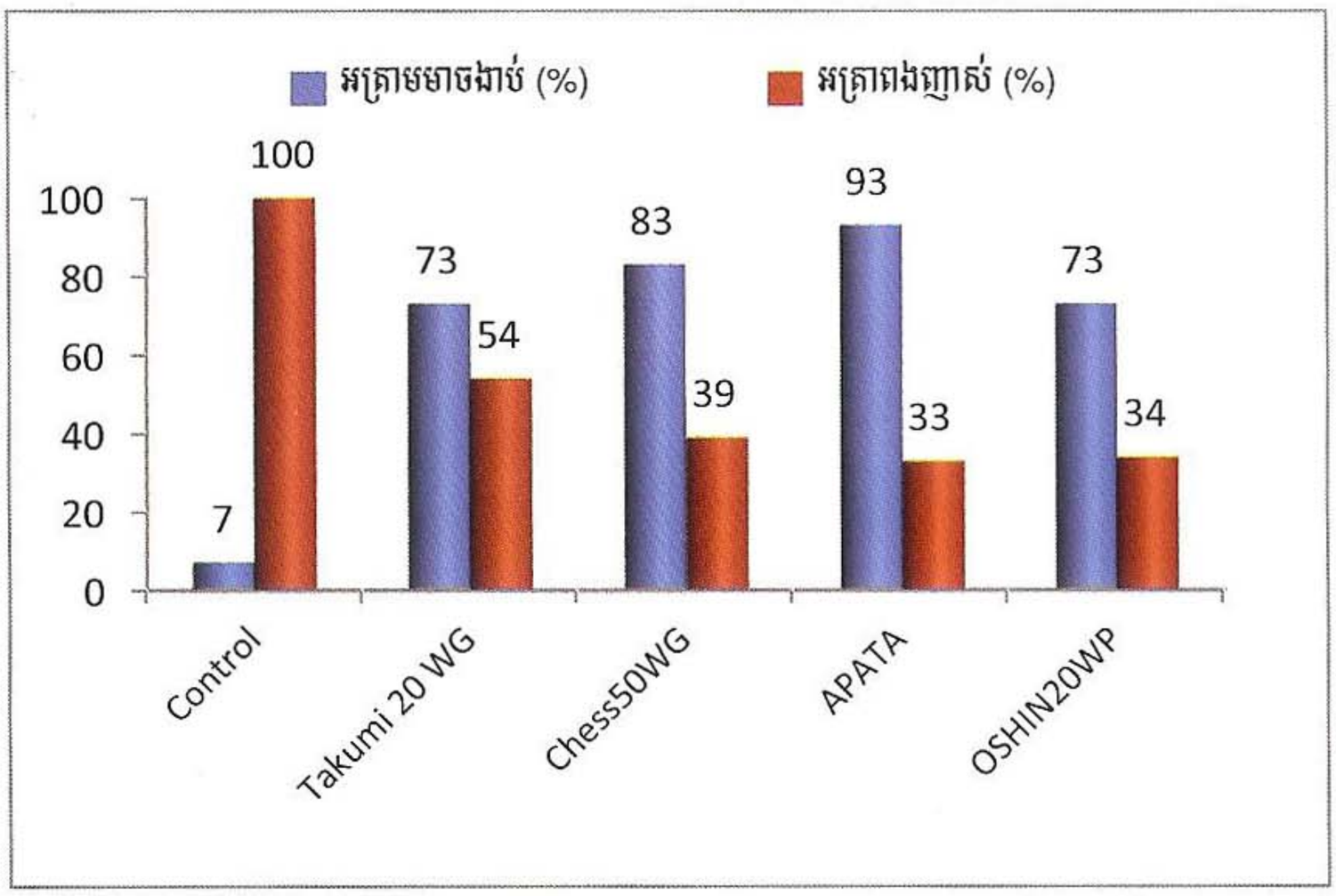


Figure 1. Effectiveness of pesticides, sold in market places on BPHs and hatching egg (LSD5% BPH nymp die=8, hatching ability=5)

Table 2. Pesticide names, active ingredient and application dose

Trade name	Chemical name	Active ingredient rate (%)	Dose of Active ingredient (g/ha)	Dose of Product (g/ha)
Control				
Takumi 20 WG	Flubendiamide	20	16	80
Chess 50 WG	Pymetrozine	50	120	240
APATA	Fipronil	40	120	300
	Imidaclopride	40	120	
OSHIN 20 WP	Dinotefuran	20	26	130

- **Rice seed drill:** This planter was modified to meet with soil and field conditions in Cambodia. Results from testing at 23 farmer fields show that average rice grain yield obtained by using this planter was 3.25 t/ha which was 0.45 t/ha higher than that received by manual broadcasting. It reduced seeding rate from 120-150 kg/ha (manual broadcasting) to 60-80 kg/ha.
- **Adoption of mechanization in rice production:** The results indicate that land preparation was done by animal draught power accounted for 17%, 61% by power tiller and the other 22% by tractor (Figure 2). Cattle are still in use by farmers for some reasons such as farmers' affordability to purchase or hire (31%), paddy fields are too small (21%), desire for manure as organic fertilizer (13%) and some other reasons (36%) [Figure 2]. Apart from that, harvesting was done manually by hand about 10% of dry season rice, 19% for early wet season rice, and 42% of wet season rice (Figure 3). Reapers was used mostly in early wet season rice (16%) then dry season rice (11%) and least for wet season rice (7%). Combine harvester has been very popular now among farmers as it was used to harvest up to 80% of all dry season rice, 64% of early wet season rice and 51% of wet season rice.

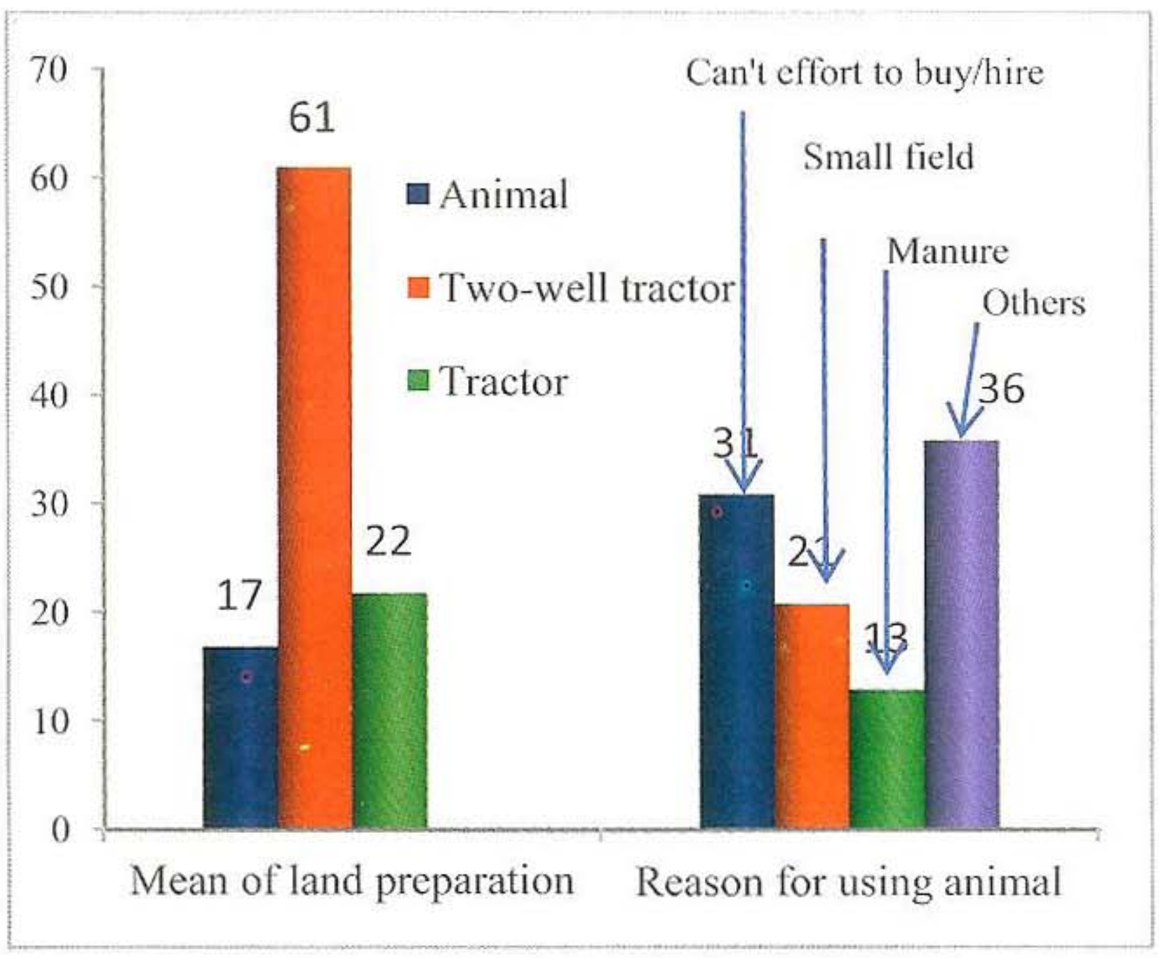


Figure 2. Mean of land preparation

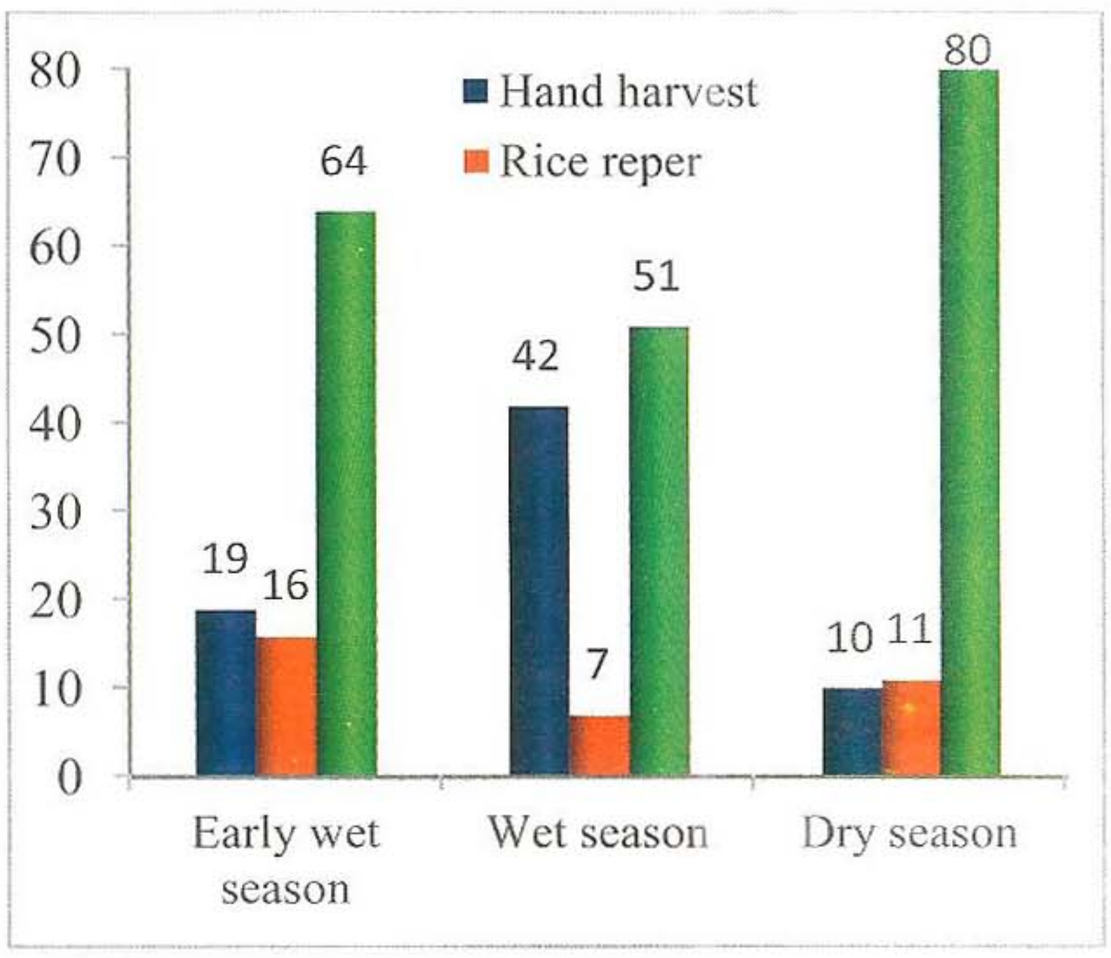


Figure 3. Mean of harvesting rice

- **Impact of climate change on rural livelihoods:** Results from a survey of 150 rice farmers in Kampong Speu, Kampot and Kampong Cham Provinces show that about 83% of the interviewed farmers noticed that the climate has changed over the last decade. The climate change increased or decreased the temperature, prolonged dry season period, shortened wet season duration, decreased annual precipitation, and caused irregular rainfall with very early rain or late rain than common years and also fierce wind or even thunderstorm. The farmers in the three provinces also emphasized that the climate change affected their crop productions resulting in fallow paddy field, frequent occurrence of insect pests, deteriorated soil fertility and significant decreased crop yields. Further, farm family members and their daily activities for livelihoods were also affected such as frequent domestic violence due to tension and deep anxiety among family members, shortage of food supply and poor health condition.
- **Post-harvest loss of pak choy**: The results of study show that 30% of pak choy was damaged (decayed) and 2.5% weight loss when the product was transported from farmer field in Saang district of Kandal province to the market in Siem Reap by passing through wholesale

market in the district, and in Phnom Penh (Neak Meas wholesale market).

- **Effect of cassava plantation on soil quality:** Results from experiments at three locations show that without fertiliser application cassava produced fresh roots of 27 t/ha. Applying with defferent rates of NPK fertilisers produced root yield between 31-33 t/ha (Table 3). Starch content ranged from 27-29% which was not significantly different between the tested treatments. Comparing with soil property before the experiments the values of soil pH, organic C, and available P after experiment increased by 0.2 unit, 0.27-0.62%, and 1.86-4.34 mg/kg, respectively. But there was no remarkable change in total N and exchangeable K in the soil for the first year of planting.

Table 3. Effect of cassava planting (First year) on soil properties (soil pH, org. C, total N, avail. P, and exchangeable K)

Treatments*	Soil texture	pH	Organic C (%)	Total N %	Available P (mg/kg)	Exch. K (cmol/kg)	Fresh biomass (t/ha)	Starch content (%)
Before experiment	Silty clay	8.07	0.94	0.12	3.43	0.48	-	-
After experiment								
T0. No fertiliser	Silty clay	8.30	1.21	0.11	5.29	0.48	26.93	28
T1. Low NPK	Silty clay	8.27	1.56	0.10	7.01	0.50	31.93	29
T2. Medium NPK	Silty clay	8.29	1.31	0.10	7.32	0.51	31.02	28
T3. High NPK	Silty clay	8.27	1.50	0.11	7.77	0.43	32.94	27

*Rates of applied NPK (kg/ha): T1: 40-20-80, T2: 80-40-80, T3: 160-80-100 (as N, P2O5, K2O).

3.2. Subprogram 1.19. Research on diversification and technology transfer

This Subprogram has an objective to develop technology package and transfer technology suitable to growing conditions and socioeconomic situation of farmers with maintaining sustainable crop production growth and safety with main five achievements as below:

- **Crop seed production**: All crops released by CARDI for farmers and other stakhoolders are guranteed its purification through the production of Foundation Seeds and supplying it by ordering from private companies, agricultural co-operatives and other development projects, which implementing by specialized institutions of the ministry and other organizations to produce and supply to farmers. During visiting CARDI/MAFF exhibition boot of Cambodia Rice Forum, organized by Cambodia Rice Federation at Sokha Phnom Penh Hotel on the 25th January 2015, **Samdech Akka Moha Sena Padei Techo Hun Sen** indicated that to ensure purification of crop seeds released by MAFF, the Ministry must countinue to produce Foundation Seeds for supplying to clients in order to produce next seed classifications for supplying to farmers. In wet and dry seasons of 2016, CARDI will distribute foundation seeds of two rice varieties, Damneub Sbai Mongkul (DSMK) and Phka Rumduol Prang (PRDP) to all 25 Provincial Departments of Agriculture (DSMK=15kg and PRDP=30kg each) and Department of Rice Crop (DSMK=PRDP=40kg) in order to produce registered seeds and distribute it to farmers and other stakhoolders.

- **Technology package for increased rice productivity in coastal areas:** Results of three years comprised of 52 demonstration fields conducted in Preah Sihanouk and Kep provinces show that (1) Phka Rumduol, Phka Rumdeng and Phka Romeat high rice varieties grown well and produced an averaged yield of 2.85t/ha compared to farmers varieties (2.67t/ha) with

additinal profit of 0.73 million Riels, and (2) implementing technology package increased an average grain yield up to 3.25t/ha providing additional profit 1.19 million Riels compared to farmer's practice (Figure 4).

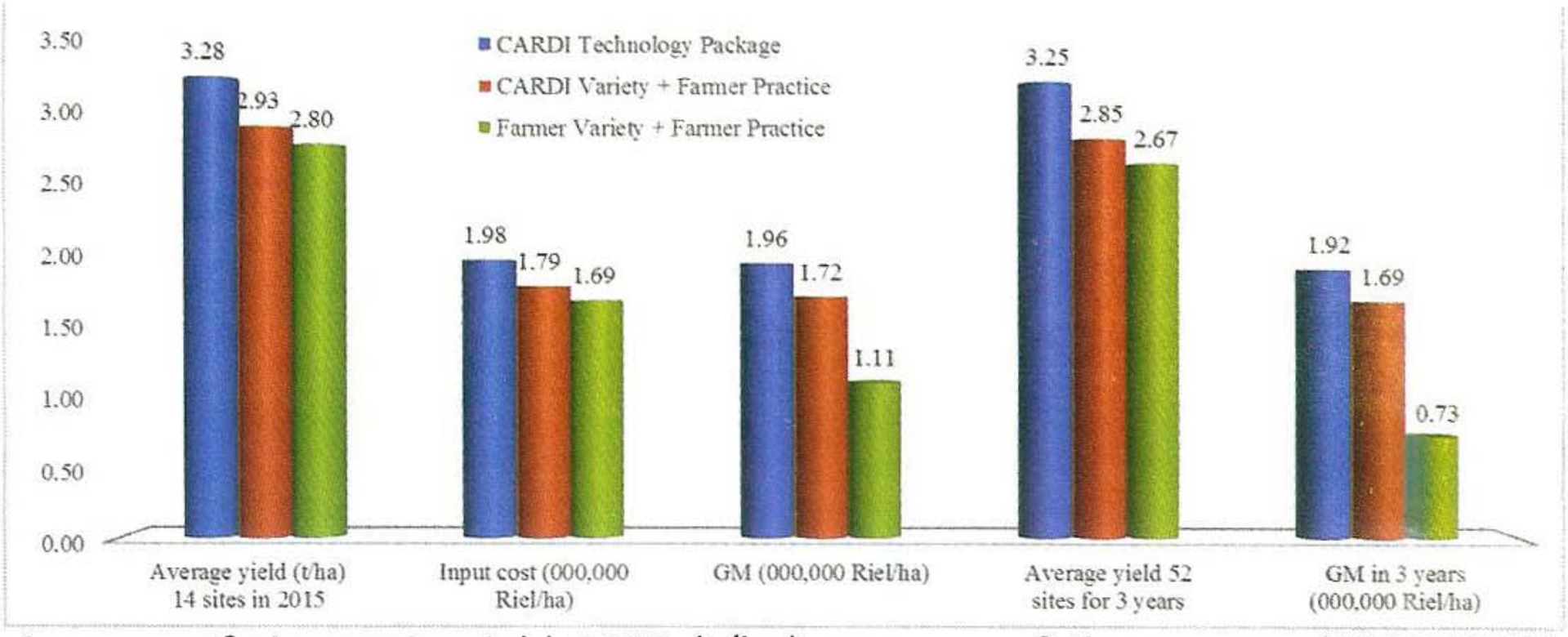


Figure4. Average of rice grain yield 2015 (t/ha), average of three years (2013-2015) and net profit.

- **Adoption of rice varieties released by CARDI**: Data obtained 1966 households in 8 provinces (Takeo, Prey Veng, Svay Rieng, Kampong Chhnang, Pursat, Battambang, Kampong Thom and Kampong Cham) indicated that in 2014 wet season, about 50% of the rice area was covered by Phka Rumduol variety, 10% area by Riang Chey and 6% by other varieties released by CARDI, and from the remaining area, 29% of wet season rice area was cultivated with traditional varieties and the other 5% was of introduced varieties (Figure 5). Altogether in 2014, 66% of the total wet season rice area in the 8 provinces was cultivated by rice varieties that released by CARDI.

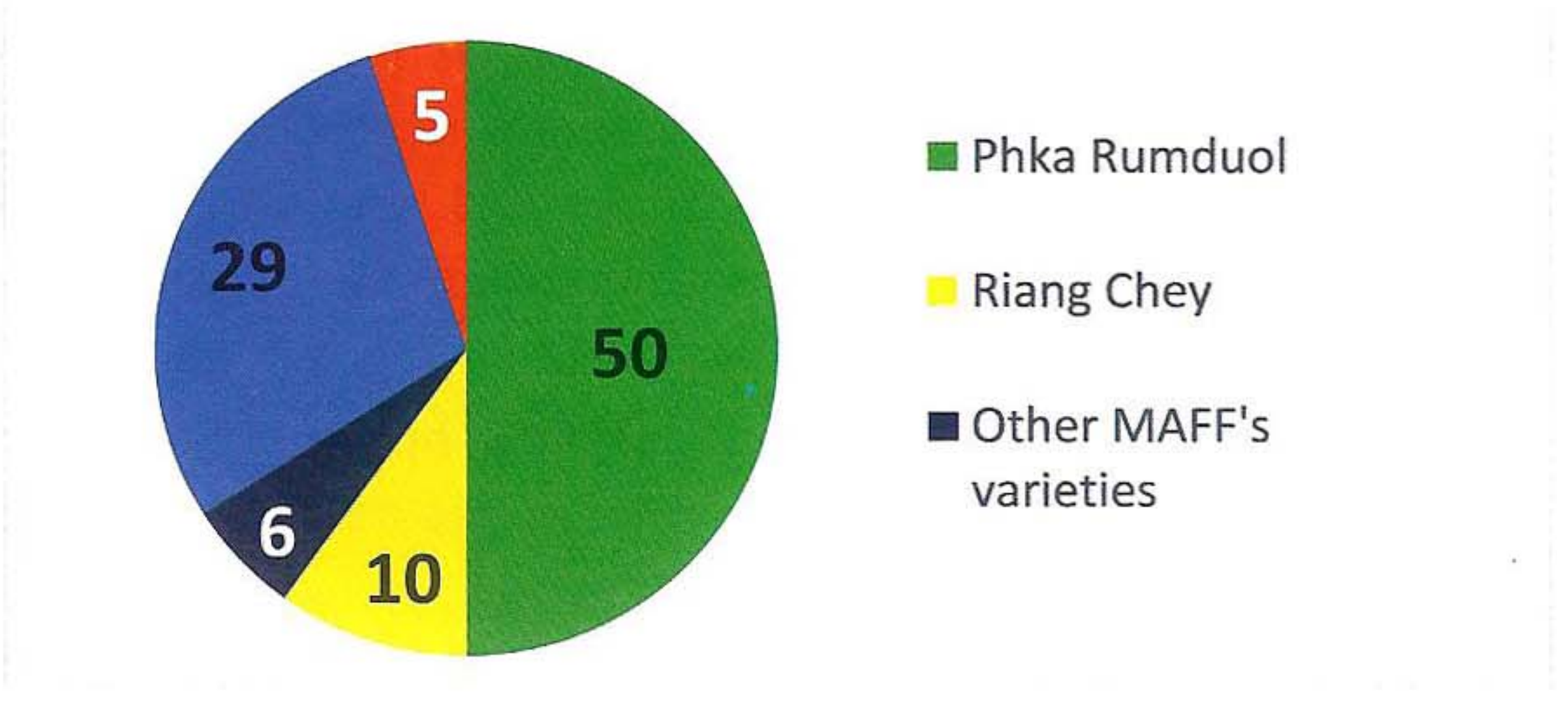


Figure 5. Proportion of area cultivated of CARDI/MAFF released varieties in 8 provinces in 2014 wet season.

- **Technology transfer:** CARDI has conducted 13 farmer fielddays and evaluation in Takeo, Kep, Kampot, Kampong Cham, Prey Veng, Svay Reing and Siem Reap provinces with the total of 942 farmers participated. Twenty nine (29) farmer field training on rice crop management were organized in Kampong Chhnang, Kep, Preah Sihanouk and Ratanakiri provinces for 1,050 farmers. Moreover, certified seeds of 10 promoted rice varieties were distributed to193 farmers (5 kg each) in Kampong Chhnang, Kep, Preah Sihanouk and Ratanakiri provinces to produce good seeds. A total of good seeds produced by participating farmers was about 41 t and that they can use and share with neighboring in next season.
- **Additional nutrition values of Phka Rumduol white rice**: To complete result of nutritional

values of white rice of Phka Rumduol, a sample of milled rice have been sent to the same laboratory to reanalyse as sown in Table 4. Values of new parameters are in italic while values of the rest are remained the same as obtained from the frist analyasis.

Table 4. Nutrition facts in white rice (WR) and brown rice (BR) of Phka Rumduol variety.

No	Parameter	Unit	Phka Rumduol		No	Parameter	Unit	Phka Rumduol	
			WR	BR				WR	BR
1	Fe	mg/kg	*2.35*	11.20	10	Vitamin A	ppm (mg/kg)	ND	ND
2	Carbohydrate	g/100g	79.10	75.90	11	Vitamin B2	ppm (mg/kg)	*0.70*	2.67
3	Dietary fiber	g/100g	1.99	3.82	12	Vitamin B3	ppm (mg/kg)	*1.60*	10.16
4	Energy	kcal/100g	356	366	13	Vitamin B6	ppm (mg/kg)	*ND*	ND
5	Protein	g/100g	7.32	8.22	14	Vitamin C	ppm (mg/kg)	*ND*	ND
6	Total fat	g/100g	1.16	3.29	15	Vitamin D	mcg/kg	*ND*	36.00
7	Cholesterol	mg/100g	ND	ND	16	Vitamin E	ppm (mg/kg)	*ND*	5.00
8	Polyunsaturated fat	g/100g	0.40	1.03	17	Vitamin K1	ppm (mg/kg)	*ND*	ND
9	Thiamine	ppm (mg/kg)	0.81	2.39	18	Vitamin B12	mcg/kg	*ND*	ND

ND: Not detectable

3.3. Subprogram 1.20. Enhancing the effectiveness of supporting services and human resources development for research

The objective of this Subprogram 1.20 is to built capacity and skills of management staff, researchers, support services and infrastructures which supports the development of technologies. These include 4 main activities:

- **Strengthening and human resource development:** Supervised 27 students from RUA for doing research and writing thesis for their Bachelor degree. Conducted 16 of training courses, workshops and meeting with a total of 604 participants attended. A total of 14 CARDI staff attended 8 in-country training courses, workshops and meetings. A total of 57 CARDI management staff and researchers attended 41 oversea training courses, workshops and meetings. Seven (7) CARDI staff have undertaken MSc and PhD degree in abroad.
- **Scientific papers and articles:** Nine scientific papers and articles about CARDI research finding were written and published in English in international journals and proceedings. They are listed below:
  1. Birch, C.J., Bonney, L.B., Ives, S. W., McPhee, J. Bounneuang, D., **Seng Vang**, **Sokun Bo** and Sacklokham, S. (2015). Whole of System and Value Chain Analyses reveal research needs in horticulture in Laos and Cambodia. pp72-73 in Book of Abstracts, 'Meeting the Challenge of Productivity in the Tropics, Tropical Agriculture Conference, Brisbane, 16-18 November 2015, Brisbane, Australia.
  2. **Chanthy, P.**, R. J. Martin, R. V. Gunning and N. R. Andrew (2015). "Influence of Temperature and Humidity regimes on the Developmental Stages of Green Vegetable Bug, Nezara Viridula (L.) (Hemiptera: Pentatomidae) from Inland and Coastal Populations in Australia." Gen. Appl. Ent 43: 37-55.
  3. **Chhourn Orn**, Rieko Shishido, Masahiro Akimoto, Ryo Ishikawa, Than Myint Htun, Ken-Ichi Nonomura, Yohei Koide, Men Sarom, **Seng Vang, Sakhan Sophany**, **Ouk Makara**, and Takashige Ishii (2015). Evaluation of genetic variation among wild rice populations in Cambodia. Breeding Science 65: 430–437.

4. Ntui, V. O., **K. Kong**, R. S. Khan, T. Igawa, G. J. Janavi, R. Rabindran, I. Nakamura and M. Mii (2015). "Resistance to Sri Lankan Cassava Mosaic Virus (SLCMV) in Genetically Engineered Cassava cv. KU50 through RNA Silencing." PLoS ONE 10(4): 1-23.

5. Perry L Poulton, Neal P Dalgliesh, **Seng Vang**, **Touch Veasna**, Philip Charlesworth, Alison Laing (2015). Resilience of smallholder farmers in Cambodian lowland rice ecosystems in managing for future climate uncertainty. In: "Building Productive, Diverse and Sustainable Landscapes" - Proceedings of the 17th ASA Conference, 20–24 September 2015, Hobart, Australia. Website: www.agronomy2015.com.au

6. Perry L Poulton, **Touch Veasna**, Neal P Dalgliesh, **Vang Seng** (2015). Applying simulation to improve rice varieties in reducing the on-farm yield gap in Cambodian lowland rice ecosystems. Expl Agric. (2015), volume 51 (2), pp. 264–284.

7. **Seng Vang** and **Hin Sarith** (2015). Land resources of Cambodia: A review of knowledge and management. In: "ISC 2015 - Sustainable Uses of Soil in Harmony with Food Security" – Proceedings of the International Soil Conference, 18-21 August 2015, Cha Am, Thailand.

8. **Seng Vang, Hin Sarith, Touch Veasna, Lim Vanndy, and Ly Tyneth** (2015). Effects on soil qualities and crop yields of applied rice husk biochar fortified with inorganic NPK or organic fertilizers in rice-growing soils of Cambodia. In: "Proceedings of the 2nd National Conference on Agriculture and Rural Development", 21 November 2015, Royal University of Agriculture, Phnom Penh, Cambodia, pp. 1- 4.

9. Vote C., Oeurng C., Sok T., Phongpacith C., Inthavong T., **Seng V.**, Eberbach P. and Hornbuckle J. (2015). A comparison of three empirical models for assessing cropping options in a data-sparse environment, with reference to Laos and Cambodia. ACIAR Technical Reports No. 87. Australian Centre for International Agricultural Research: Canberra. 30 pp.

- **Publication and dissemination:** A total of 1,550 copies of report books were published. Farmer Notes with a total of 19,700 copies, Brochures of maize, tomato with a total of 7,500 copies and 10 Banners were published. 26 types of Farmer Note with a total of 11,600 copies, brochures of maize and tomato with a total of 3,330 copies and Cluster Documents on Rice Agro-ecosystem in Cambodia: soil classification, the main characteristic of 10 rice varieties, Technology Package for Increased Rice Productivity in Cambodia, Books of weeds of rice in Asia, Rice production books in Cambodia, Research Achievement and CARDI Annual Report with a total of 1,600 copies and Banners of chemical fertilizer types and main soil groups with a total of 30 copies were distributed to all key stakeholders including management staffs of MAFF, Board of Director, other institutions under the MAFF such as PDAs, District Offices of Agriculture and other stakeholders, especially farmers.
- **CARDI's Website:** In one year period of year 2015, there were 439,095 visitors accessed to CARDI's homepage http://www.cardi.org.kh for agricultural information. Therefore, it was giving an average of 1,203 visitors per day with increasing 14 visitors/day compared to year 2014.