Support to the Commercialization of Cambodian Rice Project
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ANALYSIS OF ADDED VALUE DISTRIBUTION IN CAMBODIAN RICE VALUE-CHAIN AND SUPPORT TO THE CREATION OF A RICE SECTOR OBSERVATORY

Cambodian Rice Value chains study
Final report

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1 Objectives

This report presents the analysis of the Cambodian rice value chains achieved in the framework of the Support to the Commercialization of Cambodian Rice Project. The objectives of the study were:

- i) to compute financial and economic indicators for a number of key value chains of the Cambodian rice sector as an input to the reformulation of the Cambodian Rice policy
- Ii) to propose a mechanism to establish a Rice Economic Observatory to enhance the capacity of the rice sector stakeholders to monitor the impact of various parameters (input-output prices…) on the viability of the rice sector to support the policy debate

This report focus on the first objective, whereas material pertaining to the second is attached in Appendix 4. The study aim at providing a comprehensive and representative picture of the rice economic sector using existing information completed with the collection of primary data to fill up knowledge gaps on inputs and prices along the whole chains. The study produce 14 models of rice value chains, each one corresponding to a particular combinations of rice varieties, producing and processing technology and targeted market. The models have been set up within an Excel files that could be easily updated to simulate or assess the impact of changes in input-output technical coefficients and prices.

The report will firstly remind a number of key features of the Cambodian rice sector trends. Then the structure of the rice sector will be presented and detailed by rice cropping systems and market outlets whit an estimate of the respective volume of rice. The following section will present attributes and budgets of the value chain players and the indicators compute for the 14 systems. The last section will deal with policy implications.

2 Background and issues about recent rice development in Cambodia

Rice production acknowledged an accelerated development throughout the last decades, with an average annual growth rate above 6% from 1990 to 2008. This accelerated development is in line with the recovery of the Cambodian economy from the 90's. It was initially mainly based on productivity increase (+4% a year) with improvement of water control and the gradual dissemination of chemical inputs. However since 2000, yield increase level off, its growth rate went down to 1.5% against 4.9% for the previous decade. The rice sector momentum rely mainly on rice cropped land expansion. In terms of yield the average yield remains very low compare to Asians standard (2.4 for Cambodia assent 3.8 in South East Asian countries). The Cambodian rice sector expansion did not follows the conventional Green Revolution pathway. Limited investment in water control technique combined with the persistence of “traditional variety” in farmer's choice are determinant factors of this low yield. Productivity increase remains a classical objective of the stakeholders focused on production stage (MAAF, reseach…). However, this perceived constraint didn't prevent the rice sector to embark toward a more radical change on the occasion of the 2008 rice price surge on the world market.

Like the 1975 price crisis, the emergence of new exporters, Vietnam and Thailand, in the early 90's, the 2008 rice price surge on the world rice market is another landmark of history of this global cereal. With the sudden interruption of rice exports by major exporting countries (India and Vietnam), importing countries and rice traders realized the need for diversifying their sources of supply. The post 2008 world rice market was also impacted by the Thai political crisis. The Thai rice policy supporting domestic price through storage subsidy, leading to uncompetitive procurement price resulted in a sharp reduction of Thai exporters operations on the market

This setting opened a window of opportunity to an emerging Cambodian rice industry to gain market share on the world market. The gradual upgrading of the rice milling industry through investment in up to date milling technology (color-sorted rice) combined with, rice varieties highly valued on the world market (Jasmin, Fragrant…), and high prices boosted Cambodian experts from almost 0 before the crisis up to 530 000 Tons in 2016. Belonging to a less advance country, Cambodian rice industry also benefited from the Everything But Arms clause which give to its exporters a tariff free entry into the European Union market. In 2015, Cambodian exporters supplied around 18% of the European Union rice imports.

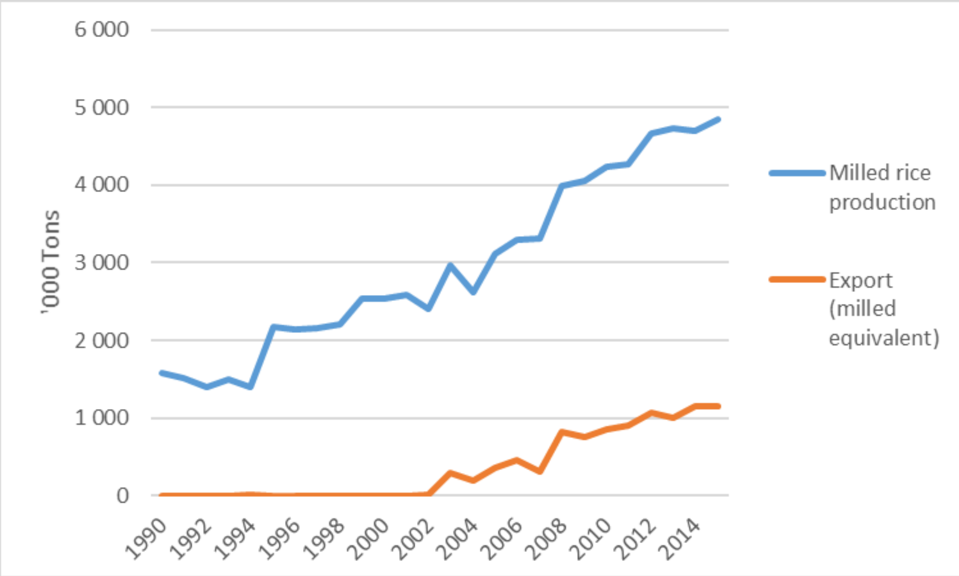
The exposure of the Cambodian rice sector to international trade was also driven by the expansion of unrecorded export to Vietnam and to a lesser extent to Thailand. Vietnamese and Thai millers and exporters looked to new sources of procurement to overcome limited prospect for rice supply growth in their respective country. Vietnam rice industry reach a maturing stage with an increasing competition from other sectors (shrimp, fruits…) for land resources allocation. The expansion of paddy purchase in Cambodia allows Vietnamese miller to maintain their supply of milled rice to the exporters at competitive price. On the Norh Western side, Thai rice industry operators plagued by the rice pledging scheme in the mid-2000 and high domestic prices, looked for alternative source of supply of paddy having the same quality attribute than Thai Hom Mali rice They, logically, turned to equivalent sources of supply Cambodia. The estimation of this unrecorded trade is rather difficult and rely on the estimation of a rice balance as proposed hereafter. The order of magnitude of various experts' estimates varies between 1.5 Million to 2 Millions of paddy exported to Cambodian neighbors.

Table 1 : Cambodian rice economy major trends

Attribute	Country	Trend 90 – 00	Trend 00 – 08	Trend 09-16	Average 09-16
Area Harvested	Cambodia	1.5%	4.5%	2.2%	2 889
	Southeast Asia	1.6%	1.0%	-0.1%	46 462
Production	Cambodia	6.6%	6.3%	3.1%	4 500
	Southeast Asia	2.6%	2.2%	0.5%	113 394
Exports	Cambodia	na.	n.a	7.3%	984
	Southeast Asia	6.9%	4.6%	0.7%	18 063
Yield	Cambodia	4.9%	1.5%	0.8%	2.4
	Southeast Asia	1.1%	1.1%	0.6%	3.8

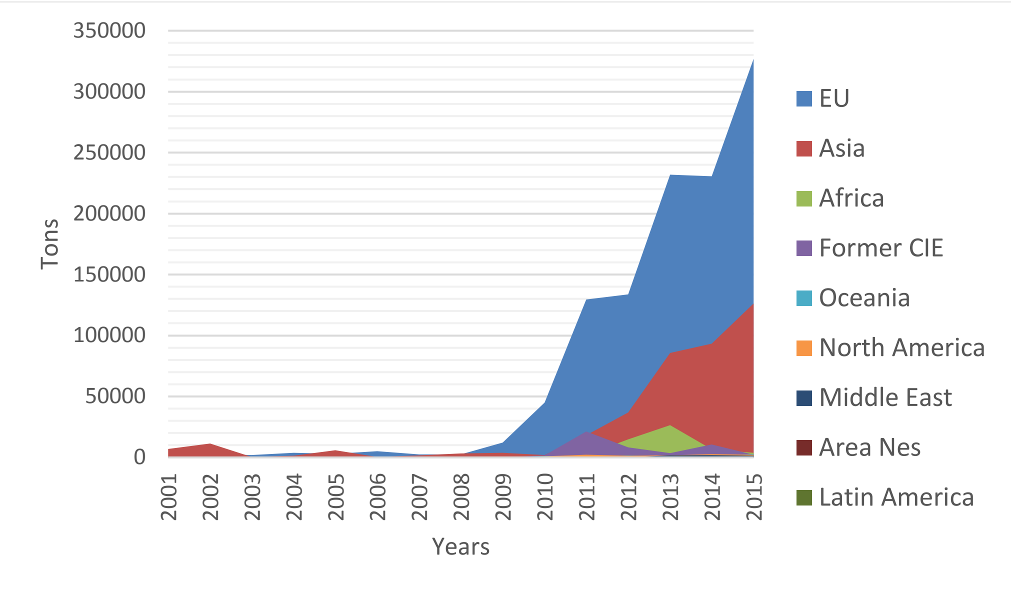
Source: USDA, FAS, PS&D, 2017

Figure 1 : Cambodian rice production and export trend



Source: USDA, FAS, PS&D, 2017

Figure 2 : Cambodia export by major destination

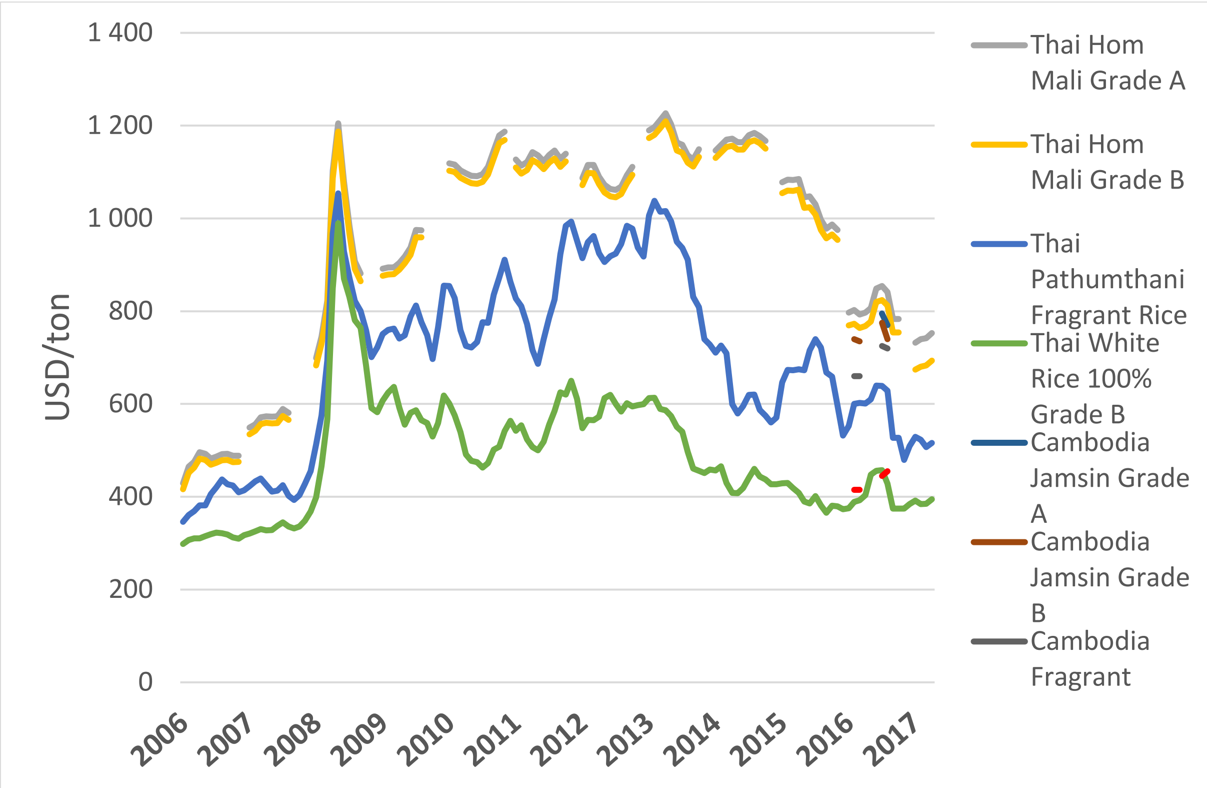


Source: www.Trademap.org

The expansion and upgrading of the Cambodian rice sectors has been driven since the mid 2000's by its increasing openness to international trade and regional, which represents around 1.5 million ton in milled equivalent out of a total supply of 5 million. However, a number of uncertainties question the sustainability of this trend in the coming years. The highly favorable setting of mid 2000 has significantly changed. World price have declined coming back to level comparable to the pre 2008 (Figure 3) and competition among rice exporters is becoming fiercer. Thailand is back on the market with a very aggressive policy to get rid of its stocked accumulated during the pledging scheme policy. On the customers side the continuous Cambodian growth may result in the termination of the EBA clause, which will reduce the competitive advantage of the Cambodian rice on the EU Market. The expansion of paddy exports supplying Vietnamese miller, and beyond Vietnamese customers or exporters is less subject to threat but it is competing with the Cambodian rice milling sectors.

The target of 1millons tons of rice milled exports required a diversification of Cambodian rice customers on the world market, as the demand from the EU will not likely double in the near future. A lower dependency on EU is also welcomed to anticipate the adverse effect of new trading rules with this major customer. Customers diversification has already occurred although it is mainly supported by Cambodian major commercial partners, such a s China. The high quality rice market segment on which Cambodian have built their reputation is also highly competitive and Cambodia rice industry will have also to look for other market segments and destination (Central Asia, Africa, East Asian importing countries).

Figure 3 Thai and Cambodian Rice FOB price 5USD/Ton



Source: Thai export association and Cambodian Rice Federation

3 Rice sector structure

The Cambodian rice sector is complex in terms of type of rice produced (non-photoperiodic, photoperiodic, non-fragrant, fragrant…); seasonality, technology and market outlets (rural, urban, international). In order to select the value chains that should be included in the analysis, a rice balance sheet has been computed.

The balance sheet computations is based upon current data published by the Ministry of Agriculture and an estimation of per capita consumption per rural and urban population in Cambodia provinces published by S.Sar (S.Sar 2012), the detailed computation are reported in Appendix 1.

According to MAAF statistics, Cambodia produced about 9 320 000 tons of Paddy in 2016. If we assume an average seed ratio of 180 kg ha (based on cropping system survey outcome) and average losses of 10% of the paddy produced before reaching the mill, paddy available for milling is about 7 470 000 tons. With an average milling ratio of 0.55 (to take into account village mills lower technology) we can estimated the total milled rice production at 4 110 000 tons.

The total demand for domestic consumption is estimated at 2 481 582 tons of milled rice, about 163 kg of rice par head per year, a figure closed to the data reported by FAOSAT for 2013 (160 kg per head/capita). Based on the rice balance disaggregated per province and urban – rural population, we can estimate that the rural population consumption is about 2 241 229 tons of milled rice. The local urban market (within the provinces that have a rice surplus) would use 97 0000 tons of milled rice and the inter-provincial trade feeding the large urban areas (Phnom Penh, Sianouk villle…) would take 143 194 tons of milled rice.

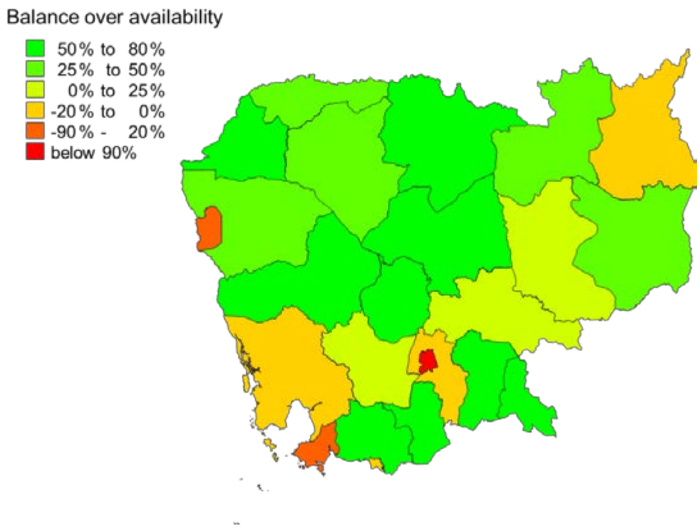
For 2015 the exportation of milled rice reached 538 000 tons. Thus, the balance of milled rice available, 1 090 900 tons, gives a coherent estimate of the quantity of milled rice equivalent of paddy exported to Vietnam and Thailand, about 1 980 000 of paddy would be exported directly to Vietnam and a smaller share to Thailand.

Table 2: Rice Balance in Tons (2016)

Item	V1 (Ton)
Production (Paddy)	9 324 170
Seeds	545 177
Losses (10%)	1 305 384
Available (Paddy)	7 473 609
Available (Milled equiv))	4 110 485
Total consumption (milled)	2 481 582
Rural consumption(milled)	2 241 229
Local urban market(milled)	97 160
Inter-provincial trade (milled)	143 194
Milled export	538 000
Total used milled	3 019 582
Unofficial export(Milled equiv)	1 090 903
Total export (milled equiv)	1 628 903
Unofficial export (paddy equiv)	1 983 460

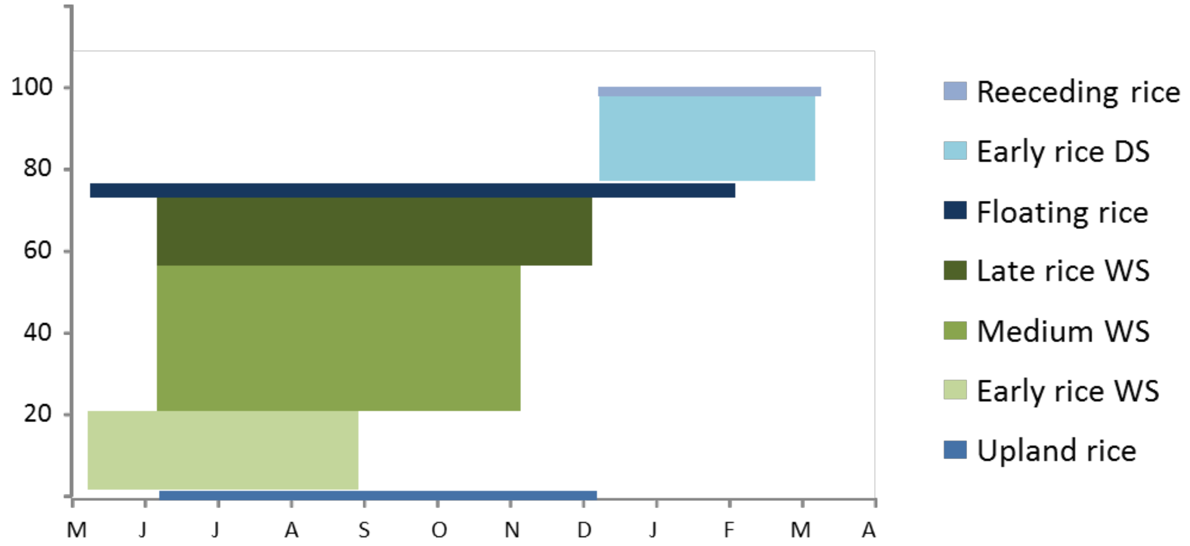
Parameters: Seed requirement (Kg/ha) 180
Milling ratio (Kg of milled rice per Kg of paddy) 0.55

Figure 4 : Rice balance by provinces



Following the disaggregation of the Cambodian rice in different outlets, the paddy supply can also be differentiated. The seasonality and the type of variety planted are the major parameters used to characterize Cambodian rice cropping system. Rice cropping season are divided into the rainy season which last from June to November-December, and the dry season which start in January and last until March. Cambodian rice farmers' traditional varieties are photoperiodic and require more than 6 months to reach maturity. These varieties are planted during the wet season and harvested from November until January. Among the photoperiodic variety there are: Jasmin or fragrant rice, ordinary non-fragrant rice. The Cambodian research has adapted and developed a number of improved non-photoperiodic varieties aiming at reducing the length of the growing cycle; some of these improved varieties are fragrant varieties. These non-photoperiodic varieties allowed Cambodian farmers who have access to water to extend rice-cropping season. Farmers using improve varieties can plant at the very beginning of the wet season and harvest paddy a soon as August, while with supplemental irrigation they can plant a second rice crop between January and March. The dataset reported by Gergerly, 2010, propose the following chart (Figure 5) of the major rice producing systems with an estimate their production share.

Figure 5 : Rice cropping systems



Source: Gergerly, 2008

Our analysis of the Cambodian rice sector performance will focus on the major cropping systems, using secondary data available to get the best estimate of the share of the different cropping system. MAAF standard annual report usually distinguish between wets and dry season production. A table of the monthly distribution of the paddy production up to 2009 shows the sharp increase in the share of Early Wet Season paddy production from 3% in 2000 up to 15% in 2009. This trend illustrate the impact of the dissemination of early maturing varieties, and of the expansion of the demand from Vietnamese dealers. An extensive survey of fragrant varieties production carried out by SOFDEC (2016) during the wet and dry season allows discriminating further between photoperiodic ordinary and Jasmin rice in the wet season, and fragrant and on-fragrant non-photoperiodic varieties produced in the dry season.

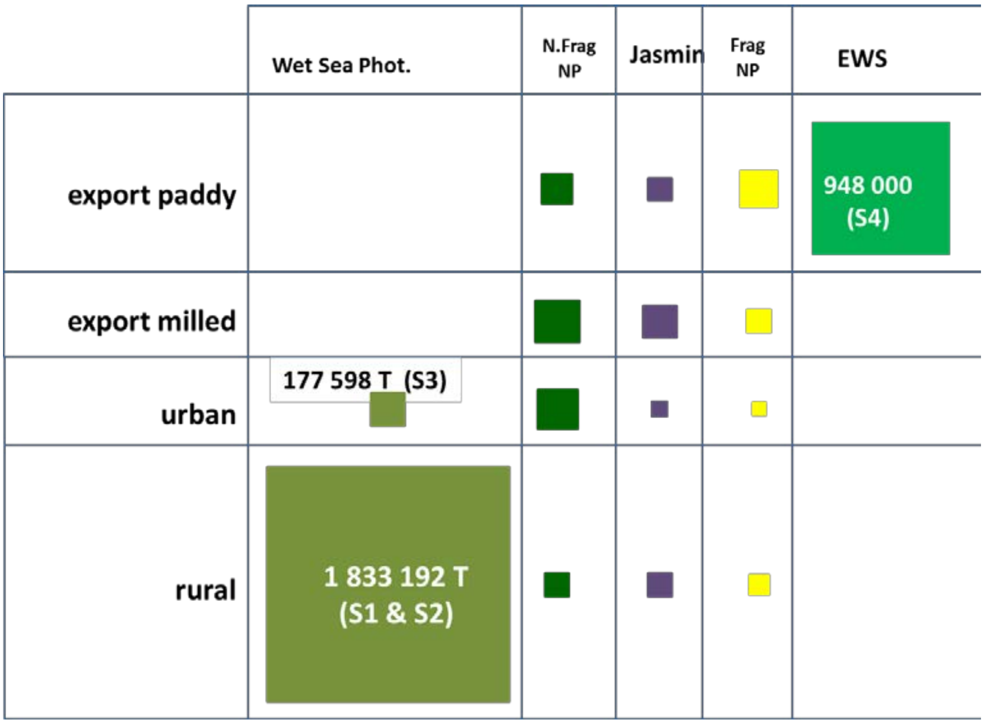
Table 3 summarizes our estimates of the structure of the rice Cambodian sector by major categories of rice and main outlet. For Early West Season rice (EWS) we assume that all the production is exported as paddy to Vietnam, as mentioned by farmers interviewed in the southern provinces. After deduction of the recorded exports, the balance has been disaggregated by major domestic outlet along the shares computed for the aggregated rice balance above.

Table 3 : Rice market structure in milled equivalent

	Rice categories						
Outlets	**EWS**	**Jasmin**	**WS**	**DSnF**	**DSF**	**Total**	**Share**
Export paddy (milled equiv.)	948 506	0	0	27 500	27 500	1 003 506	23%
export milled	0	186 758	0	263 725	87 913	538 396	12%
Large cities	0	27 690	69 760	213 015	12 055	322 520	7%
Small cities	0	14 768	96 454	85 206	7 233	203 661	5%
Rural	0	153 220	1 833 192	127 806	221 805	2 336 023	53%
Total	948 506	382 436	1 999 406	717 252	356 505	4 404 106	100%
Total (paddy equiv)	1 724 556	695 338	3 635 284	1 304 095	648 192	8 808 212	
Share	20%	8%	41%	15%	7%	100%	

Figure 5, provides a graphical representation of the rice sector structure, the size of the squares being proportionate with the volume of each market outlet and categories of rice. It is worth noting that rural demand for photoperiodic white rice and early wet season rice are by far the two majors outlets for the sector, representing almost two thirds of the total demand (respectively 42% and 22%). In terms of volume, dry season non-photoperiodic follows with 16% of the total supply. This category represent half of the volume exported. Fragrant varieties for both photoperiodic (Jasmin) and non-photoperiodic categories have only a marginal share of the total rice market (9% and 8% respectively). Fragrant varieties represent, however, half of the official exports justifying the attention received from rice exporters.

Figure 6 : Rice value chains estimated weight



4 Characterization of the value chain

4.1 Methodology

The first step for building the rice value chains models is to carry out a functional analysis to characterize the sequence of operations from the production of the raw material (i.e. paddy) down to the delivery of the product to the domestic end consumers or to the point where the product cross the border for exports. The application of the functional analysis is subject to a trade-off between the diversity of technologies used and practices followed by agents at different stages of the chain and the availability of data and validated information to integrate these details into the analysis.

With the given resources available data collection focused on the major cropping systems and rice milling technologies combining both primary data collected from a sample of agents and secondary sources from the literature. Eventually budgets, gathering costs and income, for each type of agent have been discussed and validated by representative from farmers' organization and millers, member of the CRF. Rather than aiming at a comprehensive and detailed coverage of the value chains, the objective was to focus on the most important agents and technology.

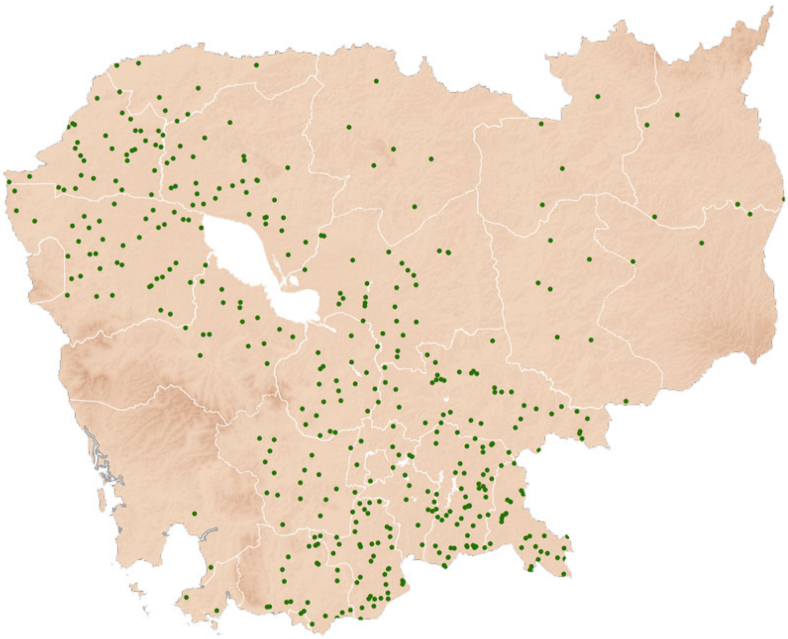
The following section will present the rationale for selecting the different agents while methodology for establishing the agent budget and the budget at the consolidated level is detailed in Appendix 3.

4.2 Agent included in the VC models

4.2.1 Farmer.

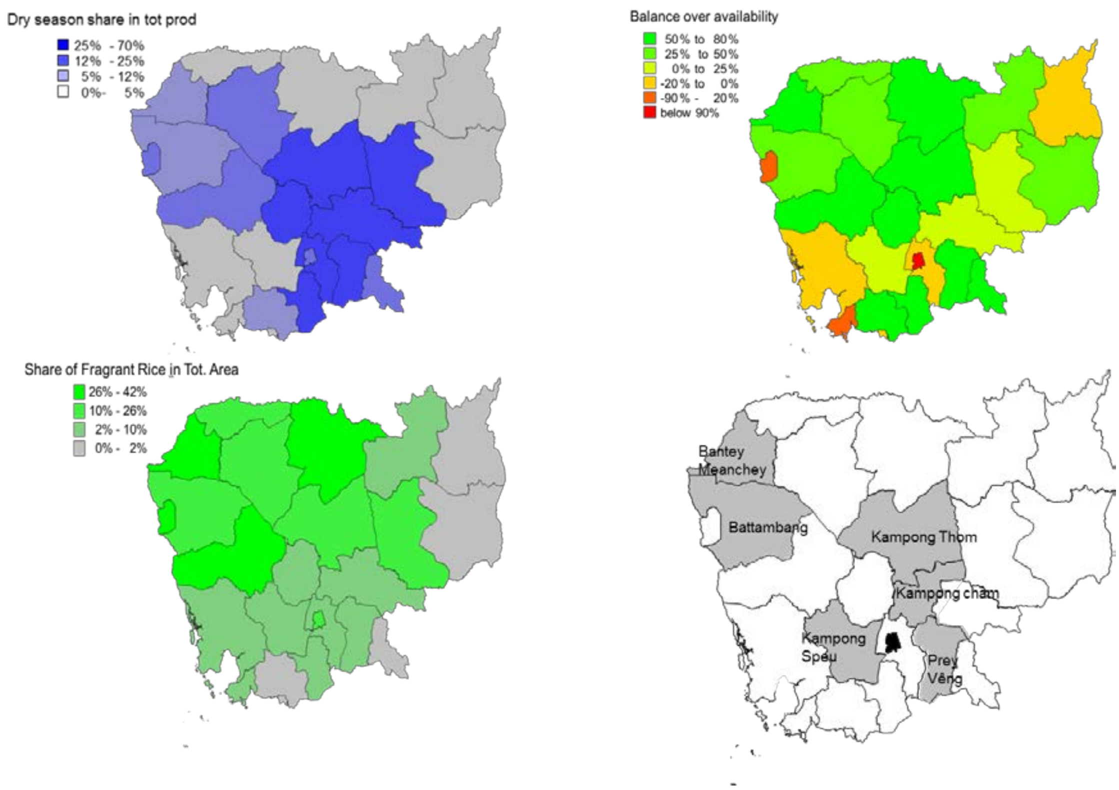
A sample of 107 farmers were interviewed to collect up to date data about cropping practices (manual, mechanized, transplanting, direct seeding), the quantity of input use and the yield. A purposeful sample was built to collect data from 20 to 30 plots per major category of rice produced. Targeted major producing provinces based on available disaggregated data as shown in the following figures.

Figure 7 : Rice production distribution in Cambodia



Source: http://ricepedia.org/cambodia (access 2017) 1 dot = 600 ha

Figure 8 : Mapping of criteria used to select survey areas



Source: Based on MAAF data.

The distribution of total cropped land per farm, in pir sample, differs somewhat from the distribution of the farm size computed by the 2013 Agricultural Census. Farmers holding less than 1 ha represents only 18% of our sample while it represents more than 40% of the farmers in the Agricultural Census. Farmers owning between 1 to 4ha of land represent 40% of our sample against 45% in the census; farmers owning between 4 to 10ha represent 21% of our sample against 7% in the census. Eventually farms over 10ha represent 10% of our sample against 1% in the farm recorded by the census. Our sample is therefore bias toward the largest farms. This might be due to the geographical stratification of the sample focusing on the major rice producing areas, whereas farm located in areas that are less favorable to rice production might be smaller.

Figure 9 : Sample distribution of farm size

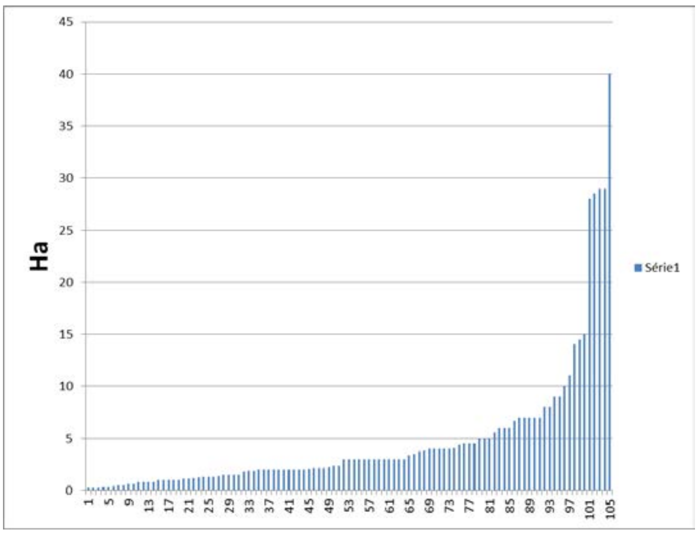


Table 4 present the distribution of the sample. For each farmer interviewed one plot was selected for a detailed recording of cultural practices.

Table 4 : Distribution of the plots surveyed by rice cropping system and provinces

Province	Non photo-periodic fragrant	Non photos-periodic non-fragrant	Early West Season	Jasmine Photo-periodic fragrant)	West Season non fragrant photo-periodic	Total
	Frag	N-Frag	EWS	Jasmine	WS	
Banteay Meanchey	7		10	1	8	26
Battambang	3	12	4	12	6	37
Kampong Cham	3					3
Kampong Speu				8	8	16
Kampong Thom		5	3	5	8	21
Prey Veng			4			4
Total	**13**	**17**	**21**	**26**	**30**	**107**

The analysis of the rice cropping practices shows that mechanization of land preparation and harvesting has become a standard practice combined with direct seeding. Animal traction was applied on 7 plots only. This outcome is consistent with the rapid increase of hand-tractors imports noted in the policy review (Golleti and al., 2016). It is also in line with the sharp increase of rural wages acknowledged by interviewed farmers; according to several observations, rural wage has been multiply by a factor of 4 to 5 in the last 6 to 7 years. This change in labor costs illustrates the impact of urban based and migrant jobs (garments factory, building) on Cambodia rural labor market. Hence, the issue is not anymore whether or not mechanizing but rather how to mechanize.

The modalities follows by farmers for mechanizing is the most discriminating factors in the sample: farmers either invest in their own capacity and purchase hand tractors or they rent the equipment from tractors ‘owners (likely neighbors) and pay for land preparation on a service basis.
The largest farm, with a land holding around 10 ha are the one who have invested in mechanical equipment, while farmers owning less than 4ha usually rent the equipment.

Table 5 Average farm size according to equipment ownership (Ha)

	Frag	N-Frag	EWS	Jasmine	WS	Total
Rent tractor	3.56	3.30	2.08	2.03	1.33	1.98
Own tractor	3.77	10.39	13.35	8.29	9.43	9.60
Average	**3.69**	**9.56**	**10.13**	**5.64**	**4.57**	**6.61**

4.2.2 Paddy collector:

After paddy production, the second function considered was the collection of the paddy from the farmer field to the miller or to the border for paddy export value chains. Around 15 traders have been surveyed. The stylized agent for paddy collection is a trader owing a 20T truck to collect Paddy within a procurement area of 10 km radius. The distance of paddy delivery was adjusted according to the different type of value chains (paddy exports, milling for domestic market…). When the delivery point is closed to the procurement areas (i.e <100 km) we assumed that a truck can do two cycles of purchase and buying in one day. We estimate that an average collector truck will travel for 30000 km per year (for marketing rice and other products). We also assume that the trader will not be able to have backload from the delivery point back to his paddy procurement areas; hence, the cost for closing the purchase and selling cycle and returning to his home base is inputted as an additional cost to the paddy collection.

4.2.3 Miller:

Around 10 millers were interviewed in different producing areas with complementary information provided by two miller-exporters based in the capital. For the rice value chain models two types of millers have been stylized depending upon their paddy milling capacity.

A first type corresponds to a mill of 1.5T of paddy throughput per hours. These mills are based in production areas, and they can do basic cleaning and sorting with mechanical systems and generally target the local provincial market.

A budget for a mill with a capacity of 10 ton/hours was established to represent modern mills . These mills are equipped with mechanical dryer to keep the paddy for a longer period and to ensure the best outcome in terms of milled rice. These mills are able to produce milled rice that can match export standard, using color sorter and packing techniques. In the rice models paddy and rice storage are performed at the miller stage, although rice sector review mention the role of specific agent in producing areas that are specialized in storing paddy (Sophors et al. 2009). The value chain models will also ignore the village-based mills that is generally used by farmers and rural population for home consumption.

The rice value chains models will also not take into account the case of agents specialized in rice exports who purchase milled rice from different sources and reprocesses it (whitening, sorting…) to ensure that the milled rice match international standards. The cost associated with rice exports (custom procedure, shipment from the mill to the harbor) are included in the advance miller (10T) budget when the outlet considered in the export. Although this does not reflect all possible arrangements, it reflects the cost structure in value chains targeting export markets.

4.2.4 Rice retailers

Regarding the marketing of milled rice on the local market, a set of 4 rice retailers have been interviewed in urban centers. There are clients of rice mills, specialized in the retailing of milled rice with a store having a capacity of 10T of milled rice and an annual turnover or capacity of 1500T. They can sell to end users but also to smaller retailers operating in different quarters of the cities. Hence, the retailers included in the rice value chain models are rather half-wholesaler than pure retailers and the complete retailing down to the end-consumers would require the imputation of additional costs supported by smaller retailers.

4.3 Systems represented

Thirteen rice value chains models, or systems, have been established by combining different types of agents fulfilling production, collection, milling and retailing functions. They represent value chains targeting the different markets by categories of rice. For a given category of rice and targeted market models can differs according to the type of agent performing the paddy production or the milling. For instance, the first three systems concerns the production of Wet Season photoperiodic rice sold on the domestic market. Systems 1 and 2 will differs by the type of farming practices (own machine or rent machine) while system 2 and 3 differ by the type of milling technology (1T mill or 10Tmill). These variations in the combination of agents, technology and targeted markets provide a basis to compare the relative impact of these changes on the value chain performances.

The performance of emerging value chains cans also be assess using alternative combination of players and parameters associated with new technology or institutional arrangement (such as contracts). For instance, the system 14 has been developed to assess the viability of an emerging value chain, which aims at milling for export early wet season non-photoperiodic rice as an alternative to paddy export to Vietnam.

Table 6 : Value chain systems modeled

System number	Final product	Cropping system	Farming Practice	Collection	Milling	Retail	Target market
System 1	Milled rice	Wet season	Own machine	Collector	1T mill	Retail	Urban market
System 2	Milled rice	Wet season	Rent machine	Collector	1T mill	Retail	Urban market
System 3	Milled rice	Wet season	Own machine	Collector	10T mill	Retail	Urban market
System 4	Paddy	Early Wet Seas Non Fragrant NonPh	Own machine	Collector			Export market
System 5	Milled rice	Non Fragrant NonPh	Own machine	Collector	10T mill		Export market
System 6	Milled rice	Non Fragrant NonPh	Own machine	Collector	10T mill	Retail	Urban market
System 7	Milled rice	Jasmin	Own machine	Collector	10T mill		Export market
System 8	Milled rice	Jasmin	Rent machine	Collector	10T mill		Export market
System 9	Milled rice	Jasmin	Own machine	Collector	10T mill	Retail	Urban market
System 10	Milled rice	Jasmin	Rent machine	Collector	1T mill	Retail	Urban market
System 11	Paddy	Fragrant rice NonPh	Own machine	Collector			Export market
System 12	Milled rice	Fragrant rice NonPh	Own machine	Collector	10T mill		Export market
System 13	Milled rice	Fragrant rice NonPh	Own machine	Collector	10T mill	Retail	Urban market
System 14	Milled rice	Early Wet Non Fragrant NonPh	Own machine	Collector	20T mill		Export market

4.4 Price system

As detailed in the methodological note attached in Appendix 3, the rationale for building the value chain model consist, firstly, in building representative budget per agent. The second step links each agents' budgets with prices corresponding to each transaction.

The selection of the prices inputted in the model mobilize the different sources of price time series available. Farm gate price has been retrieved from price published by the CRF. For the collectors' selling prices we use the price published by the Agricultural Market Information System (AMIS) that follows prices per type of paddy at several mills throughout the country. We use also AMIS data for milled rice marketed by millers on the domestic market. For milled rice export, the FOB price published by CRF was used, while for paddy export we assumed that the same price applied as for paddy sold to the miller. The Ministry of Commerce follows retail prices for milled rice sold to end users on the domestic market. This data set aims particularly at the computation of the Consumer Price Index and thus it does not discriminate the milled rice prices by type of rice variety but according to the quality of the processing (i.e. percentage of broken). We used this data set to define a price for the ordinary white rice while applying quality rewards for more valued varieties, assuming the same spread as the one observed at the miller gate. We also assumed that milled rice produced by large mills earn a price reward for a more homogeneous and cleaned output.

Agricultural prices are by nature highly variables due to the seasonal nature of the supply while demand is much more rigid and stable. The value chain models timeframe is the marketing campaign from the harvest until the distribution of the milled rice. As mentioned above, the smoothing of the milled rice supply is done by the miller who take in charge the storage cost in the model. To take into account price seasonality, the available time series have been averaged by major cropping season: August-October, November-January and February-April. Table 7 presents the computed price applied for the value chain systems.

Table 7 : Computed Price references inputted in the value chain model (KHR/ton)

	Farmer	Collector	Miller/exporter	Retailer	USD/T
WS 1T (System 1 and 2)	840 000	900 000	1 850 000	1 900 000	
WS 10T (System 3)	840 000	900 000	2 100 000	2 200 000	
EWS Paddy export (System 4)	750 000	900 000			
DSnF (System 6)	740 000	810 000	1 650 000	1 700 000	
DSnF export (System 5)	740 000	810 000	1 800 000		450
Jasmin Urban 1MT market (System 10)	1 000 000	1 100 000	2 300 000	2 400 000	
Jasmin Urban market 10T (System 9)	**1 100 000**	**1 200 000**	**2 450 000**	**2 600 000**	
Jasmin export (System 7 and 8)	1 100 000	1 200 000	2 800 000		700
DSF Paddy export (System 11)	**850 000**	**950 000**			
DSF (System 13)	**850 000**	**950 000**	**2 200 000**	**2 350 000**	
DSF export (System 12)	900 000	1 000 000	2 350 000		588

Sources: Computed from CRF, AMIS and Ministry of Commerce.

5 Rive value chains performances

5.1 Rice cropping system cost structure and performance.

Figure 9 presents the cost structure per cropping systems for 1 ha. The production of West Season photoperiodic rice (WS) acknowledges the lower costs (1 to 1.5 million Riel), while cropping systems requiring more inputs (improved seed, chemical and water) have much higher cost (from to 2 to 3.5 millions). The cost of Jasmin cropping systems are in-between.

In terms of return to cash invested (Figure 10), the comparison is more balanced as higher value and yield for fragrant rice grown with improved variety compensate partially for their higher cost. On the contrary the non-photoperiodic white rice high cost undermine their profitability as the more capital intensive cropping system is not compensated by higher output prices compared to the Wet Season rice.

Farmers owning their own mechanical equipment have a better return on investment than the one who rent the services from hand tractor owners. This is consistent with, and reflects the rapid shift toward mechanization (with the decrease of transplanting for plant establishment method). It is more profitable to use mechanization with the rapid increase in labor cost. The need and high demand for hand tractor services likely translate into high price for these services. Under this setting if a farmer has the capital it is much more rational to invest to have its own equipment rather than relying on the hand tractor service market.

The opportunity cost of land has been inputted to assess the econocmic incentive for producing rice, by applying the custom rate for land rent (400 000 KHR per hectare) recorded during the cropping system survey. This additional cost inpputed reduced the return that a farmer can expect from investing in rice cropping. While without inputting land opportunity cost, returns to rice production are above 10%, inputting land opportunity cost particularly affect the profitbaility of small holders rice farmers who are not able to invest in their own hand tractors. For non-photo periodic non fragant rice grown either in the Early Wet Season or Dry Season and for Jasmin rice, the return to investment varies from 8% to a mere 1%, a return comparable to saving in micro-credit institutions where the agro-climatic and market uncertainty does not prevails. Therefore one can question the attractiveness of rice cropping for small holder farmers if they can shift their cropping to other product or get alternative source of income from off-farm activities.

The return to family labor provides another mean for assessing the profitability of rice farming Figure 11). With the adoption of mechanization, direct seeding and chemical treatment, paid labor is mainly limited to harvested crop handling. The owner or the manager of the field take care of the tasks done manually (seed broadcasting, chemical spraying, and water control); according to our survey these tasks required around 20 to 28 man-days. Along the same lines, the return to man-day of labor spent by the farmer (after the imputation of land cost) indicates the rather low attractiveness of rice farming. This is especially the case for the one who rent their mechanical equipment, which get less than the average daily wages in rural areas (set at 20000 KHR/day according to interview). This raise the issue on the long run of maintaining an interest for rice farming when other income opportunities from agricultural or non-agricultural activities expand.

Figure 10 : Rice cropping systems cost structure

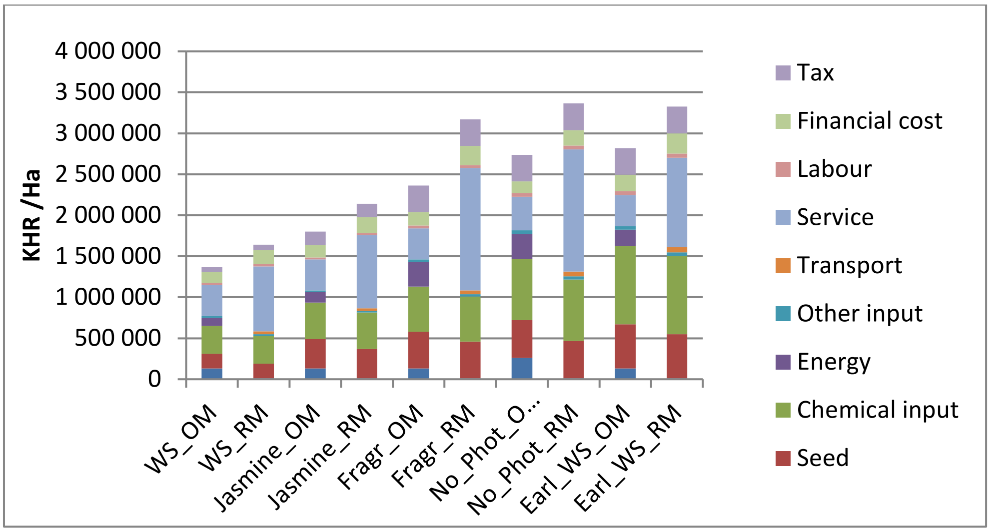


Figure 11 : Return to cash by rice cropping pattern

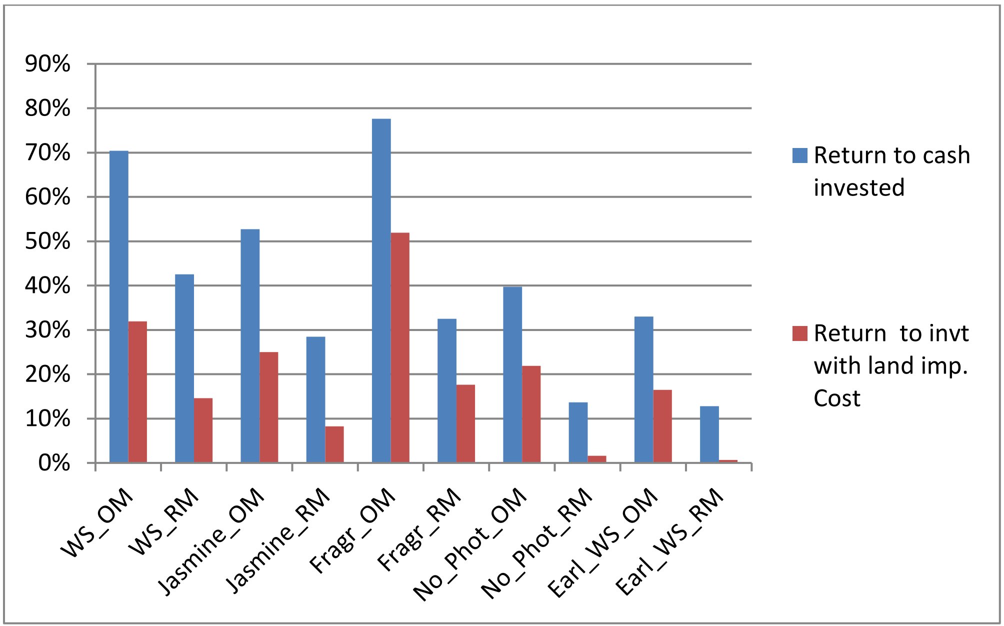


Figure 12 Return to family labor

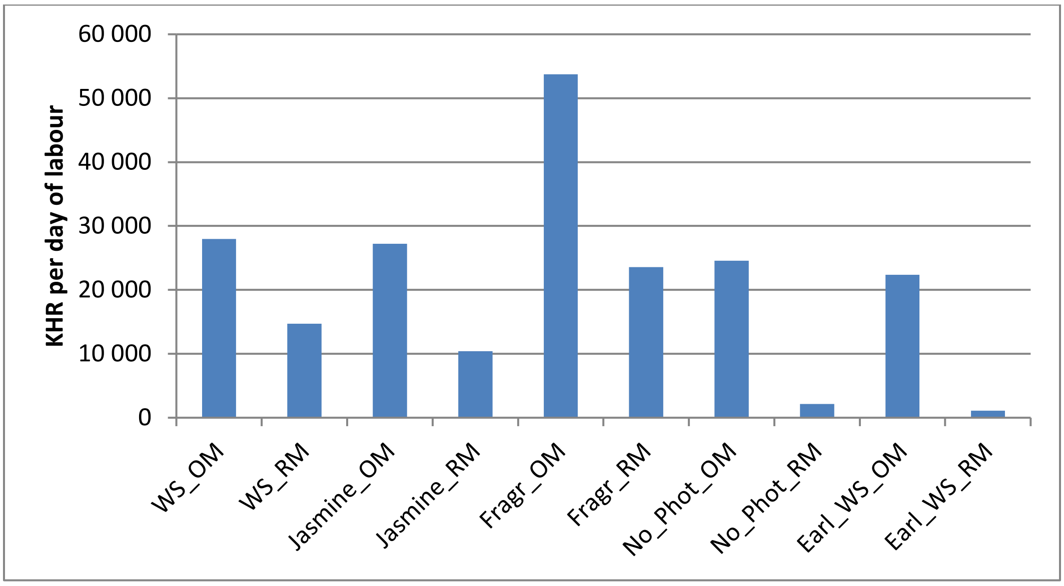


Table 8 : Rice cropping systems costs structure and return

Cropping system parameters	WS Photo Own M	WS Photo Rent M	Jasmine Own M	Jasmine Rent M	Fragrant Non Photo. Own M	Fragrant Non Photo. Rent M	Non Frag. Non Photo. Own M	Non Frag. Non Photo. Rent M	Early WS . Non Photo. Rent M	Early WS . Non Photo. Rent M
Cycle duration (month)	6	6	5	5	4	4	3	3	4	4
Cubic meter water/ha	1000	1000	3000	3000	15000	15000	15000	15000	7000	7000
Seed (Kg/ha)	130	130	120	120	150	150	230	230	270	270
Bag fertilizer	3	3	4	4	4.3	4.3	6	6	8	8
Yield (Ton/ha)	2.6	2.6	2.5	2.5	3.5	3.5	4.5	4.5	5	5
Paddy price (KHR/ton)	900 000	900 000	1 100 000	1 100 000	1 200 000	1 200 000	850 000	850 000	750 000	750 000
Paddy price (USD/ton)	221	221	270	270	295	295	209	209	184	184
Fixed asset	130 990	9 146	130 990	9 146	130 990	9 146	261 981	9 146	130 990	9 146
Seed	182 000	182 000	360 000	360 000	450 000	450 000	460 000	460 000	540 000	540 000
Chemical input	336 230	336 230	443 480	443 480	548 330	548 330	745 403	745 403	953 570	953 570
Energy	100 380	0	127 750	0	302 050	0	308 350	0	199 500	0
Other input	22 750	22 750	21 875	21 875	30 625	30 625	39 375	39 375	43 750	43 750
Transport	0	33 800	0	32 500	0	45 500	0	58 500	0	65 000
Service	377 000	792 000	377 000	892 000	377 000	1 492 000	412 000	1 492 000	377 000	1 092 000
Labor	26 000	26 000	25 000	25 000	35 000	35 000	45 000	45 000	50 000	50 000
Financial cost	133 128	174 938	151 771	193 746	165 456	234 132	140 120	189 929	199 122	245 562
Tax	65 040	65 040	162 600	162 600	325 200	325 200	325 200	325 200	325 200	325 200
Total non-paddy cost	1 373 518	1 641 905	1 800 466	2 140 347	2 364 652	3 169 934	2 737 428	3 364 553	2 819 132	3 324 228
Total cost	1 373 518	1 641 905	1 800 466	2 140 347	2 364 652	3 169 934	2 737 428	3 364 553	2 819 132	3 324 228
Revenue Paddy/Rice	2 340 000	2 340 000	2 750 000	2 750 000	4 200 000	4 200 000	3 825 000	3 825 000	3 750 000	3 750 000
Revenue Bran	0	0	0	0	0	0	0	0	0	0
Profit	966 482	698 095	949 534	609 653	1 835 348	1 030 066	1 087 572	460 447	930 868	425 772
Return to cash invested	70%	43%	53%	28%	78%	32%	40%	14%	33%	13%
Land rent	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000	400 000
Net revenue (after imputed land rent)	566 482	298 095	549 534	209 653	1 435 348	630 066	687 572	60 447	530 868	25 772
Family total labor	20	20	20	20	27	27	28	28	24	24
Return to family man-day	27 972	14 720	27 218	10 384	53 724	23 583	24 586	2 161	22 389	1 087
Return to invt with land imp. Cost	32%	15%	25%	8%	52%	18%	22%	2%	16%	1%

5.2 Marketing and processing costs and profitability.

Marketing and processing play a key role in matching supply and demand and thus supporting the competitiveness of the Cambodian rice value chains Table 8 and Figure 12 presents the cost structure for the four budgets developed for these types of agents, without the cost of the commodity in process (i.e paddy or milled rice)

For traders, including collectors assembling the paddy from the farmer and retailers distributing milled rice the modeling is relatively simple. For the paddy collector the main function is the transport, thus the main investment is the purchase of a truck, while the variable cost include essentially truck maintenance costs, fuel and labor paid for the driver and the loading. The cost per ton per km is estimated at 1.22USD, an amount above the estimation of the transport fee recorded by M.Sok (2015). This difference is likely due to the relative short distance and lower capacity of the vehicle used for this segment of the value chain, compare to longer distance shipments.

The cost for retailers is mainly the acquisition of the shop to receive the batches of milled rice that are further dispatched to smaller retailers and end users. In the retailer budget, we used the rent of a shop as an estimate of the annual cost for the building. The labor paid for handling and sorting the rice stock is the other major cost items. As mentioned before, in the rice value chain models, the storage function for matching seasonal production to regular consumption are supported by the millers. In the case of the retailer, based on the observation and survey outcome, rice stock in mainly a logistical stock and retailers' strategy aims at having a quick rotation of the stock to limit financial cost.

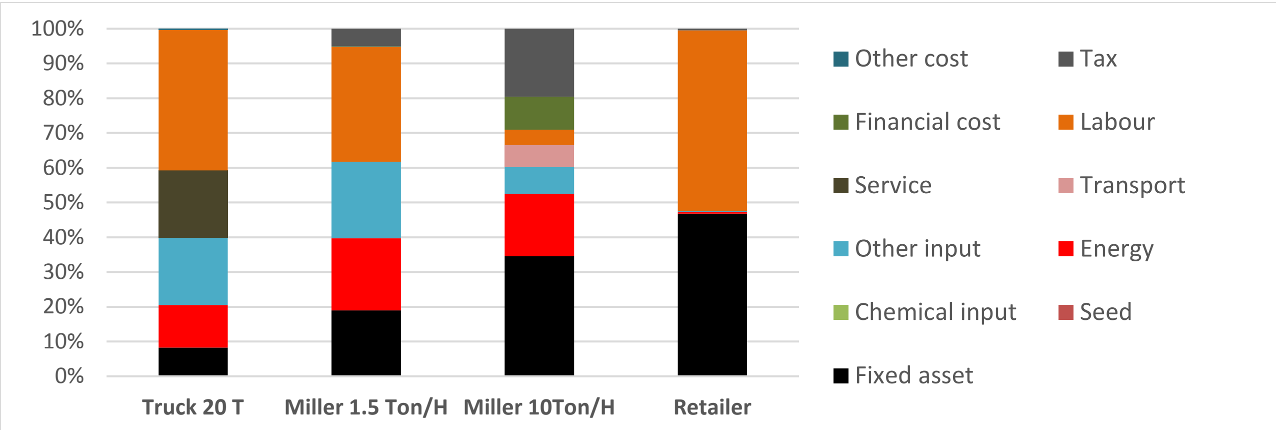
The transformation of the Cambodian rice sector has been mainly induced by the development of modern rice mills with up to date technology. A particular attention has been given to the design of a representative budget for the rice milling. The average cost per ton of paddy milled increase from 27USD in the case of low capacity mill to 38 USD in the case of modern mill, figures in lines with the estimation of rice sector review done in 2102 for the World Bank (2012). For the mill of 1.5T hourly throughput capacity, equipment depreciation cost, maintenance, energy represent each about 20% of the total processing cost; paid labor is the most important cost item in this type of mill that are not equipped with conveyors and loaders.

In the case of the modern mill, the depreciation of the equipment is the major cost (30%), followed by energy cost (15%). This reflect the technical shift that required on average an investment of 1 300 millions of Riel (330 000 USD), with more mechanization and less labor which lead to more energy consumption. Financial cost (storage function) and tax represent also a significant share of the modern mills cost. The tax component include the local tax but also the cost associated with custom clearance for exporting milled rice.

Table 9 Traders and millers' cost structure

Cost items	Truck 20 T	Miller 1.5 Ton/H	Miller 10Ton/H	Retailer
Parameters				
Technical parameters	Collection and delivery range 100 km	Milling rate 65%	Milling rate 65%	Storage capacity 10T
Maximum capacity	n.a	Maximum capacity 4500T	Maximum capacity 50000 T of paddy	n.a
Effective capacity	Total distance per year 30000 km	Annual input of 1500T of paddy	Annual input of 25000 T of paddy	1300 T Milled rice
Output (Input) of reference	20 T Paddy	975 T of milled rice (1500 T of paddy)	11050T of Rice (25000T Paddy)	1300 T Milled rice
Costs				
Fixed asset	44 715	31 029 500	1 333 445 821	29 268 000
Seed				
Chemical input				
Energy	66 000	34 000 000	693 480 317	302 658
Other input	104 710	36 072 000	293 641 000	224 536
Transport			247 232 700	0
Service	104 710			
Labour	218 491	54 024 000	168 291 000	32 512 000
Financial cost		285 867	367 062 667	0
Tax		8 400 000	754 596 650	280 000
Other cost	1 833			
Total cost	540 460	163 811 367	3 857 750 155	62 587 194
Cost/km (USD)	1.22			
Cost/ ton of input (USD)		27	38	
Cost/ton of output (USD)	7	42	87	12

Figure 13 : Traders and millers cost structure

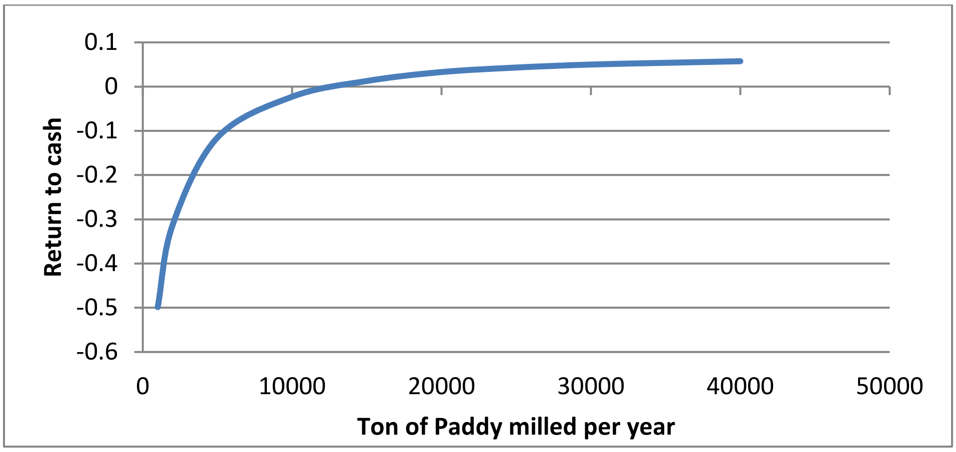


The weight of the depreciation cost of the fixed asset in the cost structure is of course determined by the rate of milling total capacity utilization. The return to cash invested has been simulated for various level of annual capacity utilization. A 10T/hrs mill that will operate for 15 hours day, 25 days a month can mill about 43000T of paddy per year. Every other cost and income parameters being constant, Figure 13 shows that this type of mill can break even (return to cash at 0%) at 13000T of paddy processed per year.

In the rice value chains modeling, the rate of capacity utilization have been set at 20 000T of paddy processed per year. According to M.Sok (2015), the total milling capacity of paddy per hour established for modern mill have reached 850T/hour of paddy in Cambodia, which correspond to 3.8 Millions of paddy per year or about 2.4 Million tons milled rice. Assuming that modern mill processed the totality of the rice exported (530 000 T of rice) and of the rice consumed in large cities (380 000 T of milled rice) this means that the rate of utilization will be at 30%. We consider in the model a rate of 50% for the utilization of the milling capacity

The sensitivity analysis, carried out with a Monte Carlo simulation[1] (Figure 14) confirm that the rate of processing captivity utilization (Volume purchases) is by far the major determinant of the millers' profitability, the second being the cost of the energy used by the mill.
The cost of energy is earmarked as one of the major issue for competitiveness of the Cambodian modern milling industry (World Bank, 2012). However, Table 9 reporting the return to cash for different combination of energy price and volume of paddy processed shows that whatever the price of the kilowatt the miller will not breakeven if he processed less than 10000T of paddy per year. Said differently, reducing processing costs cannot offer an alternative to maintaining a level of operation above a quarter of the capacity to ensure the financial viability of the milling industry.

Figure 14 : 10T/hrs mill profitability and annual capacity utilization



The cost of credit to expand the miller revolving fund for maintaining the level of operation is another issue raised by the milling industry. Table 10 shows that the threshold of 10 000 T of paddy processed is still valid in the case of the tradeoff between the interest rate and the rate of capacity utilization. With the current interest rate (12%) and volume of paddy process (20 000 T) the return to cash invested for the miller is at 6%. If the interest rate is divided by 3, (at 4%), the rate of return would increase by 1%, while an increase of the volume processed by a factor of 1.25 will be enough to reach the same rate of return. Expanding rice outlets remains the major constraint for the milling industry, if this constraint is alleviated, millers would be able to afford higher interest rate to expand their revolving funds in order to respond to an increasing demand.

[1] Monte Carlo simulation consist in defining a range of variation for a number of parameters according to a probability distribution and to simulate the outcome for a given indicators many times (1000 time in this case) while the parameters are varying within the defined distribution. In this case parameters varied along a triangular distribution, the initial value being the mean, and the minimum and maximum value being set at + and – 20% of the mean

Figure 15 Sensitivity of 10Tmill's profitability to various cost parameters.

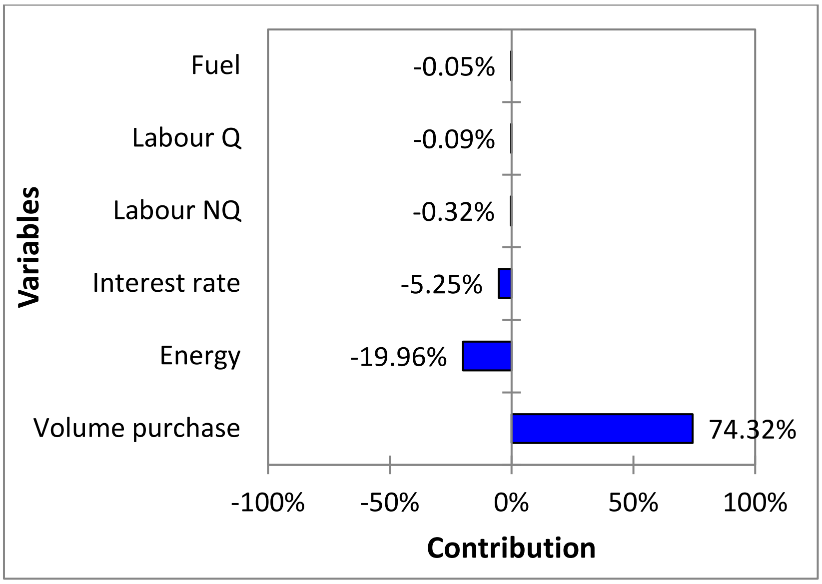


Table 10 : Return to cash for different value of electricity cost and milling volume

		Energy Price/KHR per KWH					
	5.9%	200.00	400.00	600.00	800.00	1000.00	1200.00
Tot paddy milled	40000	0.11	0.10	0.09	0.08	0.08	0.07
	35000	0.11	0.10	0.09	0.08	0.08	0.07
	30000	0.10	0.09	0.09	0.08	0.07	0.06
	25000	0.09	0.09	0.08	0.07	0.06	0.06
	20000	0.08	0.07	0.07	**0.06**	0.05	0.04
	15000	0.06	0.06	0.05	0.04	0.03	0.03
	10000	0.03	0.02	0.01	0.01	0.00	-0.01
	5000	-0.06	-0.07	-0.08	-0.08	-0.09	-0.09
	2000	-0.26	-0.27	-0.27	-0.27	-0.28	-0.28
	1000	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46

Table 11 : Return to cash for different level of interest rate for revolving fund and milling volume

		Interest rate					
		4	8	10	12	14	16
Ton of paddy milled	40000	0.10	0.09	0.09	0.08	0.08	0.08
	35000	0.10	0.09	0.09	0.08	0.08	0.08
	30000	0.09	0.08	0.08	0.08	0.07	0.07
	25000	0.08	0.08	0.07	0.07	0.07	0.06
	20000	0.07	0.07	0.06	**0.06**	0.06	0.05
	15000	0.05	0.05	0.04	0.04	0.04	0.04
	10000	0.02	0.01	0.01	0.01	0.00	0.00
	5000	-0.07	-0.08	-0.08	-0.08	-0.08	-0.09
	2000	-0.27	-0.27	-0.27	-0.27	-0.27	-0.28
	1000	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46

5.3 Value chains performances

The assessment of the value chain performance is carried out based on a consolidated account of the entire systems. The computation of the consolidated requires the conversion of agent's individual budget in final output equivalent (i.e the output of the last agent in the system) and the exclusion of the revenue and costs associated with selling and purchase of the commodity in system (i.e. paddy and milled rice).

5.3.1 Value chain financial profitability

Figure 15 presents the total cost and revenue per ton of final output produced by each value chains, showing that total cost are commensurate with total revenues generated. Cost per ton of milled rice delivered at the end user or export harbor varies from 300 USD for Wet Season rice to around 400 USD per ton for Jasmin, and non-photoperiodic rice that uses more inputs. Total revenue for milled rice value chains varies from 450 USD per ton for non-fragrant rice to around and above 600 USD per ton for Jasmin and non-photoperiodic fragrant rice. Improved seeds for short cycle varieties and fragrant varieties notably contribute to higher costs. Water pump used for irrigating field in the dry season also increased the expenditure on energy. Paddy value chains targeting the Vietnamese and Thai market have lower total cost and total revenues as expected.

The return to cost (Figure 15) is an indicator of the financial viability of each value chain considered as a whole system. The farmer cost take into account the opportunity cost of the land allocated to the production of the paddy. The average return to cost is at 30% but important discrepancies are noted according to the varieties of rice, technology used and targeted market. The value chain delivering Jasmin rice on the domestic market (S10), combining a farmer owning its hand tractor and a miller of low capacity, records the highest rate of return (60%). Similarly, the same combination of agents generate a high return for the delivery of wet season photoperiodic rice. On the opposite, non-fragrant non-photoperiodic rice value chains (S5, S6) record the lowest rate of return due to lower price for the final output and less cost-efficient milling technology. Regarding exports of non-photoperiodic varieties, the Early Wet Season paddy production exported to Vietnam (S4) perform much better (rate of return of 40%) than the export of fragrant rice to Thailand (S11) at 12%.

Figure 16 : Total costs and revenue by value chains

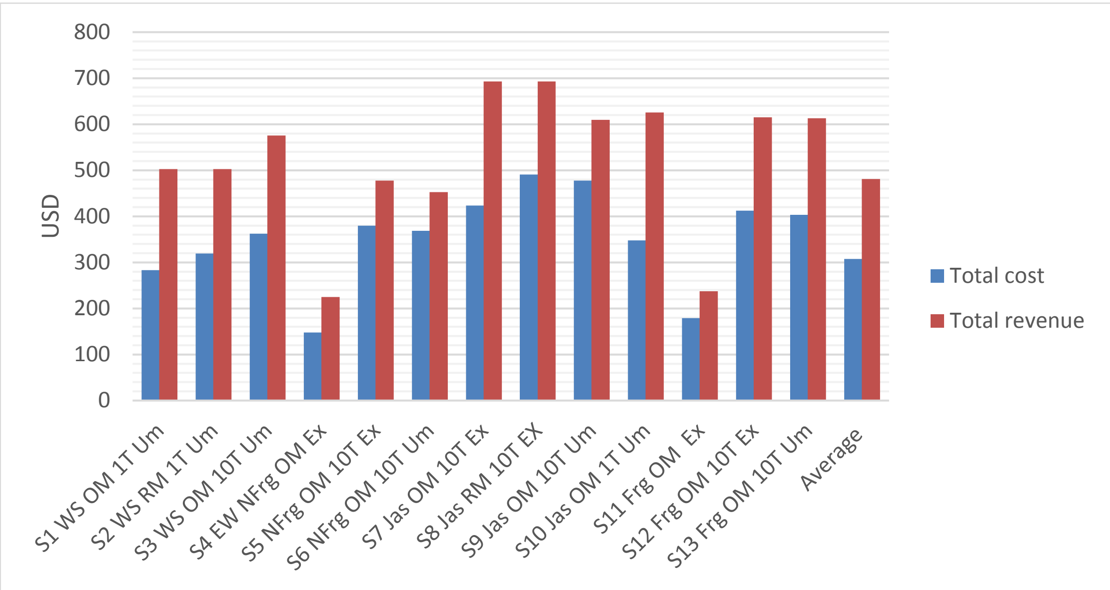
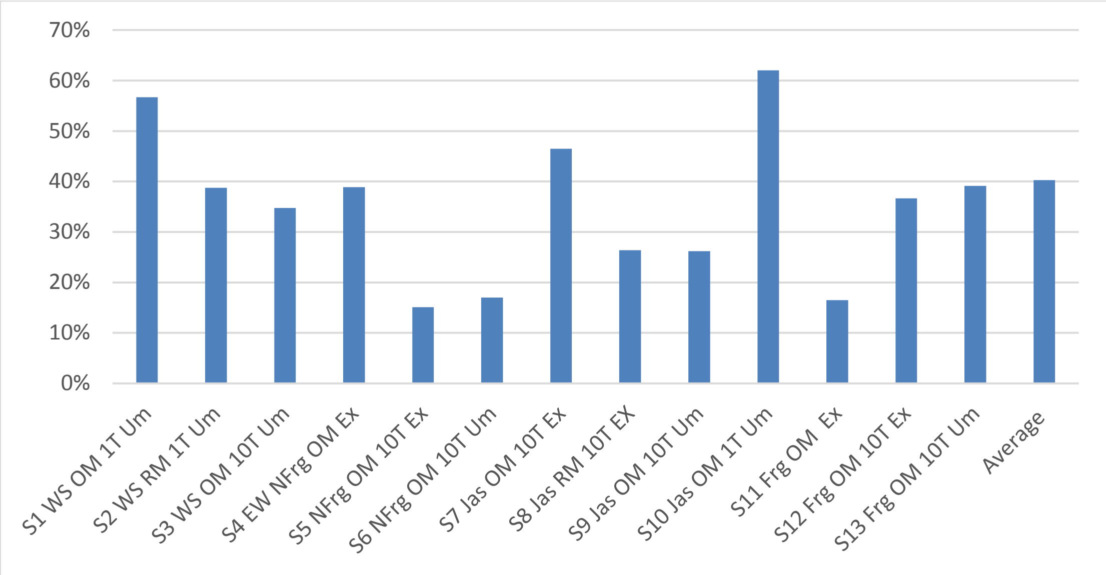


Figure 17 : Return to cost by value chain



With more than 70% of the total cost of the value chains (Figure 17), paddy production are a major determinant of the value chains total cost and consequently of their financial performance.
The payment for services, such as land preparation or harvesting at the farm level, the maintenance of equipment represents on average the highest share of total cost (29%), followed by chemical input (26%) and seeds (15%) (Figure 18). The share of energy on the average cost is at 6%.The introduction of modern milling technology adding mechanical dryer and color sorter to milling equipment have a significant impact on the cost structure, the fixed cost sharing representing more than 10% of total cost for theses value chains. As already underlined with the presentation of the budget per type of agent, labor costs represent a marginal share of the total cost (around 3%).

Figure 18 : Cost share per agent per value chains

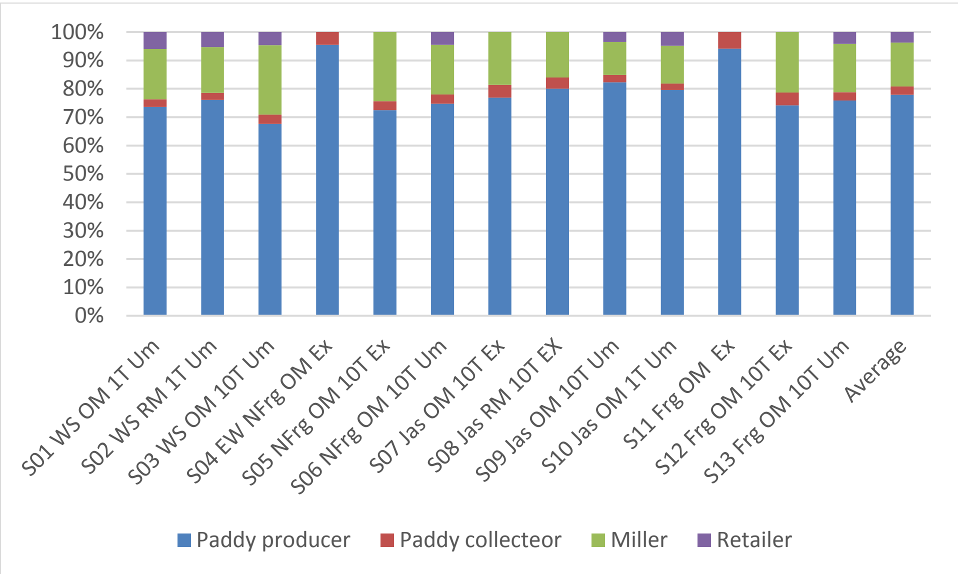
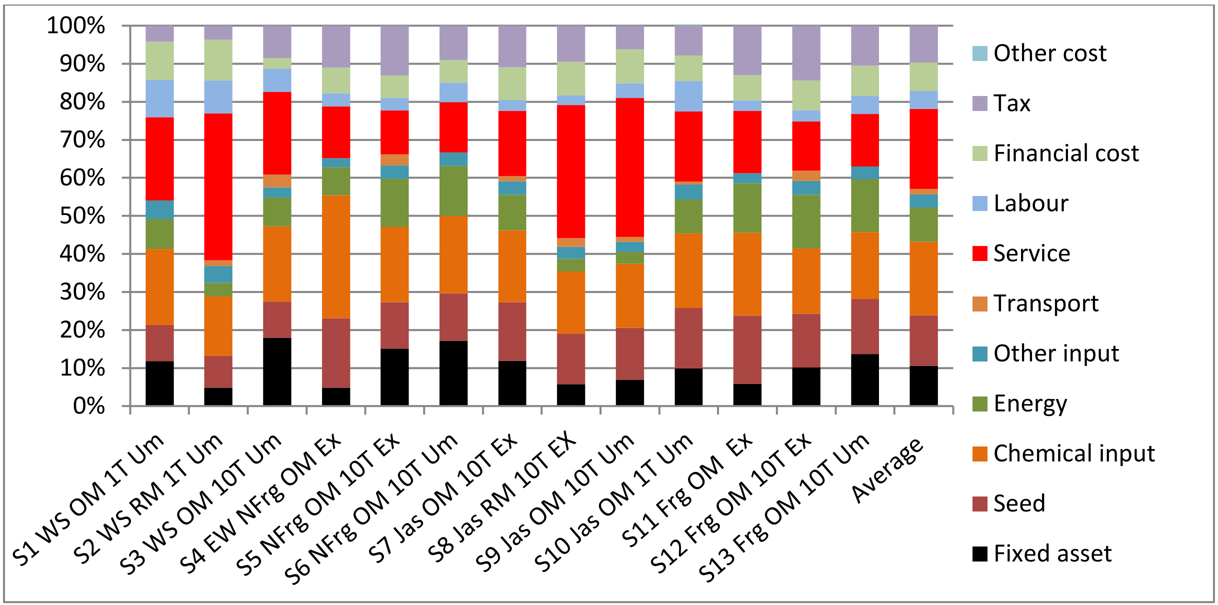


Figure 19 Costs structure per value chains



A sensitivity analysis computed at the scale of the Systems 7 (Jasmin, own machine, and 10T mille for export) confirm the predominance of fertilizer price and fuels price on the profitability of the value chains. The return to cost is less sensitive to electricity and the rate of utilization of capacity. While a lot of attention is given in the current policy debate on the consequence of the rapid development of milling capacity on milling profitability it should be underlined that the foundations of the value chains' competitiveness are primarily built on the performance of rice farmers.

Table 12 : Sensitivity analysis for System 7: Jasmin rice, Own Machine, 10T Mill exported

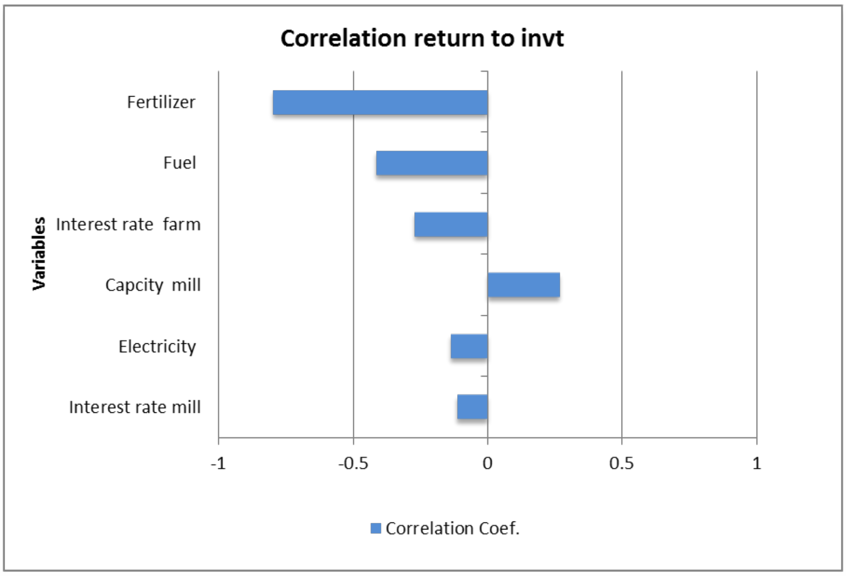
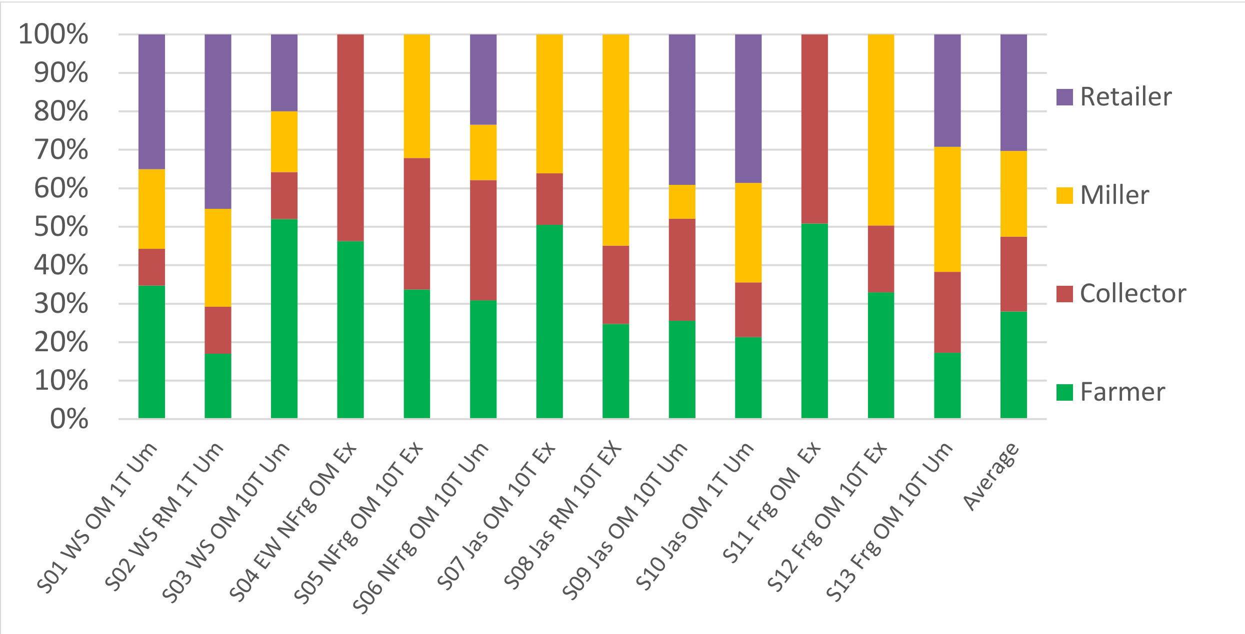


Table 13 Value chains costs and returns in KHR per ton of final output

	S1 WS OM 1T Um	S2 WS RM 1T Um	S3 WS OM 10T Um	S4 EW NFrg OM Ex	S5 NFrg OM 10T Ex	S6 NFrg OM 10T Um	S7 Jas OM 10T Ex	S8 Jas RM 10T EX	S9 Jas OM 10T Um	S10 Jas OM 1T Um	S11 Frg OM Ex	S12 Frg OM 10T Ex	S13 Frg OM 10T Um	Average
Fixed asset	134 037	61 940	240 454	28 434	230 092	252 606	201 538	113 325	132 160	137 137	41 694	167 652	221 047	99 778
Seed	107 692	107 692	126 697	108 000	185 018	185 018	260 633	260 633	260 633	221 538	128 571	232 708	232 708	129 771
Chemical input	225 580	198 953	265 388	190 714	299 810	299 810	321 071	321 071	321 071	272 911	156 666	283 558	283 558	224 195
Energy	89 243	45 691	100 877	43 750	193 749	193 978	158 802	66 313	60 207	124 306	93 650	232 261	226 155	75 790
Other input	55 584	55 584	36 050	13 986	51 887	51 887	60 502	60 502	51 887	55 584	18 745	60 502	51 887	49 634
Transport	0	20 000	44 748	0	44 748	0	22 374	45 903	23 529	10 500	0	44 748	0	15 223
Service	247 310	492 872	291 027	80 636	175 187	194 295	291 032	687 412	697 905	256 233	117 709	213 049	223 542	355 694
Labour	111 193	111 193	82 407	20 005	51 438	76 447	48 401	48 401	73 401	111 193	20 010	49 304	76 447	89 309
Financial cost	113 741	136 304	36 815	39 824	88 264	87 835	144 686	175 075	170 861	93 678	47 273	129 104	127 864	113 986
Tax	47 316	47 316	113 781	65 040	199 089	132 231	185 765	185 765	118 908	108 892	92 914	236 460	169 602	74 245
Other cost	90	90	166	92	166	166	317	317	166	90	175	317	166	117
														0
Total non-paddy cost	1 131 959	1 277 807	1 449 656	590 480	1 519 448	1 474 446	1 695 121	1 964 718	1 910 903	1 392 235	717 408	1 649 662	1 613 149	1 230 504
Revenue Paddy/Rice	1 900 000	1 900 000	2 200 000	900 000	1 800 000	1 700 000	2 670 769	2 670 769	2 336 923	2 400 000	950 000	2 351 538	2 350 000	1 831 320
Revenue Bran	110 000	110 000	101 538	0	110 000	110 000	101 538	101 538	101 538	101 538	0	110 000	101 538	94 322
Profit	878 041	732 193	781 921	309 520	390 552	411 708	1 077 187	807 590	790 636	1 109 303	232 592	811 876	838 389	699 261
Return to cash invested	78%	57%	54%	52%	26%	28%	64%	41%	41%	80%	32%	49%	52%	58%
Profit with imp. Land cost	641 355	495 507	503 466	229 520	229 667	250 823	787 594	517 997	501 043	863 149	118 306	605 024	631 537	484 881
return to cash with imp. land cst	57%	39%	35%	39%	15%	17%	46%	26%	26%	62%	16%	37%	39%	40%

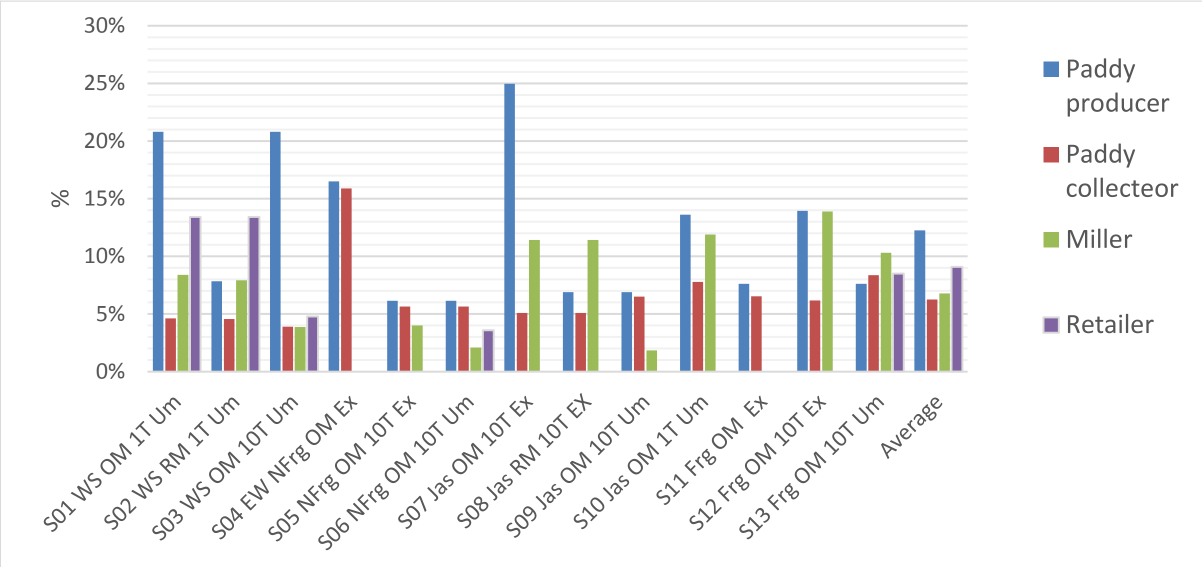
On average, taking into account the opportunity cost of land for rice farmer, farmers received 28% of the total net margin (or profit) generated by the rice value chains, the retailer 30%, the miller 22% and the collector 19% (Figure 19). For milled rice output, farmers receive 50% of the total profit in the case of Wet season (S3), Jasmin (S7) value chains and for value chains exporting paddy when they own the mechanical equipment. Millers get the highest share of total profit for Jasmin (S8) and fragrant rice (12) value chains targeting export market. Retailers get between 20% to 40% of the total profit, but it is important to recall that retailing functions budget does not take into the retailing cost down to the small shops in cities neighborhood. It is also important to keep in mind that the price systems selected to build the models determine the distribution of the net margin across agents, as a given price is an income for the agent upstream in the system and a cost for the following agent downstream.

Figure 20 : Net margin distribution among agents per value chains



Another ways to assess the relative impact of the net margin generated across each agents in a system is to compare the rate of return each agent (Figure 20). For instance, in the case of the system 8, the miller share of the total profit is about 35% and the share of the farmer about 50%, however the return to cash is much higher for the farmer (25%) than for the miller (12%). In other word, a large share of the total profit might be required to allows a given agent to maintain the profitability of its activity, and does not necessary corresponds to a dominant position in the system generating an over-profit or a rent.

Figure 21 : Return to cash per agent



5.3.2 Value added generation

While the financial viability of the value chains, or their ability to generate profit within the current input and output prices' system, assess the performance of the value chains from the agent's perspective, the value added generated by each value chains is an indicators of the contribution of each system to the whole Cambodian economy. It is worth reminding that value added is the difference between the value of the production and the value of the intermediate consumption (material inputs and services paid along the whole value chain to get the final product). The value chains can be further breakdown in wages paid to the laborer, interest paid to the financial sectors, tax paid to the state, and the gross income of the entrepreneur, further subdivided in net income (profit) and depreciation cost (i.e the amount required to ensure the renewal of the capital necessary to sustain the system).

On average, a rice value chain generates 250USD of value added per ton of final output (Figure 21). The value chain that generate the highest level of value added are the Jasmin (S7 to S10) and fragrant non-photoperiodic rice systems (S12 and S13). As expected, value chain for paddy export acknowledge the lowest level of value added, since the primary product is not processed and only marketed as a raw output. Rice farming contribute to more than 50% of the total value added generated for the thirteen systems.

The distribution of the valued added among the different component of the value chains confirms the limited impact of the rice sector in terms of wage distribution (8% of the total VA on average). The average share distributed to the state as taxes represent also 8%, the share going to the financial sector is about 11% of the value added. The gross income of the value chains agent represent 74% of the value added while the net income represents 65% of the total value added.

Figure 22 : Value added per agents per value chains

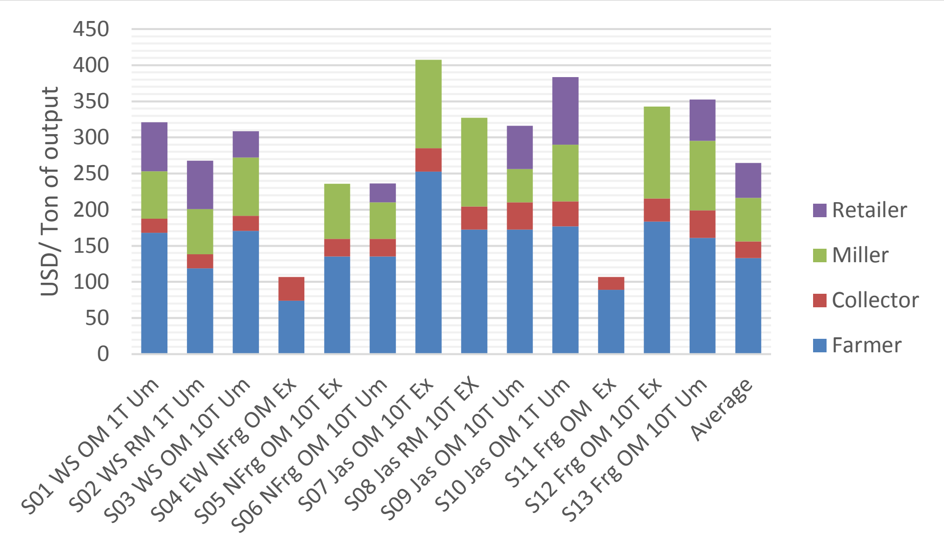
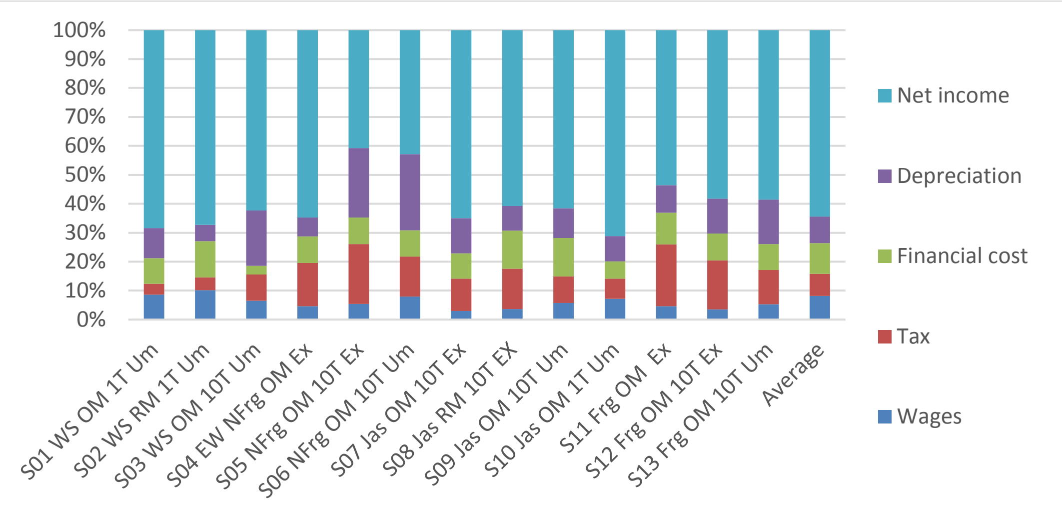


Figure 23 : Distribution of value added per agents per systems



A comprehensive estimation of the contribution of each rice value chains to the Cambodian economy require to shift from a computation per ton of final output to an estimation based on the total volume produced by each system.

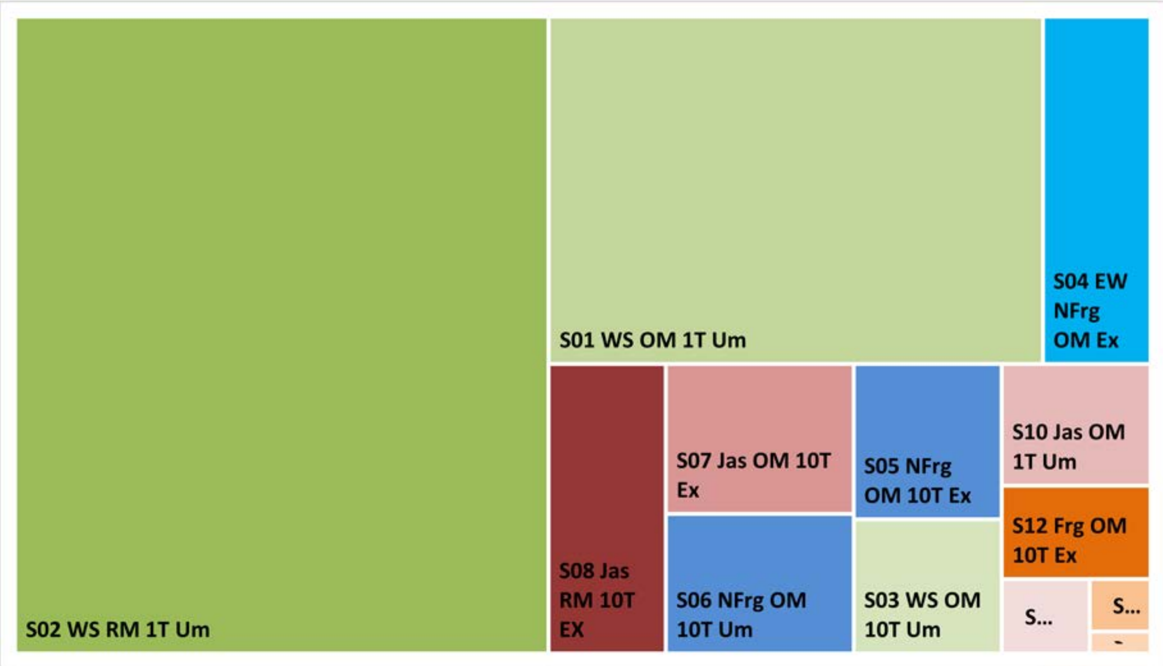
The thirteen models developed do not cover the whole set of value chains included in the rice sector, like, for instance, for the value chains supplying the rural market. We assumed that small-scale mills (1.5T throughput) was mainly supplying this market segment, while modern mills supply urban market. The relative contribution of small and large farm was considered based on the equipment owner ship, and weighted according to their respective share of cultivated land. Accordingly, small rice farms of 2ha on average represent 90% of the rice farm , while the one cropping around 10ha represent 10%. So small farm represent 75% of total cropped land and large farm about 35%. The estimation of the volume of rice produced by each systems is reported in Table 13; the thirteen systems represent about 70% of the total milled rice equivalent production.

Table 14 : Estimation of total volume of supply per system

	EWS	Jasmin	WS	DSnF	DSF	Total	
Production estimate by outlet							
Export paddy (milled equiv.)	948 506	0	0	27 500	27 500	1 003 506	
export milled	0	186 758	0	263 725	87 913	538 396	
Large cities	0	27 690	69 760	213 015	12 055	322 520	
Small cities	0	14 768	96 454	85 206	7 233	203 661	
Rural	0	153 220	1 833 192	127 806	221 805	2 336 023	
Total	948 506	382 436	1 999 406	717 252	356 505	4 404 106	
Total (paddy equiv)	1 724 556	695 338	3 635 284	1 304 095	648 192	8 808 212	
Allocation across system							
Systems						Milled rice equiv.	Paddy
S01 WS OM 1T Um			578 894			578 894	
S02 WS RM 1T Um			1 350 752			1 350 752	
S03 WS OM 10T Um			69 760			69 760	
S04 EW NFrg OM Ex	379 402					379 402	689 822
S05 NFrg OM 10T Ex				105 490		105 490	
S06 NFrg OM 10T Um				127 809		127 809	
S07 Jas OM 10T Ex		74 703				74 703	
S08 Jas RM 10T EX		112 055				112 055	
S09 Jas OM 10T Um		27 690				27 690	
S10 Jas OM 1T Um		50 396				50 396	
S11 Frg OM Ex					13 750	13 750	25 000
S12 Frg OM 10T Ex					43 957	43 957	
S13 Frg OM 10T Um					9644	9 644	
Total allocated						2 944 302	
Total allocated share of total supply						67%	

Figure 23 provide a graphical representation of the value added distribution across the various systems. Wet Season photoperiodic rice (WS) generate around 70% of the total value added, followed by, Jasmin rice value chains (10%) , Early Wet Season sold as paddy (9%), while fragrant non-photoperiodic rice only 2.6%. The policy debate focus on rice value chains targeting the export market, however in terms of economic impact the domestic market is much more important even if it generate less value added per ton of final output.

Figure 24 : Contribution of rice value chains to rice sector value added generation



6 Lessons and implications for policy formulation.

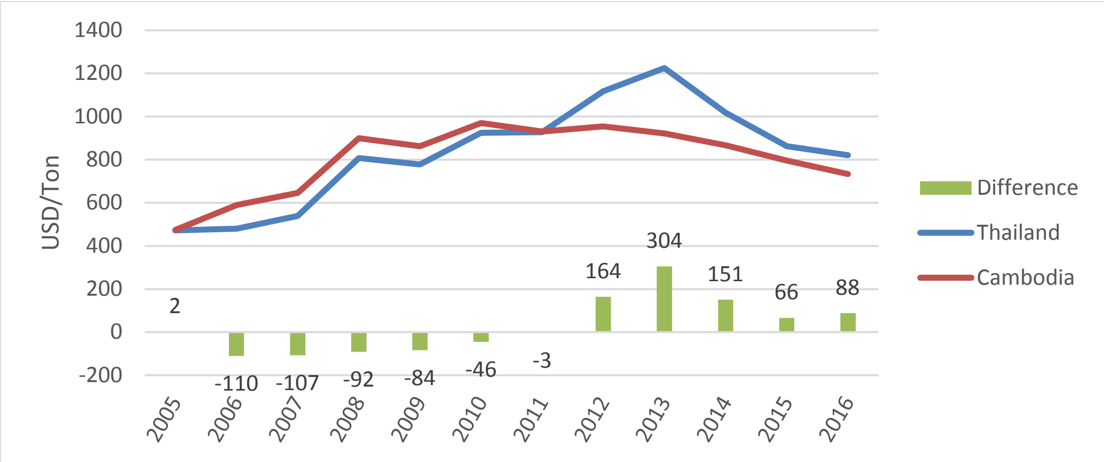
The assessment of the performance of a set of major value chains making up the Cambodian rice sector highlights several issues for its future. The rice sectors is confronted to a rapid transformation for the last ten years.

The international rice price surge of 2008 and the ensuing Thai rice policy that affected the competitiveness of the Thai rice exports triggered the expansion of the Cambodian rice exports of high value fragrant varieties. This market expansion was also supported by the competitive edge given to Cambodian export to the EU market with the benefit of the EBA trade clause. Concurrently, the Vietnamese milling industry expanded its paddy catchment to the Cambodian side of the Mekong basin providing a significant market outlet for paddy producers.

This increasing openness of the Cambodian rice economy combined with the rapid economic growth has an impact on the organization of the rice sector. At the production stage, the rapid increase of the labor cost lead rice farmers to reduce labor utilization for rice cropping and to substitute mechanization and herbicide for weed control. At the milling stage, the export market expansion open the way for a massive investment and upgrade of milling capacity that match international quality standard in terms of quality. According M.Sok (2015) the milling capacity for large mill would have increased from 322 tons per day in 2012 up to 853 tons in 2015.

The on-going rice sector transformation shifts the policy agenda from a focus on food security to the issue of the capacity of the rice sector to be competitive on the international market, to sustain and expand its market share. With the return of the Thai rice industry on the rice world market with a range of types of rice similar to the Cambodian one , the market segment targeted by the Cambodian miller, high quality non-fragrant and rice, is becoming more and more competitive. The Cambodian position might become even more difficult if at mid-term the EBA trade clause does not anymore apply which will increase the Cambodian rice price on the EU market. Figure 24 displays the rice CIF price spread between the Thai and Cambodian exported to EU. Cambodian rice was more expensive at EU border until 2010. The pattern changes after 2010, with the constraints hampering Thai rice industry competitiveness; however the spread tend to decrease, below 100 USD per ton since 2014. The EU tariff on milled rice at 175€/ton give an additional advantage to the Cambodia rice as far as it is still applied.

Figure 25 : CIF unit value price for rice import in EU from Cambodia and Thailand



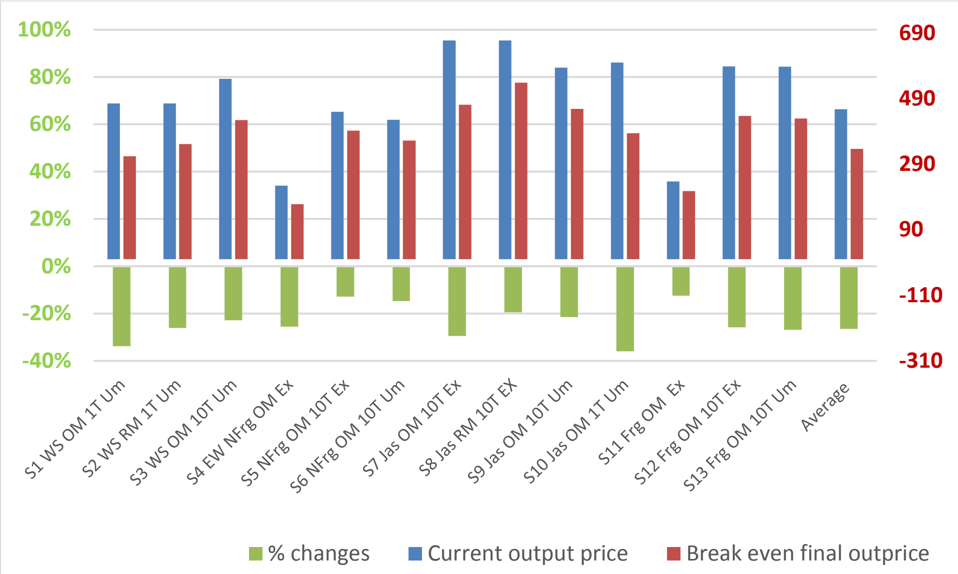
Source: Trademap.org, 2016.

A first range of issue to sustain Cambodia market share concern the capacity of the rice to remain competitive if we foresee a less favorable price condition in the targeted markets. In terms of price competitiveness, most of the value chains analyzed are still operating above the break- even output price (Figure 25) with the exception of the non-photoperiodic non-fragrant varieties that are closer to the break-even price. Even though, most of the rice value chain are still profitable under the current price setting, their competitiveness depends upon the attractiveness of rice business for each of their agent. We have noticed above that, the return to farmer days of labor is close to the daily rural wages and that the profitability of the milling sector is jeopardized if the rate of milling capacity utilization declines further down.

Sustaining or improving the competitiveness of the exporting value chain could be achieved either through productivity increase and/or through cost reduction. Productivity increase is stated as a major objective by many review of the Cambodian rice sector. This might be an option for non-photoperiodic varieties if the gain in yield and revenue overcome the incremental cost often associated with rice cropping systems intensification. This might not be an option for the Jasmin rice that represents one third of the milled rice exports, and weights heavily in the reputation of the Cambodian rice. Marketing and milling functions do not present a potential for productivity increase because the technology in place is already at an international standard. The reduction of input and service cost is the main issues for these downstream activities, such as the price of energy or the cost of shipment.

However, the competiveness of the Cambodian rice sector cannot be assed in terms of price and cost only. The capacity of the millers and exporters to maintain their market share also depends upon their logistical ability (shipment on time) and the quality of their relation with their customers.

Figure 26 : Current and break-even prices



Another option for expanding Cambodian export is to target the low-income countries, markets for ordinary white rice. Jasmin and fragrant rice are the flagship of the Cambodian exporters, but these markets segment is limited to the wealthy consumers and countries. The Cambodian ordinary white rice could be supplied in major importing market in South-East Asia (Indonesia, The Philippines Malaysia) and Africa (Nigeria, Côte d'Ivoire, Ghana). Besides the diversification of the exports destination, focusing on of ordinary with rice exportation would also provide a mean to processed paddy that is currently sold to Vietnamese dealers. Some millers, who are currently investing in large milling facilities to produce milled rice from the non-fragrant non-photoperiodic, pursue this option

A fourteen models has been developed to assess the financial and economic viability of this strategy; the break-even point for this systems would be at 298 USD per Ton/FOB while the current price is at 400USD. If the private profitability is robust, the economic impact of these emerging value chains would remain rather limited (Table 14). A ton of paddy exported to Vietnam generates 107 USD per ton of GDP, while a ton of non-fragrant, milled rice would generates about 188 USD/ton. However the net gain has to be computed by comparing 1.69 ton of paddy exported to Vietnam as this is equal to volume of paddy processed to get 1 ton of milled rice. On this basis the incremental value added generated is rather limited 8USD only.

Table 15 : Gain in benefit with EWS rice exported as milled rice

System	reference	Paddy producer	Paddy collecteor	Miller	Retailer	Total
S04 EW NFrg OM Ex	1 ton of Paddy	74	33	0	0	107
S04 EW NFrg OM Ex	1.69 Ton of paddy	125	55			180
S14 EW NFrg OM 20T Ex	1 ton of milled rice from 1.69 Ton of paddy	125	20	43	0	188

Considering the limited prospect for an expanding rice international trade and the fierce competition that prevails among established and new exporting countries, the diversification of Cambodian rice exports destinations and of the extension of the range of type of rice supplied should be pursued. Fragrant rice exports are still the most profitable options but the Cambodian rice industry could be also competitive in exporting ordinary white rice to low income markets.

As a matter of fact, maintaining, if not expanding, the volume of the rice process is a key determinant for sustaining the rice milling industry profitability. A high rate of milling capacity utilization is required to amortize the amount of the capital invested in modern mills. However, even within the most optimistic scenario, there is likely some adjustment ahead for matching the milling capacity to slow market growth. Some miller exporters would be able to strengthen their markets share through branding or supplying specific rice market such as organic, but these strategies cannot be an option for the entire industry. The current transition will also likely lead to an increasing differentiation at the farm level between the one who are able to invest in mechanization and the smaller one for whom rice cropping may become less attractive compared to other crops and off-farm jobs.

Eventually, if exports became the engine of the rice sector expansion, it should be kept in mind that the domestic market remains the major outlet for most of the rice sectors agents.

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Appendix 1. Estimation of the demand by major outlets.

The data available for estimating the domestic demand, its spatial distribution was the population census for 1998 and for 2008 at provincial level, the paper of Sar and al. (2012) reporting the consumption level per meal in rural and urban areas and per major region of the country, and the paddy production by province for 2015 reported by MAAF.

The first step consisted in extrapolating rural and urban population per province for 2015 on the base of the growth trends between 1998 and 2008 (Table 15). The per capita consumption is computed based on the quantity of daily rice consumption, multiply by the average number of meal per capita per day. The average number of meal per day has been adjusted to get an average per capita annual consumption of 160 kg similar to the one computed by FAOSTAT. Eventually we compute the total, rural and urban rice consumption by multiplying per capita annual consumption with the population per province.

The estimation of the milled rice surplus by province (Table 16) is based on paddy production reported by MAAF, after deduction of the provincial rural and urban demand. We assume local production respond firstly to rural consumption and then supply the urban population within the city. The interprovincial trade corresponds to the supply from surplus provinces to province having rice deficit, mainly the provinces with major urban centre (Phnom Phen, Sianouk ville).

The remaining parts is exported as paddy or milled rice.

Table 16 : Consumption estimation for rural and urban population and by province

Area	Population 2015			Quantity per meal		Per capita consumption		Total consumption		
	Total	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Total
		Share				*Meal per day*				
		20%	*80%*			*1.3*	*2.5*			
	n	n	n	Gram	Gram	Kg/year	Kg/year	Ton/year/	ton/year	ton/year
Cambodia	15 140 000	3 038 053	12 101 947	180	168	79	185	240 354	2 241 229	2 481 582
Banteay Meanchey	767 047	230 741	536 305	202	189	89	197	20 642	105 445	126 087
Battambang	1 231 893	159 696	1 072 197	202	189	89	197	14 286	210 808	225 094
Kampong Cham	1 743 312	118 014	1 625 298	202	189	89	197	10 557	319 555	330 113
Kampong Chhnang	521 024	43 131	477 894	202	189	89	197	3 858	93 960	97 819
Kampong Speu	822 120	59 063	763 057	180	168	80	175	4 708	133 688	138 396
Kampong Thom	686 953	31 466	655 487	202	189	89	197	2 815	128 878	131 692
Kampot	637 025	50 430	586 595	161	150	71	157	3 596	91 923	95 519
Kandal	1 434 681	249 361	1 185 319	180	168	80	175	19 878	207 668	227 546
Kep	42 072	5 113	36 959	161	150	71	157	365	5 792	6 156
Koh Kong	118 746	30 107	88 639	161	150	71	157	2 147	13 890	16 037
Kratie	369 142	32 186	336 957	192	179	85	187	2 737	62 970	65 707
Mondul Kiri	86 675	6 483	80 192	192	179	85	187	551	14 986	15 537
Otdar Meanchey	290 530	7 051	283 479	202	189	89	197	631	55 736	56 367
Pailin	112 873	8 265	104 608	202	189	89	197	739	20 567	21 307
Phnom Penh	1 619 647	1 493 249	126 398	166	155	74	162	109 777	20 423	130 200
Preah Sihanouk	265 637	111 436	154 201	161	150	71	157	7 946	24 164	32 110
Preah Vihear	217 355	12 861	204 494	192	179	85	187	1 094	38 216	39 309
Prey Veng	948 557	30 843	917 714	180	168	80	175	2 459	160 783	163 242
Pursat	429 870	23 110	406 760	202	189	89	197	2 067	79 974	82 042
Ratanak Kiri	200 553	27 541	173 011	192	179	85	187	2 342	32 332	34 674
Siem Reap	1 074 863	259 319	815 543	202	189	89	197	23 198	160 347	183 545
Stung Treng	138 929	16 408	122 520	192	179	85	187	1 395	22 897	24 292
Svay Rieng	486 829	17 047	469 782	180	168	80	175	1 359	82 306	83 665
Takeo	893 670	15 133	878 537	180	168	80	175	1 206	153 920	155 126

Table 17 : Rice balance sheet by provinces and estimation of inter-provincial rice flows

Province	Paddy production	Seeds	Losses	Paddy supply	Milled rice Supply (rc=0.55)	Total milled consumption	Milled rice balance	Urban consumption	Rural consumption
Banteay Meanchey	699 202	45 883	97 888	555 431	305 487	126 087	179 400	20 642	105 445
Battambang	766 193	53 476	107 267	605 450	332 997	225 094	107 903	14 286	210 808
Kampong Cham + Tbong Khmum	775 220	39 441	108 531	627 249	344 987	330 113	14 874	10 557	319 555
Kampong Chhnang	511 895	28 325	71 665	411 905	226 548	97 819	128 729	3 858	93 960
Kampong Speu	308 795	19 489	43 231	246 075	135 341	138 396	-3 055	4 708	133 688
Kampong Thom	725 181	46 370	101 525	577 285	317 507	131 692	185 815	2 815	128 878
Kampot	436 765	25 492	61 147	350 126	192 569	95 519	97 050	3 596	91 923
Kandal	402 926	18 951	56 410	327 565	180 161	227 546	-47 385	**19 878**	207 668
Kep	11 419	631	1 599	9 189	5 054	6 156	-1 102	**365**	5 792
Koh Kong	29 029	1 872	4 064	23 093	12 701	16 037	-3 336	**2 147**	13 890
Kratie	148 115	8 239	20 736	119 140	65 527	65 707	-180	2 737	62 970
Mondul Kiri	54 075	4 091	7 571	42 413	23 327	15 537	7 790	551	14 986
Otdar Meanchey	151 433	12 955	21 201	117 277	64 502	56 367	8 136	631	55 736
Pailin	21 287	1 282	2 980	17 025	9 363	21 307	-11 943	**739**	20 567
Phnom Penh	36 638	2 289	5 129	29 220	16 071	130 200	-114 129	**109 777**	20 423
Preah Sihanouk	46 885	2 982	6 564	37 339	20 536	32 110	-11 573	**7 946**	24 164
Preah Vihear	209 300	13 398	29 302	166 600	91 630	39 309	52 321	1 094	38 216
Prey Veng	1 257 390	65 660	176 035	1 015 695	558 632	163 242	395 390	2 459	160 783
Pursat	386 699	21 543	54 138	311 018	171 060	82 042	89 018	2 067	79 974
Ratanak Kiri	63 447	4 665	8 883	49 899	27 445	34 674	-7 230	**2 342**	32 332
Siem Reap	551 950	36 326	77 273	438 351	241 093	183 545	57 548	23 198	160 347
Stung Treng	72 909	4 839	10 207	57 863	31 824	24 292	7 533	1 395	22 897
Svay Rieng	541 678	33 564	75 835	432 280	237 754	83 665	154 089	1 359	82 306
Takeo	1 115 739	53 413	156 203	906 123	498 367	155 126	343 241	1 206	153 920
Cambodia	9 324 170	545 177	1 305 384	7 473 609	4 110 485	2 481 582	1 628 903	240 354	2 241 229
Rural consumption									2 241 229
Urban consumption within the province								97 160	
Inter provincial trade for supplying defict areas								**143 194**	
Total consumption									2 481 582
Export milled basis									1 628 903

Appendix 2: Detailed representative budget per cropping systems, traders and millers

Agent	Producer					
System	WS Photo Own M					
Output	Wet Mix paddy					
Technical parameters						
Based on	1	ha				
Cycle	6	months				
Water requirement	1 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	1	unit	8 130 000	10	0.1	81 300
Trailer	1	unit	800 000	10	0.1	8 000
Pump	1	unit	1 627 200	5	0.1	32 544
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	130	kg/Ha	1 400	KHR/kg	1	182 000
Fertilizer	3	bags (50kg)	105 000	KHR/bag	1	315 000
Pesticide	1	Ha	17 000	KHR/ha	0.5	8 500
Herbicide	1	Ha	19 000	KHR/ha	0.67	12 730
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	2	70 000
Diesel Irrigation	0.4	liter/100cm	3 500	KHR/liter	10	14 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	2.6	16 380
Bags	32.50	bags	700	Khr/bag	1	22 750
Service						
Land preperation	0	Ha	200 000	KHR/Ha	2	0
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.1	25 000
Pump Maintenance	1	Year	100 000	KHR/Ha	0.1	10 000
Irrigation	0	hours	10 000	KHR/hours	1	0
Transportation	0	Ton	13 000	KHR	1	0
Labour						
Family						
Land prepearation	2.4	days/Ha			2	
Broadcasting	0.6	days/Ha			1	
Fertilizer application	1	days/Ha			1.72	
Pesticide application	0.8	days/Ha			0.5	
Herbicide application	0.47	days/Ha			0.67	
Irrigation	0.42	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Insecticide application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	2.6	Ton	10 000	KHR/ton	1	26 000
Other cost						
Financial cost on input	24	%/year				133 128
Water fee	1	season	325 200	KHR	0.2	65 040
Revenue						
Production	2.6	Ton/Ha	900 000	KHR/Ton	1	2 340 000

Agent	Producer					
System	WS Photo rent M					
Output	Wet Mix paddy					
Technical parameters						
Based on	1	ha				
Cycle	6	months				
Water requirement	1 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	0	unit	8 130 000	10	0.1	0
Trailer	0	unit	800 000	10	0.1	0
Pump	0	unit	1 627 200	5	0.1	0
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	130	kg/Ha	1 400	KHR/kg	1	182 000
Fertilizer	3	bags (50kg)	105 000	KHR/bag	1	315 000
Pesticide	1	Ha	17 000	KHR/ha	0.5	8 500
Herbicide	1	Ha	19 000	KHR/ha	0.67	12 730
Diesel Land prepe	0	liter/ha	3 500	KHR/liter	2	0
Diesel Irrigation	0	liter/100cm	3 500	KHR/liter	10	0
Diesel Transport	0	liter/Ton	3 500	KHR/liter	2.6	0
Bags	32.50	bags	700	Khr/bag	1	22 750
Service						
Land preperation	1	Ha	200 000	KHR/Ha	2	400000
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	0	Year	250 000	KHR/Ha	0.1	0
Pump Maintenance	0	Year	100 000	KHR/Ha	0.1	0
Irrigation	1	hours	10 000	KHR/hours	5	50 000
Transportation	2.6	Ton	13 000	KHR	1	33 800
Labour						
Family						
Land prepearation	2.4	days/Ha			2	
Broadcasting	0.6	days/Ha			1	
Fertilizer application	1	days/Ha			1.72	
Pesticide application	0.8	days/Ha			0.5	
Herbicide application	0.47	days/Ha			0.67	
Irrigation	0.42	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Insecticide application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	2.6	Ton	10 000	KHR/ton	1	26 000
Other cost						
Financial cost on input	24	%/year				174 938
Water fee	1	season	325 200	KHR	0.2	65 040
Revenue						
Production	2.6	Ton/Ha	900 000	KHR/Ton	1	2 340 000

Agent	Producer					
System	Jasmine Own M					
Output	Wet Jasmine paddy					
Technical parameters						
Based on	1	ha				
Cycle	5	months				
Water requirement	3 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	1	unit	8 130 000	10	0.1	81 300
Trailer	1	unit	800 000	10	0.1	8 000
Pump	1	unit	1 627 200	5	0.1	32 544
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	120	kg/Ha	3 000	KHR/kg	1	360 000
Fertilizer	4	bags (50kg)	105 000	KHR/bag	1	420 000
Pesticide	1	Ha	38 000	KHR/ha	0.16	6 080
Herbicide	1	Ha	29 000	KHR/ha	0.6	17 400
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	2	70 000
Diesel Irrigation	0.4	liter/100cm	3 500	KHR/liter	30	42 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	2.5	15 750
Bags	31.25	bags	700	Khr/bag	1	21 875
Service						
Land preperation	0	Ha	200 000	KHR/Ha	2	0
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.1	25 000
Pump Maintenance	1	Year	100 000	KHR/Ha	0.1	10 000
Irrigation	0	hours	10 000	KHR/hours	1	0
Transportation	0	Ton	13 000	KHR	1	0
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	0.6	days/Ha	0		1	
Fertilizer application	1.5	days/Ha			1.72	
Pesticide application	1	days/Ha			0.16	
Herbicide application	1	days/Ha			0.6	
Irrigation	1.25	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Insecticide application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	2.5	Ton	10 000	KHR/ton	1	25 000
Other cost						
Financial cost on input	24	%/year				151 771
Water fee	1	season	325 200	KHR	0.5	162 600
Revenue						
Production	2.5	Ton/Ha	1 100 000	KHR/Ton	1	2 750 000

Agent	Producer					
System	Jasmine Rent M					
Output	Wet Jasmine paddy					
Technical parameters						
Based on	1	ha				
Cycle	5	months				
Water requirement	3 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	0	unit	8 130 000	10	0.1	0
Trailer	0	unit	800 000	10	0.1	0
Pump	0	unit	1 627 200	5	0.1	0
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	120	kg/Ha	3 000	KHR/kg	1	360 000
Fertilizer	4	bags (50kg)	105 000	KHR/bag	1	420 000
Pesticide	1	Ha	38 000	KHR/ha	0.16	6 080
Herbicide	1	Ha	29 000	KHR/ha	0.6	17 400
Diesel Land prepe	0	liter/ha	3 500	KHR/liter	2	0
Diesel Irrigation	0	liter/100cm	3 500	KHR/liter	30	0
Diesel Transport	0	liter/Ton	3 500	KHR/liter	2.5	0
Bags	31.25	bags	700	Khr/bag	1	21 875
Service						
Land preperation	1	Ha	200 000	KHR/Ha	2	400000
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	0	Year	250 000	KHR/Ha	0.1	0
Pump Maintenance	0	Year	100 000	KHR/Ha	0.1	0
Irrigation	1	hours	10 000	KHR/hours	15	150 000
Transportation	2.5	Ton	13 000	KHR	1	32 500
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	0.6	days/Ha	0		1	
Fertilizer application	1.5	days/Ha			1.72	
Pesticide application	1	days/Ha			0.16	
Herbicide application	1	days/Ha			0.6	
Irrigation	1.25	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Insecticide application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	2.5	Ton	10 000	KHR/ton	1	25 000
Other cost						
Financial cost on input	24	%/year				193 746
Water fee	1	season	325 200	KHR	0.5	162 600
Revenue						
Production	2.5	Ton/Ha	1 100 000	KHR/Ton	1	2 750 000

Agent	Producer					
System	Fragrant Non Photo. Own M					
Output	Wet Fragrant paddy					
Technical parameters						
Based on	1	ha				
Cycle	4	months				
Water requirement	15 000	cm				
Fixed asset						
	Qty		Unit t price (KHR)	Duration	Share	Value (KHR)
Hand Tractor	1	unit	8 130 000	10	0.1	81 300
Trailer	1	unit	800 000	10	0.1	8 000
Pump	1	unit	1 627 200	5	0.1	32 544
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	150	kg/Ha	3 000	KHR/kg	1	450 000
Fertilizer	4.3	bags (50kg)	105 000	KHR/bag	1	451 500
Pesticide	1	Ha	25 000	KHR/ha	2.3	57 500
Herbicide	1	Ha	57 000	KHR/ha	0.69	39 330
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	2	70 000
Diesel irrigation	0.4	liter/100cm	3 500	KHR/liter	150	210 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	3.5	22 050
Bags	43.75	bags	700	Khr/bag	1	30 625
Service						
Land preperation	0	Ha	200 000	KHR/Ha	2	0
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.1	25 000
Pump Maintenance	1	Year	100 000	KHR/Ha	0.1	10 000
Irrigation	0	hours	10 000	KHR/hours	1	0
Transportation	0	Ton	13 000	KHR	1	0
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	0.9	days/Ha	0		1	
Fertilizer application	0.8	days/Ha			2.23	
Pesticide application	1	days/Ha			2.3	
Herbicide application	0.7	days/Ha			0.69	
Irrigation	6.25	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Pesticide application						
Herbicide application						
Harvesting						
Handling	3.5	Ton	10 000	KHR/ton	1	35 000
Other cost						
Financial cost on input	24	%/year				165 456
Water fee	1	season	325 200	KHR	1	325 200
Revenue						
Production	3.5	Ton/Ha	1 200 000	KHR/Ton	1	4 200 000

Agent	Producer					
System	Fragrant Non Photo. Rent M					
Output	Wet Fragrant paddy					
Technical parameters						
Based on	1	ha				
Cycle	4	months				
Water requirement	15 000	cm				
Fixed asset						
	Qty		Unit t price (KHR)	Duration	Share	Value (KHR)
Hand Tractor	0	unit	8 130 000	10	0.1	0
Trailer	0	unit	800 000	10	0.1	0
Pump	0	unit	1 627 200	5	0.1	0
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	150	kg/Ha	3 000	KHR/kg	1	450 000
Fertilizer	4.3	bags (50kg)	105 000	KHR/bag	1	451 500
Pesticide	1	Ha	25 000	KHR/ha	2.3	57 500
Herbicide	1	Ha	57 000	KHR/ha	0.69	39 330
Diesel Land prepe	0	liter/ha	3 500	KHR/liter	2	0
Diesel irrigation	0	liter/100cm	3 500	KHR/liter	150	0
Diesel Transport	0	liter/Ton	3 500	KHR/liter	3.5	0
Bags	43.75	bags	700	Khr/bag	1	30 625
Service						
Land preperation	1	Ha	200 000	KHR/Ha	2	400000
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	0	Year	250 000	KHR/Ha	0.1	0
Pump Maintenance	0	Year	100 000	KHR/Ha	0.1	0
Irrigation	1	hours	10 000	KHR/hours	75	750 000
Transportation	3.5	Ton	13 000	KHR	1	45 500
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	0.9	days/Ha	0		1	
Fertilizer application	0.8	days/Ha			2.23	
Pesticide application	1	days/Ha			2.3	
Herbicide application	0.7	days/Ha			0.69	
Irrigation	6.25	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Pesticide application						
Herbicide application						
Harvesting						
Handling	3.5	Ton	10 000	KHR/ton	1	35 000
Other cost						
Financial cost on input	24	%/year				234 132
Water fee	1	season	325 200	KHR	1	325 200
Revenue						
Production	3.5	Ton/Ha	1 200 000	KHR/Ton	1	4 200 000

Agent	Producer					
System	Non Frag. Non Photo. Own M					
Output	Wet Non Frag. paddy					
Technical parameters						
Based on	1	ha				
Cycle	3	months				
Water requirement	15 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	1	unit	8 130 000	10	0.2	162 600
Trailer	1	unit	800 000	10	0.2	16 000
Pump	1	unit	1 627 200	5	0.2	65 088
Sprayer	1	unit	365 850	4	0.2	18 293
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	230	kg/Ha	2 000	KHR/kg	1	460 000
Fertilizer	6	bags (50kg)	105 000	KHR/bag	1	630 000
Pesticide	1	Ha	33 700	KHR/ha	2.59	87 283
Herbicide	1	Ha	37 000	KHR/ha	0.76	28 120
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	2	70 000
Diesel irrigation	0.4	liter/100cm	3 500	KHR/liter	150	210 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	4.5	28 350
Bags	56.25	bags	700	Khr/bag	1	39 375
Service						
Land preperation	0	Ha	200 000	KHR/Ha	2	0
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.2	50 000
Pump Maintenance	1	Year	100 000	KHR/Ha	0.2	20 000
Irrigation	0	hours	10 000	KHR/hours	1	0
Transportation	0	Ton	13 000	KHR	1	0
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	1.1	days/Ha	0		1	
Fertilizer application	1.1	days/Ha			2.06	
Pescticide application	1	days/Ha			2.59	
Herbicide applicattion	1	days/Ha			0.76	
Irrigation	6.25	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	4.5	Ton	10 000	KHR/ton	1	45 000
Other cost						
Financial cost on input	24	%/year				140 120
Water fee	1	season	325 200	KHR	1	325 200
Revenue						
Production	4.5	Ton/Ha	850 000	KHR/Ton	1	3 825 000

Agent	Producer					
System	Non Frag. Non Photo. Rent M					
Output	Wet Non. Frag paddy					
Technical parameters						
Based on	1	ha				
Cycle	3	months				
Water requirement	15 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	0	unit	8 130 000	10	0.1	0
Trailer	0	unit	800 000	10	0.1	0
Pump	0	unit	1 627 200	5	0.1	0
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	230	kg/Ha	2 000	KHR/kg	1	460 000
Fertilizer	6	bags (50kg)	105 000	KHR/bag	1	630 000
Pesticide	1	Ha	33 700	KHR/ha	2.59	87 283
Herbicide	1	Ha	37 000	KHR/ha	0.76	28 120
Diesel Land prepe	0	liter/ha	3 500	KHR/liter	2	0
Diesel irrigation	0	liter/100cm	3 500	KHR/liter	150	0
Diesel Transport	0	liter/Ton	3 500	KHR/liter	4.5	0
Bags	56.25	bags	700	Khr/bag	1	39 375
Service						
Land preperation	1	Ha	200 000	KHR/Ha	2	400000
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	0	Year	250 000	KHR/Ha	0.1	0
Pump Maintenance	0	Year	100 000	KHR/Ha	0.1	0
Irrigation	1	hours	10 000	KHR/hours	75	750 000
Transportation	4.5	Ton	13 000	KHR	1	58 500
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	1.1	days/Ha	0		1	
Fertilizer application	1.1	days/Ha			2.06	
Pescticide application	1	days/Ha			2.59	
Herbicide applicattion	1	days/Ha			0.76	
Irrigation	6.25	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	4.5	Ton	10 000	KHR/ton	1	45 000
Other cost						
Financial cost on input	24	%/year				189 929
Water fee	1	season	325 200	KHR	1	325 200
Revenue						
Production	4.5	Ton/Ha	850 000	KHR/Ton	1	3 825 000

Agent	Producer					
System	Early WS . Non Photo. Rent M					
Output	EWS Non. Phot paddy					
Technical parameters						
Based on	1	ha				
Cycle	4	months				
Water requirement	7 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	1	unit	8 130 000	10	0.1	81 300
Trailer	1	unit	800 000	10	0.1	8 000
Pump	1	unit	1 627 200	5	0.1	32 544
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	270	kg/Ha	2 000	KHR/kg	1	540 000
Fertilizer	8	bags (50kg)	105 000	KHR/bag	1	840 000
Pesticide	1	Ha	75 000	KHR/ha	1.09	81 750
Herbicide	1	Ha	37 000	KHR/ha	0.86	31 820
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	2	70 000
Diesel Irrigation	0.4	liter/100cm	3 500	KHR/liter	70	98 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	5	31 500
Bags	62.50	bags	700	Khr/bag	1	43 750
Service						
Land preparation	0	Ha	200 000	KHR/Ha	2	0
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.1	25 000
Pump Maintenance	1	Year	100 000	KHR/Ha	0.1	10 000
Irrigation	0	hours	10 000	KHR/hours	1	0
Transportation	0	Ton	13 000	KHR	1	0
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	1.4	days/Ha	0		1	
Fertilizer application	1.1	days/Ha			2.3	
Pesticide application	1	days/Ha			1.09	
Herbicide application	0.9	days/Ha			0.86	
Irrigation	2.92	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Insecticide application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	5	Ton	10 000	KHR/ton	1	50 000
Other cost						
Financial cost on input	24	%/year				199 122
Water fee	1	season	325 200	KHR	1	325 200
Revenue						
Production	5	Ton/Ha	750 000	KHR/Ton	1	3 750 000

Agent	Producer					
System	Early WS . Non Photo. Rent M					
Output	EWS Non. Phot paddy					
Technical parameters						
Based on	1	ha				
Cycle	4	months				
Water requirement	7 000	cm				
Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	0	unit	8 130 000	10	0.1	0
Trailer	0	unit	800 000	10	0.1	0
Pump	0	unit	1 627 200	5	0.1	0
Sprayer	1	unit	365 850	4	0.1	9 146
Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	270	kg/Ha	2 000	KHR/kg	1	540 000
Fertilizer	8	bags (50kg)	105 000	KHR/bag	1	840 000
Pesticide	1	Ha	75 000	KHR/ha	1.09	81 750
Herbicide	1	Ha	37 000	KHR/ha	0.86	31 820
Diesel Land prepe	0	liter/ha	3 500	KHR/liter	2	0
Diesel Irrigation	0	liter/100cm	3 500	KHR/liter	70	0
Diesel Transport	0	liter/Ton	3 500	KHR/liter	5	0
Bags	62.50	bags	700	Khr/bag	1	43 750
Service						
Land preperation	1	Ha	200 000	KHR/Ha	2	400000
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	0	Year	250 000	KHR/Ha	0.1	0
Pump Maintenance	0	Year	100 000	KHR/Ha	0.1	0
Irrigation	1	hours	10 000	KHR/hours	35	350 000
Transportation	5	Ton	13 000	KHR	1	65 000
Labour						
Family						
Land prepearation	1.5	days/Ha	0		2	
Broadcasting	1.4	days/Ha	0		1	
Fertilizer application	1.1	days/Ha			2.3	
Pesticide application	1	days/Ha			1.09	
Herbicide application	0.9	days/Ha			0.86	
Irrigation	2.92	days/Ha			1	
Harvesting	1	days/Ha			1	
Handling	1	days/Ha			1	
Supervision	10	days/Ha			1	
Paid labour						
Land preperation						
Braodcatsing						
Fertilizer application						
Insecticide application						
Pescticide application						
Herbicide applicattion						
Harvesting						
Handling	5	Ton	10 000	KHR/ton	1	50 000
Other cost						
Financial cost on input	24	%/year				245 562
Water fee	1	season	325 200	KHR	1	325 200
Revenue						
Production	5	Ton/Ha	750 000	KHR/Ton	1	3 750 000

Paddy collector							
Technical parameter							
Capacity per trip	20	T					
Tota distance per year	30 000	Km					
Collecting trip	10	km					
Delivery Trip	50	km					
Return to base trip	50	km					
Duration of the trip	0.5	day					
Fixed asset							
	Qty	Qty Unit	Price	Currency	Year	Coef	Value
Truck	1	unit	121 950 000	KHR	10	0.4%	44 715
	Qty	Qty unit	Price	Currency	Reference	Coef	Value
Intermediate consumption							
Paddy	20	T	1 000 000	KHR	Ton	1	20 000 000
Diesel	20	l/100	3 000	KHR	liter	110	66 000
Maintenance	1	Year	28 557 360	KHR	year	0.4%	104 710
Labour							
Driver	1	employee	813 600	KHR	month	0.023	18 491
Loading	20	Ton	10 000	KHR	Ton	1	200 000
Other cost							
Insurance	1	Year	500 000	KHR	Ton	0.4%	1 833
Tax							
Revenue							
Early WS			900000				
Jasmin			1200000				
WS			850000				
DSnF			850000				
DSF	20	Ton	1 100 000	KHR	Ton	1	22 000 000

Millet 1.5T part 1

Rice Miller Samll 1.5T								
Technical parmeter								
Total paddy purchase	1 500	T		Paddy purch	4	month		
Drying rate per hours	0.90%		Number of day available for drying		42	days (based on milling day)		
Wet paddy moisture content	26.00%							
Dry paddy moisture content	13.00%							
Drying target	13.00%							
Hours of dryer	14.4		722	Hours	50	Days	1	dryers
Drying batch capacity	30.0	T						
Drying Throughput Paddy/hours	2.1	T/hour			375	T WP Drying capacity per month WP		
					375	T DP capacity per month		
Conversion rate								
Dry Paddy to wet paddy	1						0.0	
West Paddy	1 500	Ton	125	T DP processed per month				
Hour per day milling	8	hour/day	1000	hours per ye	125	Days	10	days/ month
Milling Throughput Paddy/Hours	1.5	T						
Sorting Throughput **Rice**/hours	10	T	98	Hours per year				
Paddy to milled rice			Price difference					
Head rice	15		100					
Mixed broken (10%)	35		85					
Small broken 25%	10		80					
Broken 100%	5		75					
Bran	11							
Husk	24							
	100							
Stroage capacity	100	T						
Storage required	5	T						
Strorage avarge duration	5.3	Month						
Warehouse capacity	100	T						
Loader capacity	20	Ton/hour						

Fixed asset

	Qty	Qty Unit	Price	Price unit	Year	Coef	Value KHR
Mill	1	unit	406 500 000	KHR	25	1	16 260 000
Dryer	0	unit	345 525 000	KHR	7	1	0
Sorter	0	unit	406 500 000	KHR	10	1	0
Packing line	0	unit	406 500 000	KHR	15	1	0
Ware house 100T	1	unit	24 390 000	KHR	20	1	1 219 500
Milling Hangar	1	unit	406 500 000	KHR	30	1	13 550 000
Loader	0	unit	101 625 000	KHR	10	1	0

Intermediate consumption

	Qty	Qty unit	Price	Price unit	Unit price	Coef	Value
Material input							
Paddy purchase							
Early WS	0.00	% of total P	900 000	KHR	Ton	0	0
Jasmin	0.15	% of total P	1 200 000	KHR	Ton	225	270 000 000
WS	0.75	% of total P	850 000	KHR	Ton	1125	956 250 000
DSnF	0.05	% of total P	850 000	KHR	Ton	75	63 750 000
DSF	0.05	% of total P	1 200 000	KHR	Ton	75	90 000 000
Total	1.00	% of total P	1 005 000	KHR	Ton	1500	1 380 000 000
Electricity mill	50	Kwh	680	KHR	KWH	1 000	34 000 000
Electricity dry	0	Kwh	813	KHR	KWH	722	0
Electricity sorting	0	KWH	813	KHR	KWH	97.5	0
Diesel (loader)	0	liter/hour	3 500	KHR	liter	75	0
Spare parts	1	set	3 252 000	KHR	milling/hour	5	16 260 000
Bags	19 500	50 kg bag	1016	KHR	bag	1	19 812 000
Services							
Maintenance	0	set	2 032 500	KHR	month		0
Transport -Delivery	0	ton	224	KHR	ton km	70	0
Labour							
Permanent staff qualified	1	staff	813 000	KHR	month	12	9 756 000
Permanent staff Other	4	staff	609 750	KHR	month	12	29 268 000
Temporary worker (handling)	1 500	Ton	10 000	KHR	Ton of hand	1	15 000 000
Others							
Interest on storage vol	12	% -year	53 600	KHR	KHR/ton	5.33	285 867
Local tax	1	set	100 000	KHR	month	12	1 200 000
Licence	1	set	600 000	KHR	month	12	7 200 000
Export processing document	0	ton	67 073	KHR	ton	1	0

Millet 1.5T part 2

Revenue								
Head rice	225	Ton	975					
Mixed broken (10%)	525	Ton						
Small broken 25%	150	Ton						
Broken 100%	75	Ton						
Bran	165	Ton	600 000	KHR	Ton	1	99 000 000	
Husk	360	Ton						
Husk dryer	120	kg/hour/30T	722	hours	87	Tons requierd for dryning		
Milled rice								
Head rice price								
Early WS	0.00	% of	1 600 000	KHR	Ton	0	0	
Jasmin	0.15	% of	2 900 000	KHR	Ton	34	97 875 000	
WS	0.75	% of	1 800 000	KHR	Ton	169	303 750 000	
DSnF	0.05	% of	1 600 000	KHR	Ton	11	18 000 000	
DSF	0.05	% of	2 900 000	KHR	Ton	11	32 625 000	
Total	1.00					225		
Mixed broken (10%)								
Early WS	0.00	% of	1 360 000	KHR	Ton	0.00	0	
Jasmin	0.15	% of	2 465 000	KHR	Ton	78.75	194 118 750	
WS	0.75	% of	1 530 000	KHR	Ton	393.75	602 437 500	
DSnF	0.05	% of	1 360 000	KHR	Ton	26.25	35 700 000	
DSF	0.05	% of	2 465 000	KHR	Ton	26.25	64 706 250	
Small broken 25%								
Early WS	0.00	% of	1 280 000	KHR	Ton	0.00	0	
Jasmin	0.15	% of	2 320 000	KHR	Ton	22.50	52 200 000	
WS	0.75	% of	1 440 000	KHR	Ton	112.50	162 000 000	
DSnF	0.05	% of	1 280 000	KHR	Ton	7.50	9 600 000	
DSF	0.05	% of	2 320 000	KHR	Ton	7.50	17 400 000	
Broken 100%								
Early WS	0.00	% of	1 200 000	KHR	Ton	0.00	0	
Jasmin	0.15	% of	2 175 000	KHR	Ton	11.25	24 468 750	
WS	0.75	% of	1 350 000	KHR	Ton	56.25	75 937 500	
DSnF	0.05	% of	1 200 000	KHR	Ton	3.75	4 500 000	
DSF	0.05	% of	2 175 000	KHR	Ton	3.75	8 156 250	
Average unit price of out put per ton			Unit price			Tot Qty	Total Value	Bran value
Early WS			na			0	0	0
Jasmin			2 622 308			146	368 662 500	14 850 000
WS			1 666 154			731	1 144 125 000	74 250 000
DSnF			1 492 308			49	67 800 000	4 950 000
DSF			2 622 308			49	122 887 500	4 950 000
Total Revenue							1 802 475 000	

Miller 10T/hours part 1

Rice Miller Large								
Technical parmeter								
MaxNumber of operating days/month	25	day						
Max number of operating hours/day	15	hours						
Maximum milling capacity/month	3 600	T						
Maximum milling capacity/year	43 200	T						
Total paddy purchase	20 000	T	Wet Paddy purchase period		6	months	3 333	T/month
			Milled paddy selling period		12	months	921	T/month
Paddy Drying								
Drying rate per hours	0.90%		Number of batch/Month		111	Batch		
Wet paddy moisture content	26.00%		Number of batch/day		4.44	Batch		
Dry paddy moisture content	13.00%		Number of dryer		5.00	unit		
Drying target	13.00%		Ton per day		133	T		
Hours of dryer	14.4							
Drying batch capacity	30.0	T						
Drying Throughput Paddy/hours	2.1	T/hour	Total hours		9 630			
Conversion rate for Dry paddy								
Dry Paddy to wet paddy	0.85							
Dry Paddy to process	17 000	Ton	Number of month for milling		4.7	month		
Dry Paddy Milling								
Hour per day milling	15	hour/day	1700	hours per ye	113	Days		
Milling Throughput Paddy/Hours	10	T	150	Ton per day paddy				
Sorting Throughput **Rice**/hours	10	T	1 105	Hours per year				
Conversion rate for Milled rice			Price difference					
Head rice	50		100					
Mixed broken (10%)	5		85					
Small broken 25%	5		80					
Broken 100%	5		75					
Bran	11							
Husk	24							
	100							
Max storage required	5 525	T	Average duration					
Paddy avarege storage required	0	T	0.00	Month				
Milled rice average storage rquired	2 763	T	6.00	Month				
Loader capacity	20	Ton/hour	300	Ton per day				

Paddy and rice storage flows

	Month1	Month2	Month3	Month4	Month5	Month6	Month7	Month8	Month9	Month10	Month11	Month12	Average	Total
	1	2	3	4	5	6	7	8	9	10	11	12		
Dry Paddy cumulated supply	2 833	5 667	8 500	11 333	14 167	17 000	17 000	17 000	17 000	17 000	17 000	17 000		
Dry paddy supply	2 833	2 833	2 833	2 833	2 833	2 833	0	0	0	0	0	0		
Dry paddy stored	0	0	0	0	0	0	0	0	0	0	0	0		
Cumulated storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dry paddy unstored		0	0	0	0	0	0	0	0	0	0	0		
Paddy milled	2 833	2 833	2 833	2 833	2 833	2 833	0	0	0	0	0	0		
Milled rice supply	1 842	1 842	1 842	1 842	1 842	1 842	0	0	0	0	0	0		
Milled monthly sales	921	921	921	921	921	921	921	921	921	921	921	921		
Milled rice storage	921	921	921	921	921	921	0	0	0	0	0	0		
Milled rice cumulated storage	921	1 842	2 763	3 683	4 604	5 525	4 604	3 683	2 763	1 842	921	0	2 763	33 150
Milled rice unstored	0	0	0	0	0	0	921	921	921	921	921	921		
Total storage requirement	921	1 842	2 763	3 683	4 604	5 525	4 604	3 683	2 763	1 842	921	0	5 525	

Miller 10T/hours part 2

Fixed asset							
	Qty	Qty Unit	Price	Price unit	Year	Coef	Value KHR
Mill	1	unit	6 097 500 000	KHR	15	1	406 500 000
Dryer	12	unit	345 525 000	KHR	7	1	592 328 571
Sorter	2	unit	406 500 000	KHR	10	1	81 300 000
Packing line	1	unit	406 500 000	KHR	15	1	27 100 000
Warehouse of 10000T capacity	2	unit	1 347 547 500	KHR	20	1	134 754 750
Milling Hangar	1	unit	1 219 500 000	KHR	20	1	60 975 000
Loader	3	unit	101 625 000	KHR	10	1	30 487 500
Intermediate consumption							
	Qty	Qty unit	Price	Price unit	Unit price	Coef	Value
Material input							
Paddy purchase							
Early WS	0.00	% of total P	900 000	KHR	Ton	0	0
Jasmin	0.20	% of total P	1 250 000	KHR	Ton	4000	5 000 000 000
WS	0.40	% of total P	1 000 000	KHR	Ton	8000	8 000 000 000
DSnF	0.20	% of total P	780 000	KHR	Ton	4000	3 120 000 000
DSF	0.20	% of total P	1 200 000	KHR	Ton	4000	4 800 000 000
Total	1.00	% of total P	1 358 000	KHR	Ton	20000	20 920 000 000
Electricity mill	300	Kwh	813	KHR	KWH	1 700	414 630 000
Electricity dry	30	Kwh	813	KHR	KWH	9 630	234 866 667
Electricity sorting	10	KWH	813	KHR	KWH	1105	8 983 650
Diesel (loader)	10	liter/hour	3 500	KHR	liter	1000	35 000 000
Spare parts	1	set	40 650	KHR	milling/hour	1 700	69 105 000
Bags	221 000	50 kg bag	1016	KHR	bag	1	224 536 000
Services							
Maintenance	0	set	2 032 500	KHR	month	0	0
Transport -Delivery	11 050	ton	224	KHR	ton /km	100	247 232 700
Labour							
Permanent staff qualified	4	staff	1 219 500	KHR	month	12	58 536 000
Permanent staff Other	15	staff	609 750	KHR	month	12	109 755 000
Temporary worker (handling)	0	Ton	10 000	KHR	Ton of hand	1	0
Others							
Interest on Paddy storage vol	12	% -year	13 580	KHR	KHR/ton	0	0
Interest on Rice storage vol	12	% -year	22 146	KHR	KHR/ton	16 575	367 062 667
Local tax	1	set	100 000	KHR	month	12	1 200 000
Licence	1	set	1 020 000	KHR	month	12	12 240 000
Export processing document	11 050	ton	67 073	KHR	ton	1	741 156 650

Miller 10T/hours part 2

Head rice	8 500	Ton						
Mixed broken (10%)	850	Ton						
Small broken 25%	850	Ton						
Broken 100%	850	Ton						
Bran	1 870	Ton	600 000	KHR	Ton	1	1 122 000 000	
Husk	4 080	Ton						
Husk dryer	120	kg/hour/30T	9 630	hours		1 156	Tons requierd for dryning	
Milled rice								
Head rice price								
Early WS	0.00	% of	0	KHR	Ton	0	0	
Jasmin	0.20	% of	3 200 000	KHR	Ton	1 700	5 440 000 000	
WS	0.40	% of	1 900 000	KHR	Ton	3 400	6 460 000 000	
DSnF	0.20	% of	1 708 560	KHR	Ton	1 700	2 904 552 000	
DSF	0.20	% of	2 900 000	KHR	Ton	1 700	4 930 000 000	
Total	1.00					8 500		
Mixed broken (10%)								
Early WS	0.00	% of	0	KHR	Ton	0.00	0	
Jasmin	0.20	% of	2 720 000	KHR	Ton	170.00	462 400 000	
WS	0.40	% of	1 615 000	KHR	Ton	340.00	549 100 000	
DSnF	0.20	% of	1 452 276	KHR	Ton	170.00	246 886 920	
DSF	0.20	% of	2 465 000	KHR	Ton	170.00	419 050 000	
Small broken 25%								
Early WS	0.00	% of	0	KHR	Ton	0.00	0	
Jasmin	0.20	% of	2 560 000	KHR	Ton	170.00	435 200 000	
WS	0.40	% of	1 520 000	KHR	Ton	340.00	516 800 000	
DSnF	0.20	% of	1 366 848	KHR	Ton	170.00	232 364 160	
DSF	0.20	% of	2 320 000	KHR	Ton	170.00	394 400 000	
Broken 100%								
Early WS	0.00	% of	0	KHR	Ton	0.00	0	
Jasmin	0.20	% of	2 400 000	KHR	Ton	170.00	408 000 000	
WS	0.40	% of	1 425 000	KHR	Ton	340.00	484 500 000	
DSnF	0.20	% of	1 281 420	KHR	Ton	170.00	217 841 400	
DSF	0.20	% of	2 175 000	KHR	Ton	170.00	369 750 000	
Average unit price of out put per ton			Unit price			Tot Qty	Total Value	Bran value
Early WS			na			0	0	0
Jasmin			3 052 308			2 210	6 745 600 000	224 400 000
WS			1 812 308			4 420	8 010 400 000	448 800 000
DSnF			1 629 703			2 210	3 601 644 480	224 400 000
DSF			2 766 154			2 210	6 113 200 000	224 400 000
Total			2 214 556			11 050	24 470 844 480	

Retailer							
Technical parmeter							
Store capacity	10	T					
Turn over	5	T/purchase	5	per week	1300	per year	
Total paddy purchase	1 300	T					
Fixed asset							
	Qty	Qty Unit	Price	Price unit	Year	Coef	Value
Shop	1	unit	29 268 000	KHR	1	1	29 268 000
Scale	2	unit	250 000	KHR	5	1	100 000
Intermediate consumption							
	Qty	Qty unit	Price	Price unit	Unit price	Coef	value
Material input							
Milled rice purchase	1 300	Ton	**1 600 000**	KHR	Ton	1	2 080 000 000
Electricity	1.2	Kwh/day	691	KHR	KWH	365	302 658
Bags	1 300	50 kg bag	690.88	KHR	bag	0.25	224 536
Services							
Telephone subscription	12	month	40 000	KHR	month	3	1 440 000
Delivery transport cost	1 300	ton	18 000	KHR	ton/km	1	23 400 000
Labour							
Permanent staff	2	staff	813 000	KHR	month	12	19 512 000
Temporary worker (handling)	1 300	Ton	10 000	KHR	Ton	1	13 000 000
Other							
Interest on storage vol	0	% -year	0	KHR	year/ton	0.00	0
Local tax	1	set	20 000	KHR	month	12	240 000
Licence	1	set	40 000	KHR	year	1	40 000
Revenue							
Milled rice standard	1 300	Ton	1 800 000	KHR	Ton	1	2 340 000 000

Appendix 3 : Methodological note on the computation of the value chain financial and economic indicators.

Support to the Commercialization of Cambodian Rice Project
[AFD Grant - CKH-1077-01-S and CKH-1077-02-T

ANALYSIS OF ADDED VALUE DISTRIBUTION IN CAMBODIAN RICE VALUE-CHAIN AND SUPPORT TO THE CREATION OF A RICE SECTOR OBSERVATORY

Methodological note on the computation of the Value Chain financial and economic indicators.

Table of content

1 Introduction

In order to monitor and assess the potential impact of policy options of the financial and economic performances of Cambodian rice value chains a set of models have been developed. Each model combines costs and incomes along the whole chain of operations required to deliver a given type of rice (Photoperiodic non-fragrant, Jasmin, Non-photoperiodic fragrant ...) at a given market (local market, export FOB spot...) and taking into account different practices to perform each action (milling technology, access to mechanization...)

Table 1 : Parameters for the typology of agents and systems

	Functions					Output	Outlet
	Paddy production			Collecting	Milling		
Parameters	Season	Variety	Access to mechanization	Distance for delivery	Throughput		
	– Early wet season – Wes season – Dry season	– Photoperiodic non-fragrant – Photoperiodic fragrant (Jasmin) – Non-photoperiodic fragrant – Non-photoperiodic non-fragrant	– Owned machines – Rent machines	km	– 1.5 Ton per hour of paddy milling capacity – 10 ton per hours of Paddy milling capacity	– Paddy – Milled rice packed	– Export market – Major urban market – Other market

This methodological note presents how the models have been organized using Excel templates specifically developed to this end. After presenting the overall rationale of the data organization and computation, we will present how budgets are built for each player in the selected value chain and how they are consolidated in a synthetic sheet in equivalent milled paddy delivered at the last point of the chain

This note is a companion document to the Excel spreadsheet.

2 Value chain models rationale

The value chains is composed of economic agents or players that perform a given function in the systems: production, collection of the paddy, processing (milling) and retailing to the consumer. For paddy export, we assume that the collector is delivering to the foreign trader purchasing at the border. For the export of milled rice we assume that the costs of bringing the product to the FOB step (transport to harbor, administrative documents, and export fee) are borne by the rice miller. Although this configuration does not capture value chains where specialized rice exporters managed the delivery to the FOB step, it still takes into account this task into the assessment of the whole value chain profitability. Similarly, on the retail side within the national or domestic market we have only considered urban traders who dispatch milled rice supplied by rice mills to the various marketing point where smaller retailers may actually supply to the consumers.

2.1 Budget by agents

A budget is developed on separate sheets for each agent taking into account different technical parameters such as the quantity of inputs, yield, the distance and the volume of product trader per purchase and selling cycle, the total milling capacity and the actual level of capacity utilization…

Each budget distinguish between different cost items.

Fixed asset gathered all the cost associated with the purchase of durable goods, equipments that are subject to depreciation

Intermediate consumption considers all material input and the services that are required to perform the function and paid by the agents. The purchase of input corresponding to the commodity in systems, are recorded separately. The commodity in system is to the good produced throughout the chain from the raw material at the first step (i.e. paddy produced by farmers) to final output (milled rice deliver at the harbor or retail into the urban market).

Labor paid by the agent are recorded separately. A distinction is made between family and paid labor as no value is imputed to the family labor given the imperfection that prevails on the rural labor market. However the return to family labor in KHR/Day is computed on the basis of the net income generated by rice producers.

Other cost including tax, fee, financial cost are recorded in separate blocs

Revenue is computed for the all the outputs produced, commodity in process and joint product (such as rice bran at the milling stage).For each budget the total cost are consolidated into the following major cost and income items

- Fixed asset
- Seed
- Chemical input
- Energy
- Other input
- Transport
- Service
- Labor
- Financial cost
- Tax
- Other cost

- Total non-paddy/rice cost
- Paddy /milled rice purchase
- Total cost

- Revenue Paddy/Rice
- Revenue Bran

- Net income

This consolidated cost items are then converted into the equivalent of one unit of output (i.e. ton of paddy, ton of milled rice...)

2.2 Consolidated budget of the value chain system

The value chain systems model consist of an array of budget sheets gathered in one file, and connected to the "System Consolidation_Parameter" sheet where the agents budget are consolidated on the basis of the major costs and items.

The consolidated budget at the system level take into account the conversion of all budget into the final product equivalent, which is the output of the last agent in the system. For instance if the recovery rate of milled rice to paddy is 65%, it means that 1.53 Ton of Paddy is required to produce 1 ton of milled rice. Thus, each value of budget's items for agent producing paddy is multiplied by 1.53 to keep consistency across the whole system.

The consolidated budget for the whole system, sum up all the cost items in final product equivalent from each budget excluding the commodity in system (i.e. paddy and milled rice) purchased as an input by agent below the farmer. Similarly the, the value of the output of the last agent of the system is kept as the final output and added with the joint outputs generated by any agent in the system (i.e value of the rice bran sold by the miller) to compute the total income of the value chain. Paddy and milled rice sold as output within the system are excluded because they corresponds to a cost for another agent.

The consistency of the consolidated budget at the system level is checked by comparing the total net income or profit computed by deducting the consolidated costs from the total final value and the total profit computed by adding the profit from each agent. Each ways should lead to the same amount.

3 Agent budget sheets

The system 3 spread sheet "System 03 Wet Season OM 10T mill urban market " is used as a reference to present the spreadsheets organization and computation.

3.1 Farmer budget spreadsheet (Wet Seas OM)

3.1.1 Technical parameters

A box displaying technical parameters is at the top of the spreads sheet. It mentions, the area of reference for building the budget, the duration of the cycle of production from land preparation to harvesting, the quantity of water used

Table 2 : Farmer budget technical parameters

Technical parameters						
Based on	1	ha				
Cycle	6	months				
Water requirement	1 000	cm				

3.1.2 Fixed asset:

The format contains the quantity of equipment used (Qty), the unit of quantity (Unit) the Unit price, the Duration (or shelf life) of the each equipment and a Share column used to allocate the exact amount of the equipment used in to perform the task in the commodity chain. The depreciation

Value is computed by applying the straight-line method without salvage value. For each equipment, the value attributed to the 1ha budget take into account the total size of the farm, and the Share coefficient is used to allocate the share of the equipment value that is used for this area, or production volume of reference.

For instance if the total rice planted area of the farmer is 10 Ha the share of the equipment used for 1 ha will be 0.1.

Table 3 : Farmer budget fixed asset

Fixed asset						
	Qty	Unit	Unit price	Duration	Share	Value
Tractor	1	unit	8 130 000	10	0.1	81 300
Trailer	1	unit	800 000	10	0.1	8 000
Pump	1	unit	1 627 200	5	0.1	32 544
Sprayer	1	unit	365 850	4	0.1	9 146

3.1.3 Intermediate consumption.

They include all the input and services purchase by the agents.

Each cost item is recorded as much as possible based on the quantity of input use (yellow cells here after) and a unit price for each cost item (green cells in Table 4). For cost items that are too heterogeneous such as pesticide, insecticide the costs are recorded on the base of an average value of purchase per ha.

The Coef column in blue allows to adjust the total quantity of input use for the budget reference (here 1 ha). When the Coef)= 1 it means that the quantity refers to 1 Ha.
For the pesticide the Coef = 2.15 because on average farmers interviewed for this cropping systems applied 2.15 time pesticide on their field.

For irrigation, based on available sources from pump makers, we estimate that a 4HP pump consumes 0.4 liter of diesel per 100cm of water supply, at 3500KHR per liter of diesel. To provide 10000 cm of water the Coef cell is set to 100.

Whenever possible variable cost is linked to the volume of production: for instance the number of bags required to ship the paddy is computed on the basis of the yield level set in the spread sheet.

Table 4 Format for recording cost items.

Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	180	kg/Ha	2 400	KHR/kg	1	432 000
Fertilizer	4.3	bags	105 000	KHR/bag	1	451 500
Pesticide	1	Ha	25 000	KHR/ha	2.15	53 750
Herbicide	1	Ha	57 000	KHR/ha	0.69	39 330
Insecticide	1	Ha	25 000	KHR/ha	0.15	3 750
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	1.69	59 150
Diesel irrigation	0.4	liter/100cm	3 500	KHR/liter	100	140 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	3.5	22 050
Bags (80kg)	43.75	bags	700	Khr/bag	1	30 625

The cells in orange are cells that are linked to the parameter box in the "System Consolidation_ Parameter" sheet so these parameters can be easily modified from the Synthesis sheet (Table 5).

Table 5 Farmer budget for intermediate consumption.

Intermediate consumption						
	Qty	Unit	Unit Price		Coef	Value
Material input						
Seeds	130	kg/Ha	1400	KHR/kg	1	182 000
Fertilizer	3	bags (50kg)	105 000	KHR/bag	1	315 000
Pesticide	1	Ha	17 000	KHR/ha	0.5	8 500
Herbicide	1	Ha	19 000	KHR/ha	0.67	12 730
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	2	70 000
Diesel Irrigation	0.4	liter/100cm	3 500	KHR/liter	10	14 000
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	2.6	16 380
Bags	32.50	bags	700	Khr/bag	1	22 750
Service						
Land preperation	0	Ha	200 000	KHR/Ha	2	0
Plant management						
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.1	25 000
Pump Maintenance	1	Year	100 000	KHR/Ha	0.1	10 000
Irrigation	0	hours	10 000	KHR/hours	1	0
Transportation	0	Ton	13 000	KHR	1	0

3.1.4 Labor

Labor is recorded separately for family labor and paid labor, per type of activity. Labor associated with a service such as maintenance, land preparation, transportation of good is incorporated into the cost of the service

There is no imputed cost for family labor since the labor market in rural areas is far from being efficient. The average cost for a day of rural worker recorded from farmers interview is about 20000 KHR, but this is the case when workers are available; there are many instances where the supply of labor is weak. The option here is to compute the net income, or profit generated by the cropping systems and to assess the amount earn per day of family labor. (cf: the computation of the return to man-day of family labor at the bottom of the spreadsheet). Furthermore, when a farmer decide to grow rice it does not mean necessarily that can he leave his farms between agricultural operation to get a job elsewhere; he has to stay on the farm to monitor his crop. Thus, the return per day of family labor (actually used to perform a task) does not take into account these gaps, and eventually overestimate the value of a day of family labor.

Table 6 Farmer budget for labor cost

Labour							
Family						Total	F.Lab
Land prepearation	2.4	days/Ha			2		4.8
Broadcasting	0.6	days/Ha			1		0.6
Fertilizer application	1	days/Ha			1.72		1.7
Pesticide application	0.8	days/Ha			0.5		0.4
Herbicide application	0.47	days/Ha			0.67		0.3
Irrigation	0.42	days/Ha			1		0.4
Harvesting	1	days/Ha			1		1.0
Handling	1	days/Ha			1		1.0
Supervision	10	days/Ha			1		10.0
Paid labour							
Land preperation							
Braodcatsing							
Fertilizer application							
Insecticide application							
Pescticide application							
Herbicide applicattion							
Harvesting							
Handling	2.6	Ton	10 000	KHR/ton	1	26 000	

3.1.5 Other costs.

These cost category include financial cost and various fee or taxes. For financial cost we assume that the farmer has to borrow the working capital required to carry out the production. The amount of interest to be paid is based on the annual interest rate weighted by the number of month required to get the return (i.e duration of the cropping cycle).

Table 7 Farmer budget for other costs

Other cost						
Financial cost on input	24	%/year				133 128
Water fee	1	season	325 200	KHR	0.2	65 040

3.1.6 Revenue

Paddy yield and farm gate price. Yield level is computed based on farmers' reponse..

3.1.7 Synthesis

Financial return on cash cost

This section provide a summary of the cost and income and compute the profit per ha and the return

Return with land imputed cost

The return to cash does not takes into account the opportunity cost of land utilization for land owner or what would be the return for a farmer who has/want to rent the field to grow rice. Land rent was recorded in 20 cases out of 107 farmers interviewed. The amount given either referred to a payment in cash or a payment in kind (about 800 to 1000kg per ha) and varies according to the season (however the size of the sample does not allows to test the significance of this differences)
Deducting the opportunity cost of land from the profit allows computing the return to family manday of labor

Table 8 : Complete farm budget – Part 1

Paddy Prod DS Fragrant Own Machine							
Technical parameters							
Based on	1	ha					Observations
Cycle	4	months					
Water requirement	10 000	cm					
Fixed asset							
	Qty	Unit	Unit price	Duration	Share	Value	
Tractor	1	unit	8 130 000	10	0.1	81 300	Share of one rice field = 50% of average farm size of 10, 1 HA 0.1
Pump	1	unit	1 627 200	5	0.1	32 544	
Sprayer	1	unit	365 850	4	0.1	9 146	
Intermediate consumption							
	Qty	Unit	Unit Price		Coef	Value	
Material input							
Seeds	180	kg/Ha	2 400	KHR/kg	1	432 000	
Fertilizer	4.3	bags	105 000	KHR/bag	1	451 500	
Pesticide	1	Ha	25 000	KHR/ha	2.15	53 750	
Herbicide	1	Ha	57 000	KHR/ha	0.69	39 330	
Insecticide	1	Ha	25 000	KHR/ha	0.15	3 750	
Diesel Land prepe	10	liter/ha	3 500	KHR/liter	1.69	59 150	
Diesel irrigation	0.4	liter/100cm	3 500	KHR/liter	100	140 000	
Diesel Transport	1.8	liter/Ton	3 500	KHR/liter	3.5	22 050	Fuiel cost for bringing the harvest to the storing/marketing point
Bags (80kg)	43.75	bags	700	Khr/bag	1	30 625	
Service							
Land preperation	0	Ha	150 000	KHR/Ha	1	0	
Plant management							
Harvesting	1	Ha	342 000	KHR/Ha	1	342 000	
Tractor Maintenance	1	Year	250 000	KHR/Ha	0.1	25 000	Share of one rice field = 50% of average farm size of 10, 1 HA 0.1
Pump Maintenance	1	Year	100 000	KHR/Ha	0.1	10 000	
Irrigation	0	hours	10 000	KHR/hours	1	0	80THB/hours to 10 000KHR/hours assuming 1hours for 200 cm with 8HP pump
Transportation	0	Ton	10 000	KHR	1	0	

Equipments that are depreciated

Number of years applied for a straight lines (linear) depreciation

Coefficient use to wheight the share of the fixed asset cost attributed to the current budget - see observation

mean that ther is on average 2.15 application of pesticide

mean that insecticide is applied one time by 15% of the sample

mean that on average farmer pass the tractor 1.69 time per hectare

Based on water requirements in technical parematers

Based on the quanity of paddy produced

Used for budget for farmer renting machine. Here the farmer own the machine

Table 9 : Complete farm budget – Part 2

Labour								number of maday required per ha to carry out the task
Family							Total F.Lab	
Land prepearation	1.5	days/Ha	0		1.69		2.535	
Broadcasting	0.9	days/Ha	0		1		0.9	
Fertilizer application	0.8	days/Ha			2.23		1.784	
Insecticide application	1	days/Ha			0.15		0.15	
Pesticide application	1	days/Ha			2.15		2.15	
Herbicide applicattion	0.7	days/Ha			0.69		0.483	
Irrigation	4.17	days/Ha			1		4.2	100 cm of water per hours
Harvesting	1	days/Ha			1		1.0	
Handling	1	days/Ha			1		1.0	
Supervision	10	days/Ha			1		10.0	
Paid labour								Paid Labour is included in service operation such as handling
Land preperation								**or underestimate?**
Braodcatsing								
Fertilizer application								
Insecticide application								
Pesticide application								
Herbicide applicattion								
Harvesting								
Handling	3.5	Ton	10 000	KHR/ton	1	35 000		Labour cost for handling the paddy bag out of the field
Other cost								
Financial cost on input	36	%/year				201 619		Interest paid for the season months to borrow input costs
Water fee	1	year	60 000	KHR	0.6	36 000		Assuming 2/3 of water use goes to dry seaons paddy
Revenue								
Production	3.5	Ton/Ha	1 000 000	KHR/Ton	1	3 500 000		
						2 004 764		
Financial return on cash cost						KHR/Ha	KHR/Ton paddy	
Fixed asset						122 990	35 140	
Seed						432 000	123 429	
Chemical input						548 330	156 666	
Energy						221 200	63 200	
Other input						30 625		
Service						377 000	107 714	
Labour						35 000	10 000	
Financial cost						201 619		
Tax						36 000	10 286	
Other cost						0	0	
Total non-paddy cost						2 004 764	572 790	
Paddy purchase						0	0	
Total cost						2 004 764	572 790	
Revenue						3 500 000	1 000 000	
Profit						1 495 236	427 210	
Return to cash invested						0.75	0.75	
Return to land imputed cost								
Land rent						600 000	KHR/crop seas	
Net revenue (after imputed land rent)						895 236		
Family total labour						24	day	
Return to manday						37 041	KHR/day	
Return to investment						34%		
Water requirements	Source:	http://www.cdri.org.kh/webdata/download/wp/wp51e.pdf						
Pumping cost	Source:	http://akvopedia.org/wiki/Small_and_efficient_motor_pumps						
Irrigation fee	Source:	http://www.cdri.org.kh/webdata/download/wp/wp62e.pdf						

3.2 Collector budget spreadsheet (Pad coll. truck 20T)

For the collector, the technical parameters include:

-the total distance accomplished per year for the truck that will be used to assess the cost per Km for services such as maintenance that are paid a few time per year,

- the distance achieved to collect the paddy from different spot

- the distance achieved to deliver the product.

The computation take also into account the return trip from the delivery point back to the homebased of the collector. Eventually, we assume that a truck can operate for 400km per day which mean that one trip of 110km will take about a quarter of a day. These parameters are used to weight the cost of equipment depreciation and other cot items.

The collector budget is built in reference to a purchasing cycle of one truck of 20T

Table 10 : Collector budget technical parameters

Technical parameter							
Capacity per trip	20	T					
Tota distance per year	30 000	Km					
Collecting trip	10	km					
Delivery Trip	50	km					
Return to base trip	50	km					
Duration of the trip	0.275	day	400 km per day				

The organization of the remaining part of the sheet is similar to the farmer budget.

3.3 Miller budget spreadsheet (Milling 10 T (2))

The selected mill in the System 3 is modern mill with a capacity of 10T of paddy per hours and mechanical drying capacity.

3.3.1 Technical parameters

The miller budget is the most complex in term of parameters. The first step is to determine the *maximum processing capacity of the mill*. Assuming that the mill can operate for 25 days a month and 15 hours per days the total annual capacity is of 43 200 T

3.3.2 Effective level of capacity utilization.

Based on the list of mills installed published by Sok (2015) the cumulated milling installed capacity in modern mill is at 856Ton/hour for the whole country, which means 3.8 Million Ton of paddy processing capacity or about 2.5Millions Ton of milled rice production potential. If we assume that all exported rice, (i.e 500 000 T of milled rice) is processed by modern mills and the same for the urban and domestic market (i.e 380 000 T of milled rice), but that rural market (2.4 Million Ton of milled rice) is still mainly supplied by smaller mills, we can estimate that modern mill may have an outlet of MT to 1.2 MT of milled rice. Accordingly, the effective level of milling capacity utilization for the system 3 mills will be set at 50% or 25000 tons of paddy in the case of 10T mill model

3.3.3 Drying and storage.

As paddy production for a given variety is seasonal, Miller have interest in purchasing paddy, dry it and store it to maximize the utilization of their milling capacity. We can fix in the parameters the number of months where the selected variety of paddy is available on the market. In the example with assume that the paddy can be purchased for 5 months, meaning 5000T of paddy purchase per month, while milled rice will be sold throughout the whole year.

Drying parameters are display taking into account the drying efficiency per hours in terms of moisture content reduction the initial level and targeted level of moisture content from which the number of hours to reach the target level is deducted for a drying unit with a capacity per batch of 30T (large mills combined several unit). The model compute the number of batch required to dry 5000T of taking into account the operating hours and the drying throughput. Taking into account the number of day of operations per month, we can deduct the number of drying oven that is required to match the volume of paddy purchase. Furthermore, we assume that the factory is design for an operation at full capacity (i.e 43 200T). The amount of unit required and purchased as equipment is defined on this basis (12 units).

3.3.4 Milling technical parameters.

Then the milling and technical parameters are display with the recovery ratio for different category of milled rice (Head rice, mixed broken (10%), small broken (25%), broken), plus the bran and husk. No sources were identified to distinguish between head and broken rice prices. The user can therefore fixed the price penalties attached to the lower quality in reference to the higher quality.

Table 11 : Miller technical parameters

Technical parmeter								
MaxNumber of operating days/month	25	day						
Max number of operating hours/day	15	hours						
Maximum milling capacity/month	3 600	T						
Maximum milling capacity/year	43 200	T						
Total paddy purchase	25 000	T		Wet Paddy purchase period	5	months	5 000	T/month
				Milled paddy selling period	12	months	1 151	T/month
Paddy Drying								
Drying rate per hours	0.90%			Number of batch/Month	167	Batch		
Wet paddy moisture content	26.00%			Number of batch/day	6.67	Batch		
Dry paddy moisture content	13.00%			Number of dryer	7.00	unit		
Drying target	13.00%			Ton per day	200	T		
Hours of dryer	14.4							
Drying batch capacity	30.0	T						
Drying Throughput Paddy/hours	2.1	T/hour		Total hours	12 037			
Conversion rate for Dry paddy								
Dry Paddy to wet paddy	0.85							
Dry Paddy to process	21 250	Ton		Number of month for milling	5.9	month		
Dry Paddy Milling								
Hour per day milling	15	hour/day	2125	hours per ye	142	Days		
Milling Throughput Paddy/Hours	10	T	150	Ton per day paddy				
Sorting Throughput Rice/hours	10	T	1 381	Hours per year				
Conversion rate for Milled rice			Price difference					
Head rice	55		100					
Mixed broken (10%)	3		85					
Small broken 25%	2		80					
Broken 100%	5		75					
Bran	11							
Husk	24							
	100							
Max storage required	9 195	T	Average duration					
Paddy avarege storage required	1 950	T	3.67	Month				
Milled rice average storage rquired	3 819	T	5.97	Month				
Loader capadity	20	Ton/hour	300	Ton per day				

3.3.5 Storage requirement and duration.

A special table has been designed on the side of the parameter box to model storage flows of dry paddy and milled rice along the 12 months. The algorithm take into account the quantity purchased per month that are accumulating at the beginning of the cycle and gradually depleting when the selected quality of paddy is not anymore available of the market. This table allows to estimate the higher volume of storage capacity require to operate, the average volume stored, and the duration of the paddy and milled rice stock. These parameters are used to estimate storage capacity requirements

Table 12 : Miller storage flows

	Month1	Month2	Month3	Month4	Month5	Month6	Month7	Month8	Month9	Month10	Month11	Month12	Average	Total
	1	2	3	4	5	6	7	8	9	10	11	12		
Dry Paddy cumulated supply	4 250	8 500	12 750	17 000	21 250	21 250	21 250	21 250	21 250	21 250	21 250	21 250		
Dry paddy supply	4 250	4 250	4 250	4 250	4 250	0	0	0	0	0	0	0		
Dry paddy stored	650	650	650	650	650	0	0	0	0	0	0	0		
Cumulated storage	650	1 300	1 950	2 600	3 250	0	0	0	0	0	0	0	1 950	9 750
Dry paddy unstored		0	0	0	0	3 250	0	0	0	0	0	0		
Paddy milled	3 600	3 600	3 600	3 600	3 600	3 250	0	0	0	0	0	0		
Milled rice supply	2 340	2 340	2 340	2 340	2 340	2 113	0	0	0	0	0	0		
Milled monthly sales	1 151	1 151	1 151	1 151	1 151	1 151	1 151	1 151	1 151	1 151	1 151	1 151		
Milled rice storage	1 189	1 189	1 189	1 189	1 189	961	0	0	0	0	0	0		
Milled rice cumulated storage	1 189	2 378	3 567	4 756	5 945	6 906	5 755	4 604	3 453	2 302	1 151	0	3 819	42 006
Milled rice unstored	0	0	0	0	0	0	1 151	1 151	1 151	1 151	1 151	1 151		
Total storage requirement	1 839	3 678	5 517	7 356	9 195	6 906	5 755	4 604	3 453	2 302	1 151	0	9 195	
Paddy wheighted cumulated	650	2 600	5 850	10 400	16 250	0	0	0	0	0	0	0	35 750	3.67
Milled wheighted cumuluated	1 189	4 756	10 701	19 023	29 724	41 438	40 286	36 833	31 078	23 021	12 661	0	250 710	5.97

3.3.6 Fixed asset.

The management of fixed asset is similar to the design follows in the farmer and collector budget.

3.3.7 Intermediate consumption:

For the paddy purchase, the model allows to consider that the miller can purchase the different category of varieties: Eearly Wet Season (Early WS), Jasmin, Wet season photoperiodic (WS), Dry Sesaon non-photoperiodic non-Fragrant (DSnF) and Dry Season non-photoperiodic Fragrant. The weight of each rice type can be adjusted by the user base on educated guess, each category having a different gross margins (milled rice – paddy purchase price x conversion ratio of rice to paddy), with a different impact on the profitability of the milling operation.

The remaining part of the cost recording format is similar to the one used in other budget.

Table 13 : Miller Paddy purchase by variety.

Paddy purchase							
Early WS	0.00	% of total P	900 000	KHR	Ton	0	0
Jasmin	0.20	% of total P	1 200 000	KHR	Ton	5000	6 000 000 000
WS	0.30	% of total P	890 000	KHR	Ton	7500	6 675 000 000
DSnF	0.20	% of total P	950 000	KHR	Ton	5000	4 750 000 000
DSF	0.20	% of total P	1 300 000	KHR	Ton	5000	6 500 000 000
Total	0.90	% of total P	1 337 000	KHR	Ton	22500	23 925 000 000

3.3.8 Revenue.

As for paddy purchases, milled rice selling are computed taking into account the different variety of rice and the different quality of milling (head rice to broken). A weighted average milled rice price (taking into account the penalties for lower quality) is computed that will be used in the computation at the system level.

Table 14 : Miller's milled rice sale by variety and type

Milled rice							
Head rice price							
Early WS	0.00	% of	0	KHR	Ton	0	0
Jasmin	0.20	% of	2 700 000	KHR	Ton	2 338	6 311 250 000
WS	0.30	% of	2 050 000	KHR	Ton	3 506	7 187 812 500
DSnF	0.20	% of	1 700 000	KHR	Ton	2 338	3 973 750 000
DSF	0.20	% of	2 900 000	KHR	Ton	2 338	6 778 750 000
Total	0.90					10 519	
Mixed broken (10%)							
Early WS	0.00	% of	0	KHR	Ton	0.00	0
Jasmin	0.20	% of	2 295 000	KHR	Ton	127.50	292 612 500
WS	0.30	% of	1 742 500	KHR	Ton	191.25	333 253 125
DSnF	0.20	% of	1 445 000	KHR	Ton	127.50	184 237 500
DSF	0.20	% of	2 465 000	KHR	Ton	127.50	314 287 500
Small broken 25%							
Early WS	0.00	% of	0	KHR	Ton	0.00	0
Jasmin	0.20	% of	2 160 000	KHR	Ton	85.00	183 600 000
WS	0.30	% of	1 640 000	KHR	Ton	127.50	209 100 000
DSnF	0.20	% of	1 360 000	KHR	Ton	85.00	115 600 000
DSF	0.20	% of	2 320 000	KHR	Ton	85.00	197 200 000
Broken 100%							
Early WS	0.00	% of	0	KHR	Ton	0.00	0
Jasmin	0.20	% of	2 025 000	KHR	Ton	212.50	430 312 500
WS	0.30	% of	1 537 500	KHR	Ton	318.75	490 078 125
DSnF	0.20	% of	1 275 000	KHR	Ton	212.50	270 937 500
DSF	0.20	% of	2 175 000	KHR	Ton	212.50	462 187 500

3.4 Retailer budget spreadsheet (Retailer)

The milled rice retailer is the most simple. Technical parameters considers the storage capacity, the average volume purchase per cycle of purchase and the number of purchasing cycle per week. From this parameters we can derive the total volume of ice handled by the retailer in one year, 1 300T in the case of the system3

Table 15 : Retailer parameters

Technical parmeter						
Store capacity	10	T				
Turn over	5	T/purchase	5	per week	1300	per year
Total paddy purchase	1 300	T				

4 Synthesis sheet (System Consolidation_Parameter)

The first sheet of the file allows modifying key parameters of the value chain model, displays the summary cost and income value per agent and their consolidation into costs and income value at the system level

4.1 Technical parameters

At the top of the sheet a number of technical parameters are grouped (in cells formatted in grey), linked to the individual budget, so the user can easily modified this parameters to mode a new situation.

The output price table at the right down corner of the table is key. Output price should be entered for the various commodity in process (paddy and milled rice) down to the final product. The price of the type of rice models in the value chain is circled in black. The share of each variety for the miller is keyed in the first column of the table. The output price of one agent is the input price of the following agent. Thus, the level of these prices determined how the net margin is distributed among the different agent.

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Table 16 : Synthesis sheet parameters table.

Parameters										
Technical				**Type of milled rice**	Milling rate	.t. price penality				
Paddy yield	2.6	Ton/ha		Head rice	55	100				
Collector truck	30 000	km/year		Mixed broken (10%)	3	85				
Trip distance	50	km		Small broken 25%	2	80				
Miller capacity	25 000	Ton Paddy/year		Broken 100%	5	75				
				Bran	11					
Delivery distance	200	km		Husk	24					
					100					
Price				Wet to Dry Paddy	0.85					
Input price				**Output price**						
Fertilizer price	105 000	KHR/bag			Share in milling	Producer	Collector	Miller	Retailer	output price
Electricity	813	KHR/KWh		Early WS	0.00	750 000	900 000	0	0	0
Diesel	3 500	KHR/liter		Jasmin	0.20	1 100 000	1 200 000	2 700 000	3 000 000	2 612 769
Transport farmer	13 000	KHR		WS	0.30	800 000	890 000	2 050 000	2 150 000	1 983 769
Delivery Miller	150	KHR/ton/km		DSnF	0.20	900 000	950 000	1 700 000		1 645 077
				DSF	0.20	1 200 000	1 300 000	2 900 000	3 200 000	2 806 308
				Bran				650 000	2 000 000	
					0.9					
Macro										
Interest rate Farmer	24	%/year								
Interest rate Miller	12	%/year	KHR/USD	4068						

4.2 Financial and economic indicator

4.2.1 Report of individual agent budget.

The first table is linked to the summary costs and income from each agent's budget sheet. To ensure a consistency for the consolidation, the purchase price of the paddy at the miller stage is adjusted based on the selling price of the collector, so the computation are based on a unique variety of rice (cells circled in red).

Basic indicators of performance by agent are computed at the bottom, Profit (i.e total revenue – total total cost) and return to cash invested. For the miller, the return to cash computed considering all variety of rice processed is reported separately. In the example, the higher "Return to cash invested" compared to the "Miller total return" indicates that the milling of the Wet season rice has a higher profitability than the other category with the selected parameters.

Table 17 : Individual budget report.

Stage Reference prod	Paddy producer 1 Ton Wet paddy	Paddy collecteor 1 Ton Wet paddy	Miller Milled rice exported	Retailer
Reporting of individual budget fro 1 ton of Output				
Fixed asset	50 381	2 236	103 019	9 381
Seed	70 000	0	0	0
Chemical input	129 319	0	0	0
Energy	38 608	19 250	62 758	274
Other input	0	5 236	26 574	0
Transport	0	0	30 000	0
Service	145 000	5 236	0	0
Labour	10 000	10 509	16 952	25 009
Financial cost	0	0	43 736	0
Tax	25 015	0	68 046	215
Other cost	0	92	0	0
	0	0	0	0
Total non-paddy cost	528 276	42 557	351 085	35 052
Paddy/rice purchase	0	800 000	1 610 860	1 983 769
Total cost	528 276	842 557	1 961 944	2 018 821
Revenue Paddy/Rice	800 000	890 000	1 983 769	2 150 000
Revenue Bran	0		110 000	0
Profit	271 724	47 443	131 825	131 179
Return to cash invested	51%	6%	6.7%	6%
Miller total return			*2%*	

4.2.2 Consolidation table.

The consolidation consists in converting each budget into an equivalent form of the commodity in process, here it is the milled rice sold by the retailer. This is done by applying to the original budget the coefficient of recovery that take into account the dry to wet paddy ratio and the milled rice to dry

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paddy ratio. In this example, 1 ton of milled rice at the retailer stage requires the production and marketing to the mill of 1.81 ton of paddy.

Then the consolidated budget for 1 ton of milled rice for the whole system is computed by adding of the major cost items; the purchase of the commodity in process is omitted at it is balance by the corresponding revenue earned by the supplier within the system. Eventually the total revenue of the system includes the value of the revenue earned by the last agent, (i.e the retailer) plus other revenue earned by any agents along the process (joint product) and sold outside the system (i.e. the bran at the milling stage)

The indicators of performance are computed with and without taking into account,the imputed land cost. The return to cash at the system level is higher than the return to cash for individual agent as the purchase of the commodity in process is not counted in for the consolidated budget.

Table 18 Consolidation table.

Equivalent 1 Ton of Milled rice (KHR)					
Stage	Paddy producer	Paddy collecteor	Miller	Retailer	Total
Reference prod	1 Ton Wet paddy	1 Ton Wet paddy	Milled rice exported		
Coefficient recovery	***1.81***	***1.81***	***1.00***	***1.00***	
Fixed asset	91 187	4 047	103 019	9 381	207 634
Seed	126 697	0	0	0	126 697
Chemical input	234 062	0	0	0	234 062
Energy	69 878	34 842	62 758	274	167 752
Other input	0	9 476	26 574	0	36 050
Transport	0	0	30 000	0	30 000
Service	262 443	9 476	0	0	271 919
Labour	18 100	19 020	16 952	25 009	79 080
Financial cost	0	0	43 736	0	43 736
Tax	45 277	0	68 046	215	113 538
Other cost	0	166	0	0	166
Total non-paddy cost	956 156	77 026	351 085	35 052	1 419 319
Paddy/rice purchase	0	1 447 964	1 610 860	1 983 769	[redacted]
Total cost	956 156	1 524 990	1 961 944	2 018 821	1 419 319
Revenue Paddy/Rice	1 447 964	1 610 860	1 983 769	2 150 000	2 150 000
Revenue Bran			110 000	0	110 000
Profit	491 808	85 870	131 825	131 179	840 681
Return to cash invested	51%	6%	7%	6%	59%
Profit with imp. Land cos	*213 353*	*85 870*	*131 825*	*131 179*	*562 227*
return to cash with imp. l	*17%*				*40%*

The models are built in Khmer Riel, although several costs and incomes are often declared in USD. However, it was easier and more consistent to build the budgets using one currency, the KHR being often the preferred denomination for a range of input purchase and rice price reporting. However, at the analytical stage the USD is often taken as the denomination, thus the analytical tables on cost structure, income distribution and value added are built in USD terms. The exchange rate can be easily adjusted in the parameter panel at the top of the spread sheet

Table 19 Consolidation table in USD

Equivalent 1 Ton of Milled rice (USD)					
	Paddy producer	Paddy collecteor	Miller	Retailer	Total
Fixed asset	22.4	1.0	25.3	2.3	51.0
Seed	31.1	0.0	0.0	0.0	31.1
Chemical input	57.5	0.0	0.0	0.0	57.5
Energy	17.2	8.6	15.4	0.1	41.2
Other input	0.0	2.3	6.5	0.0	8.9
Transport	0.0	0.0	7.4	0.0	7.4
Service	64.5	2.3	0.0	0.0	66.8
Labour	4.4	4.7	4.2	6.1	19.4
Financial cost	0.0	0.0	10.8	0.0	10.8
Tax	11.1	0.0	16.7	0.1	27.9
Other cost	0.0	0.0	0.0	0.0	0.0
Total non-paddy cost	235	19	86	9	349
Paddy/rice purchase	0	356	396	488	[redacted]
Total cost	235	375	482	496	349
Revenue Paddy/Rice	356	396	488	529	529
Revenue Bran	0	0	27	0	27
Profit	121	21	32	32	207

4.2.3 Cost structure.

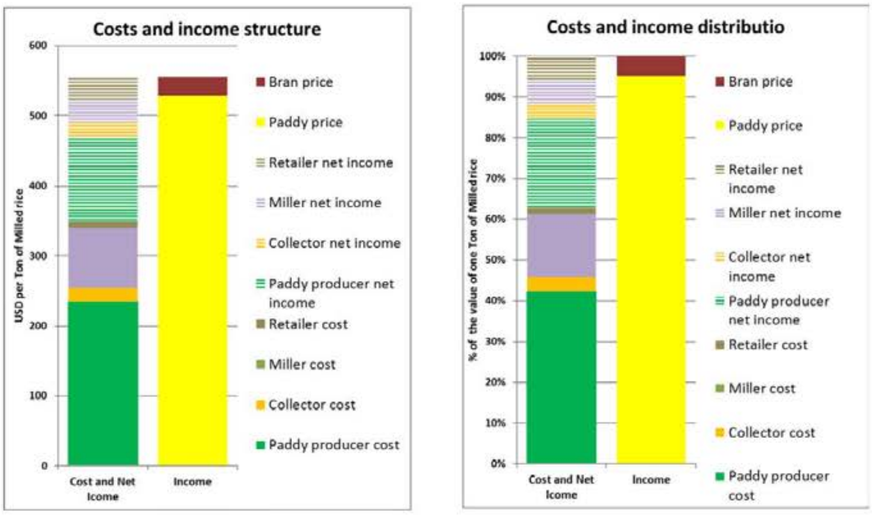
The following table present the cost structure for each agent and for the whole system without taking into account the commodity in process (Paddy and rice milled). Paddy and rice obviously represents the major cost for the traders and millers but they do not affect the overall performance of the system being simultaneously a cost and an income. This cost structure give an insight into the extent to which different categories of input and production factors impact on the viability of the system represented. For instance in the example labor represent only 6 % of the cost for the system, while Services, Chemical input, Fixed asset and energy represent each more than 10%

Table 20 Cost structure.

Cost structure (without paddy)					
	Paddy producer	Paddy collecteor	Miller	Retailer	Total
Fixed asset	10%	5%	29%	27%	15%
Seed	13%	0%	0%	0%	9%
Chemical input	24%	0%	0%	0%	16%
Energy	7%	45%	18%	1%	12%
Other input	0%	12%	8%	0%	3%
Transport	0%	0%	9%	0%	2%
Service	27%	12%	0%	0%	19%
Labour	2%	25%	5%	71%	6%
Financial cost	0%	0%	12%	0%	3%
Tax	5%	0%	19%	1%	8%
Other cost	0%	0%	0%	0%	0%
Total non-paddy cost	100%	100%	100%	100%	100%

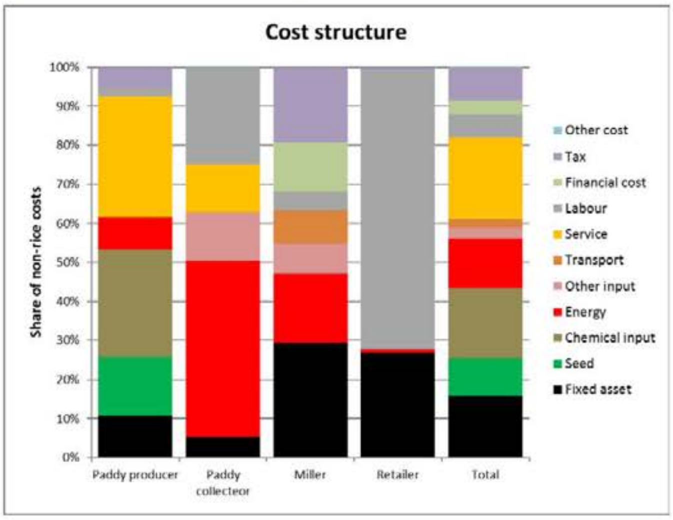
Cost structure, Income and the profit generated ate the system level is projected on two graphs in absolute and relative terms.

Figure 1 : Cost structure figures.



Another graph display the cost structure per agent in order to compare the weight of various cost items across agents.

Figure 2 : Cost structure per agent budget.



4.2.4 Financial and economic indicators.

The last table provide a number of financial and economic indicators. In financial terms, the return to cash is reported and the distribution of the total net income or net margin computed across the different agents.

In economic terms, the same indicators has been computed taking into account farmers' opportunity cost of land (i.e. the income foregone by the farmer by allocating his land to paddy cultivation instead of renting it out).

The last part of the table display the value added generated by each agent and at the system level. The value added is the difference between the value of the agent or system's output and material input and services purchased. It is equal to the sum of labor paid, tax, interest paid to the banking sector, the depreciation of fixed asset (or the investment required to replace the equipment after its complete use) and the net income retained by the agent. For instance in the case of the system 3, 1 ton of milled rice sold at the retailer generates an added value of 316USD, out of which 65% goes to the owner, 16% to replacement of the asset 9 % to the state (tax) 3% to the banking sector and 6% to the wages.

Table 21 Financial and economic indicators.

Financial and economic					
	Paddy producer	Paddy collecteor	Miller		Total
Return to cash	51%	6%	7%	6%	59%
Share of net income	59%	10%	16%	16%	100%
Return to cash with inp. L	*17%*	*6%*	*7%*	*6%*	*40%*
Share of net income with	*38%*	*15%*	*23%*	*23%*	*100%*
Value added (USD)	159	27	89	41	316
Value added/Total reven	45%	7%	17%	8%	57%
VA distribution					
Wages	3%	17%	5%	15%	6%
Financial cost	0%	0%	12%	0%	3%
Tax	7%	0%	19%	0%	9%
Depreciation	14%	4%	28%	6%	16%
Net income	76%	79%	36%	79%	65%
	100%	100%	100%	100%	100%

5 Validation process.

The set of value chains models have been design to support policy dialogue among stakeholders. In order to fulfill this objective it is critical that there is an agreement among the parties about the data used for building the models.

5.1 Data sources and reliability

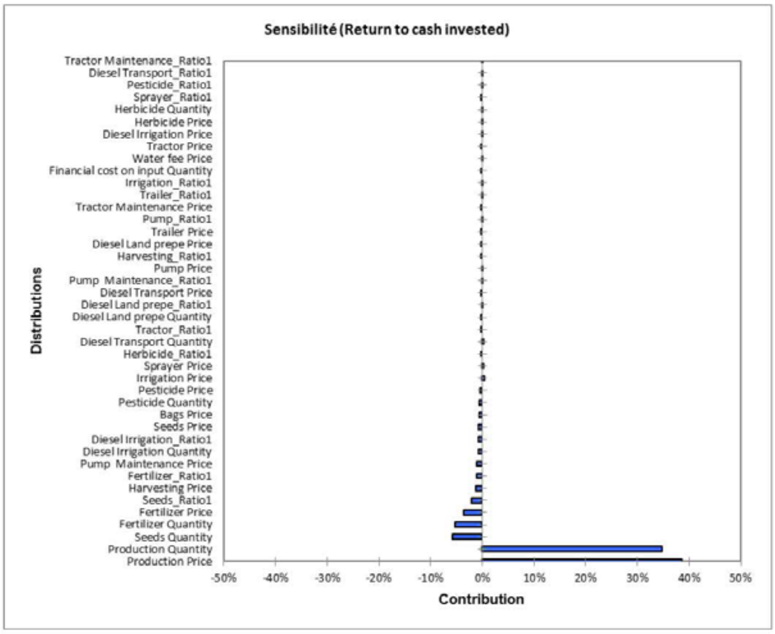
The data used to develop these models combine primary data collected at various step of the rice value chains, statistics, information extracted from the available grey literature and information provided by key informants such as experts, and stakeholder. The primary data were collected from

100 rice farms located in major paddy producing areas in Cambodia, the interview of 14 collectors, 12 millers and 4 retailers.

The reliability of the information gathered is subject to the size of the sample covered but also to the intrinsic variability of the parameter of the variable assess. For instance, the pesticide dosage applied will vary from one farmer to another depending upon the severity of the pest attack from location to location, farmers' assessment of the crop damage, and their purchasing power or access to credit. But, the quantity of diesel use for pumping is given by the power of engine and will not vary significantly across farmers.

The sensitivity of the return to cash to the variation of input quantity, unite price of intensity utilization and to to paddy yield and price is strongly correlated to a limited number of variables, namely yield, paddy price, seed and fertilizer quantity and seed and fertilizer price. It means that the assessment of the farmer budget reliability should focus on this variable.

Figure 3 : Sensitivity of farmer's return to cash to various costs items.



Considering marketing and processing functions, the potential variability of the data is much lower compare to the paddy production. For a given technology, quantity of input will be clearly defined such as the throughput of paddy for milling, the consumption of energy.

5.2 Price systems

The price system is a critical component of the modeling, has it ensure the linkages between the agents along the chain, and determine the distribution across agents of the total net income generated by the whole chain. The following sources of price data are used to select the price system:

- Paddy field gate price has been set base on CRF publish data (to be checked with CPS)

- Miller paddy purchase price (equivalent to collector selling price) and miller selling price are based on average price computed from price date released by the Agricultural Market Information System.

- The retail price nomenclature published by the Ministry of Commerce (for the Consumer Price Index computation) does only distinguish by the quality of rice (high and low grade depending upon the broken percentage) for ordinary white rice. Jasmin retail price has set up on the base of key informant.

- Milled rice export price data are provided by CRF data.

5.3 Validation process.

Individual budgets have been presented and discussed with farmers' representatives and millers' representatives. The review process consist of the following sequence:

- Looking at the list of costs items to check to if any important input, services or tax has been omitted.
- Review the input quantity
- Adjust the price level as necessary.

The revision of the value chain models from one rice season to the next will have to focus on price adjustment and yield level at farmer stage.
Most of the technical coefficient (input quantity) are less likely to change from one year to another. This will be revised on longer cycle of 3 to 4 years in particular if the rice value chain environment change significantly.

5.4 Sensitivity analysis

Sensitivity analysis is used to assess how a given indicators (level of profit, return to investment) will be affected by any changes of a technical or price parameters.

The Data Table[1] function embedded into Excel allows assessing the sensitivity of one indicator to the variation of one or two variables. For instance, the sensitivity of the return to investment to the level

[1] https://support.office.com/en-us/article/Calculate-multiple-results-by-using-a-data-table-e95e2487-6ca6-4413-ad12-77542a5ea50b

of capacity utilization indicate that below 10000T of paddy milled per year the 10T mill is not profitable, every other parameters being constant.

Table 22 : Sensitivity of miller's return to cash to capacity utilization.

		Return to Invest.
		3.3%
Capacity utilzation	40000	0.057346
	35000	0.053766
	30000	0.049898
	25000	0.043114
	20000	0.032896
	15000	0.012725
	10000	-0.02286
	5000	-0.11502
	2000	-0.31267
	1000	-0.49856

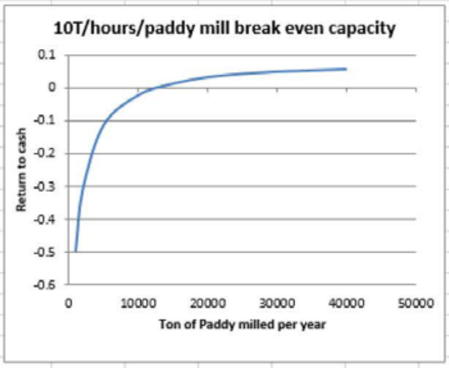


Table 26 shows the output of Data Table computation for the sensitivity of the return to investment to the combined variations in the level of capacity utilization and the interest rate. The analyst can conclude that lower interest ray will have a lower impact on the return to investment than a change in the level of capacity utilization, other parameters being constant. Whatever the interest rate applied to the mill model, the process will not be financially viable below a level of capacity utilization of 10 000T.

Table 23 : Sensitivity of miller's return to cash to capacity utilization

Return to Invest.	3.3%	Interest rate 4	8	10	12	14	16
	40000	0.07	0.06	0.06	0.06	0.05	0.05
	35000	0.07	0.06	0.06	0.05	0.05	0.05
	30000	0.06	0.06	0.05	0.05	0.05	0.04
	25000	0.05	0.05	0.05	0.04	0.04	0.04
	20000	0.04	0.04	0.04	0.03	0.03	0.03
Capacity utilzation	15000	0.02	0.02	0.02	0.01	0.01	0.01
	10000	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03
	5000	-0.11	-0.11	-0.11	-0.12	-0.12	-0.12
	2000	-0.31	-0.31	-0.31	-0.31	-0.31	-0.32
	1000	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50

The limit of two parameters can be overcome using software that compute Mote Carlo simulation. The principle is to define a range and shape of variation for any parameters in the models, the basic one being a triangular distribution, with a minimum, median and maximum value. The spreadsheet model will be computed thousand or more times with a different set of value of each parameter within the range of the distribution.

The outcome is represented by computing the regression of the indicators to the parameters or by computing the correlation coefficients between the indicators tested and the parameters. Monte

Carlo analysis can be used to assess the most influential variables in the models, but it cans also improve the robustness of the analysis. To this end instead of defining a homogenous distribution of the parameters with the same range and mode, each parameters can be modeled on the bases of the past-observed variables. For instance, the distribution of the yield for the past ten years can be used taken as the reference, the same for the price range of variation. There is also the possibility to define a matrix of correlation between the parameter to make the simulation more realistic; the matrix can specify that and increase in yield, and thus supply, is not consistent with a simultaneous increase in price.

There are a number of software available to perform this analysis as an add-in to an Excel spreadsheet; while most of them are expensive, cheaper options[2] are available with basic functions and distributions. The technical team for the Rice Sector Economic Observatory has been trained for sensitivity analysis using Simular ©[3].

6 Organization of the rice value chains database

The dataset for the rice value chains are stored in excel files:

The reference budgets are store in specific files as a library of value chain components, that will be combined the models. This library can be expanded with the development of budgets for new agents or new technology on the bases of available information. Price data used to set up the price systems that stored by sources in a specific file and a third file is devoted to supply and demand of rice by volume for different outlet.

As already mentioned above, each VC model is developed in one Excel File.

The output from the synthesis sheet are stored in the last file of the systems entitled "Z results_synthesis. The Result file store the budget converted in final output equivalent in one sheet, the financial and economic indicators in another sheet and compile of all the price levels use in the price systems. This output data set can be used to build table and graph facilitating the comparison among value chains.

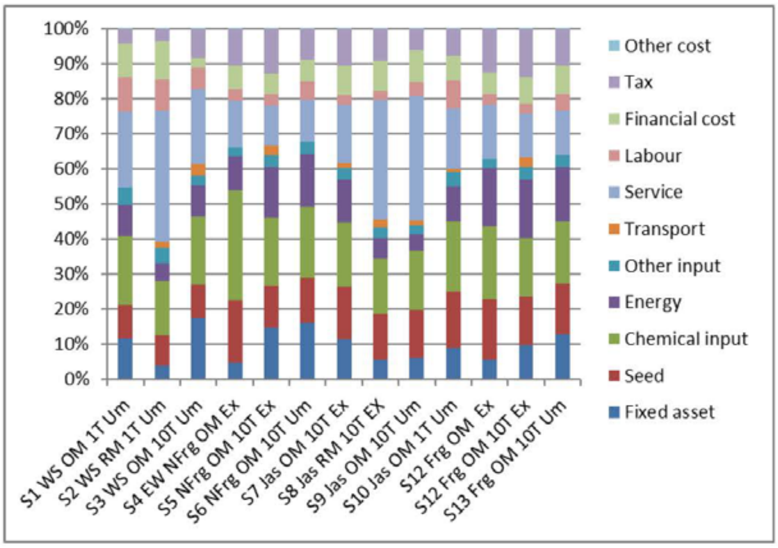
[2] http://www.butleranalytics.com/monte-carlo-simulation-free-software/

[3] http://www.simularsoft.com.ar/SimulAr1e.htm

Table 24 : Data files systems

Type of files	File name
Budget of reference	A Data 01. Reference budgets.xlsx
Price data source	A Data 02. Price system.xlsx
Rice Balance sheet	A Data 03 Rice Balance sheet.xlsm
Rice VC model	System 01 Wet Season OM 1T mill urban market.xlsx
Rice VC model	System 02 Wet Season RM 1T mill urban market .xlsx
Rice VC model	System 03 Wet Season OM 10T mill urban market .xlsx
Rice VC model	System 04 Early Wet Season OM Paddy Export .xlsx
Rice VC model	System 05 Non Frag Non Photo OM 10T mill export.xlsx
Rice VC model	System 06 Non Frag Non Photo OM 10T mill urban market.xlsx
Rice VC model	System 07 Jasmin OM 10T Mill export.xlsx
Rice VC model	System 08 Jasmin RM 10T Mill export.xlsx
Rice VC model	System 09 Jasmin OM 10T Mill urban market.xlsx
Rice VC model	System 10 Jasmin OM 1T Mill urban market.xlsx
Rice VC model	System 11 Fragrant Non Photo OM Paddy export.xlsx
Rice VC model	System 12 Fragrant Non Photo OM 10T mill export.xlsx
Rice VC model	System 13 Fragrant Non photo OM 10T mill urban market.xlsx
Rice VC model	System 14 Non Frag Non Photo OM 20T mill export.xlsx
Output	Z Results synthesis.xlsx

Figure 4 : Cost structure comparaison across Rice VC



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Appendix 4: Cambodian Rice Sector Observatory – concept.

Support to the Commercialization of Cambodian Rice Project
[AFD Grant - CKH-1077-01-S and CKH-1077-02-T

ANALYSIS OF ADDED VALUE DISTRIBUTION IN CAMBODIAN RICE VALUE-CHAIN AND SUPPORT TO THE CREATION OF A RICE SECTOR OBSERVATORY

Design of a Cambodian Rice Sector Observatory: proposed concept

Remark: this note present the proposed institutional setting of a Cambodian Rice Sector Observatory (RSO) in the framework of the study: "Analysis of added value distribution in Cambodian rice value chain and support to the creation of a rice sector observatory". This note is for the purpose of discussion among the various stakeholders potentially involved in the implementation of the RSO.

1. Background and objectives.

Rice policy formulation on-going process underlines the need for monitoring the evolution of the rice sector with up to date, consistent information to observe and assess the impact of policies decisions, taking into account changes in the rice input and output market at the national, regional and international level.

The availability of shared and validated data on costs and incomes along the rice value-chains is a basic requirement for building a policy consensus among rice private and public stakeholders confronted to various policy trade-off.

The on-going rice value chains study will provide a set of up-to-date data for selected rice value chains, organized in Excel templates to compute indicators of financial and economic performances. The RSO can build upon this baseline study.

2. Functions of the RSO

The RSO will have to perform the following **basic functions**:

- Compile available information and data from secondary and primary sources.
- Analyze and process the data to compute updated indicators of rice sector performances
- Validate the results from the analysis with a panel of stakeholder
- Produce a report on a bi-annual basis to support policy dialogue and policy monitoring

In addition the RSO could also take in charge the following **additional functions:**

- Develop new Value chains models to respond to RSO users
- Train users of the SOR in interpreting and using the RSO results.

1

Data compilation and collection for updating the VC Excel templates.
Twice a year after the wet season harvest /marketing (around January) and after the dry season the RSO will collect data information from various sources (MAAF, NIS, members of CRF ...) for adjusting the unit price of input and output and the yield achieved by the various selected representative rice VC.

Every three to four years, a specific study, collecting data though targeted surveys will be done to assess the reliability of several technical coefficients (quantity of input use per unit of output) and incorporate revised figures into the Excel template to take into account the emergence of new cultural, processing and marketing practices. Rice value chains that are not any more relevant will be discarded and new systems might be developed (new technologies, organization, areas involved, market).

Data analysis and indicators computation.
Updated Excel templates will compute the indicators of performance

Results validations.
The updated Excel templates containing the representative budgets and indicators of performance derived will be discussed within a **validation panel** including CRF members, ministries' staff and other scholars to validate the outcome.

RSO marketing campaign bi-annual reports.
A short report will be produce after the end of each major rice producing season. It will provide a synthesis of the performance of each selected value chains. The report will be stored on a web page and disseminate through various channels (Ministry and CRF) as a support to the rice policy dialogue.

Remark: the RSO does not have the responsibility to drive or organize the policy dialogue.

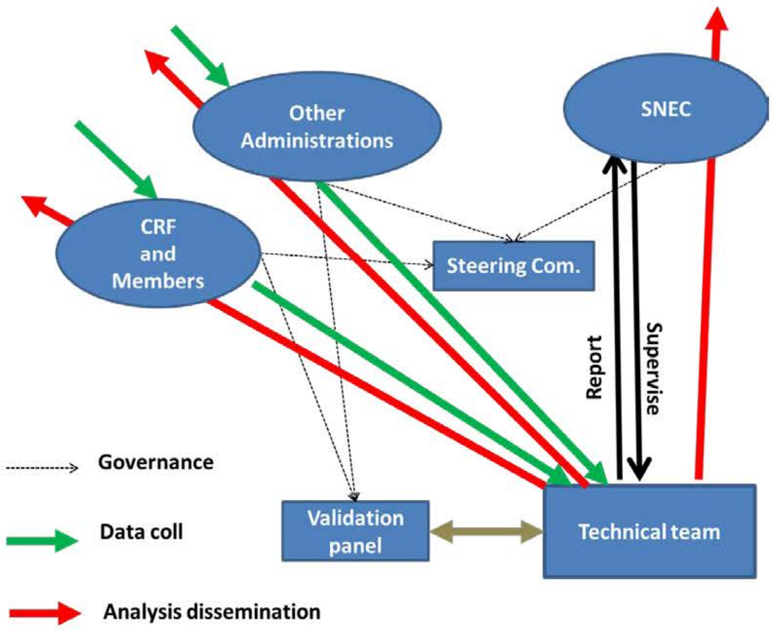
3. Proposed organization of the RSO

The whole process could be operate under the **supervision of SNEC** . SNEC will be in charge of chairing a **RSO steering committee** that will ensure that all private and public stakeholders (Ministries, CRF, CARI...) are informed about the RSO operations. The steering committee will in particular facilitate the necessary access to the data and information and propose resource persons that will participate in the data validation process.

The RSO functions (data compilation, analysis, validation and publication) can be carried out by a **technical team** with 2 to 3 economists that have the capacity to master the computation and interpretation of the results.

At this stage different options are explored about the position and status of the "technical team". If the capacities are available it can be sheltered and staffed by a Ministry (MAAF?). Another option would be to attach this team to the CRF. However, given the sensitive nature of certain information that should be handled with care (ensuring anonymity) it might be more efficient and neutral to outsource the RSO functions to a third party that is not a rice stakeholder such as a consultancy office, or an academic institutions with proven capacity in economic analysis and data handling.

The following chart present the propose organization of the RSO.



Summary table of tasks

Tasks	**Frequency**	**Resources**			**Output**
		Information /data	**Human**	**Material**	
Variable data update					
Output, input Prices, yield, production,	Marketing season 2 times per year	Statistics, Report, CRF members	Technical team	Office Computer Internet	Updated VC models
validation panel meeting to validate marketing camapaign report	2 times (Jan and April)		Technical team Validation panel	Meeting room	
Marketing campaign report	2 times (Jan and April)		Technical team RSO council member		Report
Structural data update and development					
Cheking technical coefficients	Every 3 years	Survey + CRF members	Technical team, Consultants, Surveyors		Revised VC models
Develop new VC systems models					
(new technolgy, new policy, changes in rice sector environment) Simulation of policy changes on VC systems performance	On demand from Government CRF Private Donors	Survey	Consultant +RSO technical expert		VC systems database expanded
RSO staff capacity building					
Modeling capacity developement	At least once every 3-4 year		Training RSO technical team	Material/ software revewal	Improved analytical capacities Inclusion of new indicators of performance
Capacity building of stakeholder					
Training seminar on RSO data analysis and interpretation	Annual and on demand		Technical team Trainer		Strengthening the quality of the policy dialogue
RSO steering committee					
Review RSO performance Approved workplan proposed by RSO	Annual				
RSO assessment	Every 5 years				