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■ MISSION FINAL REPORT

Feasibility study for a pilot project on investments by Farmer Organizations on paddy drying and paddy storage centers in Cambodia

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

Conseil National Economique Suprême (SNEC)

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ABSTRACT

1. Rationale

The Project to Support the Commercialization of Cambodian Rice (SCCRP), funded by the French Development Agency (AFD) and led by the National Council Supreme Economic (SNEC) aims to contribute to the development and implementation of the National Strategy for Promotion of Paddy Production and Export of rice. In this frame, a system of contract farming has been set up to better organize commercial relationship between farmers' organizations (FO) and millers. Consequently, the opportunity has appeared that delivering dry paddy to millers could be a good way to improve the commercialization of paddy by Farmers Organizations (FO). The objective of this study is therefore to assess the feasibility of development of drying and supporting facilities with a business model that could create a win-win situation for Farmer Organizations and Millers.

2. Rice market and stakeholders

In Cambodia, where agriculture still constitutes more than a third of the GDP of Cambodia and rice 85% of cultivated land, the rice sector is also still characterized by a family production; the percentage of families who have rice land less than 1 Ha is majority of situation in a wide area of the country. Moreover, the majority of farms have only one cycle Rice production per year and rice yields are rather low, the average yield can be evaluated at about 3 tons per hectare. The sector is also characterized by uncertainties and risks: agro-climatic risk still high for producers but also market failure of rural agricultural services, uncertainties supply for millers and risks on their investments.

For several years, a support to creation to cooperatives has been carried out to structure and enhance the production's capacities of farmers, their agricultural knowledge and the collective interest to be gathered. Besides cooperatives, another important Farmer Organization are Farmer Water User Communities (FWUC) established in different locations throughout the country wherever there are irrigations schemes to manage. Some of them get involved in paddy commercialization as well, such as Stung Chinit FWUC in Kampong Thom province. Besides, the commercialization of rice is marked by a large number of intermediaries

Nevertheless, in this landscape, the modern drying function (as a professional function in itself) is missing. This function is mainly carried out by millers (when they have the critical size) or less frequently by collectors who have invested in drying system. Actually, the drying in Cambodia is still mainly made by natural method (sun-drying) by farmers (with a risk of poor quality paddy and a consequent percentage of losses for the milling process).

Concerning access to financial resources, Cooperatives have maximum difficulties to find funds to finance the working capital requirement (and tomorrow long-term capital if they should invest in drying and storage facilities) regarding the financial institutions sector. Indeed, Cooperatives have some financial needs that are currently not addressed by neither Commercial banks nor Microfinance institutions in terms of amount, low interest rate, nor collateral requirements (land title and real estate) that Cooperatives generally don't own.

3. Hypothesis and simulations

3.1 The economic model

If cooperatives and more generally FO want to invest in modern drying facilities, the millers' demand can accept a new higher price for dried paddy from farmers at one principal condition: the average cost of drying must at least equals the current difference between dried paddy price and wet paddy price less the earn of productivity due to less losses. The issue is so formulated as follows: *Is it possible to transfer the activity of drying (and increase of storage capacity) from millers to farmers' organizations with added-value for farmers' organizations without withdrawing value for the rice millers?*

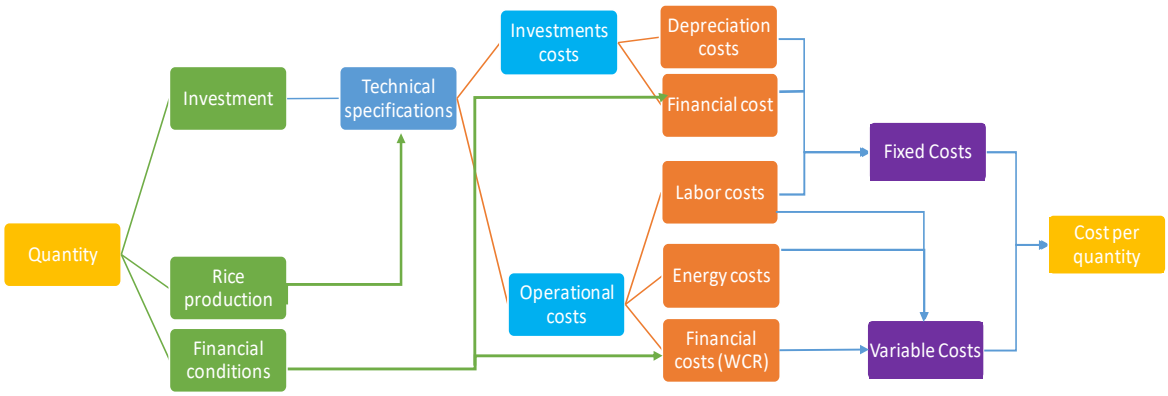
To solve this question, the financial and economic model to create requires to define all costs and their behavior according the production. In terms on function, we have 3 kinds of costs:

- Investments costs (dryers, storage, electric connection)
- Operational costs (energy, labor)
- Financial costs (for investment and/or working capital requirement)

And we have 2 kinds of behavior of costs:

- **Fixed costs**: Costs which are not directly depending on production level.
- **Variable costs**: Costs which are directly depending on production level.

This model can be summarized as follows:



With all the elements of costs, the objective is to create an economic tool that can calculate the average cost per produced quantity.

3.2 Hypothesis and results

A excel tool is created, according all required parameters according behavior of costs according quantity of paddy to dry and an average cost is determined to be compared to the margin (between wet and dried paddy) that could bear the extra-cost due to drying and storage.

Several simulations are carried out to identify the conditions of reaching the break-even point to invest in dryer and storage facilities. Simulations are based on :

- Different mix of rice varieties (with or without photo-sensitive and non-photo-sensitive rices)

- Different period of selling according the evolution of dried paddy price.
- Different interest rate to assess the impact of credit conditions.

According those simulation, the elements of conclusion can be summarized as follows:

1. Investing in modern system of drying has no comparative advantage with traditional drying system (sun-drying) if this investment is not dedicated to store paddy and allow its selling after storage, betting on increasing of dried paddy price.
2. it will need big quantity of produced rice to reach some economy of scale (between 2.000 and 3.000 tons per year). The capacity of cooperatives or FO to mix photo-sensitive and non-photo-sensitive is quite the only way to obtain this forwarded economies of scale.
3. The profitability totally depends on a real and increasing variation of price between dried paddy after harvest and dried paddy after storage for several months. A variation of price of 20% between harvesting and storage period of few months will be a guarantee to achieve feasibility but it is risky to speculate a regular 20% margin, as far as Cambodian rice market is included in a regional market, mainly dependent on Thailand's rice exportation policy, so that the Cambodian rice price is a "exogeneous"[1] price. The fact is that a small price difference would surely generates losses.
4. Fixed and variable costs have quite the same influence in the determination of costs so that the achievement of break-even point is difficult to reach.
5. The cost of working capital requirement in case of storage (interest costs) has a huge impact on the total cost and the main financial stake is the need of cash for financing this working capital requirement before selling.

4. Governance model and possible organizations

Independantly of economic conditions, several models of organizations and governance are possible to set up modern drying and storage facilities for farmers' organizations, based on 2 different strategies :

1) First a strategy consisting in by-passing (short-circuit) middlemen and enhance relationship between farmers and millers.
2) Secondly, a strategy consisting in specialization of the supply-chain by changing collectors and small millers as dryer specialist. So, it consists in including collectors (becoming dryers) as a real partner of contract farming, reducing informal market and informal export trade.

4.1 Bring together cooperatives and rice millers

One big cooperative or a union of cooperatives

If one cooperative invest in drying facilities, I must be a big one according conditions to ensure financial equilibrium of investment in drying and storage system. This big cooperative must at least have the capacity to dry and store 3.000 tons per year. It means that today, only FWUCs (irrigation communities) can gather more than 1000 or 2000 members. The PSG (Paddy Selling Groups) currently stemming from FWUCs should so gather maximum members from their FWUC.

[1] Not determined by cost of production but by international supply and demand market

An alternative is the creation of a Union of Cooperatives, which is a gathering of cooperatives. Union of cooperatives is ruled and managed according the same governance than a cooperative. In this model, we could have several medium size cooperatives, linked by proximity relationship that build one union of cooperative.

Either in case of FWUCs or Union of cooperatives, in such organizations, it will require to have competent staff, totally dedicated to the dry and storage activities and remunerated for this full-time job. This operational staff could also be a separate staff under a delegation contract between cooperative and a small rural entrepreneur.

Joint-venture

In this case, a rice miller and several cooperatives decide to create a private company and to become shareholders of this company. In Cambodia, there is different model of companies. The most usual is the private limited company. A private limited company is a form of limited company with main characteristics are:

- The company may have from 2 to 30 shareholders (when a private limited company is established by one person, it shall be called a "Single Member Limited Company.") and may not offer its shares to the public.
- The minimum numbers of share must be at 1.000 with a nominal value of 4.000 riels.
- The company shall be considered as a private limited company once registered in compliance with prescribed forms determined by a Prakas of the Ministry of Commerce.

4.2 Specializing collectors as dryer

In this strategy, the aim is to build a new stakeholder, specialized in drying and storage paddy. It will consist to convince current collectors, who only store paddy and act as middlemen between farmers and ricers to invest in drying system and to upscale his skills and competencies.

Such a strategy could be achieved by a tender or a call for proposals for collectors who are interested in such project. The advantage of such a strategy can sum up as next:

1) The current collectors have sometimes already invested in warehouse
2) They have better skills in terms of cash and logistics management than the cooperatives.
3) They probably have more capital to invest than cooperatives.

Those stakeholders could become part of contract farming with a three parties contract between Cooperative, collector-dryer and rice miller, where obligations and rights will be defined for all.

4.3 Financial need and process

Whatever the choice of organization and governance, the issue of access to finance is essential. In case of storage after drying, the stakeholders should need to proceed thanks to a system of warrantage that allows farmers to have credit rather than selling their harvest at once, and offering their production as collateral to obtain the credit from a bank or MFI. But, such financial system required strong organization to be in place: 1) a well-functioning farmer's association 2) an interested local bank or other financial institution, 3) a safe place where to store the produce 4) The crop used to guarantee loans must be non-perishable and 5) its price must have a proven record of rising in the months after harvest 6) Finally, agricultural produce as a guarantee needs to be recognized by the banking legislation of the country concerned. These conditions are not yet fulfilled in Cambodia.

5. Conclusion

At the present time, there are some very narrow possibilities for investing in modern mechanical dryers for storage. It will deeply depend on a lot of conditions, currently not fulfilled (positive variation of price between harvesting time and storage period, the mix of photo-sensitive and non photo-sensitive varieties of rice, a strict harvesting calendar and also a strong organization of farmers' production to ensure the optimization of investment).

But, even if the economic prerequisite conditions could be achieved, the mains stakes are not only economic or technic. These mains stakes are actually twofold:

First the relative weakness of cooperatives in terms of business management: the existing experimentations of cooperative for storage, drying and even milling for some of them are not concluding (and even with bankrupt end). The lack of technical skills, of industrial and logistics organization, of maintenance are currently obvious.

Secondly, the lack of real financial services that could fit with needs and capacity for FO to reimburse. Indeed, the current banking and microfinance sector is not adapted to cooperatives needs. The real assets owned by cooperatives are the rice production that represents a real collateral. However, nowadays, bank and even microfinance institutions only accept land title and real estate (contract farming or other collateral could be accepted but only as complement and not substitution of land title and real estate). Moreover, the real financial need less concerns the access to long-term loan to invest in assets than the short-term loan for financing the working capital requirement. This is financially the main stake for cooperatives and the scenario of a joint-venture between farmers and millers would be nowadays the lone that could be relevant.

This also means that investing in drying system should be a medium (or long) term process included in a larger project that will first integrate strong capacity building inputs and financial innovations for Cambodian agriculture.

I. BACKGROUND AND TERMS OF REFERENCES

1. Background and rational

Rice is the principal crop of farmers in Cambodia. Rice production accounts for 15 percent of agricultural value added and paddy occupies 75 percent of the cultivated land. Rice production, processing, and marketing are estimated to employ 3 million people, or more than 20 percent of the country's working-age population.

A large part of the paddy produced in Cambodia is exported to neighbors countries, where it is milled and either locally distributed or further exported to other countries as milled rice. That process represents a huge lost opportunity for Cambodian rice millers and traders to add value, export directly, and create employment locally. In addition, limited access to services and information is creating a lack of awareness and understanding of the standards and preferences of the international rice market[2].

To support the improvement of the commercialization and exportation of Cambodian rice, has been implemented since 2013 The Project to Support the Commercialization of Cambodian Rice (SCCRP), funded by the French Development Agency (AFD) aims to contribute to the development and implementation of the National Strategy for Promotion of Paddy Production and Export of rice, which was approved by the Council of Ministers in July 2010, with an objective of maximizing the value and from this added value captured by producers as a contribution to the primary objective of rural poverty reduction. This project involves various public and private actors, which led to assign the coordination of implementation of the National Council Supreme Economic (SNEC).

The project is structured around four technical components with respective objectives are:

1. Contribute to the organization of the rice sector (coordination Inter, public-private partnerships, development support professional and interprofessional organizations);

2. Participate in the establishment of quality labels to differentiate Cambodian rice, help to promote and generate value added;

3. Promote the involvement of Peasant Organizations like commercial players in the sector, through the development of Contract farming practices or through other models economic, and through support for the development of a framework political and regulatory support this involvement OPs;

4. Support reform of the Rural Development Bank to develop its capacity to serve the rice millers and producers.

[2] Cambodia Rice Export Potential and Strategies (in partnership with Cambodia agribusiness series) – N o. 4, January 2015

2. Remind of terms of references

The Component n°3 of the SCCRP (Support to the Commercialization of the Cambodian Rice Project) aims at promoting contract farming and enhancing the involvement of Farmers organizations in paddy collecting and processing. The objective is to maximize the share of added value caught by farmers in the rice value chain.

As part of this component, the SCCRP Project implemented pilot activities of "contract farming" and "paddy Selling Groups". Those pilots showed the conditions under which those two systems can be successful. It concluded that additional efforts of farmers Organizations to sort quality would increase the benefit for farmers.

It appears also that delivering dry paddy to millers could be a good way to improve the commercialization of paddy by Farmers Organizations (FO). The project is therefore considering supporting the development of drying and supporting facilities with a business model that will create a win-win situation for Farmer Organizations and Millers:

- FO will be able to maximize the selling price by choosing the delivery date (thanks to the storage facilities) while controlling the humidity rate (thanks to the drying facilities).
- Millers will have the guaranty to get the right quantity and right quality of paddy at the right time for their business activity.

The overall objective of the study is to undertake the feasibility of this experiment and propose a modelization of this part of the rice value chain taking into account:

- The different technical options for drying and storing the paddy under the actual environment (type of equipment, choice of technology…)
- The constraints of all stakeholders (like the minimum volumes of delivery…)
- The different funding options (FO, Millers or shared investment, options for additional fundings – banks, project contribution…)

The model should assess the financial results of the investment depending on the different options (technical, economic and financial) for each stakeholder, and especially for the FO who are the main targets of the project. The Mission will develop an Excel tool that the Project will be able to use in order to develop new scenarios and/or modify the parameters in the future.

II. SUPPLY CHAIN AND STAKEHOLDERS DESCRIPTION

1. Brief Glance of the rice supply chain

Agriculture still constitutes more than a third of the GDP of Cambodia and rice is the principal sector in agriculture, representing 85% of cultivated land. The rice sector is also still characterized by a family production; the percentage of families who have rice land less than 1 Ha is majority of situation in a wide area of the country (cf. Figure *1*. Moreover, the majority of farms have only one cycle Rice production per year and rice yields are rather low, the average yield can be evaluated at about 3 tons per hectare.

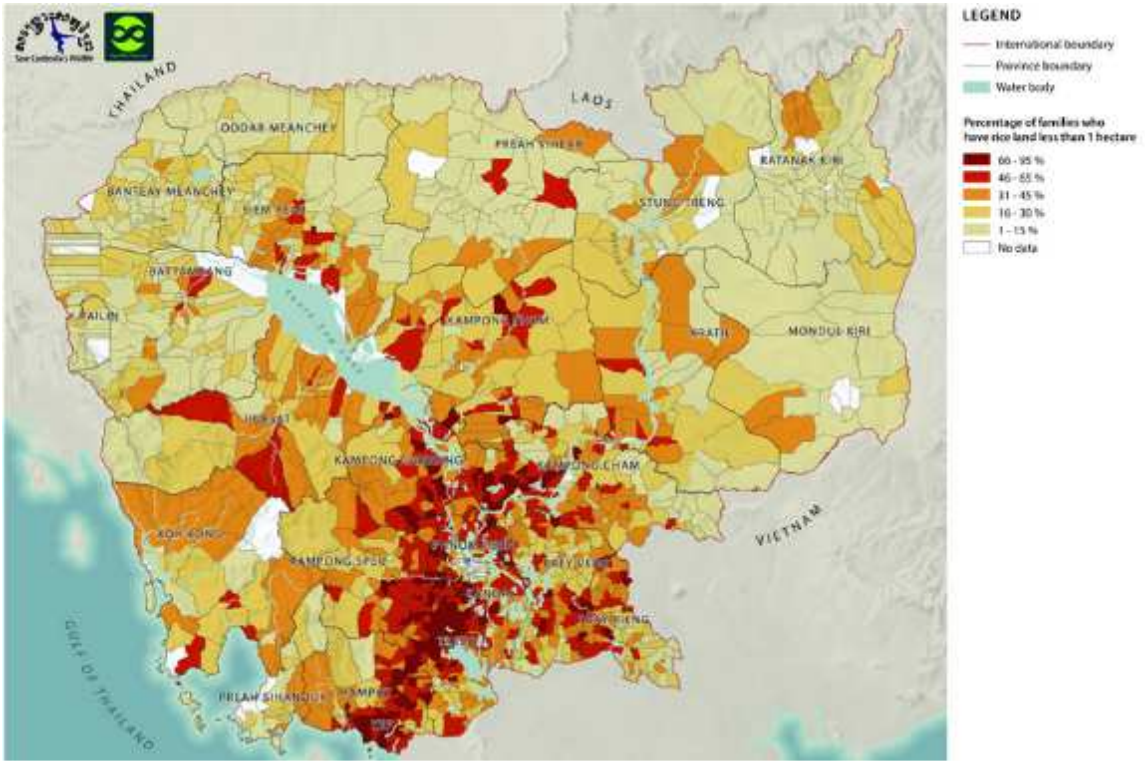


Figure 1 : Map of Cambodia by percentage of families who have rice land than 1 hectare

Rice area in 2015/16 is estimated at 3.1 million hectares, up nearly 1 percent from last year. Milled rice production is forecast at a record 4.9 million tons, up 0.2 million tons or 4 percent from last year. Rice yields are estimated at a record 2.51 tons per hectare, up 3.0 percent from last year. Cambodian rice area has steadily expanded over the past two decades. This process is expected to continue, with area increasing roughly 25,000 hectares in 2015/16. The country has some of the slowest growing rice yields in the region, owing to the extremely limited use of improved high-yielding varieties[3].

At a regional level for the whole South-east Asia, Cambodia are a minor producer, though it has ambitious plans to increase crop yields and production to enable greater export potential (cf. Figure 2).

[3] Source : United States Departement of Agriculture (Foreign Agriculture Service)

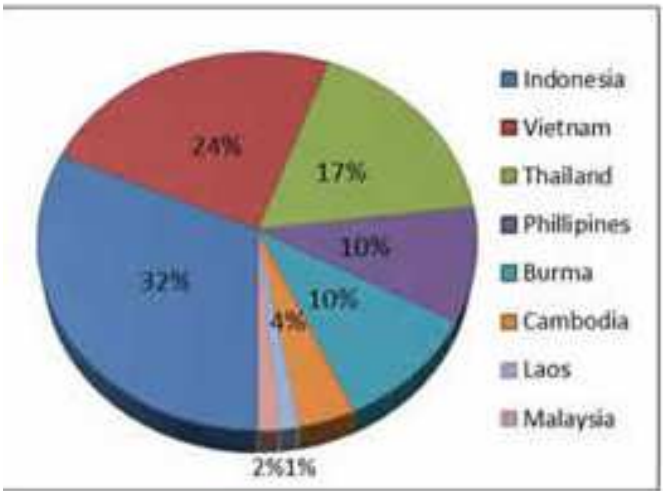


Figure 2 : Weight of national rice production in south-east Asia

For both producers and millers, it is known they face uncertainties and risks in their functioning: agro-climatic risk still high for producers and market failure of rural agricultural services, uncertainties supply for millers and risks on their investments[4].

For several years, a support to creation to cooperatives has been carried out to structure and enhance the production's capacities of farmers, their agricultural knowledge and the collective interest to be gathered. One the most useful farmers organization is the water users communities, mainly established in Kampong Thom province, where rice production relies on irrigation system.

A summarized supply chain shows the stakeholders all along the supply chain (cf. Figure 3), from farmers to consumers. In this scheme, there are a lot of combinasons of relationship: in some case, farmers directly sell their production to rice millers, or to collectors who are middlemen between farmers and rice millers. The small collector can himself sell to other larger collectors, frequently for informal export market to Vietnam or Thaïland. In some this case, this relationship between farmers and collectors or/and rice millers can be transferred to cooperative or farmers' associations (either called Agricultural Cooperatives [AC], Farmers Organizations [FO], or FWUC (Farmers Water User Communities) for irrigated rice production). Some rice millers are also traders and exporters, some rice millers are only millers, etc. The size of millers are very large, from very small rice millers milling a few tons of paddy to real medium-enterprises that mill more than 50.000 tons per year. On the downstream of the supply chain, the rice millers sells to exporters for international market or to national wholesalers for network of local retailers.

In this supply chain, the transportation is present at several steps. The financial coverage of transport is either paid by buyers or by sellers according the nature of relationship between buyers and sellers.

[4] Marché du riz au Cambodge, la résilience du « patronage », in Économies et Sociétés, Série « Systèmes agroalimentaires » 2010, Sylvaine Lemeilleur, CIRAD, UMR 1110 Moisa

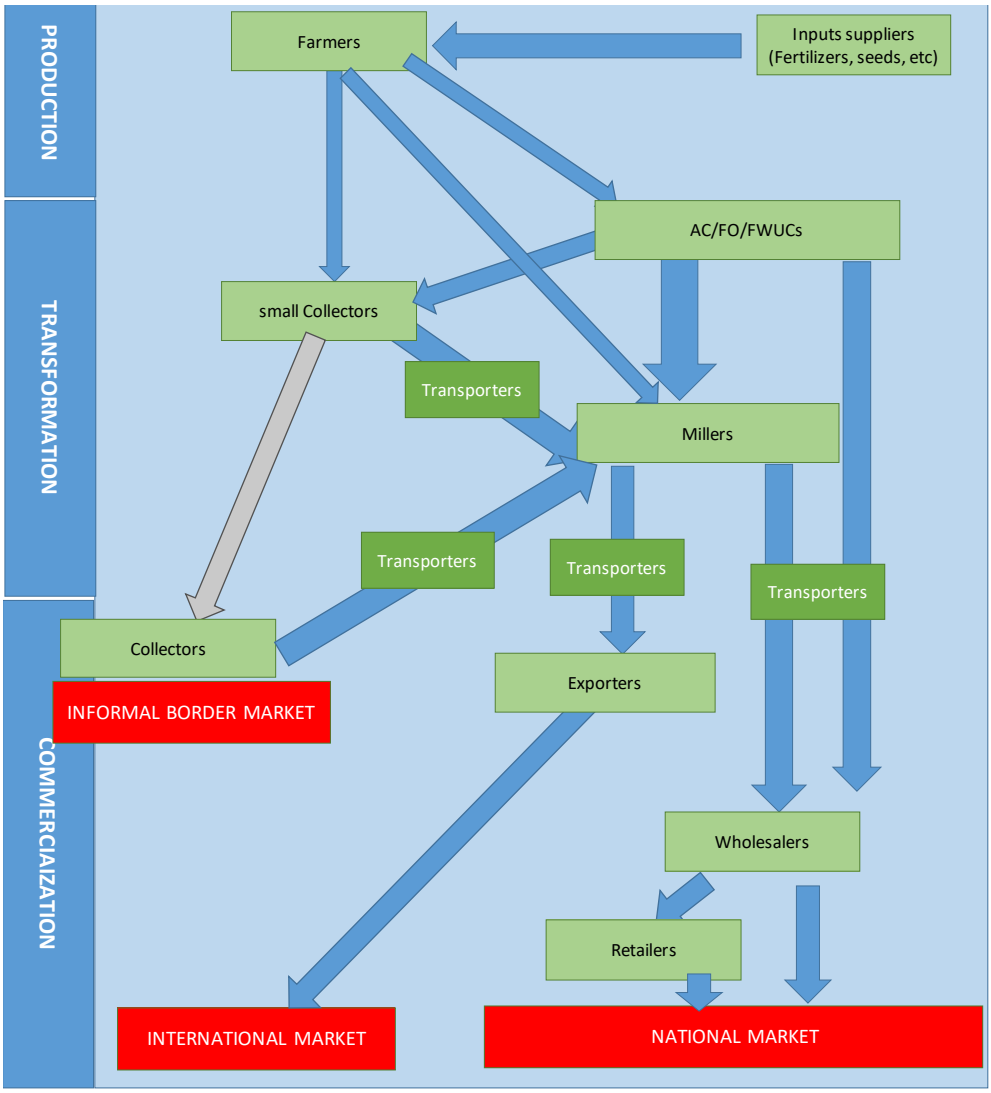


Figure 3 : Cambodian rice supply-chain description

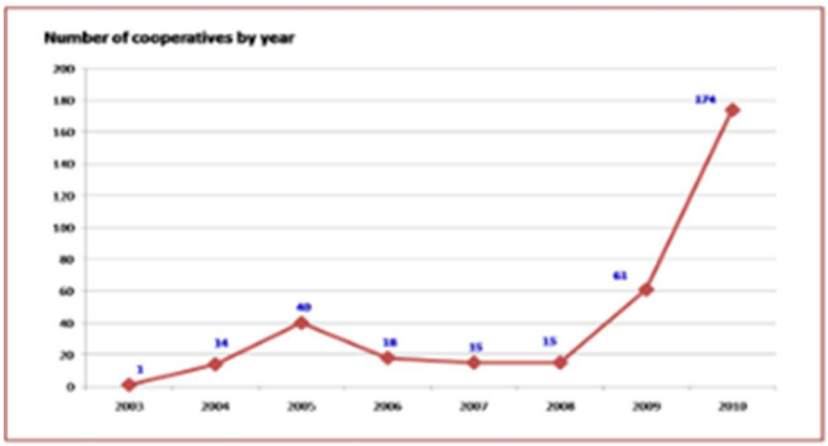
Globally, the commercialization of rice is marked by a large number of intermediaries. In this heterogeneous landscape, cooperatives are new stakeholders which could directly manage the commercialization of their products, in the name of their members, the small farmers.

Nevertheless, in this landscape, the modern drying function (as a professional function in itself) is missing. This function is mainly carried out by millers (when they have the critical size) or less frequently by collectors who have invested in drying system. Actually, the drying in Cambodia is still mainly made by natural method (sun-drying) by farmers (with a risk of poor quality paddy and a consequent percentage of losses for the milling process).

2. Supply chain stakeholders

2.1 The Agricultural Cooperatives

The raising of cooperatives in Cambodia are a recent and raising progression. This raising is mainly due to strategy policy from Royal Government. Indeed, according to the strategic plan of the government on exporting 1 million tons of milled rice at the horizon of 2015, MAFF has encouraged and promoted the establishment of agricultural cooperatives throughout the entire country (cf. Figure 4).



Source: Department of Agricultural Extension, MAFF, June 2010

Figure 4 : Evolution of numbers of Cambodian Agriculture cooperatives (2003-2010)

The generic term of AC (agricultural cooperatives) or FO cover a large range of profile and organisations: From small farmers organizations with less than 100 members to more than 2.000 members (FWUCs). The AC are mainly characterized by a relative weakness in term of commercialization and management capacities. Even if they are members of AC, farmers often sell directly to collectors or millers, as far as their own cooperatives has not enough financial capital to purchase the crops, nor facilities to store the paddy.

Granted through projects and foreign support, some cooperatives have invested in drying system and/or storage (and even milling). Those investments have been most of time totally paid by third parties (except contribution of AC for storage investment).

The current conclusions are not really evidential and successful. For instance, in Takeo Province, The Udom Sorya AC has a warehouse whose capacity is 100 tons (dimension are: L: 12 m x W: 8 m x H: 3 m). This warehouse has been granted by Alsace region and AFDI (on ADG project) for 70% (30% paid by AC). The cost is 11.130 USD. But the Udom Sorya AC admits that most of crops are actually sold just after the harvest because AC has no working capital (the initial capital paid by the farmers was only 107 million of riels for 130 members).

In the same province, the Sen Preah Ream Agriculture Cooperative (130 members) has been strongly supported in 2015 (by Cambodian government and JICA) to develop their own drying system and rice milling with a large storage capacity (the dimension of warehouse is 50 X 17 X 12 m. Nevertheless, in spite of additional working capital given by JICA (75.000.000 Riels for 70 tons), the AC has used only once the drying system (for the first harvest) because the generator coupled to the drying machine is not powerful enough. They only use generator for rice

milling machine. Moreover, with earned cash-flows (the AC has sold part of the milled rice at 2.500 riel/kg instead of 1070 riels for paddy, the Sen Preah Ream AC has made hazardous business (in Silk, mushrooms production, etc) and loans (for 50.000 USD) never reimbursed. In 2016, the AC was in bankrupt and JICA needs to capitalize once more the cooperative, even if 3 salaries are already supported by JICA.

At least, even with other attempts of dryers such as flatbed dryers, the experimentation is not evidential: by instance, an agricultural cooperative in Battambang province possesses one flat-bed dryer (capacity of 10 T), supported by ADB and PDA since 2014. But, according the members, due to high operation cost, this dryer has never been used. It was mentioned that such dryer is not appropriate for exporting standard.

Globally, the agricultural cooperatives face to:

- **A lack of working capital** (and savings from members) so that they have difficulties to buy the whole production of AC members after the harvest. This lack of working capital (an access to finance) prevent also cooperative, when they have storage facilities, to use this advantage to sell according a planned schedule to obtain higher prices.
- **A weak knowledge on market information**; AC and farmers have no information on price evolution and they have only relationship with one or two collectors or rice millers and no competition strategy.
- **No management capacities** (except for FWUCs) and technical skills for drying and storage nor for market knowledge (to find the better prices in the surroundings).
- **Contract farming system is appreciated** by cooperatives, giving guarantees on the price conditions and quantities to deliver.

Sankor AC : an example of Cooperative in Kampong Thom

This AC is established in 2010, located in Sankor commune, Kampong Svay district, Kam-pong Thom province. It has 400 members from 14 villages where 90% are from Sankor commune. The main works of this AC are cash credit and rice mill. Total capital is around US$ 700,000 in which US$ 130000 is invested on infrastructure of rice mill (purchase land and construct warehouse; 50m x 20m x 6m). In addition, in 2013 JICA supported rice mill and paddy dryer which was cost US$ 500,000. Provincial department of agriculture (PDA) also support one small warehouse for storing the inputs; fertilizers, seed etc.

This community produces two rice a year, wet season (2000 ha) and dry season (2000 ha) rice. In wet season, Phka Rudul rice variety (fragrant rice) is grown by 85% of the members while majority of farmers grow IR variety. In wet season, although there are large volumes of paddy being produced by the members, in 2015 the AC can purchase only 60 T of Phka Rumduol a year or around 2% of total Phka Rumduol. The nearby AC members brought paddy to the warehouse and AC collected the paddy of those members from far location. Price of Phka Rumduol (wet paddy) during harvest season was around 900 R/kg. And price of Phka Rumduol at 4 to 5 months after harvest is 1200 to 1300 R/kg (dried paddy). Where-as the dry season rice the AC did not purchase it.

The common issue is that AC lack of capital for purchasing paddy and lack of market as well. The purchased paddy (Phka Rumduol) is mainly milled and sold to members of the AC. The rice mill is operated one or two time a week. After selling to the members, AC has the budget

to continue purchasing more paddy for milling and selling to the members. In some cases, AC did not purchase paddy from some members due to poor quality (yellow or black grain). Farmers dried the paddy by the sun. Also paddy of some members was low purity as well.

The dryer capacity is 20 T. Dryer and mill are run by the generator, which consume around 18 L/h. In 2015, dryer was used to dry only 20T of paddy as it has technical problem. It was mentioned that it was costly to use the dryer (cannot get benefit) due to high fuel consumption. Also it needs more labor to operate. To connect to public electricity it will cost around US$ 30000.

The paddy was stored in the bag and put in the warehouse. The stored paddy is sometime damages by insect.

In total, AC spends US$ 500/month for 4 staff members of the rice mill.

The price market for farmers and cooperatives

From discussions with met cooperative, the last found price for paddy (wet or dried, for fragrant rice ou white rice) shows difference of price between variety but also according the season and the kind of paddy (wet or dried).

In Battambang, the Punleu Thmey Kdey Sangkhem Ney Kasekor AC (Agricultural Cooperative), the noticed prices for the last year were:

Type of Paddy	Price (Riel/kg)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Fragrant Rice	935 R/kg										990 R/kg	
Dried Fragrant Rice							1430 R/kg					1155/kg
Wet White Rice		715- 880 R/kg										
Dried White Rice					1320- 1375R/kg							1210/Kg

In Takeo province, the price regularly registered by the Udom Sorya & Tipat Cooperatives for the last year for the wet paddy (white rice) was summed up in the next table:

	Paid to the farmers (riel/kg)	Sold to the collector/miller (riel/kg)	Margin (riel/kg)
Nov-December 2014	850	950	100
Jan-April 2015	1000	1070	70
May-June 2015	1120	1170	50
July-august 2015	1300	1350	50
Sept-October 2015	1100	1200	100

Besides, for the fragrant rice, the price was in November/December:

- 950 R/kg paid to the farmers and 980 R/kg sold to the miller.

And for dried fragrant rice:

- 1300 R/kg to the farmers but the miller doesn't want dried fragrant rice (due to poor quality paddy dried by sun).

At last, in Stung Chinit, for a paddy selling group from Water users' community, in frame of a contract farming, the noticed price for wet paddy (fragrant pris) was, last year, 1170 R/kg (good quality paddy) sold to Golden Rice (mill). The company paid for the transportation. In case of IR variety, farmers sold to local collectors/traders then to Vietnam as wet paddy; in this case, the price was 750 R/kg (and in case of poor quality (impure) the price dropped to 690 R/kg.)

So globally, the gross margin between wet paddy and dried paddy is about 15 or 20% whereas this margin can reach 50% between selling after harvest and after several months of storage.

Those elements of prices will be references for the simulations in the set up of the economic tool provided with this report.

2.2 The collectors

The collectors (and middlemen) are an essential link in all the rice supply chain in Cambodian. They mainly compound of small traders or shopkeepers, established in villages. They have some particular strong relationship with local farmers (from several villages in the surroundings). This economic model proves that the market is not totally ruled by supply and demand market but based on informal contract, according "patronage" relationship. This is confirmed by the fact that collectors are also and frequently moneylenders who lend to farmers the seeds, fertilizers, and other inputs during seeding period.

The met collectors usually try to sell paddy (wet and dried paddy) as quick as possible after the harvest. According one collector in Kampot province, he used beforehand to sell to national rice millers but now, he sells wet paddy to other middlemen for the Vietnam market.

Most of collectors have better skills to manage cash than farmers or cooperative and, as traders, have more working capital. However, they are also under-capitalized such as their strategy is to sell paddy after the harvest.

Some of collectors have strategy to invest in warehouse and modern storage facilities and also in trucks to collect and distribute with their own means the paddy. Some of them have also invested or look forward invest in dryers.

The collectors are in the same time an essential link of rice supply chain and also a "weak" link because their smallness, their lack of capital and also with no particular competencies to guarantee paddy's quality. Finally, they only act as intermediaries without insuring added-value in the whole supply chain.

2.3 The millers

As for cooperative and collectors, rice millers cover a large range of stakeholders, from small informal individual entrepreneurs to institutionalized company (including sometimes foreign shareholders). In 2001, a census of traditional millers across the country (JICA) estimated traditional millers at 12.198 (whereas the "commercial" ricers was about 500). The traditional rice millers mainly sell to local consumers and local grocery stores whereas industrial rice millers are turned toward export market.

Thus, they all invested in large storage capacities. Furthermore, millers are demanding quality (variety, homogeneity, moisture ...) because it has become the major issue of competition between major millers. Finally, industrial millers face a significant financial risk due to financial capital immobilization and financing constraints (direct payment to suppliers but deferred payment of their buyers).

The other constraint for industrial millers is the difference between their production capacity, based on important investment in dryers and milling equipment and the short supply form farmers and AC so that the cost price is not optimized (regarding milling capacities).

Since a few years, the system of contract farming implementing by SNEC through the "Support to the Commercialization of Cambodian Rice" Project is considered by both cooperatives and millers as an efficient strategy to insure cooperation between Cooperatives and rice millers. Those contracts defines:

- The variety of paddy and quantity to deliver by AC to rice millers by variety
- A required quality (in terms of purity, moisture, broken kennel) of paddy and assessment of this quality.
- The process of collecting and transportation of paddy
- The engagement of price and payment (based on market price but at better conditions than market price).
- Exchanges, coordination and training (concerning quality) between buyers and sellers.

Actually, those contract farming are the legal institutionalization of a long tradition of relationship between farmers and traders. It's a modernized perpetuation of confident practices between farmers and traders according "patronage" relationship[5].

[5] Marché du riz au Cambodge, la résilience du « patronage », in Économies et Sociétés, Série « Systèmes agroalimentaires » 2010, Sylvaine Lemeilleur, CIRAD, UMR 1110 Moisa

AMRU
Saran Son, CEO

Mr. Saran Son is the Chief Executive Officer of AMRU, a rice milling and trading company, whose headquarter is at Phnom Penh.
AMRU suppliers are distributed as follows:
- 50% small and medium size millers (trading)
- 40% middlemen
- 10% AC (agricultural cooperatives through contract farming)

Today AMRU sells 61.000 tons of milled rice + 5.000 organic
AMRU has 2 rice mill factories with dryers of 8.000 tons in Betay and Kumpung kom and one rice processing factory in Phnom Penh.
He sells to exporters, wholesalers and supermarket network.
The difference of price between wet paddy and dried paddy is 20%. By example, He purchased 300 USD the ton the dried paddy against 270 USD/ tons the wet.
He purchased the milled paddy at 600 USD tons and sells it at 680 (15% of margin);
For Saran Son, its objective is not be big (some big rice millers has met bankrupt) but to be sustainable.
In the medium-term, Mr Saran Son sees the development of relationship of its company with cooperative as follows:
- Contract farming (currently implemented through SNEC Project)
- Strategic partnership with MOU with cooperative (3 or 4 big ones) based on 3 or 4 indicators; during this period, with financial support, AMRU could provide training, elaborate Business plan for cooperatives and organization development.
- And finally, creation of a joint-venture (with 51% of capital for AMRU and 49% for cooperatives) as a company limited.

This perspective of AMRU to create joint-venture for 2018. Today, according Mr Son, the main problem of cooperatives are in terms of lack of working capital, infrastructure, trading and unity.
According Saran Song, it's sustainable to make joint-venture with Cooperatives for about 10.000 to 12.000 tons of rice (its means 3.000 to 4.000 tons per cooperative).

3. The access to finance

3.1 Private financial institutions

Since more than a decade, the Cambodian banking system is characterized by its rising performances. Cambodian formal financing institutions are under the control of the National Bank of Cambodia (NBC). The financial sector is composed by: i) 35 commercial banks; ii) 9 specialized banks and iii) 39 microfinance institutions (MFIs) (NBC, 2014).

If the financial institutions are numerous, actually, the sector is dominated by only 3 banks: Acleda,, Canadian Bank, ANZ. Likewise, the microfinance is also totally dominated by only 3 MFI: Amret, Prasac, ANK.

In spite of its dynamism, the banking is also and mainly characterized by an over-liquidity and a total risk aversion. Indeed, the credit strategy of banks and MFI are entirely based on collateral assessment more than economic evaluation. The level of required collaterals reach at least 130% (but most time 150 to 200%) of disbursed loans; moreover, the only demanded collaterals are pledge on land title or real estate. At least, short-term loans are favored instead of more risky long-term loans for productive investments.

As a consequence, the wholesale and retail trade are the main financed sector. Contrariwise, agricultural sector, which still represent more than 33% of Cambodian economy only constitutes barely 10% of the bank loan portfolio (cf. Figure 5).

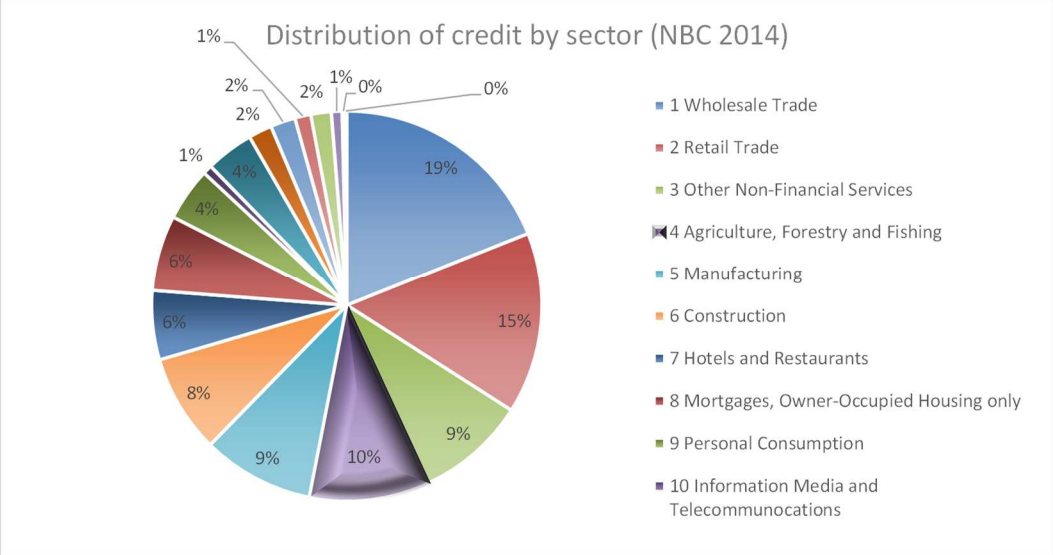


Figure 5 : Cambodian banking loan amount by economic sector (2014)

Finally, the agricultural sector has to face several constraints such as:

- The Cambodian banks are not really specialized in rural and agricultural sector (they actually finance rural sector but mainly turned toward entreprises (rice millers, exporters). They can finance long-term loan for investment as well as short-term loan (working capital requirement). They require collaterals which at least represent 130% of loan and with land title or real estate pledge. The interest rate at about 10% nowadays.
- The microfinance institutions are more invested in rural and agricultural sector; they have also a better knowledge of farmers financial needs but their amount loan and duration can't really fit with invest amount necessary for total rice milling system nor for large warehouses. Microfinance can be adapted for working capital requirement for small farmers. Paradoxically, the agricultural cooperatives, as far as they become large institution gathering a lot of farmers, have too important financial needs that MFI can't provide.

Amret SA : a Cambodian Microfinance Institution

Amret has been founded in a context of rural development project and is still one of the leading institutions in Cambodia involved in agriculture and rural lending. Most of its 46 branches are located in rural district towns and 94% of its borrowers live in the villages and 15% of its loan portfolio is still dedicated to agricultural sector (mainly for small and medium-size farmers).

Nowadays, Amret SA still finances small farmers through group loans (solidarity loan) that don't require other collateral than the social pressure of group; nevertheless, these group loans are for small amount (maximum 500 USD by borrower for group of 6 persons). Besides, Amret has upscaled its product and target beneficiaries and lend to individual entrepreneurs up to 50.000 USD. For individual loans, the collateral is the same than for classic banks (and even higher in terms of amount of garantees): land title, real estate.

With support of World Bank, Amret has implemented from 2010 to 2015 a project called Agrifin (Agriculture Finance Support Facility) whose objective to support the establishment of an agricultural lending unit at Amret's head office and to strengthen Amret capacity to serve a wide range of agricultural clients in Cambodia.

In the frame of this project, more than 15.000 clients has been targeted for 75 USD millions of loans (and 200 USD millions for agricultural sector).

Based on demand-driven approach, Amret developed the AgriFin loan, a cash flow-based loan product that was designed to meet the growing demand for larger loans among farmers who are not served by other financial institutions in Cambodia. This new product has those specificities:

- A loan amount to approximately US $6,000, compared to the average microloan offered to farmers before, which was US $1,300.
- A flexible repayment terms in line with farmers' seasonal cash inflows.
- In addition, an interest rate on average 0.10% lower as compared to the average interest on microloans during the pilot period, at about 1,5% to 1,7% per month.

Thanks to this project, Amret has developed a lending team dedicated to the agricultural lending and to its specificities.

Besides, Amret doesn't only lend to farmers but also to millers, collectors (no exporters, too large). According Amret responsibles, it is quite impossible today to finance cooperatives or formal farmers' organization

In conclusion, Cooperatives have maximum difficulties to find funds to finance the working capital requirement (and tomorrow long-term capital if they should invest in drying and storage facilities) regarding the financial institutions sector. Indeed, Cooperatives have some financial needs that Microfinance institution can't provide in terms of amount (an also because of interest rate still higher than Cambodian banks) and banks cannot also provide, due to collateral requirements (land title, real estate) that Cooperatives don't own.

3.2 Public financer: the Rural Development Bank

The RDB is a public bank whose government is the lone shareholder. The role of RDB is to provide loans to the agricultural sector. Among its portfolio of loans, the rice sector represents approximatively 60 % to 70%. One of the objective of the RDB is to promote financing to

agricultural cooperatives up to 10% whereas the cooperatives only represent 1% of the RDB portfolio.

The main problem of RDB relies in the fact it have no branch in the country. They currently study the opportunity to have some and Battambang should be the first to implement one.

The new policy of credit for cooperatives can be summarize as follows:

Short-term loan criteria for working capital needs.

- From a minimum loan amount of US$5,000 to a maximum of US$50,000.

- Loan amount shall not be more than 4 times the capital of the cooperative and shall not be greater than 80% of working capital needs.

- Duration not exceeding 12 months.

- Interest rate of 10.5% for USD loans and an additional 3% for KHR loans (service fee and guarantee fee are included).

- repayment of principal can be all at maturity or amortized depending on type of business and cash flows; interest is to be paid monthly.

Long-term/investment loan criteria for investment in real estate, machines, equipment to be used for commercial activities

- From a minimum loan amount of US$10,000 to a maximum loan amount of US$100,000

- final loan amount shall depend on past and projected cashflows of the cooperative, shall not be more than 4 times the capital of the cooperative and shall not be greater than 80% of planned investment.

- duration 1-5 years, including option of grace period up to a maximum of 1 year

- interest rate of 10.0% for USD loans and an additional 3% for KHR loans (service fee and guarantee fee are included).

- repayment of principal shall be amortized quarterly or semi-annually depending on type of business and cash flows; interest is to be paid monthly

Collateral (for both short- and long-term loans; for both new and old customers)

- Collateral can be in the form of **real estate**, **guarantee letter, fixed deposits, gold, equipment and inventory** (the latter two are difficult to implement at the moment).

- Non-real-estate collateral can be up to a maximum of 30% of required collateral coverage

- For loans less than US$10,000 soft title is sufficient.

-The loan-to-collateral-value ratio is 70% for real estate located in cities/provincial capitals that have shopfronts, factories, industrial buildings or residential buildings. The loan-to-collateral-value ratio is 60% for real estate located outside cities/provincial capitals but still have shop-fronts, factories, industrial buildings or residential buildings.

Moreover, the minimum criteria for a cooperative to borrow are:

- is properly registered as a cooperative under the relevant law

- has at least 1 year of experience in the intended commercial activity

- can provide financial information, including assets, liabilities, capital, income and expenses

In conclusion, the capacity for Cooperative to be financed by RDB seems easier than by private institutions. Nevertheless, the conditions are very tough because some strong conditions are actually required:

- *The long-term loan can't exceed 5 years which is short-time for "industrial" investment.*
- *The required collateral including land title and real estate*
- *The fact that rural land title and real estate are considered as lower guarantee*
- *The limitation of loan amount (maximum: 100 Kusd for investing and 50 Kusd for short-term loans.)*
- *At last, the limitation of loan amount regarding the equities of cooperatives (Loans can't exceed 80% of total capital) whereas the cooperative are under-capitalized.*

3.3 An alternative financing: the leasing

Since a few years, leasing (hire-purchased) is developing in Cambodia. Companies such as RMA or TL Finance are considered as financial institutions and have a mandatory banking license to lease. They have only right to lease movable assets.

The system of leasing consist in renting a machinery for a duration. During the renting period, the assets still belongs to the lessor. At the end of the renting period, the asset belongs to the lessee. To fit with seasonal revenues of farmers, leasing companies can accept seasonal repayments.

Leasing' companies prior lease farm tractor in Cambodia (except cars and trucks). The targeted farmers can be medium farmer (less than 5 hectares). RMA for instance lease high-range tractor (John Deer brand) that's cost about 25 Kusd to 30 Kusd.

Before leasing, the farmer has to pay a down paiment of 20% of the asset. A cash-flow statement and financial analysis is carried out by the leasing company to study the solvency capacity of clients. A checking of real agricultural surface and land title of the farmer is also carried out.

Besides, the leasing company demands to the lessee: 1) postdated cheques for all the months of leasing (In Cambodia, uncovered cheque is considered as a criminal offence) 2) land title pledge (but not for so much value than the bank) 3) retention of the tax paper (title evidence) of the tractor.

Todays, a company such as RMA thinks about diversification and looks forwards negociates joint-venture with new partners for such purpose. The diversification could concern: medical materials, electric generators, material for professional cooking, solar energy, and also rice milling facilities.

To facilitate investment in new economic fields, and especially in rice drying and milling, a company such as RMA should be interested in being included in a project with a system of guaranty fund on final losses (the guarantee shall only cover the possible difference after execution of usual warrantees on contract).

III. THE ECONOMIC MODEL AND DRYING-STORAGE PROBLEMATIC

1. General issue

The trade between farmers (directly or through cooperatives) and rice millers can correspond to a competition market on which the demand and supply are at equilibrium for a given price.

The current market relationship between farmers and suppliers (collectors and millers) highlights a gap between supply curve[6] ($\mathscr{S}$) and demand curve ($\mathscr{D}$) which is potentially higher (The required quantity of paddy could largely increase from $\mathscr{D}$ $\mathscr{D}^*$ with the same price or a slight difference). The new demand curve ($\mathscr{D}^*$) implies a new Supply Curve ($\mathscr{S}^*$) to offer more quantities (cf. Figure 6).

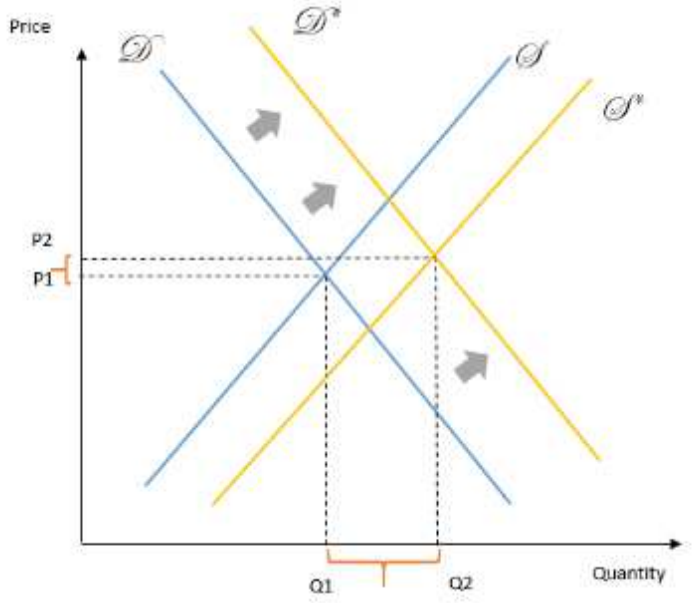


Figure 6 : Supply and demand model for rice production

Thus, the demand from the millers (but not necessary from collectors) can accept a new higher price for dried paddy from farmers at one principal condition : the average cost of drying at least equals the current difference between dried paddy price and wet paddy price less the earn of productivity due to less losses.
This problematic can be described according to the next figure (where the cost of drying reaches a minimum cost before diminishing returns). The figure show that there must be a minimum quantity to dry (Q*) such as drying investment is profitable (cf. *Figure 7).*

[6] Supply from farmers after their own consumption's withrawal of a part of their production.

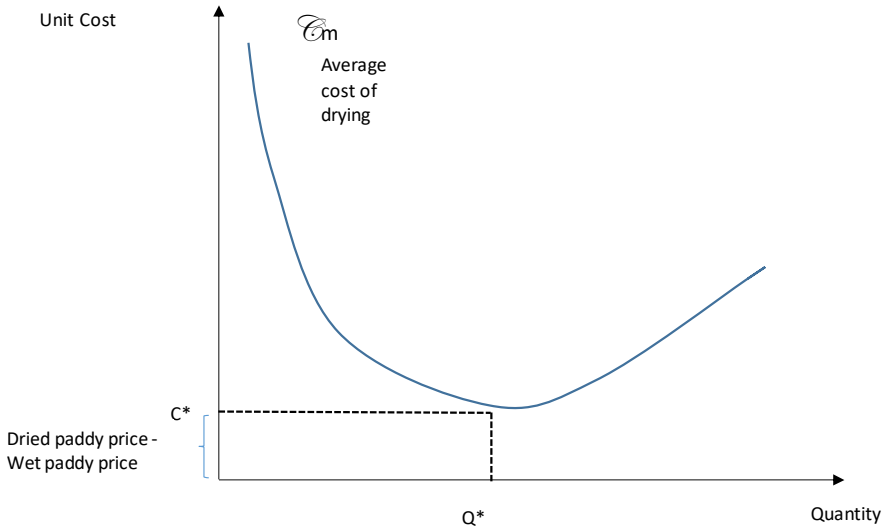


Figure 7 : Cost function for drying process

The equation can be formulated as follows:

With:

Q* = Quantity of produced wet paddy
Pwp = Unity price of wet paddy
Pdp = Unity price of dried paddy
Rd = Dry rate
Cd = Unit cost of dried paddy
Ld = Loss rate with drying system
Ls = Loss rate with sun-drying

We must find quantity **Q*** such as:

Q* x **Pd**p - **Q***(1-**R**d) x **P**wp <= **Q***(**C**d) - **Q*** x [(**L**s - **L**d) x **C**d]

Differential of unit price between wet and dried paddy

Cost of drying

Productivity earnings by lower losses

Actually, the equation is different according the dryer equipment allows to store for few months and to sell at a higher price. In this case, some new parameters must be taken into account, such as 1) the price of paddy after several months of storage 2) the cost of credit for need cash (working capital requirement)

Im: monthly interest rate
M: number of months
Cs: Unit cost of storage
P2dp: Dried paddy price after several months of storage

Q* x **P2**dp - **Q***(1-**R**d) x **P**wp = **Q***(**C**d) - **Q*** x [(**L**s - **L**d) x **C**d] + (**i**m x **m** x **Q* x P**dp) + **Q*** x **C**s

At the end, the issue can be summarized as following question:
Is it possible to transfer the activity of drying (and increase of storage capacity) from millers to farmers' organizations with added-value for farmers' organizations without withdrawing value for the rice millers)?

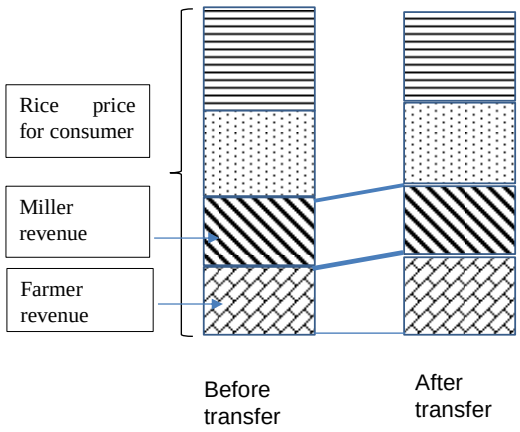


Figure 8 : Transfer of added-value in composition of cost in rice supply chain

2. Technical options and models

2.1 The system of mechanical drying

Drying process consists in decreasing the grain moisture content to the desired or safe level for storage. It is very important operation after harvesting. Rice grains contain up to 25% moisture

at harvesting. High moisture level during storage will lead to grain discoloration, development of molds, and attack from pests. Also it decreases the germination rate of the seed. Ideally rice grain shall be dried within 24 hours after harvesting; delay drying, incomplete drying or ineffective drying will reduce grain quality.

Paddy drying methods consist of traditional and mechanical systems that vary technological complexity and capacities for either farm or commercial level. Traditional drying includes sun drying (mats and pavements) and Field drying. The mechanical drying or heated air drying allows for suitable drying air conditions to be set and drying can be conducted any time of the day or night. There are at least two types of mechanical paddy dryers being used in Cambodia, namely flatbed dryer and recirculation batch dryer. Those facilities were either introduced by development project and/or private investments. We are actually 2 kinds of technics (cf. Table 1):

Flatbed dryer

- **Flatbed dryer** utilizes high temperatures for rapid drying. The process of drying is ended when it reaches the desired final moisture content. This type of dryer is used by few farmers organization to dry rice paddy and rice seeds. It has advantages in terms of low investment cost and simple to develop (by local constructors). But it is labor intensive for loading and unloading as well as stirring the paddy during operation. In some cases, the auxiliary system (e.g. stirrer) was connected to ease the operation but additional cost exists. The installment cost for flatbed dryer varies from US$ 5,000 to US$ 10,000 when the loading capacity ranges from 5 t to 10 t. This kind of dryer takes 8 to 10 hours of drying time.

Vertical dryer

Re-circulation batch dryer (vertical dryer) allows to uniformly drying grains and the automatic drying air temperature controls to maximize the drying rate and reduce over-heating or over-drying. This type of dryer is commonly used by rice mills/collectors and some FO. Such dryer is imported (from Taiwan, Korea, Japan etc.). The installment cost is from US$ 25000 to US$ 450000 when its capacity varies from 8 t to 120 t. interestingly, some Cambodian millers have made this vertical dryer by themselves. The local made dryer cost ranges between US$ 25000 to US$ 60000 for the loading capacity of 10 t to 15 t, respectively.

Mechanical dryers	Advantage/disadvantage	Capacity	Cost (US$)
Flatbed dryer	- Low cost and simple - Suitable for community - Take 8-10 hours of drying - Made of iron and concrete/brick - Labor intensive: labor for load and upload	5 T 10 T	5000 to 8000 10,000

	- Use kerosene or husk as fuel		
Recirculation batch dryer	- Loading capacity: 35-40 t - Computerize control system - Installed mostly by rice millers - Take: 8 h to dry - Use rice husk as fuel	40 T 15 T	120,000 60,000
Recirculation batch dryer from NOYAKONG Coltd	Lifespan: 4 to 8 years Drying speed: 0.8% per hour	15 T	45000
		30 T	89500
		60 T	157 000
		90 T	320 000
		120 T	450 000
Yamamoto Coltd (4 years warranty)	Lifespan: 6 years or more Drying speed: 1.2% per hour (it takes 9hour to dry)	8 T	25 000
		10 T	
		12 T	
		22 T	
		30 T	60 000
Recirculation batch dryer (locally made)	- Suitable for community - Drying time: 8 h - Semi-automatic (load and un-load) - Use husk as fuel	10T 15 T	25,000 60,000

Table 1 : Comparison of technical solutions for drying process

2.2 Paddy Storage

The grain storage facility aims at providing safe storage conditions in order to prevent grain loss caused by adverse weather, moisture, rodents, birds, insects and micro-organisms like fungi. There are many forms of rice storage facilities based on the quantity of grain, the purpose of storage, and the location of the store. Paddy can be stored in bag, bulk, or hermetic containers (cf. Table 2).

- Bag storage- grain is stored in 40−80 kg bags made from either jute or woven plastic
- Bulk storage - grain is stored in bulk at the farm or at commercial collection houses

- Hermetic storage - grain is stored in an airtight container so that that moisture content of the stored grain will remain the same as when it was sealed. These storages can extend germination life of seeds, control insect grain pests, and improve head-rice recovery; e.g. super bag, cocoon, silo.

Paddy storages	Advantage/disadvantage	Cost
wooden granary	- Avoid damage of pest: rat, bird - Suitable for individual farmer or small community - Cheap and simple - Capacity: 15-20 t	US$ 4000
Warehouse	- Avoid damage of pest: rat, bird - Suitable for cooperative and millers - High cost - Capacity: 1m3: 600 kg of paddy - Used the standard warehouse	US$ 125/m2
Silo	- Installed by millers - High cost - Capacity: 15 t - Made from steel - Load and unload by conveyor	US$ 5000/set US$ 1500 for conveyor

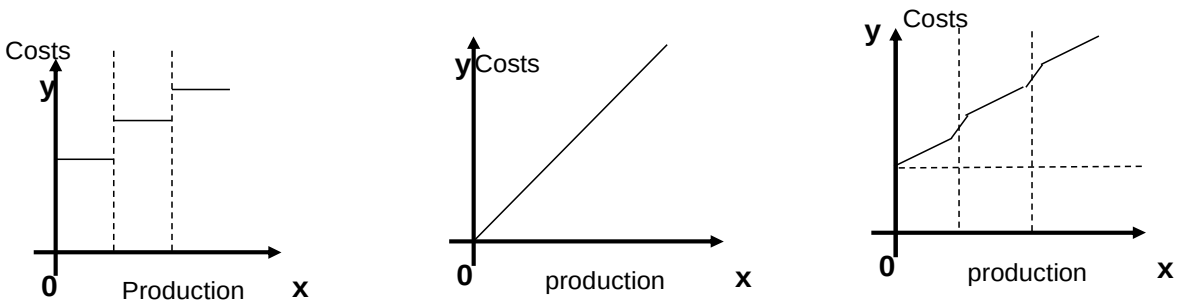
Table 2 : Comparison of technical solutions for paddy storage

3. Description and behaviour of costs

For any productive activity, to determine the costing of a product, we must isolate costs according how they behave in function of production. So, we have two kind of costs (cf. Figure 9):

- **Fixed costs**: Cost which are not directly depending on production level.
- **Variable costs**: Costs which are directly depending on production level.

So, the total cost of a good or service is the addition of fixed and variable costs.



Fixed costs function

Variable costs function

Total costs function

Figure 9 : Cost function charts for cost behavior according production level

This separation of costs according their behavior in function of production is essential because it determines the evolution of unit cost by produced quantity.

By this way, we can identify the drying and storage function of cost according quantity of paddy (expressed in Tons or kilograms) (cf. Figure 10).

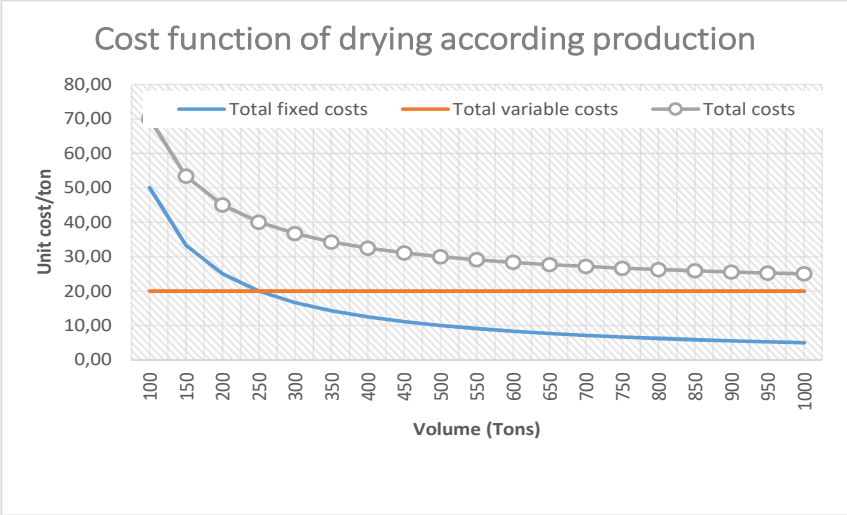


Figure 10 : Total cost function of drying activity according rice quantity

So, the first step consists in isolating nature of costs for drying and storage according to fixed or variable costs. This work ends up to the following results (cf. Table 1):

Activity	Fixed costs	Variable Costs
Drying	Depreciation of assets	Energy consumption (Energy, Fuel)
	Financial interests (on invests)	Financial interests (on working capital)
	Labor costs	Labor costs (daily workers)
Storage	Depreciation of assets	
	Financial interests	
	Labor costs	

Table 3 : Costs inventory for drying and storage by category of cost (fixed or variable)

Comparing with solar drying method or less modern method (flatbed drying), the part of fixed costs is higher and normally, the variable costs, and mainly labor, should be lessening in the determination of the total costs (by economic transfer from labor to assets).

4. Technical and economic parameters

4.1 Technical parameters

For the implementation of the economic tool and the simulations, we will consider that investment in dryers are in only in re-circulation batch dryer (vertical dryer). Indeed, the other option, the flatbed dryer can't afford enough technical guarantees for a high-quality rice for exportation.

Those technical parameters in priority concerns the technical specifications of the dryer equipment that defines the production and productivity processes. All parameters to take into account related to the investment in dryer are described in the following table:

Technical parameters	Unit	Comments
Dryer		
Tons capacity	*Tons*	Defines the total capacity of drying for one cycle of drying
Investment cost	*USD*	Cost of investment
Dry rate per hour	*%/hour*	Define for each dryer machine, the rate of drying expressed in moisture decrease per hour
Electric consumption	*Kwh*	Number of Kw used per 1 hour of drying (according to technical specifications of the dryer machine)
Loading time	*Min*	Time needed to load the dryer with wet paddy
Discharging time	*Min*	Time needed to discharge the dryer with dried paddy
Fuel consumption	*Liter/hour*	Quantity of fuel needed by hour of dryer use.
Life-time	*Years or Hours of using*	The life-time of dryer to calculate depreciation
Electric invest		
Transformer	*USD*	Cost of transformer to connect dryer to medium voltage network
Distance	*Km*	Distance from dryer to medium voltage network
Connection cost	*USD/km*	Cost of electrification connection by kilometer
Life-time	*Years*	Life-time of electric facilities
Storage		
Cost per m3 ou m2	*m2*	Unit cost for warehouse in m2 for a given height
Dimensions	*L x W x H*	Length X Width X Height of the warehouse
Capacity of storage	*%*	Part of warehouse dedicated to storage (the other part to drying)
Life-time	*Years*	Life-time of the warehouse to calculate depreciation

Table 4 : Technical and invest parameters for drying and storage cost calculation

4.2 Financial parameters

The financial parameters consider that economic model is based on capital requirement brought (in a part) by Cambodian financial institutions at current credit conditions. Contrariwise, we will consider that there is no cost of return on equities. The eventual loans in this model are for 2 different purposes: 1) loan for investing in long-term equipment 2) loan for working capital requirement:

Finance	Unit	Comments
Long-term invest		
Loan amount	USD	Needed Loan for investment
Interest Rate	%	Yearly interest rate
Duration	years	Maturity of the loan
Grace period	years or months	Grace period on capital reimbursment may have influence on loan total costs
Short term invest		
Loan amount	USD	Working capital requirement between harvest and sell after storage
Interest Rate	%	Yearly interest rate
Duration	Months	Maturity between paddy purchase and paddy selling

Table 5 : Financial parameters for drying and storage cost calculation

4.3 Rice production parameters

The process of paddy production has essential impact on productivity for the activity of drying. Indeed, the capacity of dryer limits the possibility of important quantity of drying in the same time. It means that the investment capacity is function of duration of harvesting (for photo-sensitive varieties of rice). It means it is also function of time of preservation of wet paddy before paddy is totally spoiled.

It also concerns the moisture rate to pass from wet paddy to dried paddy.

At last, the information about price of paddy, wet paddy, dried paddy after harvest and price of dried paddy after storage period are necessary to compare the cost of drying and storage with current added-value between wet and dried paddy, found on the market.

Rice production parameters	Unit	Comments
Harvest duration by type	Days	The duration of harvest determines the capacity of drying according to the technical specifications of
Wet paddy conservation before spoiling	Days	The duration of wet paddy retention before total damage
Price wet paddy by type	USD/tons or Riel/kg	Price of wet paddy after harvest according variety of rice
Price dried paddy by type	USD/tons or Riel/kg	Price o dried paddy after harvest according variety of rice
Moisture rate at harvest	%	Moisture rate found for the wet paddy before drying
Moisture rate required	%	Moisture rate required for dried paddy.

Table 6 : Rice production parameters for drying cost calculation

> For the simulations, the possible reduction of losses (difficult to assess in percentage) thanks to a modern mechanical drying system will be impacted on the dried price the ricer will accept to pay. For a better paddy quality, we can increase the price of the dried paddy.

4.4 Operational parameters

Some other operational parameters are needed to evaluate the unit cost of drying and storage. It concerns the cost of energy (electricity and fuel), the time of drying per day, the labor costs (staff needed) and the cost of transportation.

Operational parameters	Unit	Comments
Drying		
Electricity cost	Riel/kWh	Tariff of electricity (medium voltage) by kw/h (EDC tariff grid)
Fuel cost	Riel/liter	Tariff of fuel per liter
Dry duration per day	hours	Operation time per day for the dryer
Labor costs	USD/month	staff cost for operation
Transport		
Transport cost	USD/tons	Transportation costs expressed in USD per ton

Table 7 : Operational parameters for drying and storage cost calculation

All these parameters have to be taken into account to create a financial tool on Excel© software in order to find the breakeven point such as investing in drying and in storage facilities becomes profitable.

IV. HYPOTHESIS AND RESULTS

1. Description of the Excel tool

The financial tool set up is based on the determination of a drying and storage unit cost per quantity (paddy quantity). The quantity determines the amount of invest and financial conditions according to rice production constraints. The invests drives the needed technical specifications and financial conditions that determines 1) depreciation costs, financial costs, labor costs, Energy costs 2) those costs are classified in fixed or variable costs regarding their behavior according to production 3) the total unit cost is per quantity is obtained (cf. Figure 11).

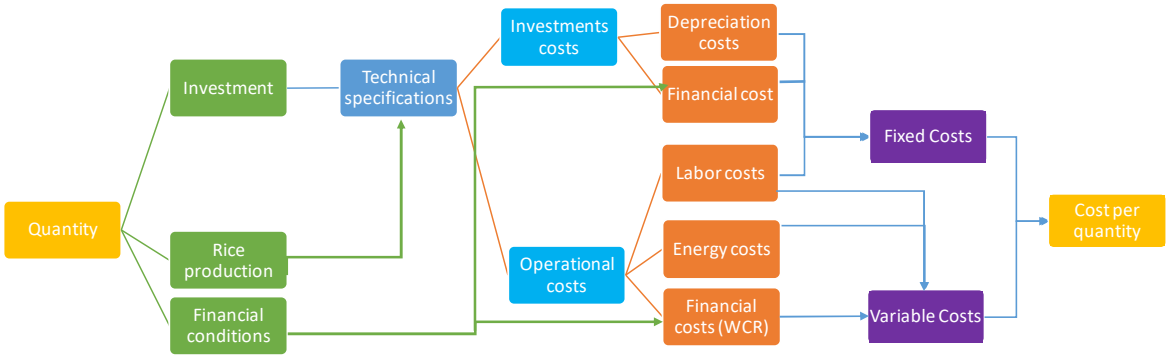


Figure 11 : Algorithmic chart for Excel© tool

A matrix describes the evolution of drying unit cost (and storage unit cost) in function of quantity to dry based on the previous algorithm.

2. Standard hypothesis and results

2.1 Definition of standard parameters

For the simulations, we will use standard following hypothesis:

The technical specifications on dryers

It exists several companies in Phnom Penh specialized in dryers. Noyakong (specialized in Taïwanese technologies), Yamamoto (Japanese systems) are the main companies on this market. Some others (TTP graindryer) are Cambodian builder, assembling pieces together (from foreign technologies).

In our simulations, we will used mostly the Noaykong technical specifications; for the 30 tons dryer, we will take the Yamamoto specifications:

Technical specification for drying machine						
Tons capacity	*Price (USD*	*Dry rate per hour*	*kw/h*	*Loading (min)*	*Discharging (min)*	*Fuel (liter/hour)*
8	25 000	1,50%	8	50	40	12
15	45 000	1,50%	8	50	40	14
30	60 000	1,25%	15	61	63	18
50	157 000	1,25%	39	60	50	24
100	320 000	1,25%	67	85	85	45
120	450 000	1,25%	67			60

Table 8 : Technical and economic specification for dryer equipment

Storage investment

For the storage equipment, we will consider the building of a warehouse. The cost is evaluated in surface (m2) with costing found in the sector of building.

A part of the warehouse will be obviously dedicated to the drying machine; so it is necessary to reduce the real useful storage capacity in the warehouse (estimated in percentage of the total surface).

To evaluate the quantity of paddy to storage, we also estimate the density of paddy (that will define the needed capacity of storage according to the quantity to store).

For a given surface, we can also define the maximum height of the warehouse.

At last, the cost of warehouse is the yearly depreciation, depending on the life-time of the warehouse.

Cost of m2	100	USD/m2
Useful storage capacity	65%	%
Tons by m3	0,6	Tons
	For x m2 -->	*Maximum heigh*
Heigh	200	3
	500	4
	750	7
	1500	8
Life-time of warehouse	20	

Table 9 : investment's parameter for storage

In the simulation, we will also consider that warehouse are partly financed by long-term loan (the excel tool allows to modulate part of auto-financing and part of loan). The cost is the depreciation cost of the warehouse and the interest costs of the loan.

Rice harvesting process and prices

We will consider that most of varieties of rice can be dried and for those variety, it is possible to enter the maximum days of harvesting (for photo-sensitive varieties) between first day to harvest and last day. The life-time of harvested paddy (before total damage) is also an influent factor for the drying process.

In our simulations, we will consider the same conditions for all the varieties.

We also consider that cooperatives have 3 different kind of rice variety (1/3 of jasmine rice, 1/3 of Neang Malis (fragrant rice) and 1/3 of white rice.

Variety	**Distribution for drying**	***Type***	***Days of harvesting***	***Life-time of wet paddy before drying***
Jasmine Rice (Phka Rumduol, Malis)	**33,33%**	Fragrant	10	1
Jasmine organic		Fragrant	10	1
Sen Kraob		Fragrant	10	1
Neang Sauy	**33,33%**	Fragrant	10	1
Neang Malis		Fragrant	10	1
White long grain (not variety, kind of white rice)	**33,33%**	White	10	1
Phka Khngey		White	10	1
Long grain parboiled (not variety)			10	1
	100%		**10,00**	**1,00**

Table 10 : Rice varieties and harvesting data for economic tool

We also consider the different prices for variety (in our simulations, we'll take 2 prices, one for fragrant rice, one for white rice).

The price informations needed to make simulations are: 1) price of wet paddy after harvest 2) price of dried paddy after harvest (expresses in terms of margin rate) 3) price of dried paddy after storage (few months later harvest)

To compare all price *ceteris paribus* (in our case, for the same weight) we must know the difference of density between wet and dried paddy (the difference correspond to the decrease of moisture rate).

	Variety	Distribution for drying	Type	Days of harvesting	Life-time of wet paddy before drying	Price wet paddy	Gross margin rate	Price dried paddy	Ratio dried/wet paddy	Price dried paddy for 1 kg Wet
photoperiodic	Jasmine Rice (Phka Rumduol, Malis)	33,33%	Fragrant	10	1	900	15%	*1040*	88%	*915*
photoperiodic	Jasmine organic		Fragrant	10	1	900	15%	*1040*	88%	*915*
non-photoperiodic	Sen Kraob		Fragrant	10	1	900	15%	*1040*	88%	*915*
photoperiodic	Neang Sauy	33,33%	Fragrant	10	1	900	15%	*1040*	88%	*915*
photoperiodic	Neang Malis		Fragrant	10	1	900	15%	*1040*	88%	*915*
photoperiodic	White long grain (not variety, kind of white rice)	33,33%	White	10	1	800	15%	*920*	88%	*809*
photoperiodic	Phka Khngey		White	10	1	900	15%	*1040*	88%	*915*
photoperiodic	Long grain parboiled (not variety)			10	1	800	15%	*920*	88%	*809*
		100%		10,00	1,00	867		1000		880

Table 11 : rice market prices data for economic tool

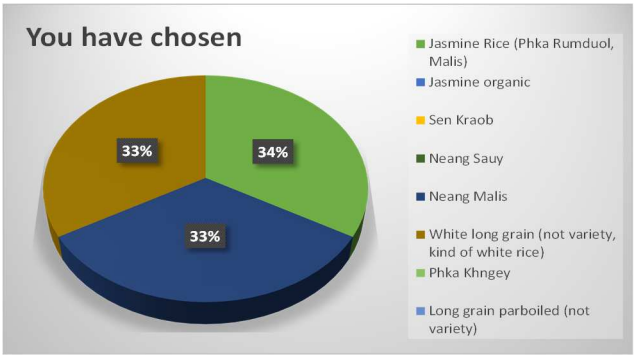


Figure 12 : Rice variety distribution for economic tool

Operational parameters

In simulations, the investments parameters we will use are summarized in the next table.

Investments data		
Item	**Data**	**Unit**
Type of dryer (Volume)	30	Tons
Number of dryer	1	
Cost of dryer (USD)	60 000	USD
Duration (years)	8	years
Depreciation yearly cost	*7 500*	USD
Electric transformer	10 000	USD
Km for connection	2	km
Cost of connection per km	10 000	USD
Lifetime	25	
Depreciation yearly cost	*1 200*	USD

Table 12 : investments data for economic tool

How many dryers?

The level of assets (dryers) will depend on quantity of paddy to dry but taking into account:

- *The tons capacity of the dryer*
- *The dry rate per hour of dryers*
- *Time needed to load and discharge dryer*
- *The rate of moisture decreasing*
- *The maximum time of harvesting*
- *The functioning hours of dryer per day*

For instance, if we have 1.000 tons of paddy to dry, the number of needed dryers will be calculated as follows:

1) Number of dryer loading: 1.000/capacity of a dryer. If we have a 30 tons dryer, the number of loading will be : 1000/30 = 33, 3.

2) Number total of hours : 33,3 x rate of moisture to reach/dry rate per hour + 33,3 x (loading time + discharging time)

3) Number of days needed : number total of hours/nb of dryer working per day

4) Number of dryers needed : Number of days/maximum time of harvesting

Financial data

The financial needs have two sides; first, the investment financing with 2 long-term loans (with periodic reimbursement), one loan for dryer, on loan for warehouse; secondly a working capital requirement loan (short-term loan) to finance the storage in case of selling several months after the harvest.

In the simulations, we will use financial conditions, based on current banking loan conditions in Cambodia (with an autofinancing ratio of 33%).

Financial information		
Investment loan conditions		
Autofinancing or grant	33%	%
Loan	67%	%
Yearly rate	8%	%/Year
Duration (years)	5	years
Grace period (in months)	12	Months
Seasonal loan rate		
Yearly rate	10%	%/Y

Table 13 : Financial data for Economic tool

Operational and labor data

The operational data concern:

1) Technical informations: moisture rate, drying rate, loading and discharging time, dryer working-time per day.
2) Energy consumption and costs : electricity, fuel

Operation data		
Electricity consumption	15,00	Kw/H
Moisture rate at harvest	25%	%
Moisture rate after drying	13%	%
Decrease points	*12,00%*	%
Drying rate/hour	1,50%	%/hour
Maximum dry duration/day	20	h
Loading time	61	min
Discharge time	63	min
Riel/KWh	690	kWh
USD/Kwh	0,173	USD/kWh
Fuel consumption	60	liter/hour
Cost of fuel	2 000	Riel/liter

Table 14 : Operational data for economic tool

And at last, the labor cost, with split between fixed labor costs and variable labor costs (daily workers).

Labor			
Fixed labor			Nb of months
Manager	300	USD/Month	12
operator	150	USD/Month	12
keeper	150	USD/Month	12
		USD/Month	
Variable labor			
seasonnal employee	5	USD/day	
Employee per tons	3,5	Tons/employee/day	

Table 15 : Labor parameters for economic tool

2.2 Results

With all the informational inputs above given, we will consider two final hypothesis:

1) The dried paddy is sold after the harvest and drying at the market price
2) The dried paddy is sold several months after the harvest and storage at an higher market price

The next figures must be read as follows:

- *The curves are the cost function of drying and storage expressed by wet paddy quantity (in tons)*
- *The lines are the margin gain between wet paddy and dried paddy (expresses in wet paddy quantity)*
- *The orange curve and line are expressed in Riel by kilogram (the right Y-axis)*
- *The blue curve and line are expressed un USD by ton (the Left Y-axis)*

- *When the curves cross the lines, the cost is cheaper than the gain and, for the quantity corresponding to this crossing, we obtain the "breakeven point". Under the line, the curve shows it is useful to invest in drying and storage facilities. Over the lines, the invest is non-profitable.*

The dried paddy is sold after the harvest and drying

In this configuration, the cost of drying and storage is much higher than the gain obtained between wet and dried paddy, so that the investment can't be profitable. It will bear the cooperatives and farmers to invest in such conditions in dryer and warehouse (cf. Figure 13).

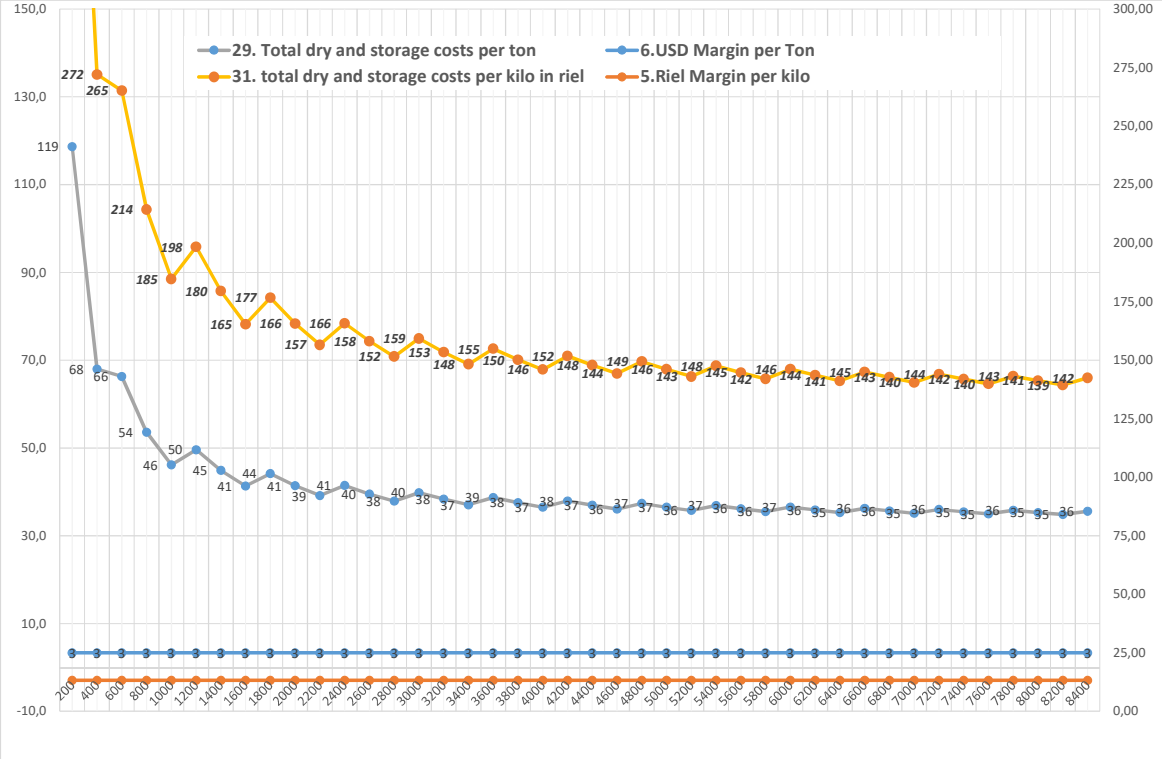


Figure 13 : Simulation 1: Drying cost analysis chart according quantity of rice for selling after harvest

The dried paddy is sold several months after the harvest and storage

For this hypothesis, we must anticipate (by speculation) the evolution of price for rice. So, we need another table with evolution of price for the following month after the harvest. This one is partly based on empirical informations obtained with met cooperative and partly theorical (we have no knowledge of future evolution of rice price). For the need of simulations, we will consider that the price is increasing at its higher price up to the 4th month and then begins to decrease after.

	After Harvest Price for dried paddy	Distribution for drying	Ratio dried/wet paddy	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
				5%	9%	15%	20%	17%	15%	10%
photoperiodic	Jasmine Rice (Phka Rumduol, Malis)	33,33%	88%	1100	1100	1150	1250	1200	1130	1050
photoperiodic	Jasmine organic	0,00%	88%	1092	1144	1227	1230	1250	1227	1196
non-photoperiodic	Sen Kraob	0,00%	88%	1050	1100	1150	1250	1150	1130	1050
photoperiodic	Neang Sauy	33,33%	88%	1092	1144	1227	1250	1200	1227	1196
photoperiodic	Neang Malis	0,00%	88%	1092	1144	1227	1230	1250	1227	1196
photoperiodic	White long grain (not variety, kind of white	33,33%	88%	966	1012	1085	1100	1100	1085	1058
photoperiodic	Phka Khngey	0,00%	88%	1092	1144	1227	1230	1250	1227	1196
photoperiodic	Long grain parboiled (not variety)	0,00%	88%	966	1012	1085	1230	1105	1085	1058
		100%								

Table 16 : Evolution of prices by varieties of rice along the months after harvest

In this configuration, normally, because of increase of price few months after the harvest, the difference between wet paddy and dried paddy prices is more consequent so that the cost of drying and storage is closer of the difference of prices between wet and dried paddy.

To check the influence of evolution of price during the year, we will try 2 sub-hypothesis:

- A storage for 4 months when the price is at its higher, 20% most expensive than after the harvest.
- A storage for 5 months when the price begins to decrease, only 17% most expensive than after the harvest.

The dried paddy is sold 4 months after the harvest and storage

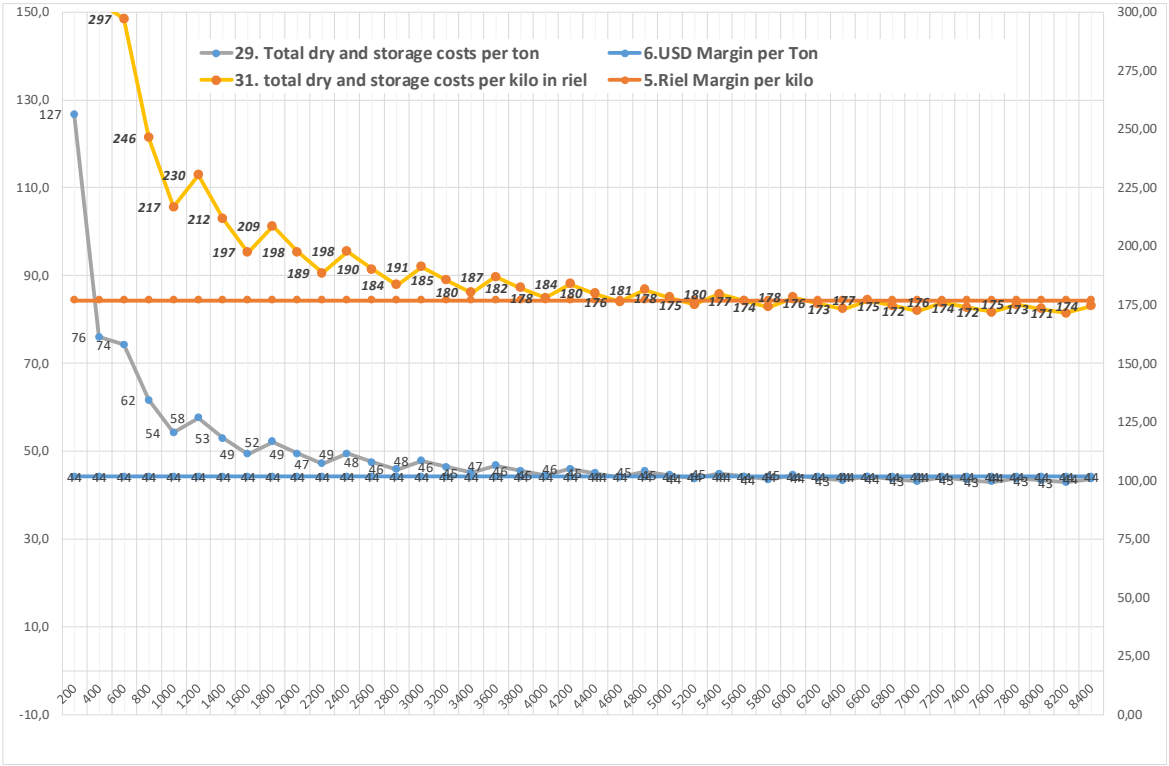


Figure 14 : Simulation 1: Drying cost analysis chart according quantity of rice for selling after 4 months of storage and 20% higher price.

With this hypothesis, the drying and storage cost will reach a breakeven point (cost lower than the price margin between wet and dried paddy) but for a big quantity of tons (at least 6.600 tons)

The dried paddy is sold several 5 months after the harvest and storage

In this new hypothesis, we have a small decrease of the price; the margin between dried paddy after storage, in this case, is no more 20% but 17%.

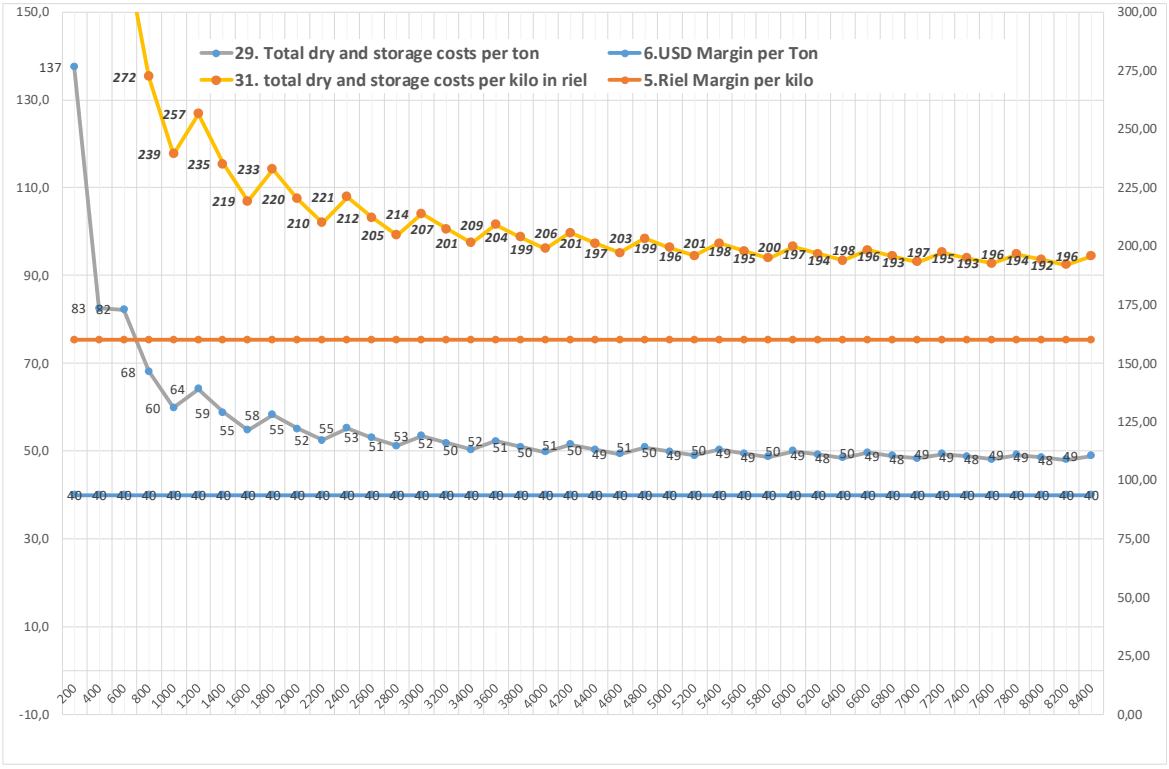


Figure 15 : Simulation 1: Drying cost analysis chart according quantity of rice for selling after 4 months of storage and 17% higher price

The figure shows that a small variation of price has a great consequence on the economic feasibility. Indeed, in this simulation (cf. Figure 15), there is no possibility to reach the break-even point and the evolution of price is too short to cover the cost.

3. Conditional hypothesis to reach profitability and choice to invest

3.1 New parameters scenario

Regarding the standard hypothesis, we will now change some parameters:

1) Mainly, we will consider this time that the Cooperatives or FO gathers farmers who have two separate kind of rice varieties: photo-sensitive (Jasmine) and not photo-sensitive rice. These 2 different categories allow to have 2 crops in the year at different times.

	Variety	**Distribution for drying**
photo-sensitive	Jasmine Rice (Phka Rumduol, Malis)	**50%**
photo-sensitive	Jasmine organic	
photo-sensitive	Sen Kraob	
non photo-sensitive	Neang Sauy	**50%**
photo-sensitive	Neang Malis	
photo-sensitive	White long grain (not variety, kind of white rice)	
photo-sensitive	Phka Khngey	
photo-sensitive	Long grain parboiled (not variety)	
		100%

Table 17 : New conditions of distribution of rice production with photo-sensitive and non-photosensitive varieties

With those modifications, we only consider two hypothesis of selling:

- After 4 months of storage with 20% of increasing of price between price at the harvest and price after storage

- After 5 months (with a 15% higher price with post-harvesting price)

Indeed, whatever the more favorable parameters we could take, it is obvious that investing in drying equipment is no sustainable with a post-harvest selling strategy.

3.2 Results

The dried paddy is sold after the harvest and drying with capital price of dried paddy 20% higher than after the harvest

With this new configuration, we observe a “point” where the cost curve comes below the price differential cost. That means that there are some conditions where the drying and storage investments can be profitable for farmers. In our simulation, the quantity of paddy to dry and storage to achieve this break-even point is about 1.500 tons of paddy (cf. Figure 16). But it means that 1) cooperatives must cultivates both photo-sensitive and non-photo-sensitive varieties 2) They must have the insurance that the price of dried paddy will be at least 20% higher few months later this harvest than just after the harvest, which is an optimistic increase.

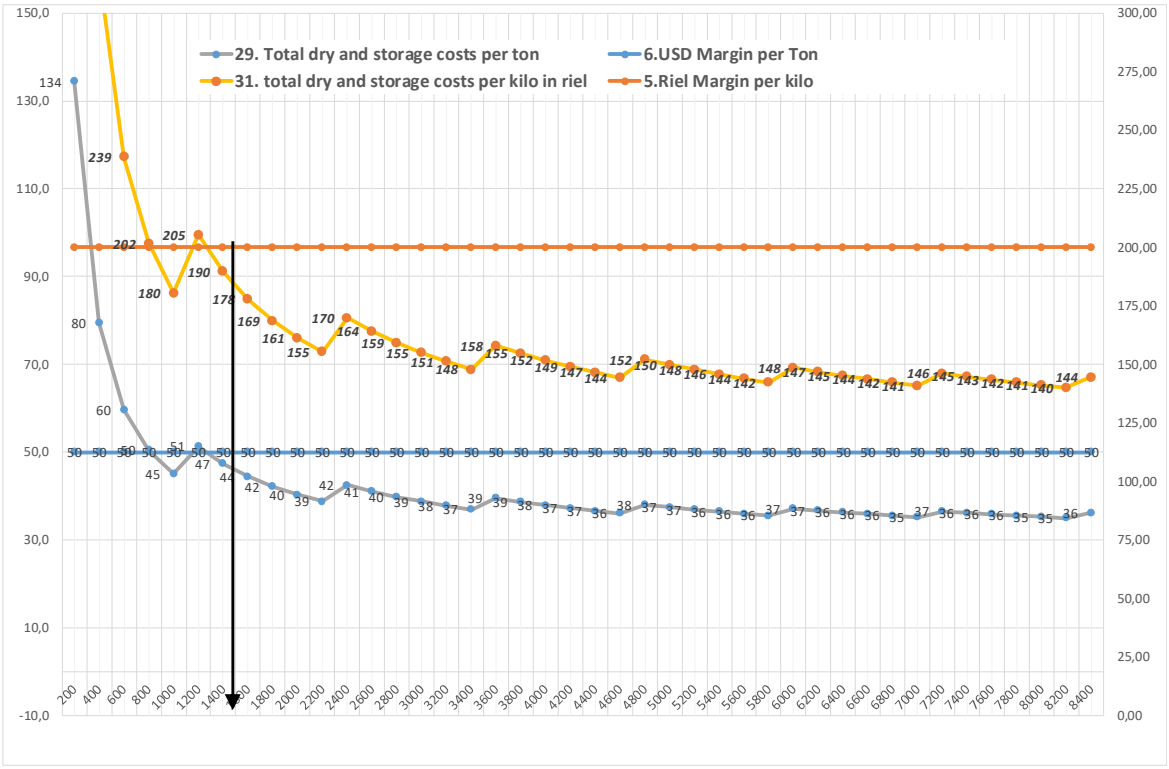


Figure 16 : Simulation 2: Drying cost analysis chart according quantity of rice for selling after harvest

The dried paddy is sold after the harvest and drying with a price of paddy 15% higher than after the harvest.

If we just change the hypothesis of price and considered this time that the price after 5 months is only 15% higher than after the harvest. we can observe a great difficulty to reach the break-even point. It would require at least 7.000 tons to be sure that cost is below the margin that makes the investment profitable. It shows the great influence of variation of price upon the economic feasibility of invest. (cf. Figure 17).

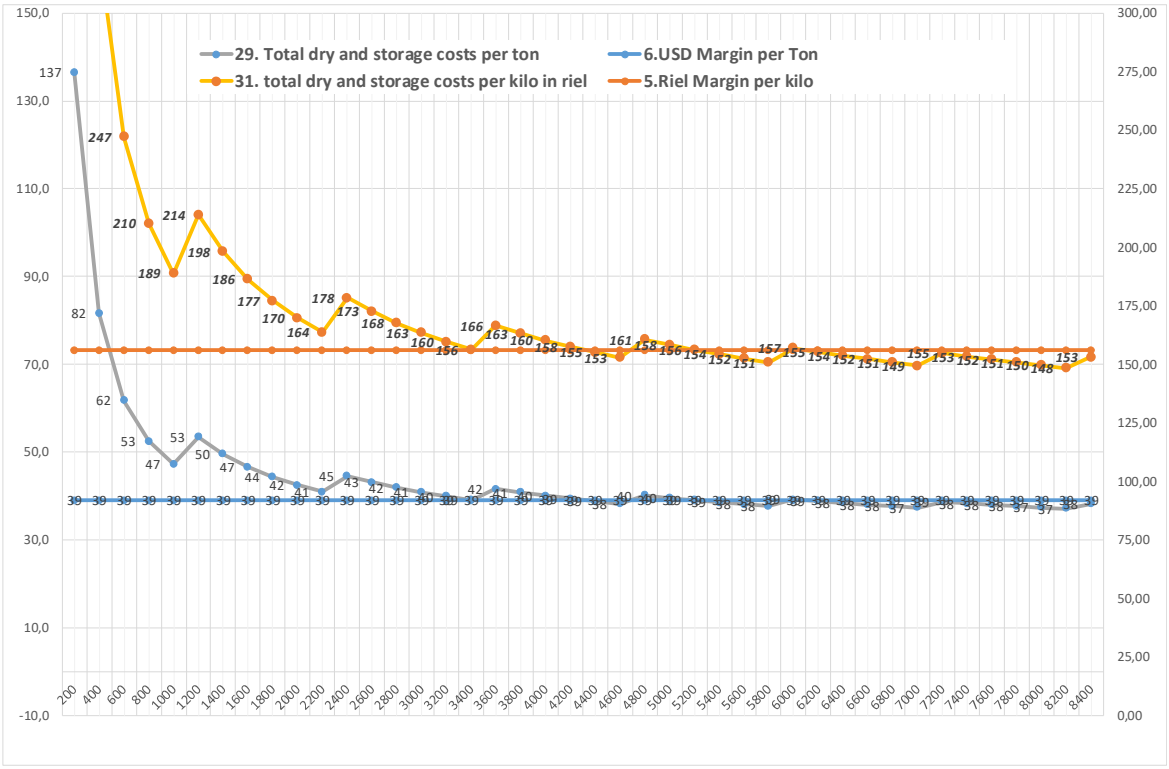


Figure 17 : Simulation 2: Drying cost analysis chart according quantity of rice for selling after harvest

Last simulation concerning the interest rate

To assess the influence of credit policy on results, we will consider this time a last simulation, with a more realistic price after harvest (only 15% higher) but with the existence of a subsidized rate for short-term loan; we will indeed suppose that, supported by donors, the Rural Development Bank (or commercial bank) is in capacity to lend with a 6% per year rate for long-term loans and working capital requirement (short-term loan).

In this simulation, the chart of comparison between cost and margin is the next:

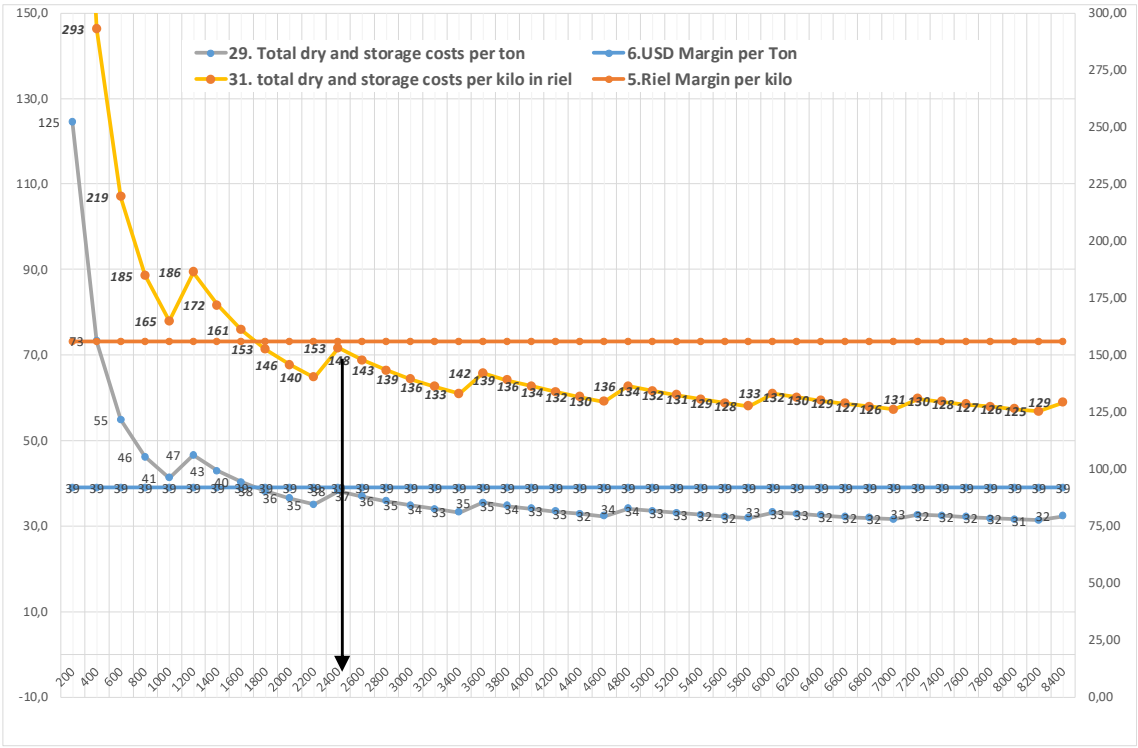


Figure 18 : Simulation 2: Drying cost analysis chart according quantity of rice for selling after harvest with subsidized interest rate

This time, the break-even point is reached with a quantity of about 2.500 tons to invest in drying machine and storage facilities, that proves this impact of interest rate in this economic model.

4. First elements of conclusion

In our projections and simulations, we can already have some first and certain conclusions, such as:

1. Investing in modern system of drying has no comparative advantage with traditional drying system (sun-drying) if this investment is not dedicated to store paddy and allow its selling after storage.
2. Even if cooperatives and FO have storage facilities and can wait before selling, this strategy is very risky because it will need big quantity of produced rice to reach some economy of scale. The capacity of cooperatives or FO to mix photo-sensitive and non-photo-sensitive is quite the only way to obtain this forwarded economies of scale. Profitability totally depends on a real and increasing variation of price between dried paddy after harvest and dried paddy after storage for several months. The found price information on the Cambodian market shows a variation at about 20% between dried paddy in November/December and April/May. But we have only price references on the previous year (2014-2015) and it is risky to speculate a regular 20% margin, as far as Cambodian rice market is included in a regional market, mainly dependent on Thailand's

rice exportation policy, so that the Cambodian rice price is a "exogenous"[7] price. The fact is that a small price difference will generates losses.

3. Fixed and variable costs have quite the same influence in the determination of costs. For 3.000 tons, with a 10% per year for the interest loan, the distribution of costs according their behavior will be as follows:

costs	USD per ton	Fixed/variable
fixed cost dry	14,93	17,42
fixed cost storage	2,48	
variable costs	14,05	23,43
cost of WCR loan	9,38	
Total costs	**40,8**	**40,8**

Table 18 : distribution of costing for 3.000 tons of paddy according fixed and variable costs

6. The cost of credit and mainly the cost of credit for working capital requirement in case of storage (interest costs) has a huge impact on the total cost. If we consider a quantity of 3.000 tons, with an interest rate of 10% per year and a duration of storage of 4 months before selling, the repartition of cost for the drying and storage is distributed as follows:

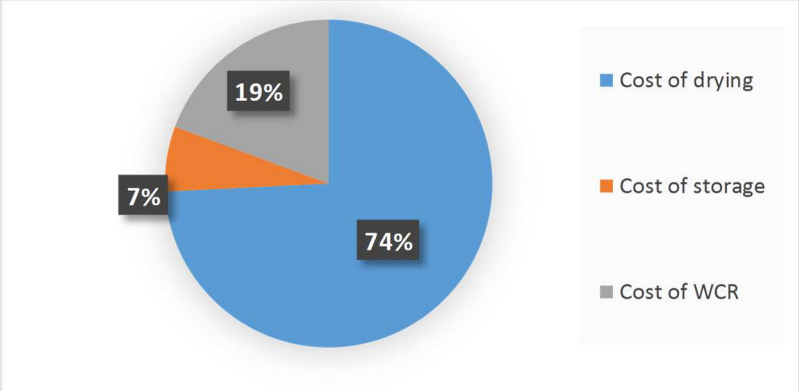


Figure 19 : distribution of cost according type of cost

We can notice that the weight of storage cost is economically low whereas the interest costs for cash needs (for 4 months) represents nearly 20% of the total cost of drying and storage process (cf. Figure 19).

Indeed, for 3.000 tons to dry and store, if we consider that a cooperative must borrow totality of cash to pay the farmers after the harvest (at the market price for wet paddy), such a cooperative will need to borrow 3.000 tons x 1000 kilo x 850 riel/kilo = 2 550 000 000 riels or 637.500 USD (for 3.000 tons, the same cooperative will need about 4 dryers, so about 250.000 USD for 100% loan).

[7] Not determined by cost of production but by international supply and demand market.

This shows that it will be very difficult for cooperative or others stakeholders to invest in such equipment if they have no capital to reduce the cost of lending. This stake concerns mainly the working capital needs.

4.1 Sensitivity Analysis

Cost analysis

To confirm the previous simulations, the Excel© financial tool allows all possibility of variation of parameters in order to assess the most influent variables on cost function. If we make a sensitivity analysis to check which parameters have most influence on results (decrease of costs), we can proceed as follows:

- For a given quantity of paddy, we use the same parameters for a basis cost result.
- For a list of parameters, we only change one parameter with a defined variation (33% by example)
- We change, one by one, each parameter with the same variation
- We compare which variation of which parameter has most influence on cost.

For the 10 following parameters, for 4.000 tons, current conditions of credit, and a variation of 33% for each parameter, we obtain the next table (cf. Table 19):

		Variation of 33% for each parameter									
	Initial Data	Cost of machine	Time harvesting	Dry rate per hour	Life-time	Debt rate	Loan duration	Interest rate for invest	Electricity cost	interest rate for WCR(*)	cost of storage
Cost of machine	60 000	40 200	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000	60 000
Time harvesting	10,00	10,00	13,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Dry rate per hour	1,5%	1,5%	1,5%	2,0%	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%	1,5%
Life-time	8	8,00	8,00	8,00	10,00	8,00	8,00	8,00	8,00	8,00	8,00
Debt rate	67%	67%	67%	67%	67%	45%	67%	67%	67%	67%	67%
Loan duration	7	7,00	7,00	7,00	7,00	7,00	9,31	7,00	7,00	7,00	7,00
Interest rate	10%	10%	10%	10%	10%	10%	10%	6,7%	10%	10%	10%
Electricity cost	690	690	690	690	690	690	690	690	462	690	690
interest rate for WCR(*)	10%	10%	10%	10%	10%	10%	10%	10%	10%	6,7%	10%
cost of storage (cost of m2)	100	100	100	100	100	100	100	100	100	100	67

(*) Working capital requirement

Total dry and storage costs per ton in USD	53,0	45,3	47,1	44,7	49,6	50,9	52,8	50,8	52,7	50,3	52,2
total costs per kilo in riel	212	181	189	179	198	204	211	203	211	201	209
	Variation	-14,6%	-11,1%	-15,7%	-6,4%	-4,0%	-0,3%	-4,3%	-0,6%	-5,1%	-1,5%

Table 19 : Evolution of drying cost according variation of each parameter of costing

The conclusion can be expressed as follows:

- The dry rate per hour has the most influence (an increase of 33% of this rate implies a decrease of the cost of almost 16%) on the cost of drying: indeed, this rate totally determines the need of invest and the number of dryers to buy.
- The cost of machine is also a main factor of cost (a reduction of 33% of the assets cost implies a decrease of 15% of the price)
- The time of harvesting and in a lesser extent the life-time of dryer have less influence but there are also an important factor of cost.

- We can also notice that the interest rate has influence on cost but mainly the interest rate for working capital requirement, whereas the interest rate for finance the investment has less impact.
- At least, the variation of cost of storage is not the main stake for assessing the opportunity to invest.

4.2 Price analysis

We can also consider the sensitivity to the variation of price and consequence of variations on the net margin for cooperative. The excel tool allows this analysis with the price reference taken for simulations.

By instance, for one variety of rice, the jasmine rice, we can assess the sensitivity of variation of price upon the net margin.

In the next table, we start from a 20% higher price after storage (1.250 riel/kg) than after harvesting (1040 k€) for dried paddy. For this increase of price, we have a margin of 0,75 USD per ton (3 riel per kg). if the price would be 19% higher rather 20%, this margin will be negative of 2 USD per ton. At the opposite, with a 1% higher price (21%), this margin will be 3,26 USD per ton.

		Price dried paddy after storage	*Price dried paddy after harvest*	*Commercial margin (in riel/kg)*	*Net margin (in Riel/kg)*	*Net Margin (in USD/tons)*
less	**-10%**	1146	1040	106	-101,0	-25,24
	-5%	1198	1040	158	-49,0	-12,24
	-2%	1229	1040	189	-18,0	-4,49
	-1%	1239	1040	199	-8,0	-1,99
Margin	20%	**1250**	1040	210	3,0	0,76
more	**1%**	1260	1040	220	13,0	3,26
	2%	1270	1040	230	23,0	5,76
	5%	1302	1040	262	55,0	13,76
	10%	1354	1040	314	107,0	26,76

Table 20 : sensitivity of variation of price upon the net margin (price –cost)

It shows (has demonstrated before) the extreme influence of variation of price on economic feasibility for cooperative to invest in drying facilities and the weight of risk in such investment, due to dependence on market price.

4.3 Conclusion

According the current technical, commercial and financial situation found in Cambodia, all the conditions for cooperatives to invest in drying and storage facilities doesn't totally exist and they will however are submitted to a couple of conditions without which it is quite impossible to achieve economic equilibrium of this model. Those five major conditions are:

1. For such investments, it is necessary (by security) to have at least 2.000 tons and more probably 3.000 tons of paddy to dry each year. This quantity should be easier to obtain with cooperatives in areas that can have 2 productions by year or with combination of photo-sensitive and non-periodic rice
2. For such investments, it is required to sell the paddy at its higher price and not just after the harvest and a guarantee that this higher price will be at more or less 20% than the price after the harvest. This is a speculative choice whereas the cooperatives have no information about the evolution of price. It also means storage capacity with consequent warehouse. It also means a variety and type of rice with more added-value such as the difference of price between wet and dried paddy after storage is consequent in absolute value.
3. For such investments, the technical performances of vertical dryers must be intensively studied. Indeed, the couple cost/life-time of the machines but also the dry rate proposed by constructors are a very significant influence on total unit cost.
4. There is a strong relationship between the process of cropping and harvesting and the total assets to invest. Indeed, the level of investment depends on harvesting calendar: Given the short duration of wet paddy before diminishing quality and so, to guarantee the quality, it is necessary to dry paddy just after the harvesting. As a consequence, the shorter the period of harvest is, the more dryers it will be necessary to buy (in order to dry paddy at the same time). The issue of schedule and optimized calendar of harvesting (so calendar of seeding) is very significant. That's why the capacity of cooperative to cultivate photo-sensitive and non photo-sensitive would be a way to lessen the average drying cost, optimizing the use of dryers.
5. At least, storing paddy before selling requires to pay farmers before collecting cash of sellers. The cooperatives (or other dryer stakeholders) must have enough working capital to purchase paddy before selling as far as the cost of short-term credit would bear the profitability of the economic model.

V. GOVERNANCE MODELS AND FINANCIAL CONDITIONS

If we consider there is economic opportunity for cooperatives to invest in dryer and storage (even if prerequisite conditions above described are not currently existing), the question of governance, organizations and financial access can be anticipated.

There is several possible scenarios that we can first separate in 2 different strategies:

1) The strategy consists in by-passing (short-circuit) middlemen: this strategy has several advantages: 1) to be in the continuity of the SNEC strategy initiated by contract farming, to bring farmers and miller together 2) to create added-value by removing intermediates.
2) The strategy consists in specialization of the supply-chain: this strategy is based on the enhancement of a weak link in the current supply chain: the collectors or small millers and to develop them as dryer specialist. This strategy could have at least 2 advantages : 1) to enhance stakeholders who have already some skills in terms of management and business (and who have already invested in storage warehouse for most of them) 2) to include collectors (becoming dryers) as a real partner of contract farming, reducing informal market and informal export trade.

1. Bring together cooperatives and rice millers

This strategy can cover different models. Based on old relationship between rice millers and farmers, the objective is to pass-by the middlemen

1.1 One big cooperative

According conditions to ensure financial equilibrium of investment in drying and storage system, it is necessary to have at least an “enterprise” in capacity to dry and store 3.000 tons per year. In case of a cooperative, if we consider that members of this cooperative have about 0,5 hectares by smallholder (excluding land for own consumption), and if we also consider that the average yield for 1 hectare is 3 tons, we can conclude that minimum members of cooperative to invest in drying must be 2.000 of farmers. In case of second cropping by year, these members could be at least 1.000 members.

Currently, the most important Farmer Organizations that can gather more than 1000 or 2000 members are the FWUCs (irrigation communities). It means that PSG (Paddy Selling Groups) stemming from FWUCs shall gather maximum members from their FWUC.

In this configuration, a cooperative (or FO) must have an organization turned towards operational skills through creation of salaries function under the responsibility of a managing director (cf. Figure 20).

According the normal governance of a cooperative, it could be a section of the cooperative in charge of the drying and storage activities, under the responsibility of a managing director hired by the board of committee (itself under the control of a monitoring committee / or internal audit committee).

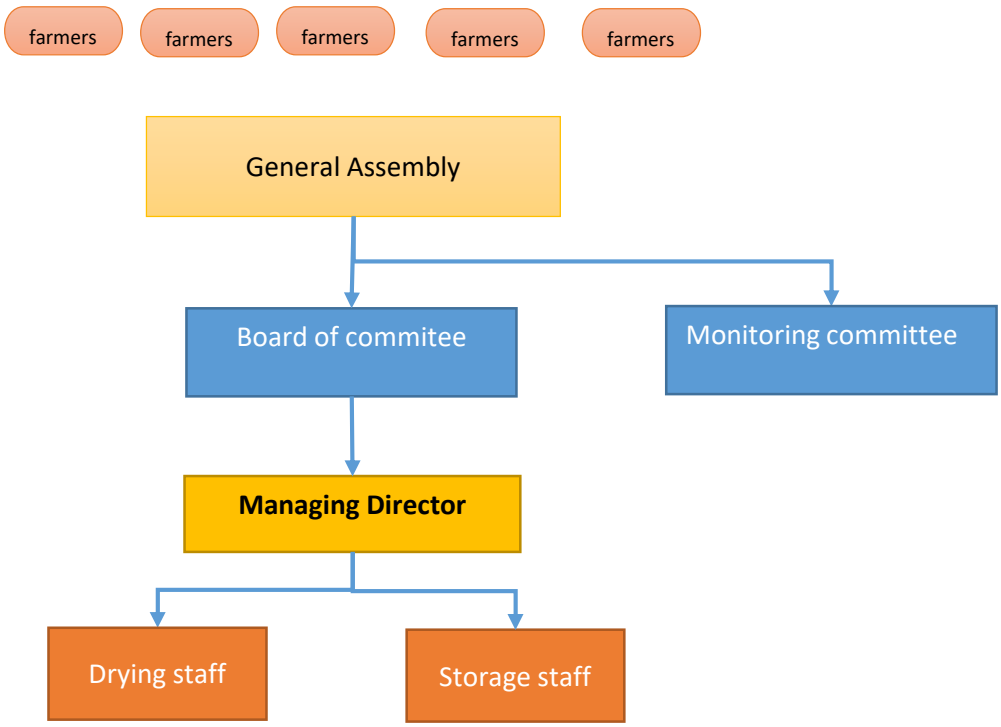


Figure 20 : Organisation chart of Cooperative for drying and storage activity

This means that the Cooperative hires competent staff dedicated to the dry and storage activities and remunerated for this full-time job.

Actually, the operational staff could also be a separate staff under a delegation contract between cooperative and a small rural entrepreneur.

1.2 An Union of Cooperative

The Union of cooperative is by definition a gathering of cooperatives. Union of cooperatives is ruled according the same governance than a cooperative. In this model, we have several medium size cooperatives, linked by proximity relationship that build one union of cooperative.

So, the organization will be designed as follows (cf. Figure 21):

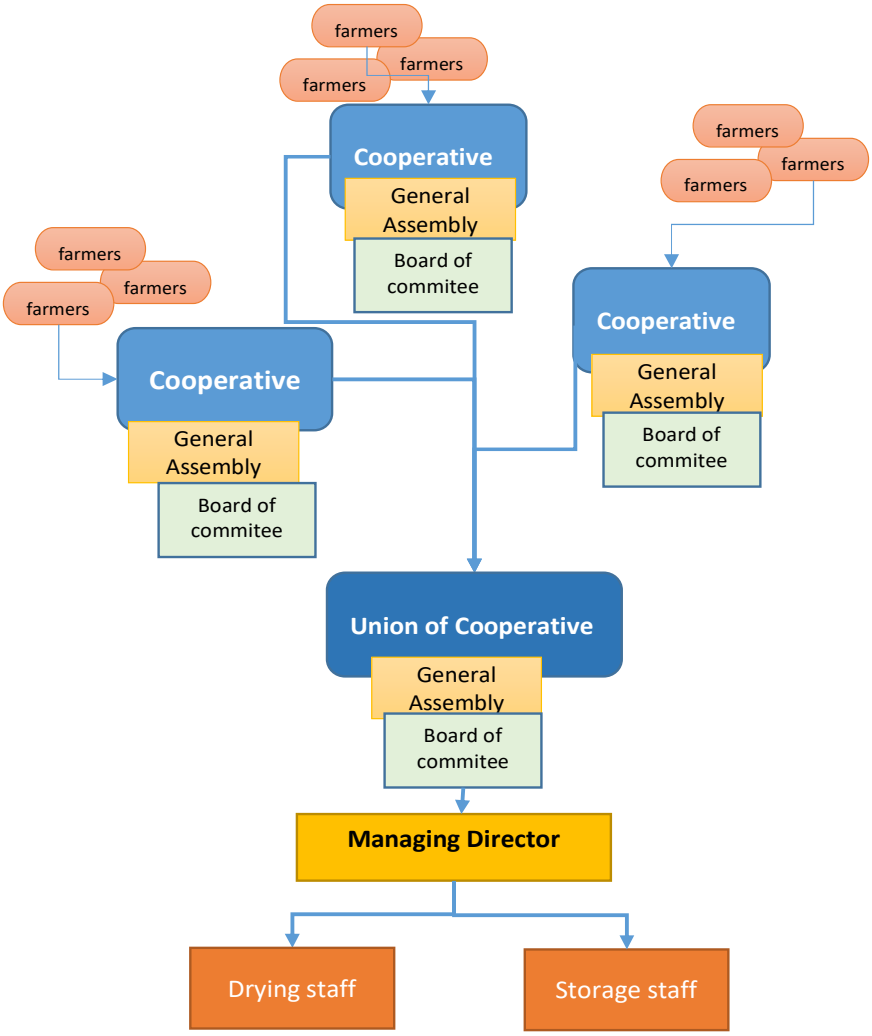


Figure 21 : Organisation chart of a Union of Cooperatives for drying and storage activity

A Union of Cooperatives is managed as a cooperative. So, in this model, the organization of the Union will be copied on a cooperative organization with a board of committee (and a monitoring

committee also) and a system of section by activity. The Board of committee could hire and control a managing director and staff for drying and storage.

In this model, the governance is more complicated because the Union must have a democratic and professional management, depending on the real involvement of each cooperative in the Union.

1.3 A joint-venture

In this case, a rice miller and several cooperatives decide to create a private company and to become shareholders of this company. In Cambodia, there is different model of companies. The most usual is the private limited company. A private limited company is a form of limited company with characteristics as follows:

- The company may have from 2 to 30 shareholders (when a private limited company is established by one person, it shall be called a "Single Member Limited Company.")
- The company may not offer its shares to the public.
- The minimum numbers of share must be at 1.000 with a nominal value of 4.000 riels (so, the minimum capital is 1000 USD.
- The company has one or more restrictions on the transfer of each class of its shares.
- The company shall be considered as a private limited company once registered in compliance with prescribed forms determined by a Prakas of the Ministry of Commerce.

Governance of Cambodian private limited company

- **Directors**

The private limited company shall have one or more directors. Shareholders elect directors by ordinary resolution and the board of directors shall elect a chairman from among its members by a majority vote of the directors. Each director shall be elected for a term of two years and may be re-elected.

- **Board of Directors**

The Board of Directors manages the business of the company. The directors may exercise the following power, such as:

- Appoint and remove all officers, determine the specific powers and set the salaries and other compensation for such officers.
- Issue notes, bonds and other evidence of debt of the company.
- Propose to shareholders amendment to, or removal of the articles of incorporation, or an agreement of merger or consolidation between the company and any other person.
- Propose to shareholders a dissolution or liquidation of the company, etc.

In this model, we can imagine a governance described according the following scheme (cf. Table 22):

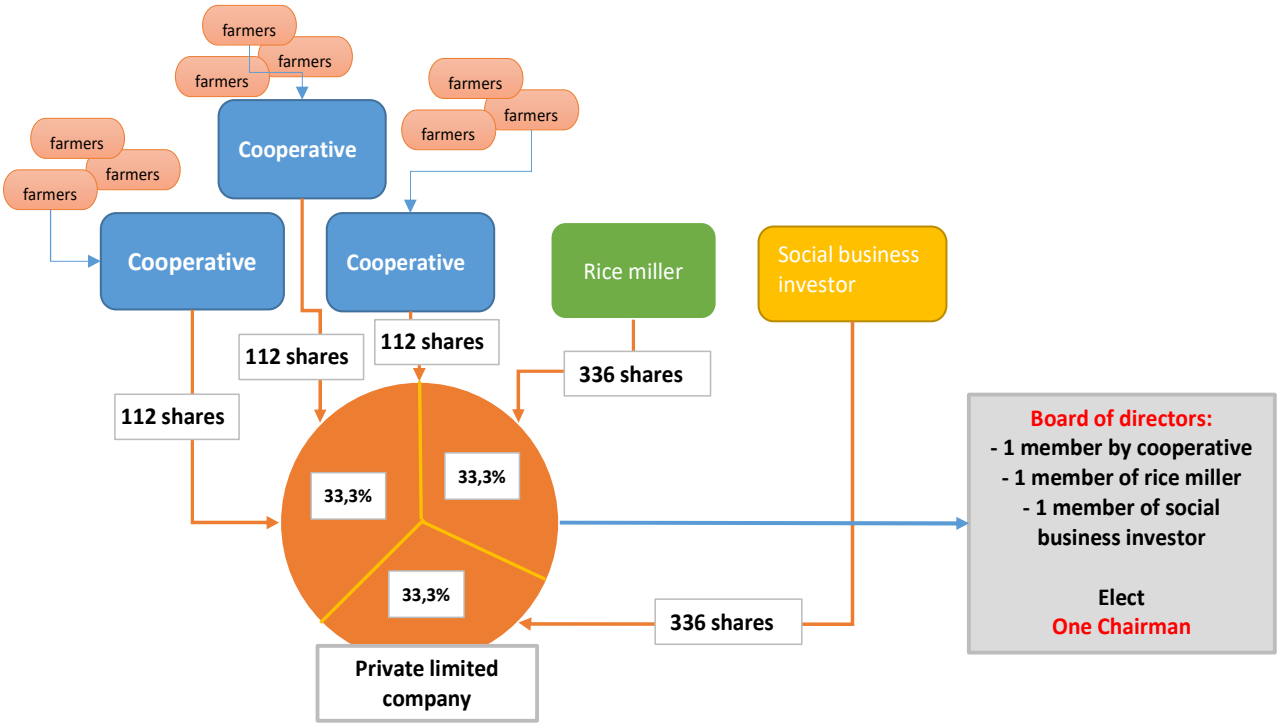


Figure 22 : Governance chart for a joint-venture for drying and storage company

This governance is based on the next principles:

- In order to guarantee a balanced relationship in the board of direction and also to bring an important capital, the joint-venture could join 3 kind of shareholders: a rice milling company, Agricultural cooperatives and another investor, such as international social business investor.
- In the status, the number of directors in the board of directors is defined such as the three parties (cooperatives, rice miller, other investors) have the same weight (or nearly) independently from shares holding. It means that the number of shares determine the potential dividends of each shareholders but not the distribution of directors (and one or two directors can be from non-shareholder institution).
- The Directors from cooperatives would be chosen by each general assembly of each cooperative, by vote (and perhaps would it better that the representative of cooperative in board of directors of joint-venture would not be the cooperative chairman).
- The Chairman of the board should be a rotating post (change each 3 years by example) to guarantee the rotation of institutions (cooperatives, rice miller, others shareholders) at the head of the board.
- At least, even if the rice milling company have its own competent staff, the staff of the joint-venture should be specially hired for the new company and not provided by the rice miller (to avoid direct hierarchic relationship between rice miller and staff of the joint-venture.

2. The financial need

Whatever the form of chosen governance and organization between stakeholders, the main stake will lies on the financial issues. If some financing can be found for investment, the working

capital will remain an essential part of the feasibility of the economic model. Indeed, for 3.000 tons of paddy, and if we consider that Cooperatives, either alone or through union of cooperative or through joint-venture can bring 25% of financial need for working capital, the remained need of cash will amount more than 500.000 USD (cf. Table 21.

Fragrant paddy price	900	Riel/kg
price in USD/tons	225	USD/tons
Tons	3 000	tons
Purchase cost	675 000	USD
Autofinancing	25%	%
Short-term loan need	**506 250**	**USD**

Table 21 : Evaluation of loan amount for working capital requirement

It means that with a 10% yearly interest rate, this amount will cost more than 25.000 USD after 6 months of loan, so 8 USD per ton or 33.000 riel per tons (33 riel per kg).

This cash cost implies that it would be very difficult for a cooperative or even for an union of cooperative to invest, not mainly because of invest cost but because of working capital requirement according the current banking conditions. Indeed, even the Rural Development bank shouldn't in capacity to lend to cooperatives because:

- The rural development bank only lend 4 times the capital of cooperatives (for a cooperative of 2.000 members for 3.000 tons of paddy, borrowing 500.000 USD will oblige the cooperative to have 100.000 USD capital, so 50 USD brought by each farmer.
- The maximum amount of loan for cooperative for short-term loan is 100.000 USD, much less than financial need for 3.000 tons of paddy to dry and store.

This finding brings the evidence that no financial institution (and even not RDB) can currently provide cash for cooperative for working capital requirement for such financial needs (several hundreds of thousands US dollars). It would require some substantial collateral (750.000 USD by example for 500.000 borrowed) given by pledging land title or real estate.

This finding advocates for a joint-venture solution, not only including rice millers and cooperatives but also other shareholders that could bring enough capital to reduce the working capital requirement and avoid over and too expensive credit costs to make the system profitable. Moreover, nowadays, a company have more opportunities to find a commercial loan to private banks with better loan conditions

Another way to solve this problem would be in touch with an institutional financer that will provide warrantage (inventory-credit) with paddy inventories accepted as collateral. The stored paddy is a real guarantee, whose value is known (market price) and that can be warranted with security.

This mean that a specific project should introduce this system of credit, with financial institution (RDB) which accept to experiment this new kind of loan (warrantage) and strong input from donor to secure the system (guarantee fund by example).

The following figure (cf. Figure 23) and explanations could be tested (with the model of joint-venture).

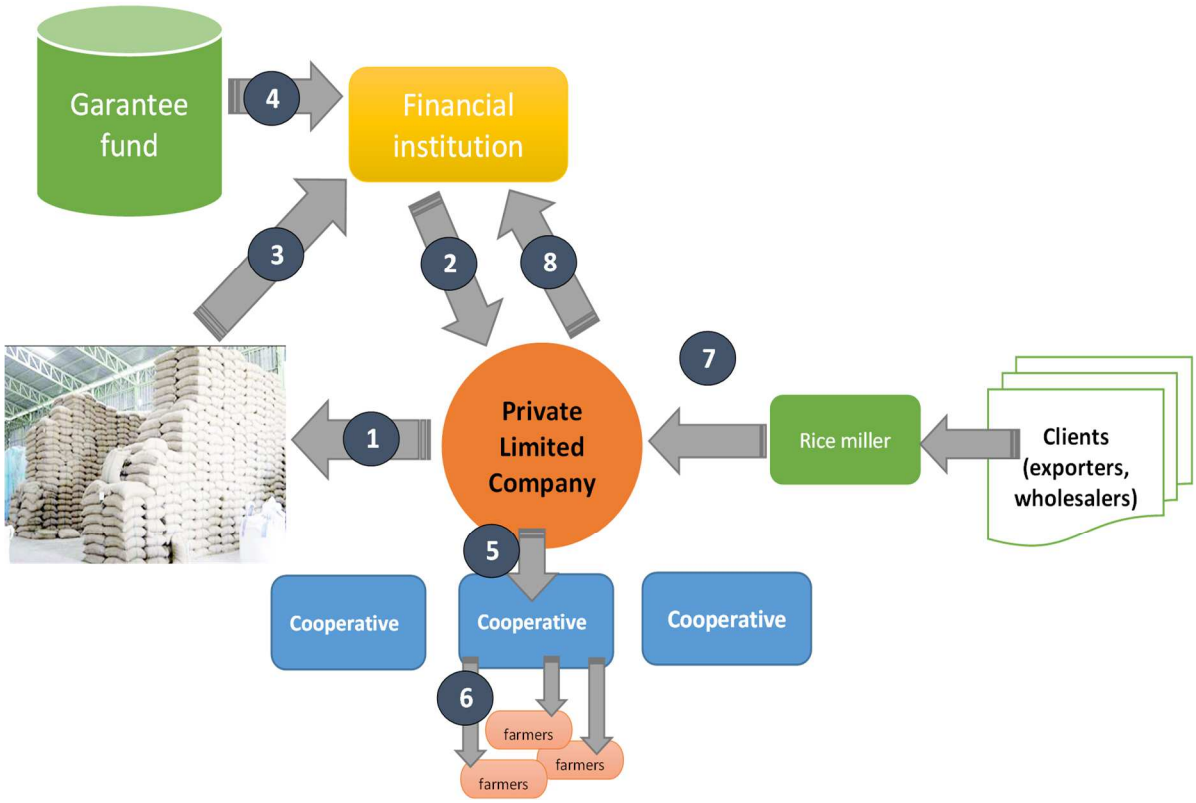


Figure 23 : Proposal of financial circuit for working capital financing with joint-venture model

(1) After drying, all the cooperative store dried paddy in the warehouse belonging to the joint-venture.
(2) The company borrows short-term loan to financial institution with a subsidized rate. The loan amount corresponds to the value of paddy inventories (market price)
(3) In counterpart, the total inventories of dried paddy is warranted by the financial institution. Both the financial institution and the store responsible have keys of warehouse and common procedures to ensure the total security of inventories (as collateral).
(4) The financial institution has besides a guaranty funds in case in insolvency (for inventory damage for instance).
(5) With cash from loan, the company can pay the cooperative for the value of stored paddy.
(6) The cooperative pay each member farmer at the harvest market price for dried paddy

***Nota bene**: For this step, it can be prejudicial for farmers to wait a couple of weeks before being paid if the bank only deliver cash after checking that all rice production is collected and store. It will require some financial procedures to avoid such disadvantage*

(7) After few months, the company and the miller decide to mill the paddy and to sell it to final customers (exporters, wholesalers, etc.)
(8) The miller pays the company after the selling.
(9) The company reimburses the financial institution.

If profit, at the end of the fiscal, dividends are shared between shareholders; the cooperatives increase their equities.

Warrantage system (inventory credit)

Warrantage, or inventory credit system, has been used at the origin, by European farmers in the 19th century. Under the warrantage system, farmers, rather than selling their harvest at once, can use it **as collateral to obtain credit from a bank**. In return for a bank loan the farmers left their produce in a **locked warehouse with keys held by both the bank and beneficiaries (or warehouseman)**. The credit gave the smallholders the means to buy essential inputs for the next planting and also allowed them to hold on to the produce until the lean season — when food stocks start to run low and prices climb.
The required elements for inventory credit have to be in place: 1) a well-functioning farmer's association, 2) an interested local bank or other financial institution, 3) a safe place where to store the produce 4) The crop used to guarantee loans must be non-perishable and 5) its price must have a proven record of rising in the months after harvest 6) Finally, agricultural produce as a guarantee for a bank loan needs to be recognized by the banking legislation of the country concerned.

3. Specialization strategy in drying process

In this strategy, the aim is to build a new stakeholder, specialized in drying and storage paddy. It will consists to convince current collectors, who only store paddy and act as middlemen between farmers and ricers to invest in drying system and to upscale his skills and competencies.

Such a strategy could be achieved by a tender or a call for proposals for collectors who are interested in such project. The interested collectors should:

1) Have already secure and large capacity of storage.
2) Bring a consequent level of autofinancing.
3) Propose a financing plan (with business plan)
4) Propose a technical solution and staff team to manage the whole process.

The advantage of such a strategy can sum up as next:

4) The current collectors have sometimes already invested in warehouse
5) They have better skills in terms of cash and logistics management than the cooperatives.
6) They probably have more capital to invest than cooperatives.

At last, those stakeholders could become part of contract farming with a three parties contract between Cooperative, collector-dryer and rice miller, where obligations and rights will be defined for all.

Such a model could be sum up according to the following figure (cf. Figure 24):

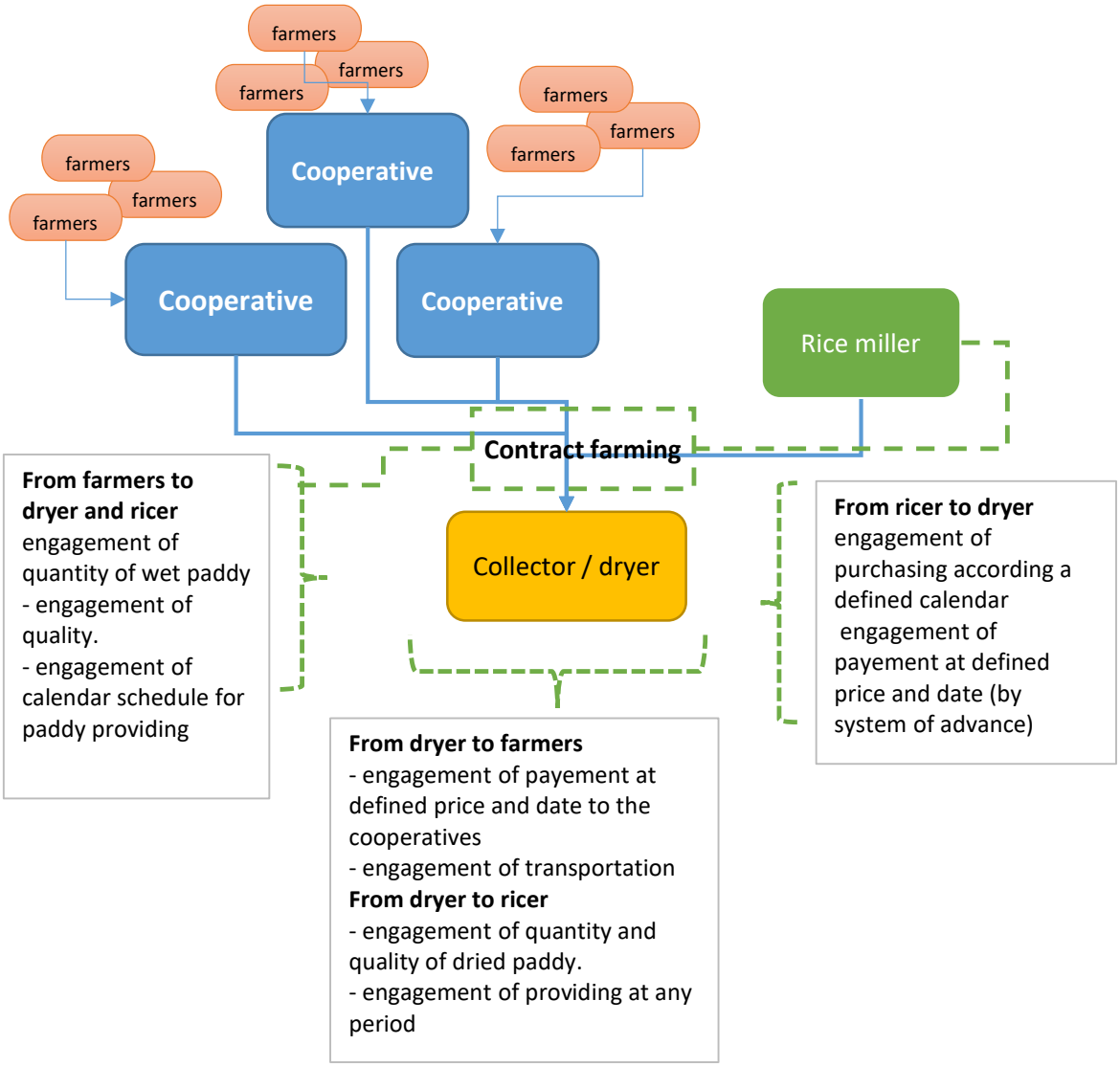


Figure 24 : Organisation chart and contracting relation for a specialized collector-dryer work in rice supply chain

One of the advantages of such model could also be a way to increase working capital availability. Indeed, in a three parties' contract farming, the payment of farmers after the harvest could be made both by collector and ricer (with loan besides financial institution). The financial model could be schematized as follows (cf. Figure 25):

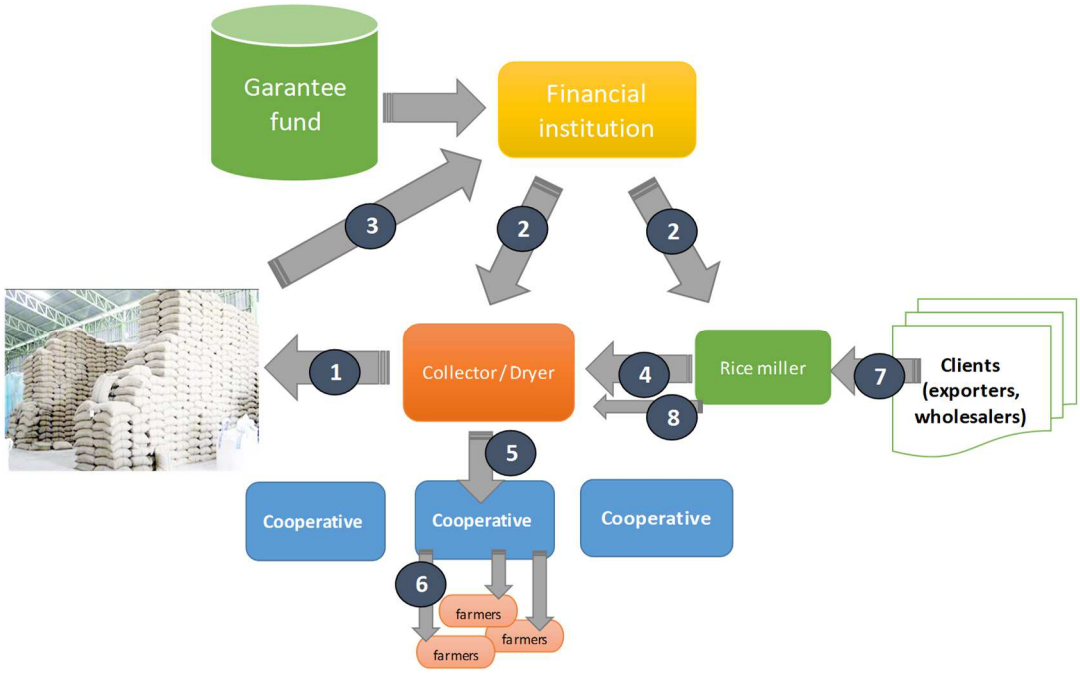


Figure 25 : Proposal of financial circuit for working capital financing with specialized collector-dryer

(1) After drying, all the cooperative sell the wet paddy in the warehouse belonging to collector-dryer.
(2) The collector dryer and the ricer both borrow short-term loans to a financial institution. The rice miller pay by advance a part of the stored dried paddy to the collector.
(3) In counterpart, the total inventories of dried paddy is warranted by the financial institution (with a system of double keys of warehouse). The financial institution has besides a guaranty fund in case in insolvency (for inventory damage for instance).
(4) With cash from its loan and with advance from the rice miller, the collector-dryer can pay the cooperative for the value of stored paddy (cf. ***Nota bene*** above)
(5) The cooperative pay each member farmer at the harvest market price for dried paddy
(6) After few months, the ricer decide to mill the paddy and to sell it to final customers (exporters, wholesalers, etc.). He is provided in dried paddy by the collector.
(7) The ricer pay the balance of its selling when all inventoried paddy is provided.
(8) The ricer and the collector reimburse the financial institution.

VI. CONCLUSION

There are some narrow possibilities for investing in modern mechanical dryers for storage. The previous analysis has shown that it would be economically possible but for a large quantity of produced paddy (under 3.000 tons, with favorable conditions, the break-even point can be

achieved) but with insurance that paddy after few months of storage is about 20% higher than after harvest and also with some guarantees about technical specifications from companies (dry rate, life-time, etc.). It will also deeply depends on a strict harvesting calendar, so a strong organization of farmers' production to ensure the optimization of investment.

But, even if the economic prerequisite conditions could be achieved (they are not), the mains stakes are not only economic or technic.

These mains stakes are twofold:

First the relative weakness of cooperatives in terms of business management: the existing experimentations of cooperative for storage, drying and even milling for some of them are not concluding (and even with bankrupt end). The lack of technical skills, of industrial and logistics organization, of maintenance are currently obvious.

For investing in drying and storage equipment that requires real management competencies, the cooperative should have:

- A long term vision and plan for its cooperative.
- A clear structure and a professional accounting system and knowledge in financial management.
- A committee of members who would have the experience and skills needed to develop business plans, leadership and management skills, a network with development partners, buyers, and local authorities on a communal, provincial and national level, etc.
- A salary staff, hired on competencies criteria and in capacity to technically and financially manage the drying and storage facilities.
- At least, a level of proper equities that gives cooperatives a sufficient working capital to work.

Nevertheless, even with those fulfilled conditions, the conditions of success are not enough. The current banking and microfinance sector is not adapted to cooperatives needs. Indeed, the real assets owned by cooperatives are the rice production that represent a real collateral. However, nowadays, bank and even microfinance institutions only accept land title and real estate (contract farming or other collateral could be accepted but only as complement and not substitution of land title and real estate).

Moreover, the real financial need less concerns the access to long-term loan to invest in assets than the short-term loan for financing the working capital requirement. This is financially the main stake for cooperatives.

Those current circumstances and facts bring the next conclusions:

- A model where a big cooperative or a union of cooperatives should invest by itself in drying and storage facilities is the more risky and difficult model to implement and it would appear a too early strategy. Even in case of joint-venture with a professional rice miller, a strong program of capacity building (in business management) should be carried out to guarantee success of such model (cf. Table 22). The capacity building of cooperative is the most relevant issue and any project should first provide trainees and support in business management to cooperatives.
- A project that would implement a drying and storage system, with involvement of cooperatives or with specialization strategy through collectors should also integrate a new financing model; indeed, as far as the investment in drying machines requires a high level of rice quantity to store, the needed working capital is essential. Such a program should include bank as partner that would accept to test new collateral with warrantage financial services.

In conclusion, allowing cooperatives (and even collectors) to invest in drying requires a long-term process where the investment will be a conclusion and not a beginning of pilot project. The first years will be first dedicated to:

- Capacity building strong enhancement (for instance organized by the Cambodian Rice Federation)
- Storage investment and support to cooperatives (or union of cooperative or collector) to manage storage.
- Support to working capital constitution with a financial experimentation of warrantage credit system with an interested national bank, supported with a guaranty fund from donors.

This means that investing in drying system should be a medium (or long) term process included in a larger project that will integrate strong capacity building inputs and financial innovations for Cambodian agriculture.

Items	Scenario 1 : One big cooperative	Scenario 2 : Union of cooperatives	Scenario 3 : Joint-venture	Scenario 4 : collector become dryer
Achievement probability	**	*	****	***
Ownership of investment	Cooperative	Union of cooperative	Joint-venture	Individual
Need to invest in Drying machine	Yes	Yes	Yes	Yes
Need to invest in warehouse	Yes	Yes	Yes	not mandatory
Who manage	Cooperative members of salaries	Salary staff	Salary staff	Collector (future dryer)
General assembly	Yes	Yes	No	No
Board of directors	Yes	Yes	Yes	No
Governance model	1 farmer = 1 vote	1 cooperative = 1 vote	Defined by status	Individual business
Access to finance	Difficult (no collateral) Limited amount for RDB	Difficult (no collateral) Limited amount for RDB	Possible if land title or real estate	Possible if land title or real estate
Main advantage	- Institutions already exist - Direct relationshipt between farmers and millers	- Big capacities of production - Scale economy - Higher capacity to borrow	- Big capacities of production - Scale economy - The miller brings its competencies of managing	- Already exists (and storage capacity exists) - Capacity of management and
Main weakness	- Low capacity of cooperative to manage technical process - Low working capital	- Need of creation and supporting new institution - Risk of governance	- Asymetric relationship between cooperatives and miller	- Risk of lack of working capital - Middlemen to be remunerated
Part of needed subsidies	Important because cooperative have no equities	Important because Union of cooperative have no equities	Depends on equities of investors	Depends on equities of investor
low interest rate	Required because no working capital resources	Required because no working capital resources	Depends on working capital resources	Depends on working capital resources

Table 22 : Comparison of different scenarios of investing in drying system

APENDIXES

Appendix 1: terms of references

Terms of Reference and Scope of the Services

AGREEMENT N° CKH 1077.01.S AND CKH 1077.02.T:
SUPPORT TO THE COMMERCIALISATION OF CAMBODIAN RICE PROJECT
[Component #3: Promotion of contract farming and enhancement of the involvement of farmer organizations in paddy collecting and processing]

Donor: Agence Française de Développement (AFD)

Title of Consulting Service:

Feasibility study for a pilot project on investments by Farmer Organizations on paddy drying and paddy storage centers in Cambodia

Contract # CKH-1077-C-15-02

List of acronyms used in the present Terms of Reference:

AC	Agricultural Cooperative
AFD	Agence Française de Développement
CRF	Cambodian Rice Federation Federation of farmer associations promoting family Agriculture Enterprises in Cambodia
FAEC	
FCFD	
FI	Federation of Cambodian Farmer Organizations for Development
FMP ExCo	Financial Institution Farming and Milling Productivity Executive Committee of CRF
FO	Farmer Organization
FWN	Farmer and Water Net
FWUC	Farmer Water User Community
MAFF	Ministry of Agriculture, Forestry and Fisheries
MFI	Microfinance Institution
RDB	Rural Development Bank
SNEC	Supreme National Economic Council
SCCRP	Support to the Commercialization of Cambodian Rice Project
ToR	Terms of Refere

Background

The "Support to the Commercialization of Cambodian Rice Project" (SCCRP)

The "Support to the Commercialization of Cambodian Rice Project" (SCCRP) is aimed at supporting implementation of the rice policy and contributing to achievement of the targets. The SCCRP is funded by the *Agence Française de Développement* (AFD). The Supreme National Economic Council (SNEC) coordinates its implementation with the involvement of various line ministries, and with the support of a project management advisor provided by IRAM-NIRAS.

The project includes five Components as follows:

- Component #1: Organization of rice sector and capacity building of all stakeholders;
- Component #2: Improvement, standardization and certification of Cambodian rice quality;
- Component #3: Promotion of contract farming and enhancement of the involvement of farmer organizations in paddy collecting and processing;
- Component #4: Upgrading the Rural Development Bank;
- Component #5: Coordination, technical assistance and studies.

SCCRP implementation started in January 2013 for an initial duration of three years. An extension of the duration is currently considered and prepared.

SCCRP's Component #3: Promotion of contract farming and enhancement of the involvement of farmer organizations in paddy collecting and processing

The component #3 of the SCCRP project aims at contributing to develop Farmer Organizations commercial role in the paddy supply chain and to maximize the share of added value caught by Farmers in the rice value chain.

As part of this component, the SCCRP project has notably implemented pilot activities based on two main models:

- Contract farming (17 contracts signed in 2014 by Farmer Organizations with 4 rice millers or exporters);
- "Paddy Selling Groups" (the FO gather the paddy produced by its members and seek higher price offers from various potential buyers at the time of harvest).

The Contract Farming model has shown various results depending on the cases and on the conditions of the contracts. They have been successful and beneficial to both parties when the paddy produced was significantly different from usual production either because of the introduction of a new variety with a higher value that what farmers were usually able to grow in the same period of time[1], or thanks to organic certification[2]. They were less successful

[1] Case notably of a new variety introduced by a Cambodian rice miller and exporter: That variety is fragrant, non-photosensitive and short-term variety. It can substitute in cropping calendar to varieties of white rice that farmers may otherwise grow in similar period (dry season, or early wet season or late wet season rice). The new variety achieves similar productivity but higher value. In contract farming deals, the miller has offered fixed price of about 1,000 KHR/kg for wet paddy, while other varieties available in Cambodia and that can be grown at the same period are sold by farmers at around 800 KHR/kg.

[2] One leading exporter has signed contracts with 8 Cooperatives of Preah Vihear province in 2014. The cooperatives have supplied about 1,500 tons of organic paddy, sold with a premium price of +128 KHR/kg in average (with variations depending on the quality grade of the paddy delivered). Signature of a contract farming agreement is a must for both parties in this case: for cooperatives, because they need to make sure they will sell to a buyer that will actually pay a premium for the organic quality, and for the exporter because he needs to secure his sourcing from the very few cooperatives which have the Internal Control System in place to guarantee his ability to supply organic rice to his clients.

when the paddy produced was just the same as what farmers would have produced out of the contract farming scheme and sold at the same price.

The Paddy Selling Group model has been mainly implemented by Farmer Water User communities (with significant surfaces and volumes of production). The collective commercialization of paddy by members of these groups has allowed farmers to get slightly higher prices for their product (about +1.5%). It is anticipated that this benefit could be increased with additional efforts of FOs to sort the quality of paddy, and by gathering price offers from more potential buyers.

Envisaged model for further improvement of commercialization of paddy by FOs, using drying and storage facilities

The SCCRP project is considering to support an experimentation of development of drying and storage facilities at the local level (Farmer Organization level), either by direct FOs' investments or by rice millers / exporters investments (or joint investments), so that FOs can deliver dry paddy to millers;

The SCCRP project wishes to undertake a feasibility studies on this model, involving the following categories of stakeholders:

1. FOs/FWUCs who wish to undertake the rice commercialization in best practice option in term of humidity rate, price and date of delivery to capture a maximum of added value at FOs/FWUCs level;

2. Millers/exporter who are willing to get the paddy in optimal quality and quantity with date of delivery in line with their business activity and;

3. The Government (notably via institutions such as SNEC and RDB) and the Cambodian Rice Federation (CRF), which are willing to develop a conducive environment and adequate services to achieve the objectives of Cambodian Rice Policy;

Key elements and hypothesis on the model envisaged

Scale of drying and storage facilities have to be defined. Investments in the infrastructures would be made by the economic stakeholders: either the Farmer Organizations themselves, or the Rice millers / Exporters or jointly by both parties.

It is foreseen that area for implementation shall be areas with possibilities to produce at least two crops per year and/or to plan the cropping and stagger in time the harvesting, in order to spread over the time farmers' need to use the drying facility (2 to 4 possible sites will be pre-identified).

Minimum volumes of each delivery to rice millers shall be taken into account. For instance some rice millers have expressed that they are interested to develop commercial partnership with a FO only if the FO is able to supply not less than 30 tons per day for several consecutive

days (minimum one week) at the time of harvest. Sizing the dryers and storage facilities shall take this into consideration.

Two technologies could be considered: flatbed dryers (one unit can dry about 5-6 t/day, the number of units can be defined according to needs) powered by electricity or vertical dryers unit with a capacity of 17 to 30 t/day, powered by electricity or rice husk.

A rice mill, partner of the project, has estimated that properly dried and clean paddy could be purchased at a price 15% higher than the price for wet paddy. But such figures will have to be verified by the feasibility study.

Objectives and expected outcomes of the consulting services

Overall objectives

The overall objectives are:

- To characterize what would be the relevant investments to be made (for paddy drying and storage), taking into consideration existing infrastructures: what type of equipment, choice of technology, size (storage capacities), costs.
- To explore different hypothesis of funding: FOs investments? Millers' investments? Shared investments? Need for some project contribution or not?
- Management modes (notably: modalities of governance in case of shared investments), support needed (training / capacity building; management skills required).
- Overall: to assess the technical, economic and financial feasibility of investments and the conditions for such an investment to be feasible and fruitful (technical conditions and financial service offer).

Scope and activities to be implemented

The feasibility will explore more in detail the possible models for investments in drying and storage facilities (FO, millers or co-investments), the technical and economic relevance and the conditions of the financial viability. It should also look at the business partnership modalities / paddy supply contracts that shall backbone the business model to secure the investor, assess the economic justification and the distribution of added value.

Among foreseen tasks to be implemented (to be developed and completed in technical proposals):

- Review existing information on key issues in Cambodian rice sector, and interview key informant to identify the potential interests and constraints of the proposed model.

- Gather information on small scale dryer technology available in Cambodia (capacity, investment and operation costs, etc…) and on investment and operation costs for storage facilities.

- Visit 2 to 4 possible sites of implementation (pre-identified by the project team) and explore the potential of use of such technology in these locations and the interest and willingness of farmers / FOs to invest in dryers /warehouses.

- Interview key informants among representatives of Farmer Organizations or Federations of Farmers Organizations and among Rice Millers.
- Explore the possibility of financing or co-financing by rice milers/exporters and modality of management (in particular in cased of joint investments).

- Define the financial conditions (duration and rate of loan) that should be reached to ensure the financial viability of the project, and start to explore the interest of selected Financial Institutions to offer a concessional loan to investors for such investment.
- Analyze data, develop scenarios based on technical, economic and financial parameter and analyze the profitability of the proposed investments. Produce an Excel tool to easily recalculate new scenarios based on changes in parameters and hypothesis.
- Present and discuss results with relevant stakeholders (project, AFD, FOs, miller, financial institutions, CRF / FMP ExCo).
- Finalize full report.

Expected outcomes / deliverables

The consultant is expected to provide the following deliverables (all in English language + a Khmer version for the Deliverable 4):

- **Deliverable 1:** Detailed work plan at early stage of the mission (can cover the two parts of the study in one document)
- **Deliverable 2:** Draft Report including basic data / hypothesis and results from the discussions with stakeholders.
- **Deliverable 3:** Excel file for economic and financial analysis of scenarios.

- **Deliverable 4:** Power point presentation of results and presentation in a restitution meeting.

- **Deliverable 5:** Final report covering all the scope and objectives described above and incorporating comments after restitution meeting.

Timeframe and foreseen steps

The mission is expected to take place between April and September 2016. Estimated number of working days is based on the technical offers of consultants.

Contracting authority and reporting

The contracting authority will be the Supreme National Economic Council (SNEC) as coordinator of the Support to the Commercialization of Cambodian Rice Project.

Restitutions of finding will target, in addition to SNEC, a larger audience of key stakeholders.

Reports will be addressed to SNEC.

Consultant's Profile

Consultant profile

A consultant or consulting firm or NGO with a strong experience of agricultural value chains and innovative financing mechanism in the agricultural sector in developing or emerging countries.

Experience in Cambodia or South-East Asia is required.

Team of Key Experts

It is foreseen that the team should include one international expert or maximum 2 key experts with one international and one national.

But applying firms are entitled to propose other team arrangements, and individual consultants are entitled to apply individually.

All team members should have:

- Experience of value chain organization.

- Excellent communication and writing skills in English.
- Experience in Cambodia or South East Asia.
- Experience in Rice sector.
- Experience of work with international development project.

The following competences / expertise shall be available in the team:

- Strong experience of feasibility study.
- Experience of work with the private sector in agro-industry.
- Experience of work with Farmer Organizations.
- Experience in paddy and rice sector, including some technical experience in post-harvest technologies is necessary.
- Very strong economic and financial analysis skills and in business plan development and analysis.
- Experience in agricultural value chain financing and good knowledge of warehouse receipt systems.
- Ability to communicate in Khmer language.

Appendix 2: Questionnaires for cooperatives, collectors and millers

1.1 Question Guide for Farmer/FO

Interviewee's Information

- Name of interviewee: …….
- Position: ……..
- Sex : …… Phone : ……
- Village: …….. Commune.....
- District: …….. Province: ……..
- Date of Interview: …….

1. What types of paddy do you produce?

2. To whom did you sell the paddy?

3. What type of rice paddy (wet or dry) did you sell and why?

4. What is the price of paddy (it should consider on good quality paddy)?

Type of Paddy	Price (Riel/kg)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Fra-grant Rice												
Dried Fra-grant Rice												
Wet White Rice												
Dried White Rice												

5. How do you dry the paddy?

6. Do have mechanical paddy dryer, if so what is the type of dryer?

7. What is the constraint in drying the paddy?

8. If dried paddy, how many times a year can you supply to collector/miller? And what is the volume of paddy can you supply each time?

9. How do you store the paddy?

10. What is the constraint in storing the paddy?

11. What is the challenge of selling paddy in group? And what is the solution?

12. Do you plan to install dryer or storage?

Paddy dryer

13. What types of paddy dryer do you plan to install/use?	14. What is the total cost of installment?	15. How do you capitalize the installation of the equipment?
(a):		
(b):		
(c):		
(d):		

16. What is the technical parameter of paddy dryers?

Model	(a)	(b)	(c)	(d)
Capacity (kg)				

Weight (kg)				
Motor Power (KW)				
Heating Power (KW)				

Paddy storage

17. What types of paddy storage do you plan to install/use?	18. What is the total cost of installment?	19. How do you capitalize the installation of the equipment?
(a):		
(b):		
(c):		
(d):		

20. What is the technical parameter of the paddy storage?

Type (e.g. Steel conical silo/Cement conical silo/)	(a)	(b)	(c)	(d)
Material (e.g. Hot galvanized steel)				

Auxiliary System (Ventilation System Temperature Sensor System Fumigation System Thermal Insulation System Dedusting System, Mechanical Equipment Steel Structure Air Compress System Computerized Control System)				
Loading Capacity				

1.2 Question Guide for Rice Miller/Collector

Interviewee's Information

- Name of interviewee: ……
- Position: ……..
- Sex : …… Phone : ……
- Village: …….. Commune.....
- District: …….. Province: ……..
- Date of Interview: ……

21. What type of rice paddy (wet or dry, fragrance or white rice) did you purchase and why?

22. What is the price of paddy (it should consider on good quality paddy) did you purchase from farmer/FO?

Type of Paddy	Price (Riel/kg)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Fragrant Rice												

Dried Fra-grant Rice												
Wet White Rice												
Dried White Rice												

23. Do you have any constraint regarding paddy drying and storage and why?

24. To what extend is the quality of dried paddy from farmers (sun dried)?

25. Do you plan to purchase the good quality dried paddy with appropriate storage from farmers?

26. How many times a year will you purchase the good dried paddy? And what is the volume of dried paddy will you purchase each time? What And how much price can you offer (it could be partly same as question 2)?

Type of Paddy	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Price (R/kg)	Volume (t)	Price (R/kg)	Volume (t)	Price (R/kg)	Volume (t)	Price (R/kg)	Volume (t)
Dried Fragrant Rice								
Dried White Rice								

27. Do you plan to invest on construction of paddy dryer and storage with FO, or what is your option?

If you have plan to install Paddy dryer

28. What types of paddy dryer do you plan to install/use?	29. What is the total cost of installment?	30. How do you capitalize the installation of the equipment?
(a):		
(b):		
(c):		
(d):		

31. What is the technical parameter of paddy dryers?

Model	(a)	(b)	(c)	(d)
Capacity (kg)				
Weight (kg)				
Motor Power (KW)				
Heating Power (KW)				

If you have plan to install Paddy storage

32. What types of paddy storage do you plan to install/use?	33. What is the total cost of installment?	34. How do you capitalize the installation of the equipment?
(a):		

(b):		
(c):		
(d):		

35. What is the technical parameter of the paddy storage?

Type (e.g. Steel conical silo/Cement conical silo/)	(a)	(b)	(c)	(d)
Material (e.g. Hot galvanized steel)				
Auxiliary System (Ventilation System Temperature Sensor System Fumigation System Thermal Insulation System Dedusting System, Mechanical Equipment Steel Structure Air Compress System Computerized Control System)				
Loading Capacity				

1.3 Question Guide for Technical Officer

Interviewee's Information

- Name of interviewee: ……
- Position: ……..
- Sex : …… Phone : ……
- Village: …….. Commune.....
- District: …….. Province: ……..
- Date of Interview: ……

Paddy dryer

36. What types of paddy dryer are used in Cambodia?	37. What are the constraints of each paddy dryer?	38. What is the total cost of installment?
(a):		
(b):		
(c):		
(d):		

39. What is the technical parameter of paddy dryers?

Model	(a)	(b)	(c)	(d)
Capacity (kg)				
Weight (kg)				

Motor Power (KW)				
Heating Power (KW)				

Paddy storage

40. What types of paddy storage are used in Cambodia?	41. What are the constraints of each paddy storage?	42. What is the total cost of installment?
(a):		
(b):		
(c):		
(d):		

43. What is the technical parameter of the paddy storage?

Type (e.g. Steel conical silo/Cement conical silo/)	(a)	(b)	(c)	(d)
Material (e.g. Hot galvanized steel)				
Auxiliary System (Ventilation System Temperature Sensor System Fumigation System Thermal Insulation System Dedusting System, Mechanical Equipment Steel Structure Air Compress System				

Computerized Control System)				
Loading Capacity				