

## FACTORS AFFECTING MECHANIZATION IN RICE HARVESTING AND DRYING IN THE MEKONG DELTA, SOUTH VIET NAM

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### ABSTRACT

*Mechanization in rice harvesting and drying in the Mekong Delta in current is at low extent. The rice area in the Mekong Delta harvested mechanically was only 1.8% of the total rice area in 2006, 13.9% in 2007 and 20.7% in 2008. The increase in rice area harvested mechanically in 2008 was due to the credit support system from the government. The rice quantity dried by dryers occupied one third of total production because most of the farmers sold fresh rice right after harvest. Rates of farmers harvesting rice by harvesters and drying by rice dryers were less than 10% in 2006 because most of the farmers (94-95%) did not attend the technical training related to mechanization of harvest and post harvest. In addition, low rate of the farmers (less than 40%) accessed to the information related to mechanization of harvest and post harvest. However, relatively high rate of farmers (50-55%) needed to harvest rice by harvesters and drying by rice dryers. Harvesters and dryers are labor-saving technologies, reducing rice loss and increasing rice quality. However, these machines are at high cost and require good infrastructure as roads and pathways among rice fields. The important factors affecting the mechanization of harvest and post harvest were farmers' education and perception on machines, capital, rice area, technical training, knowledge of extension workers, methods of extension organization, and information system. Attending training and farmers' knowledge were two important factors positively and significantly affected the use of machines in rice harvesting and drying by farmers. High education and female managed-farmers also increased the use of harvesters. The information from the intermediate agents also contributed to the use of harvesters by farmers. Due to many socio-economic factors affecting mechanization in the Mekong Delta, there is the need appropriate strategies for increasing the extent of mechanization of harvest and post harvest.*

### INTRODUCTION

Rice in the Mekong Delta, South Viet Nam is important for national food security and for exporting. Rice production in the Mekong delta accounts for 50-55% of national production. In 2005, 5.2 million tons of rice was exported (Tran Le, 2005) and about 5.3 million tons of rice was exported in 2008 (VNN, 2008). However, the manual rice harvesting and drying has caused loss about 12% of total production. For a long run, Viet Nam agriculture has been affording to reach modernization and mechanization. In the message of "1 Must and 5 Reductions" from scientists and extensionists, there is message of reduction loss after harvest. However, the rates of area and farmers using of rice dryer and harvester are still at low extent. There are several factors affecting the adoption of mechanization of harvest and post harvest. Thus, the aim of this paper is to assess the

factors affecting the mechanization of rice harvesting and drying in the Mekong delta.

Mechanization of harvest and post harvest becomes very important in the Mekong delta because of high rate of labor movement from rural to urban and industrial zone under economic change at contemporary context (Phu Khoi, 2006). According to the Decision No. 02 /2008/QĐ-BCT of Ministry of Commerce and Industry (2008), one of the orientations in industrial development is manufacturing agricultural machines for 2006-2015, and until 2020 with concentration more on harvesters. The target is meeting the demand in the year 2015 about 50%.

About the status of mechanization, in 2006, there were 1,800 rice reapers and 90 combined harvesters in the Mekong delta. There was a need of 160,000 harvesters to meet the demand of 80%

rice area harvested by machines with the rate of harvest 3 ha/day (Phu Khoi, 2006). According to Cao Phong (2007), in 2007, there were 2,793 rice reapers and 600 combined harvesters in the Mekong delta. The mechanization of rice harvest only reached 15% of rice area. According to National Extension Center, until March 2008, the Mekong delta had 3,399 rice reapers and 989 combined harvesters. To the middle of 2008, the Mekong delta had 3,400 rice reapers and 1,000 combined harvesters (Cand.com 2008). Following the direction of the State, the provinces have been supporting the cooperatives, farms, and households the low interest rate loan to buy combined harvesters. Thus, the number of machines rapidly increased (Pham Van Hanh, 2008). However, to harvest nearly 4 millions ha of rice, these numbers are still small, and machines are new to many farmers (Cand.com, 2008). The machines only met harvesting about 15% of rice area and the rest (85% area) has been subjected to loss at about 10-12%. To harvest 50% of rice area in Mekong delta by machines, there is the need of 20,000 combined harvesters (Vista, 2006). Regarding to rice drying, mechanization of this task by using rice dryers can avoid loss of 15% per season, even 18-20% loss in He Thu season also can be avoided. Thus, mechanization of rice harvesting and drying can reduce loss. To establish the strategies of successful mechanization of rice harvesting and drying, there is the need to assess the factors affecting the mechanization of these activities.

## METHODS OF DATA COLLECTION AND ANALYSIS

To know the extent of mechanization of rice harvesting and drying, the secondary data from Departments of Agriculture and Rural Development of 13 provinces in the Mekong delta were collected and summarized.

The participatory rural appraisal (PRA) was used to know the information related to mechanization in rice harvesting and drying in the Mekong delta. The staffs from extension centers and knowledgeable farmers in 13 provinces participated in PRA.

A survey of randomly selected farmers (250 farmers/village) from eight villages (2 from

rainfed area and 6 from irrigated area) in Can Tho, Tien Giang, An Giang and Ben Tre provinces was conducted to know the factors affecting farmers' use of machinery in harvesting and drying.

Data were summarized in the forms of mean, frequency and percentages. Probit analysis was used to determine the factors affecting farmers' use of machinery in harvesting and drying at household level. The model used was

$$Y = X\beta + \varepsilon$$

Of which:

Y is dependent variable, Y= 1 and 0 (1: using machinery, 0: not using machinery). This includes:

$Y_1$  (using rice dryer) and  $Y_2$  (using harvester);

X is the matrix of independent variables:

$X_1$ : Ecosystem (1= Irrigated, 0= Rainfed);

$X_2$ : Attend training (1=Yes, 0= No);

$X_3$ : Information source (1=State channels, 0= Intermediate agents),

$X_4$ : Knowledge on technologies (%);

$X_5$ : Rice grown area (ha);

$X_6$ : Education (Years in school);

$X_7$ : Gender (1=Male managed farm, 0=Female managed farm);

$X_8$ : Farming system (1= 3 rice crops per year, 0=others);

$X_9$ : Rice yield (Tons/ha/year);

$X_{10}$ : Net return from rice (1000 VND/year).

$\beta$  is the vector of parameters representing the partial effect of each of the independent variables; and  $\varepsilon$  is the error vector, which represents the amount of variable unaccounted for the independent variables. Elements of  $\varepsilon$  are assumed to have zero mean, constant variance,  $\sigma^2$ , and to be uncorrelated.

## RESULTS AND DISCUSSION

### 1. The extent of mechanization of rice harvesting and drying in the Mekong Delta:

The percentage of rice area harvested by machines in 2007 and 2008 was higher than those in 2006 due to the improvement in

machines which can cut lodged rice and supporting the low interest loan to buy machine from the government.

Farmers were familiar with sun drying for rice after harvest, thus using dryers was mostly for wet

rice season. However, the rates of rice dried by dryers were only one-third of total rice production (30% of total rice production in 2006, 27.8% in 2007 and 28.4% in 2008). Moreover, most of rice farmers also sold fresh rice right after harvest.

**Table 1:** The extent of mechanization of rice harvesting and drying in the Mekong Delta

Item	Rate (%)		
	2006	2007	2008
Harvesting by machine (% of rice area)	1.8	13.9	20.7
Rate of rice dried by dryer (% total production)	30.0	27.8	28.4

*Source: Departments of Agriculture and Rural development of 13 provinces in the Mekong Delta*

**2. Rate of farmers using machinery in harvesting and drying:** Rates of farmers using machinery in harvesting and drying were low. 7% (Table 2).

Rate of farmers using rice dryers was 5% and harvesters

**Table 2:** Rates of farmers using machinery in harvesting and drying in 2006 (%)

Farming system	Harvester	Dryer
Rice - Rice (n=668)	4	9
Rice - Rice - Rice (n=1299)	9	2
Rice - Upland crop -Rice (n= 17)	-	-
Rice - Fish - Rice (n=25)	-	33
Total	7	5

*(Source: analysis from household survey data)*

More farmers in irrigated than rainfed area applied machinery for harvesting and drying though the rate was still low.

**Table 3:** Rates of farmers using machinery in harvesting and drying distributed by ecosystem in 2006 (%)

Ecosystem system	Harvester	Dryer
Irrigated	10	6
Rainfed	0	0

*(Source: analysis from household survey data)*

**3. Source of information:** There were less than 10% of farmers attended in technical training related to rice harvester and dryer. Those who had

attended the training participated more than 80% of time of the training course.

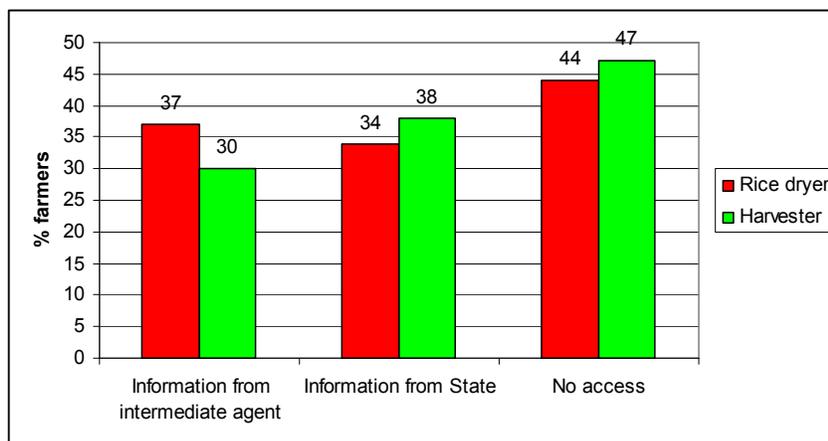
**Table 4:** Rate of farmers attended in technical training related to rice dryer and harvester (%)

Machinery	Attended training		Time of attendance (%)
	Yes	No	
Rice harvester	5	95	89
Rice dryer	6	94	87

*(Source: analysis from household survey data)*

Rates of farmers accessed to information related to rice harvesters and dryers were low. The information channels from the State included extension staff, mass media as television, radio, magazine, newspapers, posters, university,

research institute and public association as farmer's association, extension clubs. The information from intermediate agents were family members, other farmers, neighbors, friends and relatives.

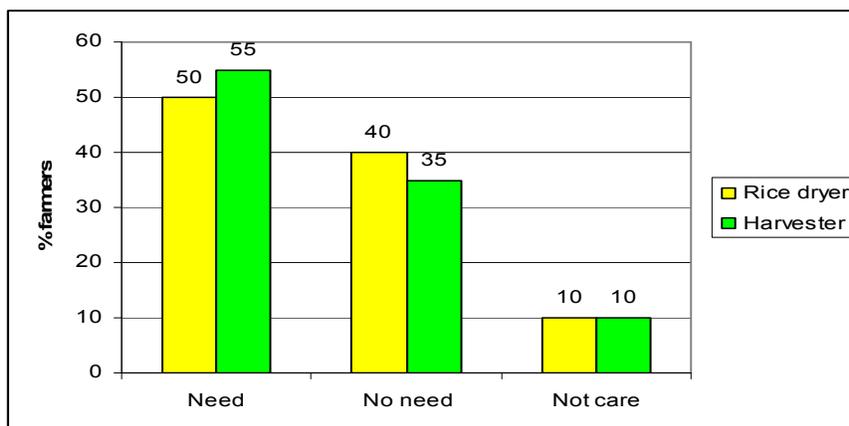


**Fig 1:** Percentage of farmers accessed to information distributed by information sources (multiple responses)

(Source: analysis from household survey data)

Rates of farmers needed to use rice harvesters and dryers were relatively high (50-55%). The rests did not need to use. These farmers did not harvest rice by machines because of lacking of harvesters; the service of harvester did not accept to harvest the rice field with thin plant density and not ripened at the same time or lodging field. Moreover, looking for labors for rice gathering was difficult if harvesting by rice reaper. Farmers

were also afraid of rice shattering when using machine and some of machines cut rice with long rice straw, which caused difficulty in threshing. Some of the farmers did not use dryer because there was sunny at the time of harvest. The others sold fresh rice right after harvest. Farmers who had small rice field did not need to bring rice to the drying service because they had to pay for transportation cost.



**Figure 2:** Rates of farmers need to use machines

(Source: analysis from household survey data)

## 5. Factors affecting farmers' using machinery in rice harvesting and drying

### 5.1. Aspects related to characteristics of harvesters and dryers under PRA

#### 5.1. 1. Advantages and disadvantages of rice harvester under PRA

Rice harvesters could resolve the problem of labor shortage at the time of harvest. They could complete harvesting faster than manual rice cutting. They also reduced loss from harvest.

**Table 5.** Advantages of rice harvesters from participatory rural appraisal (PRA)

Advantages of rice harvesters	Frequency	Rate (%)
Reducing pressure of labor shortage at harvesting time	18	42
Harvesting faster than doing manually	10	23
Reduce loss	8	21
Harvest a large area in short time	6	14
Total	43	100

(Source: From participatory rural appraisal -PRA)

Mechanization of rice harvesting has been still limited because the quality and quantity of rice harvesters were not met the demand. The disadvantages of rice harvesters included bulky and heavy which requires better-constructed infrastructures as roads and pathways to move to the fields. The prices of harvesters were high. The rice reapers needed extra labors for rice gathering

after cutting. Long straw cuts by machines caused difficulty in rice gathering and threshing than those with manually cutting. Most of rice harvesters operated in dry season, their operation in the wet season was limited. Thus, it needs to modify the rice harvester to cut rice even in the soft-mudded fields.

**Table 6.** Disadvantages of rice harvesters from participatory rural appraisal (PRA)

Disadvantages of rice harvesters	Frequency	Rate (%)
Difficult to operate in the field with water and in raining season	15	26
High cost of machines, more expenditure	17	29
Bulky and heavy	12	21
Not perfect combined harvesters	6	10
Requirement of better infrastructures (roads and pathway for movement of machines)	5	9
Cutting long rice straw which is difficulty in threshing	3	5
Total	58	100

(Source: From participatory rural appraisal -PRA)

#### 5.1.2. Conditions for mechanization in rice harvesting

Farmers need to have capital to invest for machinery. The rice fields need to be large. This needs to form cooperatives and merging small lands together. For machine passing through many canals, branches of rivers from this field to other field, there is the need of transportation means or

reconstruction of the fields in the community. The field demonstration of harvesting by machine is important. Meeting, farmers' workshop or training can help farmers understand the benefit from the machine use, know how to operate machine, maintain and preparing. The establishment of farmer group for harvesting service is also important.



Figure 3: Combined harvester



Figure 4: Rice reaper

### 5.1.3. Advantages and disadvantages of rice dryer under PRA

Farmers knew rice dryer through DANIDA programs, however, dryer was not used widely in the Mekong Delta though it has certain

advantages. Dryer could dry rice any time that farmers need. It also increased rice quality more than drying under sun in the wet season. It reduced loss and coped with the shortage of labors.

**Table 7.** Advantages of rice dryer from participatory rural appraisal (PRA)

Advantages of rice dryer	Frequency	Rate (%)
Drying rice any time needed	14	32
High grain quality after drying	12	27
Reducing loss	8	18
Dry a large amount of rice in short time	6	12
Reducing pressure of labor shortage	5	11
Total	45	100

(Source: From participatory rural appraisal -PRA)

However, the cost of rice dryer is high; the farmers who invested this machine got back the input slowly. Though farmers need rice dryers in wet season, most of them manipulated the natural energy from sun to dry rice if the harvest time at sunny and they need not to pay for drying service.

Drying rice under sun was done mostly by family labors. Moreover, some of operators did not perform well drying machine leading low quality rice that was difficult to sell at high price. In addition, there are problems related to rice dryers in the Mekong Delta

**Table 8.** Disadvantages of rice dryer from participatory rural appraisal (PRA)

Disadvantages of rice dryer	Frequency	Rate (%)
High cost of machine and installation; only operation in wet season leading to slowly getting back of the input	11	56
High cost of drying, selling price rice is not higher than those dried under sun	10	26
Technical error was high, duration of drying is still long	7	18
Total	39	100

(Source: From participatory rural appraisal -PRA)

**Table 9:** Problems related to rice dryers

Problems	Ranking of importance	Note
Location of dryer installation	1	It should be convenient for both transportation by boats and roads
Labor	2	Need the styles of dryers that require less labors.
Technical skill in operation	3	Technical skill in operation should be good to have good rice quality and low rate of broken rice after milling
Fuel cost	4	Depending on market price. Rice husk can be used as fuel to reduce cost

(Source: Post Harvest Research Group, Extension Center of Soc Trang province)

**5.1.4. Conditions for using rice dryer:** Capital is the most important condition to establish a rice dryer. Farmers also need capital to bring their rice to the drying service. Training, consultant service, meeting, workshop and demonstration are other conditions for using rice dryers by farmers. In addition, improvement the disadvantages of dryers and information dissemination can increase the use of rice dryers by farmers.

## 5.2. Aspects related to characteristics of harvesters and dryers from household survey

### 5.2.1. Advantages and disadvantages of rice harvesters

The important advantage of rice harvester recognized by most of the farmers was reducing labors. Rice harvesters also reduced loss and obtained more by-products as rice straws.

**Table 10:** Advantages of rice harvester from farmers (%)

Advantage	Percent of farmers (*)	Rank
Reducing labors	91	1
Reducing loss of grains	2	2
Harvest more by- products as rice straws	2	2

(\*) Multiple responses; Rank: 1 is the most important; (Source: Analysis from household survey data)

Farmers also experienced the disadvantages of harvesters because most of them were not able to cut the lodged rice, operate in the wet season and pass through the bunds of the field. In the relatively deep fields with soft soil, machines could not perform well. Farmers also have seen

that some of harvesters caused high rate of dropped grains. When cutting rice, machines got long rice straw that was not expected by farmers. Farmers reflected that different rice varieties could not be harvested by same harvester because the rice varieties may be mixed.

**Table 11:** Disadvantages of rice harvester from farmers (%)

Disadvantages	Percent of farmers (*)	Rank
Could not cut lodged rice	37	1
Could not apply at deep field, soft soil	22	2
Caused more dropped rice grains. Difficult to operate in raining season and presence of many field bunds	15	3
Cutting rice with long rice straws	3	4
Same harvesters could not harvest different rice varieties	1	5

(\*) Multiple responses; Rank: 1 is the most important; (Source: Analysis from household survey data)

### 5.2.1. Advantages and disadvantages of rice dryer

Rice dryers could dry rice at right time to avoid grain germination in the wet season and reduce

labors. Paddy dried by rice dryer were brighter color, which can be sold at higher price. The milled rice was also better quality as compared to manual drying in wet season.

**Table 12:** Advantages of rice dryer from farmers (%)

Advantages	Percent of farmers (*)	Rank
Dry in short time, thus can avoid grain germination in wet season	40	1
Suitable for wet season, good grain quality for storage	29	2
Reduce labors	23	3
Increase milled rice quality	9	4
Paddy with brighter color	7	5
Selling at high price and easily to sell	4	6

(\*) Multiple responses; Rank: 1 is the most important; (Source: Analysis from household survey data)

However, some of dryers could cause worse colors and loss of aroma of grains. Some of dryer services could not technically perform well. Cost

of drying by dryer was higher than manual drying. Cost of transportation to location of dryer service was added to rice production expenses.

**Table 13:** Disadvantages of rice dryer from farmers (%)

Disadvantage	Percent of farmers (*)	Rank
Discolor and aroma reduction	41	1
Higher cost than manual drying	39	2
Location of drying service is far from home	21	3
Loss grain	4	4
Not enough dryers in the locality	4	4
Low price at selling	3	5
Low technical skill from owner of dryer	2	6
Not suitable in locality	2	6

(\*) Multiple responses; Rank: 1 is the most important (Source: Analysis from household survey data)

**5.3. Factors affecting farmers' use of harvester and dryer:** From Participatory Rural Appraisal (PRA), the important factors affecting farmers' use of rice harvester and dryers included farmers' education, perception on machinery, and capital. The young person can accept and adopt more than the old ones. Small land size reduced the use of machinery at harvest and post harvest. The other factors outside the households as attending of technical training, the knowledge of extension staffs, methods of organization and extension, number of extension personnel and information system affected farmers' use of machinery at harvest. The infrastructures and rice ecosystem are

other factors affecting machinery use at harvest and post harvest. The public association and farmers' association, extension clubs, women's association could increase farmers' use of machinery at harvest and post harvest. Market price and advertisement affected farmers in using machinery.

Analysis data from household survey showed that farmers' attending training and their knowledge on harvester and dryer increased their use of these machines.

Regarding to rice harvester, training and knowledge were two important factors

significantly and positively affecting farmers' use of this machine. The information from intermediate agents was also important. Farmers who were highly educated attempt to use harvester than those with lower education. Female managed farms increased using of harvesters than male because this adoption could reduce the back pain in manual rice cutting because this manual task was

traditionally done by women. Net return from rice also increased the use of rice harvester. In the household survey, farmers with smaller rice field also adopted rice reapers because they can cut rice in the small field. The number of rice reapers in the Mekong Delta were at larger amount than combined harvesters.

**Table 14:** Factors affecting the use of rice harvester by farmers

Variable	Coefficient	T value	P value
Constant	-8.630	0.000	1.0000
Ecosystem (1= Irrigated, 0= Rainfed)	7.499	0.000	1.0000
Attend training on rice harvester (1=Yes, 0=No)	2.068	4.999	0.0000
Knowledge on rice harvester (%)	0.024	6.118	0.0000
Source of information (1= State channels, 0= Intermediate agents )	-0.995	-2.932	0.0034
Grown rice area (ha)	-0.271	-3.155	0.0016
Net return from rice (1000 VND/year)	0.000	2.542	0.0110
Male or female managed farm (1=Male , 0=Female)	-0.880	-2.215	0.0268
Education	0.170	3.264	0.0011
Rice yield (Tons/ha/year)	-0.109	-1.908	0.0564

*Dependent variable: Using rice harvester to harvest rice (1=Yes, 0= No);  
(Source: analysis from household survey data)*

About rice dryer, training and knowledge were two important factors significantly and positively affecting the using of this machine by farmers. Farmers who practiced double rice, rice –upland crop or rice –fish tended to dry rice by driers more

than the others because they needed to dry fast to use time for other activities as fish and upland crop cultivation. Rice area and net return from rice did not affect the adoption of rice dryers.

**Table 15:** Factors affecting the use of rice dryer by farmers

Variable	Coefficient	T value	P value
Constant	-1.749	-5.059	0.0000
Attend training on rice dryer (1=Yes, 0=No)	1.636	5.541	0.0000
Knowledge on rice dryer (%)	0.008	2.205	0.0275
Rice ecosystem (1= triple rice, 0=others)	-0.704	-2.465	0.0137
Rice area (ha/household)	0.119	1.499	0.1338
Net return from rice (1000 VND/year)	-0.000	-0.959	0.3376

*Dependent variable: Using rice dryer (1=Yes, 0= No);(Source: analysis from household survey data)*

## CONCLUSION

The use of rice harvester and dryer in the Mekong Delta was low. The number of the machines and their performance did not meet farmers' demand.

The important factors affecting farmers' use rice

harvester and dryer included farmer education, perception on machinery, and capital. The farmers with younger age, larger land, attending training, knowledge of extension staff, methods of organization and extension, number of extension personnel and information system, infrastructures

and rice ecosystem affected the use of machinery in harvest. Market price and advertisement affected farmers' use machinery.

Training and knowledge were two important factors significantly and positively affecting the use of harvester and dryer by farmers.

Intermediate agent was also important in providing the information. High educated farmers, female managed –farms, high rice net return increased the use of rice harvester.

The study implied that there is the need for further studies on the strategies for increase the adoption of rice harvesters and dryers in the Mekong Delta.

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## Yếu tố ảnh hưởng đến cơ giới hóa thu hoạch và sấy ở đồng bằng sông Cửu Long

Hiện trạng cơ giới hóa khâu thu hoạch và sấy lúa tại đồng bằng sông Cửu Long còn yếu và thiếu. Tỷ lệ diện tích gặt lúa bằng cơ giới tại toàn vùng đồng bằng sông Cửu Long chỉ có 1,8% diện tích gieo trồng năm 2006, 13,9% năm 2007 và 20,7% năm 2008. Phạm vi diện tích gặt lúa bằng cơ giới năm 2008 tăng nhờ chính sách hỗ trợ tín dụng. Tỷ lệ lúa sấy chỉ chiếm một phần ba sản lượng do phần lớn nông dân bán lúa tươi ngay sau thu hoạch. Tỷ lệ nông dân áp dụng cơ giới hóa thu hoạch và sấy lúa dưới 10% năm 2006 do phần lớn nông dân không được tham dự các lớp tập huấn kỹ thuật liên quan đến cơ giới hóa (94-95%). Ngoài ra tỷ lệ nông dân (dưới 40%) tiếp cận nguồn thông tin về vấn đề này thấp. Nông dân có nhu cầu cơ giới hóa khâu thu hoạch và sấy lúa khá cao từ 50-55%. Máy gặt và sấy đều giảm công lao động, giảm thất thoát lúa, tăng chất lượng gạo. Tuy nhiên, giá thành máy móc cao, yêu cầu có vốn và đáp ứng của cơ sở hạ tầng. Các yếu tố quan trọng ảnh hưởng đến cơ giới hóa thu hoạch và sấy lúa gồm có trình độ học vấn và nhận thức về máy của nông dân, vốn, diện tích đất, tập huấn kỹ thuật, kiến thức của cán bộ khuyến nông, phương pháp tổ chức khuyến nông và hệ thống thông tin. Sự tham dự tập huấn và kiến thức về gặt máy và sấy của nông dân là hai yếu tố quan trọng ảnh hưởng tích cực trong khâu cơ giới hóa thu hoạch và sấy lúa. Nông dân có trình độ học vấn cao và nữ quản lý đồng áng gia tăng gặt lúa bằng máy. Các nguồn thông tin trung gian trong cộng đồng cũng góp phần gia tăng áp dụng máy gặt của nông dân. Do có nhiều yếu tố kinh tế xã hội ảnh hưởng đến khâu cơ giới hóa thu hoạch và sấy lúa, cần có nghiên cứu sâu hơn để có chiến lược cơ giới hóa thu hoạch và sau thu hoạch.