Final Report

Enhancing Agricultural Mechanization through Efficient Land Reformation

PHILIPPINES

2015 October 27

Submitted by: PHILIPPINE RICE REEARCH INSTITUTE

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I. Abstract

To enhance the adoption of farm mechanization and application of advanced technologies in a small-farm-size production system, it is necessary to rearrange small farm lots to form clusters of economic size. This entails the re-allotment of land parcels to achieve economy of scale and the organization of farmers into functional groups. One of the few countries that have accomplished rapid growth and development in agricultural mechanization over a short period of time is Korea. Such mechanization became a foundation not only for the rural areas but also for the economic development of Korea. Its success can be largely attributed to socio-economic demand for such mechanization, strong policy drive, all-out support by the government, and its desire to become mechanized.

While the agricultural setups of Korea and the Philippines differ, much can be learned from Korea's experiences in agricultural mechanization. This joint research project evaluated the farmers' views regarding land reformation and mechanization in the Philippines. Household profiles of the farmer-respondents in this survey mirrored results of national surveys except for some improvements on their mechanization status. Farmers are willing to undergo land reformation if they are members of organizations, engaged in seed production, away from irrigation canals, and have household labor. Irrigation canals have to be improved to optimize water distribution among farmers. Whenever cultivation area expands, machine ownership also increases.

The aging farmers will continue farming as it is their main source of income. Field problems were: pests and diseases, weather, irrigation water, low price of harvest, high cost of farm inputs, and limited capital. Implementation of a good land reformation project will probably solve these problems. Farmers recognize the many advantages of using farm machines over manual, even if these are expensive and will certainly displace laborers. These could be alleviated through the provision of alternative sources of income and subsidy for machine acquisition.

Land reformation is known to only 1/3 of the farmers. They understand it as a way of re-structuring roads and fields, and will ease farm management. They believe that thru it, farm productivity will increase, irrigation and roads will be improved, cultivated area will expand, and less time for farm activities will be needed. Road access to farms is very essential to them but the cost must be shouldered by the government.

Key words: land reformation, Philippines, mechanization, farmers, agriculture

II. Introduction

A. Background and Context

Rice industry

In the Philippines, rice is cultivated in more than 33% of its 9.2 million hectares (M ha) total agricultural land. In 2014, rice was harvested from 4,739,672 ha. In 2013, rice contributed 39% to total value of production in agriculture (PSA 2014). Rice also accounts for 44% of total caloric and 31% of protein intakes of Filipinos (WHO 2008).

Rice is the staple food crop and a way of life for 70% of the total population who are greatly dependent on rice production, processing, distribution, and marketing. Agriculture employs 12.9 million people, or 37% of the total labor force. Farmers, forestry workers, and fishermen ranked second with 17.3% share of the total employed population (BAS 2008).

Annual rice per capita consumption increased by 13% from 106 kg in 2000 to 119 kg in 2009 (PhilRice 2011). As a result, the level of self-sufficiency in rice decreased from 91% in 1990 to 80% in 2010. Based on the 2002 Census of Agriculture, the Philippines had 4.8 million agricultural farms, 4.6% higher than the 4.7 million farms in 1991 (Table 1). However, average farm size declined by 3.0% from 2.2 in 1991 to 2.0 ha/farm in 2002.

Agricultural mechanization

The Philippine government has long been striving to modernize agriculture to enhance its profitability and prepare for the challenges brought about by globalization. It prioritizes the development and promotion of appropriate agricultural machinery and other mechanization technologies. Agricultural mechanization raises the efficiency of farm operations and inputs, and lowers production costs and postharvest losses. This would help address poverty, social equity, and food security, and enhance agricultural competitiveness and sustainable development leading to increased farmers' income.

FIGURE 1. THE LOCALLY MANUFACTURED HAND TRACTOR DURING PLOWING

Enacted in 1997, the Agriculture and Fisheries Modernization Act as a law defines measures to modernize Philippine agriculture for the country to compete in the global market. It aims to transform the agriculture and fisheries sectors to technology-based, advanced, and competitive industries; ensure that the small farmers and fisher folk have equal access to assets, resources and services, among others. Its provisions include: 1) production and marketing support services; 2) human resource development; 3) research development and extension; 4) rural non-farm employment; and 5) trade and fiscal incentives.

The Regional Network for Agricultural Machinery (RNAM) classified the Philippines at low-mechanization level with only about 50% mechanized production operations (RNAM 2008). Several reasons are: low buying power of

farmers, abundance of rural labor, very small landholdings per farmer, high cost of machines, and government policies not favorable to mechanizing agriculture.

Promoting farm mechanization in the Philippines has also been constrained by the small-sized, un-accessible rice fields especially during the rainy season, irregular, and non-geometric-shaped farm areas. Mechanizing these lands can be inefficient due to too much maneuvering in operations like land preparation and harvesting. The use of machinery and other large-scale agricultural practices is hampered.

Operating machines in small fields makes more unproductive times and moving them from one field to another also causes problems and conflicts among adjacent landowners due to absence of access road to each plot. Small field sizes lead to increased labor time and cultivation costs, and uncontrolled use of chemical fertilizers and pesticides.

Figure 2. Rice fields in the Philippines; a) taken at Gabaldon, Nueva Ecija, b) irregularly shaped rice fields

To enhance farm mechanization and application of advanced technology in small farm size production systems, it is necessary to rearrange small farm lots to clusters of economic size. This entails the reformation and re-allotment of land parcels to achieve economy of scale, as well as the organization of farmers into functional groups.

Likewise, contiguous farming will be promoted to effect suitable field shapes and sizes conducive to efficient operation of agricultural machinery and equipment, and also economy of scale. When economic farm size is achieved through area reformation, farms can be more productive and efficient as operations such as plowing, harrowing, furrowing, planting, and fertilizer application could be mechanized. The use of modern machines such as tractors and combine harvesters that are more appropriate and economically efficient in large farms can be optimized. Precision farming, which allows precise row-and-hill spacing and seed placement to ensure the desired plant density, uniform seedling emergence and plant stand, can also be promoted.

Table 1. The number and distribution of farms by size in the Philippines.

	1991		2002	
	Number	%	Number	%
Total	4,770,000		4,822,739	
under 0.5 ha	923,000	19.35	973,601	20.19
0.5 and under 1 ha	888,000	18.62	962,273	19.95
1 and under 2 ha	1,340,000	28.09	1,349,903	27.99
2 and under 3 ha	662,000	13.88	624,669	12.95
3 and under 5 ha	526,000	11.03	508,880	10.55
5 and under 7 ha	242,000	5.07	221,198	4.59
7 and under 10 ha	83,000	1.74	81,941	1.70
10 and under 25 ha	4,000	0.08	88,658	1.84
25 ha and over	13,000	0.27	11,616	0.24

Source: DA 2002

The Philippine government had pursued farm clustering and utilized farmers' organizations to implement mechanization programs. While the scheme enhanced farmers' awareness on the use of farm machinery, its utilization was not fully maximized due to inappropriateness of the machines to the random lay-out, irregular-shaped and small-sized farms. Unavailable access roads prevented machines from easily traversing each rice field. Irrigation water was also not efficiently utilized at farmers' level because of uneven landscape of rice fields.

To enhance mechanization in the country, the Agricultural and Fisheries Mechanization (AFMech) Law was enacted in 2013. It promotes the development and adoption of agricultural and fisheries machinery and equipment; provides venues for local assembly and manufacturer among other concerns. Programs on new roads, irrigation systems, settlement schemes and related services can likewise be more effective. Thus, the productivity per unit area of agricultural areas can be maximized.

One of the few countries that have accomplished rapid growth and development in agricultural mechanization over a short period of time is Korea. Such mechanization became a foundation not only for the rural areas but also for the economic development in Korea. The opportunity to learn of the Farm Mechanization Policy in Korea has contributed a lot to our full understanding of the critical role of mechanization in improving agricultural productivity and achieving food self-sufficiency in the Philippines. Its success can be largely attributed to the socio-economic demand for agricultural mechanization and financial support, as well as the strong policy drive and financial support by the government. In addition, the farmers desired mechanized farming.

Figure 3. Landscape of farm lands in Korea and Japan

While Korea and the Philippines differ in agricultural setups and human cultures, some lessons can be learned from Korea's experiences in successful agricultural mechanization. The Farmland System was created in Korea to preserve and manage the farm as an area for farming, eliminate the social class of landlords, and to adhere to the "land-to-tillers" principle. The government wanted to make sure that the Act was suited to the goal of food security of the country since the farmlands "must be cherished and properly managed for public welfare" (Hoe Jang 2015).

Korea's Farmland Bank System helps to consolidate land (making the size of farms bigger); purchase and preserve farmlands to stabilize land market value and support farmers in debt, and farmlands as basis of pension for aged farmers; lease farmlands to professional farmers, and guide senior farmers who no longer want to continue farming in selling their land to professional farmers (Hong Sang, 2015).

Korean policies and technology development can serve as basic reference for policy consultations and collaborative projects in the Philippines, where information on the technical, economic, and operational feasibility of land reformation is limited. Major interest of the government is to develop the agricultural sector to make it more profitable, productive, and responsive to the food security needs of the country. This joint research was proposed to identify issues, establish the feasibility and acceptability of the proposed interventions, and develop methodologies for the implementation of the program. Issues related to contiguous farming are: small and fragmented landholdings; no master plan covering the value chain; no sole agency to harmonize policies of different government agencies; lack of awareness about contiguous farming; funding constraints; weak farmer organizations and political will/leadership commitment. Further, the study aims to benchmark Korea's development experience as an input in the preparation of the Philippine Agricultural Mechanization Plan. In particular, the research goes after technology development and improvement, provision of education and training, inspection and quality control, and provision of after-sales service, as well as implementation of contiguous farming.

B. Objectives and scope of the survey/research

This joint research aims to enhance agricultural productivity and reduce production cost through mechanization. Specifically, to:

1. Identify critical issues and problems in land reformation relative to agricultural mechanization;
2. Establish the feasibility and acceptability of land reformation from the farmer's point of view;
3. Input to strategic framework to address identified bottlenecks; and
4. Compare experiences on agricultural mechanization through the KAPEX Academy.

III. Review of literatures

Adoption. According to Rogers (1983), the four elements in diffusion of innovations are: 1) the innovation, 2) communication channels, 3) time, and 4) the social system. Since innovations are a novelty, their perceived attributes form the basis for their acceptance, which are: relative advantage, compatibility, complexity, trainability, and observability. Herdt (1983) enhanced the discourse on adoption by classifying studies into the following: 1) characteristics of the adopters (whether individual or group), 2) determining the economic factors influencing adoption, and 3) location-specific performance of the innovation.

Factors identified to influence are scattered in many studies. In Nepal, their results showed that access to the area is crucial when availability of complementing inputs is necessary to accept the innovation (Floyd *et al.* 1999). A study on adoption of improved maize seeds and use of inorganic fertilizer in Tanzania showed that extension service and farmer participation influence the adoption of the said technologies (Kaliba *et al.* 2000). In the study of Ouma and colleagues (2002), factors influencing adoption of maize seeds and fertilizer technologies in Kenya were location, gender, manure use, hiring of labor, and extension. However, age, education of household head, farm size, credit, number of years in schooling, area allotted for coffee, and membership in organizations were also critical factors.

Literature yields conflicting results on age of respondents influencing technology adoption. One study saw that younger farmers were more innovative than older ones (Hildebrand 1958: 447); another asserted that older farmers were more open to innovations (Shaw 1985: 34); still another stated that age is not a factor at all in adopting technologies (IRRI 1975: 251). On the other hand, others contend that considering age vis-a-vis adoption is not that useful particularly in policymaking (CIMMYT 1993; Doss 2006).

Farming experience is a form of human capital like education and training since the time spent on a particular endeavor improves the skills and decision-making (Wozniak 1984). Herdt's (1983:32) review revealed inconclusive evidence about farming experience relative to farmers' adoption of new rice varieties. Gamba and colleagues (2002) found that farming experience influenced farmers' wheat seed management and varietal adoption. They argued that the length of time that the farmer invested in wheat farming contributed to better decision-making thus enhancing the adoption of the innovations.

Organizations provide farmers access to support services such as credit or information thus enhancing probability of technology adoption (IRRI 1975). In Nepal, it was found that membership in organizations, coupled with participation in trainings, influenced adoption of modern rice varieties (Pandey *et al*. 2012). However, the same study concluded that these were not influential in India and Bangladesh.

Early reviews on technology adoption literature concluded that generally, tenure does not influence adoption of new varieties (Feder 1985:268-270). Recently, Caswell and

colleagues (2001) supported this thesis since their analysis showed that tenure does not affect nutrient and pest management, and soil conservation except in irrigation technologies, which initially has high cost. However, tenure is a good indicator of wealth which influences adoption (Doss 2003).

Farm size also serves as a good wealth indicator and determinant of adoption particularly if the innovation being introduced needs an additional amount of financial capital (CIMMYT 1993). Applying the argument about farms, farmers with larger farm sizes most likely adopt new technologies since their benefits would be felt in a larger area. Those with larger farm sizes have more capability to finance the extra costs from the innovation, can take potential risks, and since new technologies are scale-enhancing, the larger farms "capture economies of scale from production via the learning curve more quickly, and can spread the other fixed costs associated with adoption across a larger number of units (Hall and Khan 2002:21-22)."

Number of household members working in the farm serves as proxy for labor availability "which will enhance the adoption of a new technology that may need more care and may be more labor-intensive (Pandey *et al.* 2012:29)." This was observed in the adoption of one-grade or crossbred dairy animal in Coastal Kenya since these animals require more time for caring and feeding (Nicholson *et al.* 1998).

Land Reformation. Hayami and Kikuchi (2000) documented the Philippine agrarian structure from the pre-Spanish times to the modern era. According to them, communal land ownership was common before the conquest by the Spaniards in which families had usufruct rights to certain parcels of land. When the Spaniards arrived, they introduced the concept of private property which continues today. Given such history, "*land tenure systems are institutionally established and are, therefore, difficult to alter. Political power structures; cooperative ties; and class, cultural, and ethnic interests and motives all work towards maintaining the established forms* (Kuhnen 1982:1)."

Kuhnen (1971) observed that the agrarian structure (the mode and means of production) obstructs economic development in rural areas because of fragmented lands, small landholdings, and tenure system, among other things. The main reasons for land fragmentation and small landholdings are: 1) the successive division of small farms through inheritance resulting in shrinking plot size and 2) the land redistribution policy adopted in the course of de-collectivization and farm restructuring (Deininger 2003).

One of the advocacies to address the agrarian structure and bring development in rural areas is through land consolidation. According to FAO (2004), land consolidation is used broadly to the means of structuring property rights through coordination between owners and users of land. Thus, parcels will be reallocated to remove the effects of fragmentation in terms of use of the land. Agrawal (1999:312) expounded on the concept of land consolidation since it brings: "development of areas without any dislocation; provision of urban infrastructure and facilities through voluntary contribution of land; and financing project cost covered by contributing reserve land for commercial use." The study further added that even if landowners lose a portion of their land, they still benefit because the value of their land increases due to efficient use, accessibility, and better facilities. However, land consolidation goes beyond physical alteration since it recognizes that social, economic, and political changes are necessary for its success (Coelho *et al.* 1996).

One argument in defense of fragmented lands is it lessens production risks since the farmers can easily adjust to climate and soil variations (Ali *et al.* 2015; Deininger and Byerlee 2011). Those for land consolidation argue that it ensures economic viability of the farms and rural areas, facilitates environmental management, and rationalizes urban growth

(Deininger and Byerlee 2011; Cay *et al.* 2010). This study acknowledges that the discourse on the advantage and disadvantages with regard to land consolidation will continue. Thus, this study is being conducted to contribute more to the discourse and policies on land consolidation.

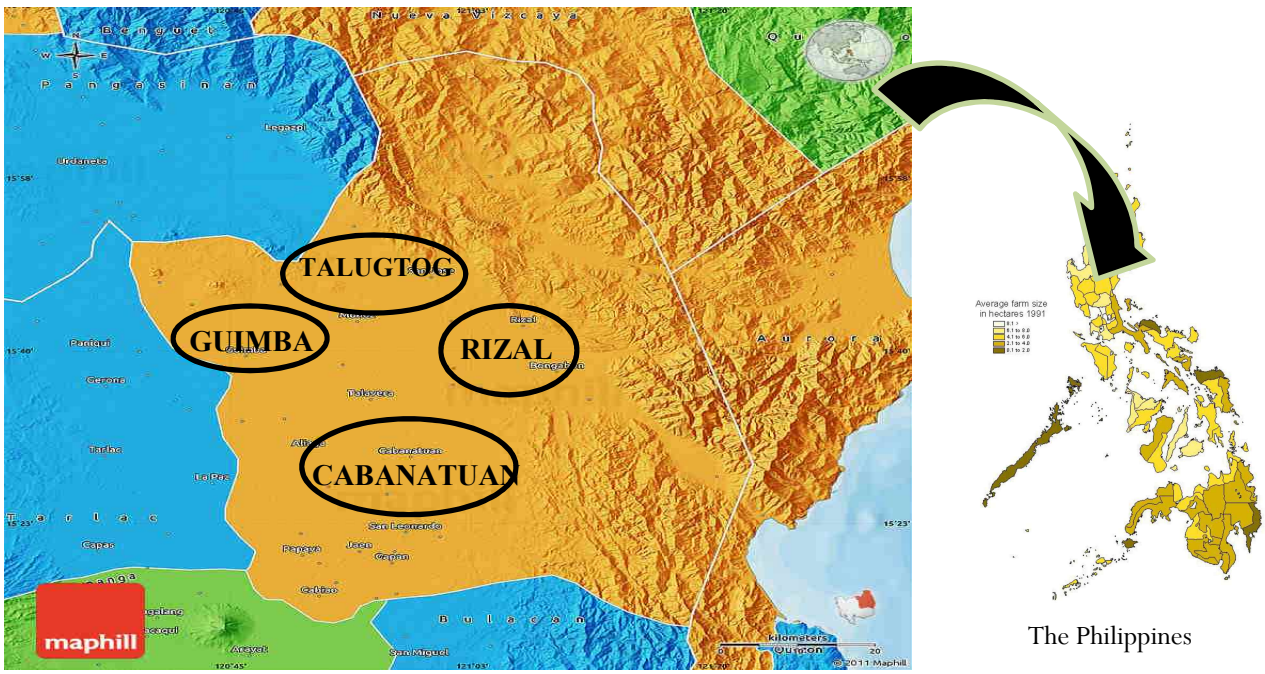
IV. Methodology

Conduct of survey. Survey method was used for data collection and a structured questionnaire was prepared for the activity. Before the actual survey, two farmers' meetings were held in Lagare, Cabanatuan City and Agbannawag, Rizal in Nueva Ecija to enable the researchers to baseline the farmers' level of knowledge on land reformation that was used in formulating questions; further, to introduce the idea on land reformation to farmers and gather their initial impressions.

A survey questionnaire was drafted after the farmers' meetings to gather ideas and views from farmer-respondents related to land reformation. Two rounds of pre-testing were conducted at Barangay Bical, Science City of Munoz, Nueva Ecija. The questionnaire was then revised and reproduced for actual interview in the target sites.

All farmers available during the entire data collection period in the target sites were interviewed. The data were collected through a face-to-face interview using the questionnaire such as farm profile (e.g. size of farm devoted to rice and other crops, number of parcels, and rice yield); socio-demographic profile (e.g. age and educational attainment); status of mechanization, and land reformation (e.g. farmers' perceptions, concerns on implementation, and suggested solutions).

Figure 4. Survey sites of the joint research project.



Surveys were conducted in Nueva Ecija in April-June 2015 in the following sites:

Site	Farmer-respondents	Ecosystem	Remarks
Barangay (Brgy) Lagare, Cabanatuan City	62	Irrigated	JICA TCP3 project sites n 2004-2009
Brgy. Agbannawag, Rizal	118	Irrigated	
Brgy. San Miguel, Guimba	31	Rainfed	recipients of shallow tube wells under the Small-Scale Irrigation System (SSIS) project funded by the FAO
Brgy. Tibag, Talugtog	69	Rainfed	
TOTAL	280		

The data and results of the survey will be used in formulating policies and guidelines for the implementation of land reformation in the Philippines. These policies will address the bottlenecks and constraints of implementing land reformation that were identified in the survey.

Probit analysis. The data were analyzed using the Probit regression model. The Probit model constraints the estimated probabilities to be between 0 and 1, and relaxes the constraints that the effect of independent variables is constant across different predicted values of the dependent variable. In common parlance, the probit model assumes an S-shaped response curve such that in each tail of the curve the dependent variable, Pr(Yi = 1), responds slowly to changes in the independent variables, while toward the middle of the curve, i.e., toward the point where Pr(Yi = 1) is closest to 0.5, the dependent variable responds more swiftly to changes in the independent variables.

The probit model assumes that while values of 0 and 1 are observed for the variable Y, there is a latent, unobserved continuous variable Y that determines the value of Y. We assume that Y can be specified as follows:

$$Pr = (Y = 1|x) = \Phi\ (X'\beta)$$

Where *Pr* denotes probability and Φ is the cumulative distribution function (CDF) of the standard normal distribution. The parameters β were typically estimated by maximum likelihood estimation method. The dependent variable (Y) in the model represents the farmer's willingness or unwillingness to adopt land consolidation. A vector regressor (X_i) represents those independent variables or the socio-economic factors that may influence the decision to land-consolidate.

Fourteen variables were included in the probit model that would explain farmers' willingness to adopt land reformation. These are organizational membership, with area devoted for seed production, ecosystem, with diversified cropping, tenure, age, farming experience, household size, per capita income, distance to the road, distance to irrigation canal, number of machines owned, household labor available per hectare, and land per capita. It was assumed that these matters will influence farmers' willingness to adopt land reformation.

Those who are aged and had more farming experience are more conservative to change. Farmers who are members of organizations may have a greater sense of community making them more agreeable to land reformation. Group affiliation may explain the differences in access to government services or in the kind of resources that they manage.

Farmers into seed production would lean more toward efficiency of their farm operations. Those engaged in diversified cropping will not favor land reformation since their areas are more profitable than rice only.

Those in irrigated areas are more likely to favor land reformation because of water availability. Those who are far from the road and the irrigation canals will also welcome land transformation for efficiency purposes

Landowners might not be keen on land reformation since they may have issues on the movement and marking of boundaries. Those with bigger household size might want to ensure that the land that they operate will not be altered. However, those with more per capita income will be more open to land transformation since they have enough capital to absorb shocks and they could invest more when the plot areas are bigger leading to higher income. Those with more machines owned, lesser household labor per capita will also be more accepting of land transformation for efficiency purposes. Lastly, those with less land per capita might ignore land transformation.

The descriptive statistics were generated using Microsoft Excel, and SPSS (version 20), a comprehensive econometrics and statistics package software, was used in the probit regression analysis.

v. Results and Discussions

Critical issues and problems in land reformation relative to agricultural mechanization

Farmer and household profile. The farmers, composed of 88% male and 12% female, have an average age of 54 years. All of the farmer-respondents have formal education: elementary (28%), high school (40%), college level (28%), and vocational education (4%). The characteristics of the households come close to the national and provincial data (PhilRice 2015). It was found that farmers during the previous surveys were among the fresh respondents. A national mechanization plan needs to be well-strategized so that the aging farmers could stay in farming activities.

Average farm household size of the farmer-respondents was four members. Thirty percent of them depend on farming as their sole source of income while 15% are engaged in non-farming activities. The remaining 51% are engaged in both farming and non-farming activities.

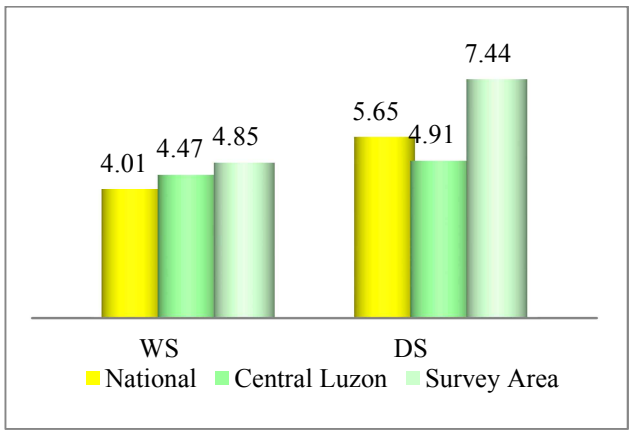
Farm landholding. The average landholding of the respondents is 2.02 ha per farmer. This is larger than the national and provincial averages of 1.43 ha and 1.62 ha, respectively (PhilRice, 2015). The number of plots cultivated by a farmer ranges from 1 to 120. The average is approximately 15 plots per household, while farm size varies from 0.14 to 38.0 ha. Land reformation through government support system is necessary to develop rice fields and improve the plot size into an economic scale to at least 10 plots per hectare. Doing this will improve the efficiency of machinery utilization due to less unproductive time during turnings.

This group was composed of 65% farmers having 1-3 hectares each, 24% having less than a hectare, and 11% having more than 3 ha. From the total farm area of 2.02 ha, 1.83 ha is devoted for rice production, 0.15 ha for other crops, and 0.03 ha is unplanted. On the average, majority (78%) own, while 22% rent the farms.

The Pearson's product-moment correlation analysis showed a correlation between the land area and number of machines owned ($r(280) = .2543, p < .0005$). This was run to assess the relationship between total farm area owned and machine ownership of the farmer-respondents. There is a small correlation found which indicated that as farm landholding increases, machine ownership also increases. The result also showed that land consolidation, or grouping of farmers in an organization, will boost their capacity to own agricultural machines.

Farm yield. Rice yields averaged 4.85 mt/ha and 7.44 mt/ha during the wet (WS) and dry seasons (DS). Paddy rice harvests are commonly placed in plastic sacks with an average weight of 50 kg per sack. The average yields of the farmer-respondents are higher than the provincial average yields in 2014 DS but less than the 2014 WS (6.97 t/ha and 5.39 t/ha, respectively). Seventy-four percent of their rice produce was sold while 26% was saved for household consumption and other purposes during both seasons.

Figure 5. Comparison of rice yields in mt/ha.



Land and seedbed preparation. All farmers prepare their seedbeds simultaneously with the whole production area. Seedbeds are thoroughly prepared in a selected area within the rice field for several days and leveled very well to facilitate irrigation water application and draining when needed. In rainfed areas, land preparation starts when seedling is 10-day-old after sowing. Rice field is submerged within 3 days to soften the soil before plowing using hand tractor or power tiller. Two harrowings by power tiller are done to pulverize big clods into mud, and to partially level the field. Final leveling is done using carabao or power tiller a day before the transplanting schedule. At national level, about 77% of farmers use

hand tractor for land preparation while 2% use 4-wheel tractors. Data showed that land preparation is 100% mechanized.

Irrigation facility and water management. During wet season, 64% of the farmer-respondents receive water from the National Irrigation Administration (NIA) system; 7% use shallow tube wells (STW); and 29% solely depend on rainfall. Most (68%) of them have sufficient irrigation water while 22% experience water shortage, and the rest have more than enough. During the dry season, 83% use water from NIA, 13% use STW, while the rest use available water from rivers. About 73% have sufficient irrigation and 19% have insufficient water. Irrigated areas had a higher proportion compared to national (60%) records. Water distribution must be optimally managed to eliminate areas with insufficient water and reduce the occurrence of excessive water. Around 70% of the respondents drain water 10 days before harvest. Irrigated rice area is 51% while rainfed is 49%. In 2006, 60% of the rice area was irrigated.

Farmers' income. In 2014, farmer-respondents' households income averaged ₱462,500 of which 66% (₱ 305,250) came from rice farming; 7% (₱ 32,375) from other crops farming; and 27% (₱ 124,875) from non-farming activities. Average per capita income was ₱ 132,224 which was above the poverty threshold in Nueva Ecija. Overseas Filipino Worker (OFW) remittances accounted for 4% of the total annual income.

Machine ownership and utilization. One-fifth (19%) use four-wheel tractors; 16% of whom rent, and 3% own a machine. Tractors are very seldom used in the farm because of limited access roads. Utilization of hand tractors at 32% is higher because such tractors can do plowing, harrowing, leveling, and even hauling of farm inputs and outputs. Small trucks that haul farm inputs and paddy harvest ae also few due to road access problems. The use of carabaos (11%) is limited to side-plowing the levees, final leveling, and hauling harvest. Low utilization of shallow tube wells is due to high cost of fuel. Certain farmer-respondents (38%) own knapsack sprayers for pesticide application; they have only two units of combine-harvester but 9% of them rent the machine. They have 58 units of axial-flow threshers, the most popular equipment for threshing that can enter inner fields with limited road access because it can be pulled by a carabao.

Table 2. Farm machine ownerships of the farmers (National survey vs. joint research).

Farm Assets	All ecosystems*	Joint Research
	(n=2,500)	(n=352)
Hand tractor	26.0	51.0
Four-wheel tractor	1.0	5.0
Knapsack sprayer	18.0	60.0
Irrigation pump/ deep	14.0	1.0
Shallow tube well	5.0	7.0
Thresher	11.0	16.0
Combine Harvester-	-	1.0

*Source: PhilRice 2015.

Machine ownership at the study sites is higher than the national data (Table 2). On machine utilization per operation (Table 3), land preparation is 100% mechanized using hand and four-wheel tractors for plowing and harrowing. Seedling preparation and pulling are manually done; 18% use machine for hauling of seedlings from seedbed to the production area. Transplanting is done manually but five farmer-respondents use the drum seeder in direct seeding.

Only 14% of the farmers used water pumps for irrigation. About 50% used hand tractors in hauling farm inputs and 50% used man-animal. Harvesting is manual, only 15% use the reaper or combine-harvester. Many (85%) used the axial-flow thresher. Machine use is higher in the survey sites except for threshing.

Table 3. Rate of farm mechanization (%) per farm operation.

Farm Operation	National survey	Joint research survey
Land Preparation	88.0	100.0
Crop Establishment		
Hauling of Seedlings	*	18.0
Transplanting	0	0
Direct Seeding	0.1	0.8
Crop Care and Maintenance		
Irrigation	*	14.0
Hauling of Inputs	*	48.0
Pesticide Application	*	0
Fertilizer Application	0	0
Harvesting	1.3	15.0
Threshing	89.6	85.0

Source: PhilRice data
*no available data

Table 4 shows results of the Probit Regression Analysis. The dependent variable (Y) represents the willingness or unwillingness of the households to adopt the land reformation program. The vector of regression (X_i) represents those independent variables that explain the outcome of the dependent variable in the model. The model identified four variables that influence farmers' willingness to adopt: organizational membership, engagement in seed production, distance to the irrigation canal, and household labor available per hectare. These variables have positive effects on willingness to adopt except distance from the irrigation canal. This means that farmers whose farms are far from the irrigation canal may no longer value the advantages of land reformation. An organization would help farmer-members to acquire expensive machines, plan community programs, and offer more income to farmers due to broadened scope of works. Seed growing is also a deciding factor for land reformation because of higher income earning per unit area of land. As the farmer ages, the number of his family labor also affects his decision to join land reformation. Other variables do not affect their decisions.

Table 4. Probit regression results of the households' willingness to adopt land reformation.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	-	.7854	-3.526	-.448	6.402	1	.011
[Organizational membership=non-	.5	.2352	.044	.966	4.607	1	.032
Organizational membership	0[a]						
[Seed growing=not seed	1.	.4721	.579	2.429	10.151	1	.001
[Seed growing=seed growing]	0[a]						
[Major land use= not irrigated land]	-	.2424	-.825	.125	2.086	1	.149
[Major land use= irrigated land]	0[a]						
[Land utility type= single crop]	-	.4286	-1.338	.342	1.350	1	.245
[Land utility type= multiple crops]	0[a]						
[Tenure= non-owner]	.2	.2355	-.176	.747	1.472	1	.225
[Tenure= owner]	0[a]						
farmer age	-	.0109	-.031	.011	.845	1	.358
farming experience	.0	.0095	-.007	.031	1.600	1	.206
household size	.0	.0635	-.118	.131	.011	1	.917
per capita income	-	9.567	-	1.016E-	.806	1	.369
distance to the road	-	.0002	-.001	.000	.099	1	.753
distance to the irrigation canal***	-	.0006	-.003	.000	6.403	1	.011
number of machines owned	-	.0960	-.247	.129	.381	1	.537
household labor available per	.0	.0524	-.009	.196	3.196	1	.074
land per capita	.0	.2578	-.471	.540	.018	1	.894
(Scale)	1.						

Dependent Variable: farmers' willingness to adopt land consolidation

a. Set to zero because this parameter is redundant.

b. Computed based on the Pearson chi-square.

Farmers' perceptions on farm mechanization

Almost half of them (44%) said that farm mechanization will make farming easier; 11% need to adopt new rice farming technologies; 12% said mechanization will displace labor. Some of them said that farm machines are advantageous in large farms only (4%), and decrease cost of production (3%). Many farmers (13%) presented no idea and did not respond to the question. Some 64% will continue farming because it is their main source of income; 19% said they are still young for the work; and 5% considered it as additional income and source of household rice supply. Problems cited were pests and diseases (43%); weather (16%); irrigation water supply (10%); low price of paddy rice (9%); high cost of farm inputs (9%); and limited capital (7%). Minor problems are availability of machines (1%); low productivity (1.3%); and farm labor (3.6).

Farmers see machines as working faster than manual (65%); less cost of production (9.3%); less manpower in the field (5.4%); favorable to farmers (6.8%); less harvest loss

(1.4%); and no constraint to weather (4.6%). The disadvantages of mechanization are: displacement of labor (42%); expensive cost of machines (8.6%); additional maintenance cost (3.6%); not suitable to Philippine conditions (4.3%); increases crimes (3.6%); and additional production cost (3.6%). Farmers said provision of alternative sources of income (45.4%) and government subsidy to machines (29%) could ease local farm mechanization.

Farmers' perceptions on land reformation

Only 28% of the respondents know about land consolidation either as structuring of fields and roads (59%); a new idea (3%); no idea about it (23%); high cost to implement (1.5%); land is easier to manage (6%); decrease of land size because of roads and irrigation canals (3.2%); advantageous to farming (2%); and displacing labor (2%). Positive responses were: increase farm productivity (25%); improve roads and irrigation canals (18%); increase cultivated area (13%); lesser time for farm activities (15%); and easier to manage fields (17%). Some 4% said land reformation lessens cost of production and increases machine efficiency.

The disadvantages of land consolidation according to farmers area: fields are difficult to level (29%); decreased cultivated areas (8%); more displaced labor force (9%); decrease in yield because of leveling (5%); and problems on irrigation (8%). Some 29% saw no disadvantage in implementing land consolidation. Farmers see bigger plots as well-leveled fields (26.4%); increase cultivated area (23.6%); easier to irrigate; apply pesticides and fertilizers (17.5%); and result in higher income (10%). Other advantages of bigger plots are: increase farm productivity (19.3%); less management of weeds and dikes (25.4%); crop is easier to manage (23.2%); machines will become efficient (9%); and increase cultivated area (6.4%). Seen as disadvantages are: irrigation problem if field is not leveled properly (17.9%); hard to level (16%); and 34.3% saw no disadvantage in bigger plots.

More than half (55%) of respondents believed that access roads are essential in the farms. They said land reformation could be done efficiently by the Department of Agriculture (56%); local government unit (18.2%); or others (17%). Farmers (66%) are not willing to shoulder the expenses for land reformation because leveling cost is too expensive for them (53%) and is necessary for the improvement of their farms (30%). They also worry about reduction of farm area because of roads and irrigation canals.

VI. Conclusion

Probit regression analysis identified four variables that can influence farmers' willingness to adopt land reformation in the Philippines: organizational membership, engagement in seed production, distance to the irrigation canal, and household labor available per hectare. Other variables such as major land use, land tenure, farmer age, farming experience, household size, distance of farm from road, per capita income, land per capita, and number of machines owned do not matter in their decisions regarding land reformation.

Land reformation is not popular to 2/3 of farmers in the Philippines. Few of them understand land reformation as re-structuring of roads and fields that will ease farm management, but it is costly to implement it and will decrease land area. They believe that through land reformation, farm productivity will increase, irrigation and roads will be

improved, cultivated area will expand, and farm activities will require less time. However, farmers claim that fields will become difficult to level, cultivation areas will decrease, and more laborers will be displaced. Yet many of them see no negative impact that can be attributed to land reformation. Some of the prevalent field problems will even be alleviated through the project.

Since land reformation technically initiates economy-of-scale plots, farmers believe that bigger plots will be well-leveled, expand cultivated areas, easier to manage, and machines will be efficient, resulting in higher income. Provision of road access to farms is very essential to farmers but must be at government expense.

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VIII. List of tables

Table 5.1 Household head and member profile

ITEM	N	MEAN	MIN	MAX	STD DEV
Household size	280	4.11	1.00	9.00	1.68
Average age of household (hh) head	280	52.85	23.00	90.00	12.82
Average educational attainment (years)	280	9.49	0.00	15.00	3.42
Proportion of hhhead working in the farm	280	98.57			

Table 5.2 Household size of respondents, Nueva Ecija.

No. of household members	Frequency	%
1-2 members	55	20
3-4 members	113	40
5-6 members	86	31
< 6 members	26	9
Total	**280**	**100**

Table 5.3 Educational attainment of respondents.

Education	Frequency	%
elementary level	34	12
elementary graduate	45	16
high school level	14	5
high school graduate	98	35
college level	32	12
college graduate	46	16
vocational	11	4

Table 6. Farm general characteristics, all parcels.

ITEM	N	%	MEAN	MIN	MAX	STD DEV
Major Land Use						
1- Irrigated Agriculture	305	51.1%				
2 - Rainfed Agriculture	146	49%				
Seed-growing area, %		14				
Land Utilization Type						
1- Single	431	96%				
2- Multiple	19	4%				
3- Compound	1	0%				
Tenure						
1-Owner	350	78%				
2- Rented, Lessee, Others	101	22%				
Distance to Road	451		72.33	1	400	160.94
Distance to Irrigation Canals	451		107.4	0	2000	235.2
Number of Plots	451		14.72	1	120	15.36
Average total farm area, ha	280		2.02	0.14	38.00	2.88
Average area exclusive for rice, ha	280		1.82	0.00	38.00	2.86
Average rice-based area, ha	280		1.79	0.00	38.00	2.86
Average other crops area, ha	280		0.15	0.00	5.50	0.61
Average idle area, ha	280		0.03	0.00	3.50	0.23
Average total area for other use, ha	280		0.02	0.00	1.50	0.13
Average number of parcels	280		1.36	1.00	9.00	0.82

Table 7. Machine ownership of the farmer-respondents.

Type of Machine	OWNED		RENTED	
	n	%	n	%
4-wheel tractor	16	3%	83	16%
Hand tractor	178	32%	107	21%
Small truck	2	0%	11	2%
Man-animal-cart	16	3%	42	8%
Shallow tubewell	24	4%	6	1%
Deepwell	5	1%	5	1%
Knapsack sprayer	209	38%	30	6%
Combine harvester-thresher	2	0%	48	9%
Thresher	58	11%	171	33%

Table 8. Use of machines during rice cultivation**.**

Field Operation	ALL	
	n	%
Land preparation	615	100
Seedbed preparation	*	*
Crop establishment		
Hauling of seedlings	113	18
Transplanting	*	*
Direct Seeding	5	1
Crop care and maintenance		
Irrigation	87	14
Hauling of inputs	294	48
Pesticide application	527	86
Fertilizer application	*	*
Harvesting	95	15
Threshing	491	80
Hauling of palay	206	34

* Manually done

Table 9. List of Technical Working Group (TWG)

Name	Position	Agency
Elmer G. Bautista	Senior Science Research Spec	PhilRice
Ronell B. Malasa	Senior Science Research Spec	PhilRice
Teodora Briones	Planning Officer	PhilRice
Eduardo V. Alberto	Information Systems Researcher	BSWM
Caesar Joventino M. Tado	Chief Science Research Spec	PhilRice
Michael A. Gragasin	Supervising Science Research Spec	PHilMech
Rossana Marie C. Amongo	Assoc. Professor	UPLB
Cristy Cecilia Polido	Chief	DA-CAFED
Manuel Jose C. Regalado	Acting Deputy Executive Director for Research	PhilRice
Janice P. Vargas	Engineer II	DA-CAFED
Ulysses J. Lustria Jr.	Head	DA-Investment Programming Division