SCOPE OF THE FIRM AND MANAGEMENT INFORMATION IN LARGE-SCALE RICE FARMS

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Abstract

Using results of a questionnaire survey of large farms in California, this study investigated the relation between information management and the scope of firms, especially integration into drying and warehousing. First, the majority of large farms are equipped with information communication technologies (ICT) such as global positioning systems (GPS) guidance systems and auto-steering. Integrated farms adopted precision agriculture technologies including Real Time Kinematic (RTK) GPS more than specialist producers did. Secondly, integrated farms accumulate more data related to yield and output inventory. They also provide video instruction and visual manuals for employee education. Farms with hierarchical structures monitor the input inventory and working time more intensively than simple structure farms do. Thirdly, large farms keep a record of input flow and input price. They also acquire information related to output rice quality. Operation schedules are well-planned in large farms. It is noteworthy that no significant adverse relation was observed despite the small sample size. Accordingly, rice farm expansion in the information age is expected in two directions. i) Integration using yield and output stock information to coordinate between upstream and downstream processes. Input inventory and working time should be monitored carefully. Yield monitors, RTK and other ICT will be used intensively to achieve uniform quality over farm fields. Employee education is also enhanced by visual ICT. ii) Scale expansion can be pursued with access to input flow and price information. Rice quality is important because it reflects the sale price to millers. A well-organized operation schedule within the farm is also important to manage farmland expansion geographically. It is noteworthy that integration and farm size are correlated strongly with each other in the California case. Both directions are therefore presumed to proceed simultaneously where land resources are abundant.

Keywords: management information, scope of the firm, integration, rice production, Information Communication Technology (ICT)

1. Introduction

Information management in a firm is regarded as an important factor determining the "scope of a firm" in the theory of organizational economics (Collis and Montgomery, 1998). A main reason for broader scope of operations is to avoid opportunistic behavior attributable to uneven inter-firm distribution of information. If partner firms with dominant information take advantage of such opportunities, then inefficiency will occur throughout an economy. Firms can expand the firm scope (product, integration, and geography) and overcome problems of uneven information distribution.

Adverse effects of intra-firm information related to the scope, in contrast, are agency problems within the firm. Employees with specific knowledge in different departments cannot be motivated and monitored as though they are single entities. Once a firm expands its scope and a hierarchal organization is constructed, costs of transmitting information in the firm increase. Information management and intra-firm communication are therefore key elements determining the scope.

Expanded farm size leads to increased geographical scope. Integration and diversification from agriculture is a common strategy to attain added value or to make efficient use of owned resources. It has been regarded as difficult for rice farming to accumulate information where vast areas of outside space are under control. Modern information communication technologies (ICT) such as remote sensing, global positioning systems (GPS), the Internet, and optical sensors facilitate information management for large farms. However, if farm-specific information is accessible to the public, firms might have little incentive to integrate because market transactions will be more efficient. In short, ICT development has both positive and negative impacts on the scope of the firm. Little related evidence has been presented.

A series of surveys of Internet access by farms was included in the Census of Agriculture, the United States Department of Agriculture (USDA, 2007). Figure 1 and Figure 2 respectively present illustrations of Internet adoption rate by farm size and operator age. A clear relation of technology adoption and size is observed. The adoption rate is fairly low by farm operators younger than 70.

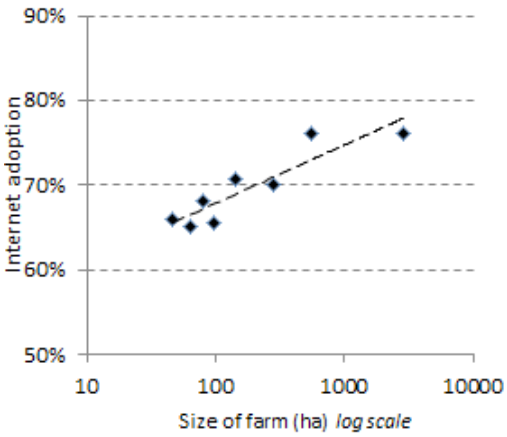

Figure 1. Internet adoption rate by size of farm (California, 2007)
Source: USDA 2007

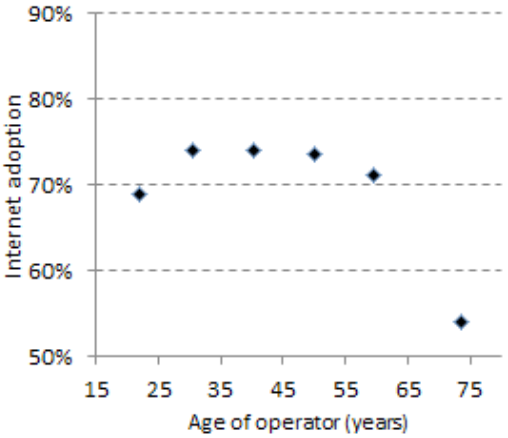

Figure 2. Internet adoption rate by age of operators (California, 2007)
Source: USDA 2007

Earlier studies (Daberkow and McBride, 2003; Banerjee et al., 2008) revealed that younger farm managers who are familiar with personal computers tend to implement precision agriculture (PA) equipment. The farm size, crop yield, and reliance on agricultural income also had a positive impact on the adoption rate. Yagi and Howitt (2010) concluded that the target cost reduction by PA is about 1% for farm managers who used the technology. These studies have particularly addressed the conditions of new technology adoption. Few researchers have examined the relation between the information contents and business attributes of the farm, especially the scope of the firm. Therefore, this paper clarifies i) the present situation of ICT application, ii) information management, and iii) these relations with farm attributes. Our studied case is Californian large-scale rice farms, where ICT has been prevailing dramatically, and where product quality is emphasized.

2. Research framework and methodology

2.1. Framework of managerial information

Figure 3 presents a conceptualized framework of managerial information. Corporate management, in theory, is composed of capital process and production process with capital and product flow. Each process includes stock and flow information. For example, quantity and quality of procured resources are flow information. The inventory is recognized as resource stock information. Resources are combined and transformed into products using technology, which includes information. This production is monitored as production condition information. Efficiency measures of procurement, production, and sales are information used to compare production processes with those of capital in financial terms. Market information and available technologies existing outside the firm can be stored as intra-firm information. This study specifically examines the production process. The use of efficiency information is exempt from the objective of this paper because it is not available to firms until the stock and flow information of production and capital process.

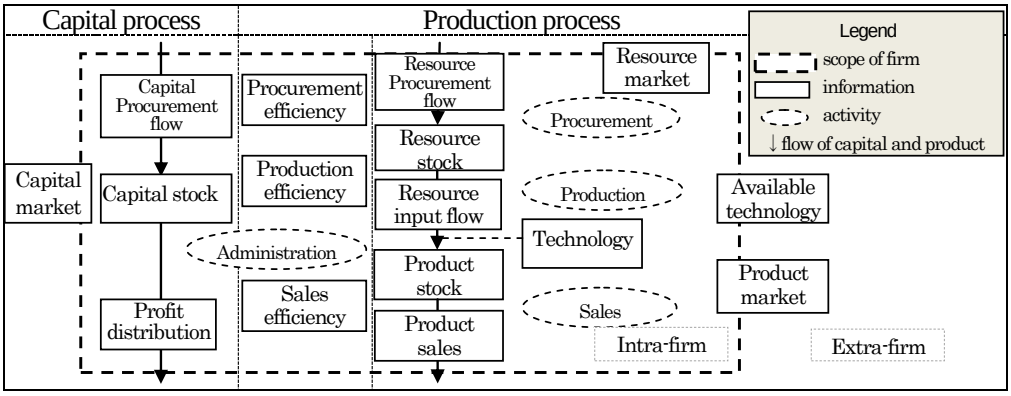

Figure 3. Framework of managerial information

2.2. Research methodology

First, the industrial structure of rice production in California must be overviewed to identify the scope of the firm. For this purpose, interviews of representatives of California Rice Commission (CRC) and the Farmers Rice Cooperative (FRC) were conducted in 2010 and 2011.

Secondly, ICT adoption, management attributes and information management by rice farms are surveyed. Our survey was administered with the support of FRC in August 2012 at the venue of Rice Field Day of the Rice Experiment Station in Biggs, California. The questionnaire sheets were distributed to 49 large-scale rice farm managers. We received 17 responses by postal mail (response rate, 35%). The sample covers some 2.2% of large scale farms with 617 ha (250 acres) and more, although they are few number[1)]. The results of the survey conducted in Japan (Nanseki et al., 2013) [2)] were compared to ours as well. Analyses specifically examine the circumstances of information management and its relation with firm scope, farm size, and manager attributes.

3. Californian rice industry and rice farms

3.1. Rice industrial structure of rice in california

The current rice industry structure as ascertained through our interviews is presented in Fig. 4. In all, 1,304 rice farms exist, although few farms hold drying facilities. Seventy professional dryers operate warehouses as well, which store dried rough rice until it is shipped to millers. Twelve millers exist, including FRC, some of whom own drying facilities. Only two large-scale rice farms own drying facilities and a mill. Vertical integration from the farmers' perspective is of two types: III) and IV) in Figure 4. A main concern is the impact of information management within these integrated farms compared to that for most specialist producers.

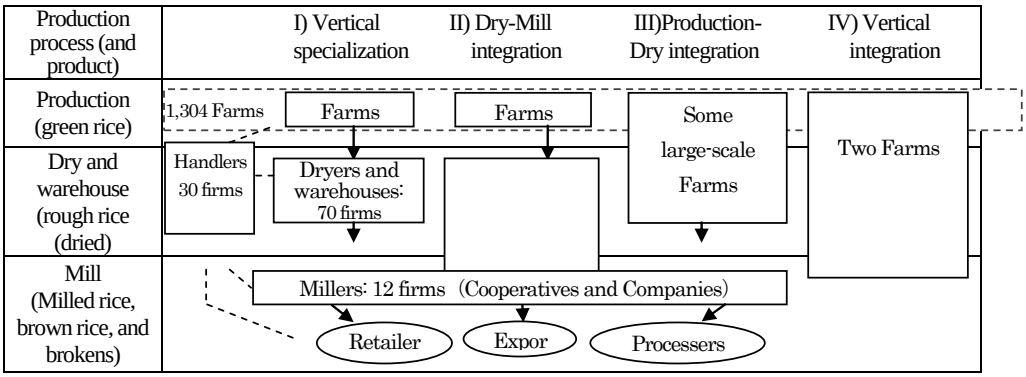

Figure 4. Industrial structure of rice in california
Source: Interviews by authors to representatives of Farmers' Rice Cooperative (FRC) and California Rice Commission (CRC) in 2010 and 2011

3.2. Summary of large-scale rice farms

Table 1 presents a summary of survey results. All farm size attributes are considerably large, reflecting our objective, compared to the state average. Of 17 sample farms, seven (41%) integrate drying and warehousing processes. Such integrated farms are large according to the positive correlation observed (0.64). Seven (41%) farms assign section managers with an average number of 1.00 (managers/farm). Fourteen (82%) farm managers received tertiary education (university or college); seven had majored in agricultural subjects (five in agri-business, two each in agricultural economics and agronomy). The farm manager age is not largely different from the state average.

4. Information management and farm attributes

4.1. Adoption of information equipment

Table 2 shows the observed adoption rate and relation with farm attributes of respondent rice farms. Twelve respondents (71%) are equipped with GPS guidance and auto-steering. Such PA equipment is commonly attached when farm machinery dealers sell tractors or harvesters. About half of respondents use inch-level accuracy Real Time Kinematic (RTK) GPS, an RTK leveler, and GPS yield monitor. One RTK system costs about 250 thousand dollars. Despite that cost, the

Table 1. Summary of Respondent Rice Farms

Item		Surveyed farms	Correlation with area	Compared to rice farm average in California (2007)
Management attributes	Integration (dry and warehouse)	41%	0.64**	–
	Assigning section manager	41%	0.13	–
	Corporation (incl. partnership)	29%	0.25	46.2%
	Number of Section managers	1.00	0.31	–
Farm size	Area of rice planted	635 ha	–	165 ha
	Number of harvesters	2.76	0.77**	0.39[a)]
	Number of employees	8.18	0.92**	2.57[a)]
Farm Manager attributes	Tertiary education	82%	0.15	–
	Majored in agriculture	41%	0.33	–
	Age	54.1 yrs old	–0.32	55.2 yrs old[b)]

State average is based on USDA: a) average of oilseed and serial farms (of which 52% are rice farms); b) average of operators whose prime occupation is farming; ** 1%, * 5%
Source: Questionnaire survey by authors in 2012, August (n = 17)

high adoption rate of RTK monitors and RTK by integrated farms are assumed to represent their need to achieve uniform yield and quality for easier post-harvest handling. Variable rate applicators (VRA) of fertilizer or chemicals and water level monitors are adopted less frequently. No significant relation was found either with farm size or manager attributes.

Table 2. Adoption rate of information equipment and farm attributes

Item	Statistical test	GPS guidance	Auto-steering	RTK	GPS yield monitor	VRA	RTK leveler	Water level monitor
Adoption rate		71%	71%	59%	41%	24%	53%	6%
Integration	Ratio difference	◆	◆		◆		◆	
Assigning Sec. Manager				◆				

Note: n = 17, significance: ◆ 5%; no significant relation was found with type of corporation, number of section managers, farm size variables (area planted, the number of harvesters and employees), or manager attributes (age and education)

4.2. Practice of information management

Results of information management practices are presented in Table 3. Results compared to Japanese rice farms are also provided. More than half of respondent farms store employees' information (address, gender, age and wage), field/farmland information (area, yield, land owner) and rice inventory information in the form of a database. Resource flow (input use and working time) and production conditions (plant and field) are less frequently acquired, probably because of the difficulty in observing real time information.

Integrated farms are more intensively using information related to yield and quantity of rough rice in the storage. They must manage the quantity of green rice and rough rice to coordinate between production, drying and warehouse sections. Specialist farms instead need only carry harvested rice into dryers' facilities and are paid based on the moisture and quantity of rice. Farms

with section managers maintain a record of input inventory and working time, probably because of the need to monitor the hierarchical structure in the firm.

Farm size has less relation with information management than the management attributes. Larger-scale farms tend to acquire information of input uses and that of quality of rice. Efficient use of input is emphasized by such farms because the larger the farm is, the more costs it can accommodate. Rice quality is also important because it reflects the price paid by mills. The transaction is made based on "Head and Total" which is the proportion of whole kernels, broken, and other residues.

Managers' objective attributes show little difference in information management. This result matches the census result for Internet access.

Japanese rice farms, from a comparative perspective, practice inventory management, quality of rice, customer information and Internet advertisement more intensively than Californian farms do. Financial management reaches one-ninth of farms. Corporate rice farms in Japan usually operate through production, drying, warehousing, milling, and retailing. Such vertical integration might reflect the importance of intra-firm information management.

Table 3. Information management practice and farm attributes

Item	Test	Resource stock			Resource flow		Production condition		Output, sales and administration					
		managing input inventories	managing employee information	managing field/farmland information	acquiring input use information	acquiring working time information	acquiring plant information	acquiring field information	accruing rice yield	evaluating rice quality	managing inventory information of rough rice in storage	managing customers information	advertisement of product through the internet	managing financial information/ book-keeping
Adoption rate	–	47%	71%	71%	29%	12%	31%	13%	38%	19%	50%	38%	31%	81%
Results in Japan [a)]	–	66%	49%	–	–	–	17%	19%	–	30%	–	73%	68%	90%
Integration	Ratio		◆	◆	◆				◆◆		◆◆			◆
Corporation	:												◆	
Sec. Manager	:	◆◆		◆	◆		◆					◆◆		
Number of Sec. Managers	Mean					◆◆								
Area of rice	Mean				◆◆					◆	◆			
Number of harvesters	:													
Number of employees	:				◆					◆				
FM Education	Ratio	◆◆										◆		
FM Agri. Major	:	◆											◆	

Note: All management in electrical basis with PC, etc.; [a)] result in Japan refers to a survey in 2011 by Nanseki et al. (2013); 3), significance: ◆5%, ◆◆1%; no negative correlation was found

We also surveyed how frequently each farm updates the information (Table 4). Only two respondents update employees' information weekly, although most farms do so less frequently. Aside from one farm acquiring plant information daily during harvesting season, checking production conditions is not a regular practice for farms.

Table 4. Frequency of information update/acquisition

Frequency	Input inventory	Employee information	Field/ Farmland information	Frequency	Plant information		Field information	
					growing season	harvesting season	growing season	harvesting season
Weekly		2		daily		1		
Monthly	3	2	2	weekly	2	3	1	1
Half-yearly	1	3	3	monthly	1			1
Less frequently than half-yearly	4	4	7	less frequently than monthly	2	1	1	
Total	8	11	12	total	5	5	2	2

Note: n = 17, figures are the quantities of respondents for each item

4.3. Reference of market price

Table 5 presents results for the frequency of reference to market price information. Nearly half of respondents (44%) check rough rice prices weekly; 19% refer to fertilizer/chemical prices weekly. Wages, land rents, and machinery prices are less frequently of concern. Significant positive correlation was found between fertilizer/chemical reference and farm size variables (area, harvester, and employees). This result is consistent with the tendency of input flow information management described in the previous section. It was also observed that younger farm managers and private farms show more concern about the output price.

Table 5. Frequency of reference to market price

	Fertilizer/ chemical price	Machinery price	Wage	Land rent	Interest rate	Rough rice price
Weekly	19%	0%	0%	0%	6%	44%
Monthly	38%	19%	0%	0%	25%	38%
Less frequently than monthly	44%	81%	100%	100%	69%	19%
Correlation with						
Corporation						−0.58*
Area planted	0.57*					
Number of Harvesters	0.69**					
Number of Employees	0.55*					
Age of FM						−0.78**

Note: n = 17, correlation is calculated using codifying as 3 (weekly) to 1(Less frequently than monthly), significance: * 5%, ** 1%

4.4. Intra-firm communication

Finally, the adopted practice of the intra-firm communication is presented in Table 6. Integrated farms provide video instruction to share the operation procedures with employees as well as manuals with photographs and figures. This relation probably reflects the hierarchical roles of employees in integrated farms. Large farms, in contrast, prepare a documented schedule of operation because they should organize well over the wide area of operation. Comparative research in Japan showed that 33% of farms provide documented work instruction and 42% prepare a documented schedule. Such practice is assumed to be necessary for coordinating operations over extremely scattered fields plots as well as integrated processes.

Table 6. Intra-firm communication and farm attributes

Item	Providing documented work instructions to direct employees with PC	Providing documented schedule of operation with PC	Email communication with employees	Providing video instruction to share the operation procedure	Providing operation manuals with photographs/ figures to share the operation procedure
Adoption rate	0%	19%	25%	31%	31%
Result in Japan[a)]	33%	42%	27%	12%	20%
Integration	-			◆	◆
Corporation	-			◆	◆
Area Planted	-	◆ ◆			
Number of Employees	-	◆			
FM Agri. Major	-	◆		◆	◆

Note: Significance: ◆ 5%, ◆◆ 1%, no negative significance was found; same statistical test is applied as Table 3; [a)] Results in Japan refer to a survey in 2011 by Nanseki et al. (2013)

5. Conclusions

This study investigated the relation between information management and scope of the firm, especially integration into drying and warehousing by large-scale rice farms in California. Relations were observed between information management practice and integration. No significant adverse relation was found despite the small sample size.

First, the majority of large-scale farms are equipped with ICT such as GPS guidance and auto-steering. Integrated farms adopt PA technologies including RTK compared to specialist producers.

Secondly, integrated farms more actively seek and accumulate information related to yield and output inventory. They also provide video instruction and visual manuals for employee education. Farms with hierarchical structures monitor the input inventory and working time more earnestly than simply structured farms.

Thirdly, large farms keep a record of input flow and input price. They also acquire information related to output rice quality. Operation schedules are well-planned in large farms as well.

Japanese rice farms, in contrast, emphasize resource stock management, output, sales and administration management. Moreover, they organize documented instructions and schedules. Such management reflects the complex operation and integration from production through retail. ICT equipment, however, is not easily available to farmers.

Accordingly, rice farm growth in the information age is expected in two directions: i) scope expansion (integration) and ii) scale expansion. Integration is proceeded using yield and output stock information to coordinate between upstream and downstream processes. Input inventory and working time should be monitored carefully. Yield monitors, RTK and other ICT will be used intensively to achieve uniform quality over farm fields. Employee education is also enhanced by visualized ICT.

Scale expansion can be pursued with access to input flow and price information. Quality of rice is of great concern because it is reflected in the price sold to millers. Well-organized operation schedules within the farm are also important to manage the farmland spreading out geographically. It is noteworthy that integration and farm size are correlated strongly in the California case. Both directions are presumed to proceed simultaneously where land resources are abundant. If land use is more limited, as it is in Japan and most Asian countries, then intensive information management and downstream integration would be more important.

These research findings are limited by the small sample size. Further qualitative investigations can verify the relations between information management and the scope of the firm in agriculture. Not only integration within the same product but also diversification into other enterprises is an important topic for further research.

6. References

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