Abstract. Tidal swamp area in the Southern of Sumatra is a source of rice production to support the national rice self-sufficiency. However, the rice yields achieved by farmers are relatively lower compared to the potential yield gained in research. To identify the problems faced by the farmers, farmers’ interviews and workshop have been conducted at the study sites located in Delta Telang, Sugihan Kanan, Karang Agung Ilir, and Pulau Rimau in April 1999. The results showed that improvement of land, water, and farm managements in cooperator farmers’ areas increased rice yield from 2 to 3.43-3.96 t ha\(^{-1}\) and farmer’s profits by 55.4%. The profits of cooperator farmers increased in following year to 69.6%. Diffusion process of technologies also increased the profits of non-cooperator farmers between 12.2-29.5%. Even though the improvement of rice farming management in tidal swamp areas has shown a significant increase in yields and farmer’s incomes, however, to develop the recommended technology to the wider areas still faces some problems on the aspects of land and water management, farm management, marketing, farmer’s institution, assistance from extension workers, and the availability of equipment and agricultural machinery.

Keywords: Rice, tidal swamp management, problems, farmers’ feed back

INTRODUCTION

The agricultural sector plays a significant role in Indonesian economic development. During the last two decades, the government has placed a major effort on agricultural development, especially in increasing rice production. Experiences showed that the instability of rice supply affected not only the economic but also the political aspects of the country. Therefore, the production and supply of rice play a central role in food policy.

One of potential areas for agricultural expansion is tidal swamp area outside Java. There is about 39 million ha of swampland in Indonesia located mainly in Sumatra, Kalimantan, and Irian Jaya islands (Noorsyamsi and Sarwani 1989). About 20.1 million ha the area is affected by tides, and about five million ha of is considered potential for agricultural production (Widjaja-Adhi et al. 1992).

The tidal swamp areas in the South Sumatra covered about 961,000 ha (Ananto et al. 2000). The land reclaimed for agricultural food crops was 34.3% (329,987 ha) and has
been inhabited by 73,500 households of transmigrants. Widjaja-Adhi et al. (1990) suggested that the tidal swamplands are marginal and fragile lands. However, the lands can be developed for productive agricultural lands.

Tidal swamplands have unique characteristics in which they are influenced by water movement because of the sea tides. The water depths in the tidal swamplands are controlled by the tides, as well as by rainfall. Based on the prevailing water levels in the fields, tidal swamp lands in South Sumatra can be classified into four types i.e. types A, B, C, and D (Noorsyamsi et al. 1984; Widjaja-Adhi et al. 1992; Widjaya-Adhi and Karama, 1994). Type A swamplands are directly affected by sea tides and the lands are always flooded during spring and neap tides. Near the rivers, water depth fluctuates by as much as 2.5 meters within 24 hours during the spring tide. Type B swamplands are directly influenced by the sea tide and they are flooded only during the spring tide. Type C swamplands are never flooded because they are influenced indirectly by the sea tide. Tides indirectly affect these lands with water infiltration through the soil, however, water levels are affected more strongly by rainfall than by the tides. Furthermore, the ground-water table is shallower than 50 cm from the land surface. Type D swamplands are not affected by sea tides at all. No water infiltration occurs through the soil. The ground-water table is deeper than 50 cm from the land surface.

A major environmental issue with tidal swamplands is the highly complex nature of soil characteristics and the uncontrolled hydrology regime. Tidal swamplands are characterized by high soil acidity (low soil pH), and the availability of pyrite, aluminum, and iron which therefore may pose acidity problems.

In the development of Indonesian agriculture especially rice, the tidal swamp areas in South Sumatra were increasingly strategic (Budianto 2000) eventhough the rice productivity was relatively low, average yield between 1-2 t ha\textsuperscript{-1} achieved by farmers. Although it has been cultivated by transmigrants for 17-20 years, the yield of food crops did not significantly improve farmers’ welfare.

Agricultural research in tidal swamp areas has been conducted by the Indonesian Agency for Agricultural Research and Development (IAARD) through various programs with satisfactory results. If the land was properly managed, in the sense that all the technical problems can be solved by the right science and technology (Ananto et al. 1999), the tidal swamp areas in South Sumatra can contribute to regional and national food security. Through some research conducted under the South Sumatra Tidal Swamp Agricultural Farming Systems and Development Project (Proyek Pengembangan Sistem Usaha Pertanian Lahan Pasang Surut Sumatera Selatan-P2SLPS2), the rice yield in the rainy season increased to 3.43-3.96 t ha\textsuperscript{-1}, even in some locations it reached 4-6 t ha\textsuperscript{-1}. 

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Budianto (2000) suggested that to develop technology package, despite many problems and challenges, both technical and social-economic aspects, marketing and institutional aspects. To find out the farmers’ opinions on the rice farming systems introduced by P2SLPS2 in the tidal swamp areas in South Sumatra, it was required a careful understanding on rice farming systems, problems, and feedbacks through interviews and workshops/discussion with farmers. Farmers’ response and problems on implementation of improve rice farming systems introduced by IAARD can be used as a base for improvement on rice farming systems in the future. The feedback to all parties involved in the development of agricultural productivity in the tidal swamp areas that was mentioned by farmers should be taken into consideration to improve farmers’ welfares.

RESEARCH METHODOLOGY

In the rainy season of 1997/98, P2SLPS2 carried out some improvements of land and water management in the South Sumatra tidal swamp areas using 32-64 ha for rice cultivation. Improvements were initiated from water management in macro water canals (primary, secondary, and quarter canals), and followed by application of farming technologies including micro level canals, crop improvement, and empowerment of institutional support.

The areas have land typology of potential soil, potential acid sulphate soil, actual acid sulphate soil, and peat/peaty soil. Although there were four different types of swamplands, this research only focused on types A and B. The type A lands were always flooded by high and neap spring tides and were managed as wetland rice areas, while the lands with type B were flooded by spring tide and were managed as wetland rice areas under surjan systems. Field activities in the rainy season of 1998/1999 and 1999/2000 were focused on improvement of agricultural technology and empowerment of farmers or farmers’ groups.

To find out the farmers’ opinion on the rice farming appearances and issues in South Sumatra tidal swamp areas, non-formal interviews and farmers’ workshop were conducted in the areas of Delta Telang, Sugihan Kiri, Pulau Rimau, Karang Agung Tengah, and Karang Agung Ilir. Farmers’ workshop was focussed on three important aspects of rice farming in tidal swamp areas, namely: a) Land and water management, b) Farm management, and c) Marketing and rural/farmer institution. The selection of topics was based on the research results and direct observation to the field, that the rice yield in tidal swamp areas is strongly influenced by land and water managements, farming technology, marketing, and institutional support.

Farmers’ workshop was attended by village officials, KUD administrators, the owners of production facilities (hand tractor and rice milling units/RMU), and the Institute
of Agricultural Extension. Some issues raised in this workshop were confirmed to the relevant officers to obtain alternative solutions and alternative plans needed to be followed up in the next season.

RESULTS AND DISCUSSION

The Performance of Rice Farming Systems in Cooperator and Non-cooperator Farmers

To achieve ecologically sustainable agriculture in tidal swamplands, the farming systems should follow appropriate management practices, which accommodate the specific environmental conditions of these areas. This also follows the selection of suitable crops varieties and species. Most of the adopted crops here were based on rice monocropping with only one harvest per year.

The rice yield potential in tidal swamp areas in South Sumatra is determined by the success of land and water managements, crop cultivation, marketing, and institutional support. Ananto et al. (1999) suggested that there are two factors determined the rice yield in tidal swamplands: the natural and technical factors. If the technical factor is limited or less, so the natural factors are more dominant to determine the rice yield.

Based on the evaluation of rice farming in the rainy season of 1997/1998, 1998/1999, and 1999/2000 (Table 1), the average rice yield of cooperator farmers was higher than the yield obtained by non-cooperator farmers.

Table 1 indicated that the increase of rice yield in each year was due to the technical barrier factors such as water management (both at macro and micro levels) while cultural practices were solved. Improvement of rice farming system in cooperator farmers gave higher yield and benefits compared to non-cooperator farmers. The research results showed that improvement of rice farming systems in tidal swamp areas in the rainy season of 1997/1998 led to increase the profits of cooperator farmers by 55.4% from the profits obtained by non-cooperator farmers. The profit of cooperator farmers in the rainy season of 1998/1999 and 1999/2000 was 69.6 and 52.2% higher than that of non-cooperator farmers. Profitability of non-cooperator farmers in the wet season of 1999/2000 also increased between 12.2-29.5% because of diffusion process of technology by cooperator farmers through the exchange of information and non-formal field trip among farmers. Herdt and Capule (1983) suggested that the increase in yield and profit of non-cooperator farmers was due to neighbourhood effects, where the cooperator farmers in-directly demonstrated the recommended technologies of land and water management, and farming management which were gradually followed by the farmers in the surrounding areas.
Table 1. Analysis of rice farming systems in South Sumatra tidal swamp areas

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<tr>
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<tbody>
<tr>
<td></td>
<td>Cooperator Farmers</td>
<td>Non-cooperator Farmers</td>
<td>Cooperator Farmers</td>
</tr>
<tr>
<td>Production Inputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Production Material (IDR)</td>
<td>383,837</td>
<td>271,224</td>
<td>482,349</td>
</tr>
<tr>
<td>-Labor (IDR)</td>
<td>434,734</td>
<td>483,225</td>
<td>598,976</td>
</tr>
<tr>
<td>Total Input (IDR)</td>
<td>818,571</td>
<td>754,449</td>
<td>1,881,325</td>
</tr>
<tr>
<td>Yield (t/ha)</td>
<td>3.43</td>
<td>2.65</td>
<td>3.840</td>
</tr>
<tr>
<td>Yield Value (IDR)</td>
<td>1,764,049</td>
<td>1,362,895</td>
<td>2,035,200</td>
</tr>
<tr>
<td>Profit (IDR)</td>
<td>945,478</td>
<td>608,447</td>
<td>953,875</td>
</tr>
<tr>
<td>Gross B/C</td>
<td>2.16</td>
<td>1.81</td>
<td>1.89</td>
</tr>
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</table>

The technology introduced to cooperator farmers/farmer groups to be implemented or not implemented by them in the next season were determined by internal and external factors, such as the availability of capitals, production inputs as well as climatic conditions. Farmer’s decision-making was determined by their orientation in farming and their courage to bear the risk. Therefore, farmers are partners of researchers and extension workers who they can evaluate directly the variability of technical and socio-economic technology that has been introduced, in which the problems occurred should be consulted to researchers and extension workers to improve and develop rice farming systems in tidal swamp areas.

**Farmers Problems, Alternative Solution, and Feedbacks**

Based on the farmer’s workshop, it can be concluded that improvement of rice farming management in tidal swamp areas showed a significant increase in yield and farmer’s income. Technical problems which limiting rice yields in tidal swamplands can be eliminated because of more intensive guidance of the project. When the project ended, the sustainability application of recommendation technologies by farmers should be anticipated. The problems that were collected from farmer’s workshop are inputs for all relevant agencies responsible in the development of tidal swamp areas.

Farmers' issues raised in the workshop were as follows:
Land and Water Management

In tidal swampland and ecosystems, water management is considered as one of the key aspects of a stable and sustainable production (Noorsyamsi and Sarwani 1989; Partohardjono 1993). Geographically, swampland is located close to the sea or a large river and poorly drained. Anwarhan (1981) suggests that the construction of canal systems for drainage is the first part of reclaiming tidal swampland.

Frequent flooding often occurs throughout the year in the lower land especially at the time of spring tide (highest level of tides) accompanied with high rainfall. The water level in the tidal swampland rises as the rainy season starts usually in October and reaches its maximum in January or February. Subsequently, it declines in March or April and remains stagnant until June. The water table drops when the dry season arrives (Noorsyamsi and Hidayat 1974; Van Wijk 1951).

The lower land is a gathering place of water that contains toxic elements/compounds to plants such as ferrous iron (Fe²⁺). A major environmental issue with tidal swamplands is the highly complex nature of soil characteristics and the uncontrolled hydrology regime. Tidal swamplands are characterized by high soil acidity (low soil pH), and the availability of pyrite, aluminium, and iron, which therefore may pose acidity problems. As a result, the water and soil pHs become very acidic to disturb the rice growth and become stunted and even death as a result of water which cannot be moved out from the farming areas. All of the problems due to the macro level canals (secondary, tertiary or water supply canals/village canal and the controlled drainage canals) were shallored by soil siltation and lack of maintenance. Based on the experience of some farmers through trial and error, they have learned that long stagnant water in their farm land must be removed because the water contains toxic elements for plants to cause a decrease in rice yield of.

Although the micro level canals (on-farm/micro water management) were better laid out, but the water entrance and exit were affected by macro canals condition under maintenance to the Regional Irrigation Office. Improvements and routine maintenance of macro canals will encourage farmers to maintain the micro-canals so that the flooding and plant poisoning can be eliminated.

Some specific cases were found in Pulau Rimau that was dredging soil sediments on tertiary canals. It caused excessive dry conditions of soil, oxidation of pyrite, and increased soil acidity so that the plants were poisoned and pest of orong-orong increased. In Karang Agung Tengah and Ilir, there was found out a conflict of interest on water among farmers, due to differences of cultivated crops (corn and wetland rice). Both cases occurred in the absence of good planning of crops cultivation in accordance to the needs.
of plant. In addition, the kind of commodity to be cultivated in each planting season can be planned in group meetings guided by extension worker.

**Guidance, Assistance, and Counseling by Extension Workers**

A farmer group is the group of farmers formed on the basis of mutual interest and solidarity to face environmental conditions (social, economic, resource, and harmony) and led by a chairman/leader. Farmer group is also as an organization that can be used as a medium of learning by doing in cooperation among farmers. The farmer group can solve some together problems, such as to fulfil the needs of agricultural inputs, technical production, and marketing, which were guided and assisted by extension worker. However, many farmers/farmer groups felt that the intensity of guidance, assistance, and counseling by the extension workers is very less frequent. Many farmers have difficulty to find extension worker to conduct counseling in tidal swamplands. The extension workers are generally preoccupied with their routine tasks, or they are completing other activities in other locations. They complain to too broad territory with limited transportation support.

Lack of understanding of farmers to the importance of proper land and water management, so that the rice yield was low. Water Users Associations (Perkumpulan Petani Pemakai Air/P3A) and farmer group are weakly organized. The extension workers must do more intensive coaching and counseling to farmers. In case of water management in tidal swamp areas, the extension worker should work closer to the farmers/farmer groups through demonstrating water flape gates maintenance and operation using locally available materials. It is hoped that strengthening the P3A and involving the farmers in operation and maintenance (OM) could be made more sustainable for the future. All parties involved in tidal swamp development should find ways to improve the involvement of extension workers and local government in the development, operation, and maintenance of water management to get higher rice productivity in the tidal swamps areas.

**Farm Managements**

Farmers cultivate their land in each season and it was determined by the decisions of each individual farmer. Land preparation as part of land management should be conducted very carefully, so that the pyritic layer is not exposed to cause oxidation of the soil.

Generally, farmers prepared the land during the rainy season from November/December until February the following year using rental hand tractor. All farmers stated
that the amount of tractor was limited, so that the soil tillage should be done in rotation and then planting time is not simultaneous. When there is no possibility for mechanized land preparation by hand-tractor, the farmers will do the land preparation manually. That means land preparation will mainly concentrate on burning and/or slashing the weeds or using herbicides. This land preparation way will be carried out with no or only little soil tillage. Seedlings planting will be done by making a hole with a stick and planting the seedling in the hole. Without tractor use, the planting period is quite extended, takes a long time, and results in more attacks of rats and other pests. It is a generally known fact that planting rice over a large area in a short time strongly reduces the hazards of pest attacks.

Most farmers usually cultivate their land as much as once a year in the rainy season for wetland rice. The land is generally fallow in the dry season, due to labor shortages, high rat pests, and farmers worry of crop failure. This is quite understandable since they are risk averse and mostly constrained by limited available funds for their farming. Like most farmers in less developed countries, they only produce their crops at a subsistence level.

Farmers suggested that to cultivate the land in the dry season, it needs togetherness and cohesiveness among farmers. The lands with A and B flood tide types can be used for rice-rice cropping patterns and minimum or zero tillage can be conducted in the second season. The land with C flood tide type can be used for rice-crops/palawija cropping patterns and in D type for crops-crops cropping pattern. Cultivating land in tidal swamp areas much needed togetherness and cohesiveness among farmers so that threat can be controlled and eradicate jointly (gropyokan) supported by toxic feeding, fogging, and environmental sanitation. Harvest processing can be done by using the existing processing equipment at each location (pedal and power threshers) although their number is still limited.

There are various crops (upland crops and wetland rice) cultivated by farmers in Karang Agung Tengah and Karang Agung Ilir, so there is a conflict of interest of water use for their plants. To avoid these problems required meeting of farmer groups on a regular basis to discuss the technologies of farming, it also addresses to the planning of commodities to be planted.

Farmers in type A area usually harvest their rice in early July to mid August, while in type B harvesting begins in mid July and continues until the end of August or early September. The difference is that the farmers in type A need to plant the rice earlier than those in type B, to avoid the salt intrusion during the generative period of the plant. Mostly transmigrant farmers use a grass-knife (arit) to harvest their crops. The main
benefit of using the arit is that farmer and his wife can harvest one ha rice in 10 days. Alternatively, it can be threshed with a threshing machine. In addition, the percentage of crops loss is bigger than with the traditional practices. Although this method resolves the labour shortage but the number was still limited.

The use of Banyuasin and Sei Lalan rice varieties (high yielding varieties) increased rice yields, however, the farmers still faced some following problems:

a. The good quality rice seed was unavailable because the crop cannot be processed directly due to lack of labor. Banyuasin and Sei Lalan varieties were very easy to grow in the field.

b. Late disbursement of fertilizers and other production inputs in farming credit (Kredit usahatani/KUT) and the types and amounts of farm credit received by farmers did not comply with the proposal on Definitive Planning of Farmers Activity/RDKK.

c. Some farmers did not get input production from KUT because they were not members of Village Cooperative Unit (KUD) or the farmers who still have arrears of KUT of previous year, borrowing money from the RMU owner with payments back after the rice harvest was very detrimental to farmers.

d. Farmers did not know the benefits of KCl fertilization

e. High fertilizer prices those were unsuitable with the rice prices at harvest time.

Based on the problems coming up in farmer’s workshop, there were some alternatives to solve and get some feed backs for the relevant agencies, as follows:

a. Selection of rice seeds before harvest as a source of seeds for the next season.

b. Banyuasin and Sei Lalan varieties are very easy to grow in the field. They make the local or traditional rice varieties are most suitable for planting. However, local varieties do not have a potential yield higher than 2 t ha\(^{-1}\) of dry husked rice. It is a very important feed back for the rice breeders in the Rice Research Institute to investigate it more deeply.

c. KUT program is an effort to empower small farmers, so that delays in the disbursement and different type and amount production inputs proposed in RDKK affect the success of rice farming in tidal swamplands. This is a feedback for KUD and Provincial and District of Agriculture Offices.

d. Farmers should be as members of Village Cooperative Unit/KUD because they get benefits from cooperatives.

e. Fertilizers that were used to the plants have different functions. It must be used according to the needs of the plant. The response of plant to fertilizers should be
explained to farmers by extension workers, so that the farmers understand and appreciate of the function and farmers can make decisions in doing fertilization.

f. Farmers need counseling, assistance, and guidance from extension workers related to the dosage, kind, time and method of fertilization. The use of alternative fertilizers that are widely offered to farmers in tidal swamplands needs to be investigated.

Cultivation technical issues and solutions related to rice cultivation found out in the workshop were:

a. Planting time is not simultaneously because soil tillage was done in rotation so that the rice varieties vary. Soil tillage should be done in rotation based on water management boundary, so the time of planting can be more uniformly.

b. Weeds growth was relatively rapid whereas the labor availability was limited. The use of herbicides should be adjusted according to the type of weeds. There are necessary needs of guidances from extension workers (PPL and PHP).

c. The use of fertilizers is relatively low due to late of disbursement of KUT. This problem is as a feedback for the local government at provincial and district levels.

d. The rice damage by rodents was relatively high. Rat pest control planning should be done regularly and simultaneously on each farmer groups. To realize these, the activities could be organized by the village leader or community leader.

**Marketing and Institutional**

Marketing and institutional play important role to improve rice production in tidal swamp areas. The problems rised in farmer’s workshop were:

a. High fluctuations of rice/husked rice prices, especially in harvest time. The rice prices fall drastically in harvest time that was inconsistent with the price of production inputs, such as pesticides and fertilizers.

b. Formal economic institutions such as Village Cooperatives Unit have not been able to act as stabilizers of rice price.

c. Formal service agencies such as extension workers have not been much helping farmers to overcome the problems of marketing and farmer institution.

d. The owner of Rice Milling Unit/RMU can help farmers to overcome the shortage of capital for rice farming, but the payment system is detrimental to farmers.

e. Farmer groups meeting were only conducted if there were programs/projects to be implemented in farmer’s location.
Some experiences in agricultural research and development in South Sumatra tidal swamp areas showed that fluctuation of rice prices due to relatively low quality of rice, which was characterized by non-uniformity in color (called batik rice) and high percentage of broken rice. The harvested plants were stacked at the field for relatively long time because of unavailable labors for processing. Ananto et al. (2000) suggested that the quality of rice from tidal swamp areas typically entering the traditional market was low and only bought by low-income consumers.

To anticipate the decrease of rice prices, it can theoretically be solved by delaying the time of sale until the prices increase, but farmers must pay back the loan to KUT or RMU owners immediately. Marketing and rice prices problems cannot be solved at the farm level. There needs awareness of policy makers and other relevant agencies relating to the welfare improvement of farmers in tidal swamp areas.

**Equipment and Agricultural Machinery**

Use of hand tractor is one way to solve the problem of limited manpower in the tidal swamp areas. Without tractor use, the planting period is quite extended, because the manual preparation takes long time. It means planting by farmers as a group in tertiary unit is distributed over quite a long time, resulting in more attacks of rats and other pests.

The ripening process of soil requires flushing and leaching at the beginning of the rainy season. The best method for leaching is deep mechanical plowing (20-30 cm depth) at the beginning of the wet season, sun drying of the clods, followed by leaching/flushing using rainwater and/or tidal irrigation water. When there is no soil tillage it will increase the hazard for toxic componen in the rice plant. When the soil becomes ripe and the shallow pyrite layers have been oxidized and leached out, the mechanical land preparation (tillage) will promote the formation of plow layer. A plow layer will extent the period a water layer that can be maintained on the field. This condition will encourage farmers to grow a second crop at the end of the rainy season.

The problems faced by farmers from the workshop were:

a. The number of tractors and power threshers were still lacking.

b. Drying machines (box dryers), which are available in some areas, have not been assembled and operated. It can be operated to help farmers in rice processing especially during the rainy season.

c. IAARD recommends the use of a manually operated row seeder to be more effective for weeding, pest control, harvesting, etc., but most farmers still use the broad-cast system.
Hand tractors are very helpful in solving manpower limitations. The number of tractors in the Delta Telang and Delta Upang was sufficient. It should be settings based on tertiary water management unit to make the time of planting more uniform. In other areas, such as Pulau Rimau, Karang Agung Tengah and Ilir, and Sugihan Kanan, the number of tractors was rared so that it was necessary to add by credit scheme or rental services from specific companies or other regions.

The bad management during the post-harvest period in the wet season will cause the farmers receive a low price for their crop. Further the low rice price for their poorly managed post-harvest crop does not encourage the farmers to grow the second crops. Drying of the husked rice using a flatbed drier with a blower and burner (box-drier) will greatly improve the quality of the dried rice and will increase rice price and the farmer's will receive a good price of rice.

CONCLUSION

Improvement of rice farming systems in tidal swamp areas in South Sumatra using high yielding varieties of Banyuasin and Sei Lalan, proper management of macro and micro level canals increased rice yield of cooperator farmers from 2 to 3.43-3.96 t ha\(^{-1}\) and also increased farmers’ profits by 55.4%.

In the second and third years, the farmer’s profit increased to 69.6 and 52.2%, respectively. The profit of non-cooperator farmers also increased between 12.2-29.5% due to diffusion process of technologies. Even though the improvement of rice farming management in tidal swamp areas has shown a significant increase in yield and farmer’s incomes, there were still some problems that need to solve. The problems were in land and water management; guidance, assistance and counseling of extension workers, farm management, marketing, farmer institutional and agricultural machinery and equipments.

The problems arised from farmer interviews and farmer workshop should take into consideration by researchers, extension workers, and related agencies involved in tidal swamps area development.

REFERENCES


