Part 3 Results

CHAPTER IX
THE THREE ROLE-PLAYING GAMES IMPLEMENTED IN LAM DOME YAI WATERSHED

Role-Playing Games (RPG) are an interactive tool to support knowledge sharing through simulated action and dialogue; that simulation might, in effect, influence action and practice in actual circumstances (Daniels and Walker, 1996). Participants assume certain roles and determine their actions based on their roles within the rules designed in a game. For the purposes of research, RPGs can be used to synthesize stakeholders' (as 'game players') perceptions when they interact freely with each other under a given set of assigned game conditions. Both the game organisers and players can learn from each other in such an interactive pattern (Hare, Heeb et al., 2002).

Games are certainly simpler than reality, but games can simulate some complexity, which is partly controlled and thus can be studied (Barreteau, 2003b). Simplified representations of complex systems emerging from a multiplicity of interactions between social and ecological processes are useful in that they can help us better understand complexity (Barreteau et al., 2007). Within games, players behave as they do in reality. They make choices within contexts and in roles, bringing with them their own habits and strategies. The key goals of using RPGs in this study was to enhance interactions among players and to provide support for an ABM design and analysis leading to better understanding of the real world system.

The RPGs used for the purposes of this study can be defined as a kind of model representing a part of an RLR ecosystem, with a focus on interactions between land & water use and labour migration. During three RPG sessions implemented in this study, the relationship between the research team and participants was promoted through interactive knowledge sharing activities. With more transparent RPG structures and rules for the stakeholders, the RPGs were also a tool used to facilitate the knowledge exchange among players. At the same time, the initial conceptual model representing the system under study was enriched as a result of the knowledge generated from the RPG sessions leading to the improvement of an ABM.

In order to understand better the RPGs implemented in this study, a background to the Overviews-Design concepts-Details (ODD) protocol is provided below. Moreover, the Unified Modelling Language (UML) diagrams used to represent the conceptual model of the RPGs are also presented. Descriptions of the three successive RPG sessions implemented in this study are then provided.

9.1. Materials and Methods

9.1.1. Overviews-Design Concepts-Details (ODD) Protocol

The ODD protocol was developed by a group of modellers to be the standard format for describing an Individual-based Model (IBM). However, it is also possible to use this protocol to describe any bottom-up simulation model such as ABMs and RPGs (Grimm, Berger et al., 2006). Three blocks of elements within the protocol were defined: Overviews, Design concepts and Details.

The aim of the Overviews block is to provide sufficient information about the model to readers so that they would be able to re-implement the skeleton of the model. This block has three elements: (i) Purpose, (ii) State variables and scales, and (iii) Process overview and scheduling. First, the purpose of the model is to inform readers what is to be done with the model. The state variables and scales outline the structure of the model, specifying all types of entities and their low-level state variables[14] in the model. The spatial and temporal scales used in the model are also covered in the Overviews block. The process and scheduling section are described by listing all the processes that occur in the model and how they are scheduled (Polhill, Parker et al., 2008).

The Design concepts block deals with a wide range of high-level concepts related to the field of Complex Adaptive Systems (CAS) such as emergence, adaptation, fitness (objective), interaction, stochasticity, and observation etc.

The Details block aims to describe key entities, process and scheduling in detail so that the model can be completely re-produced. The Details block has three

[14] Low-level state variables cannot be deduced from other state variables because they are elementary properties of model entities. For example, individuals might be characterized by age, gender, location etc.

elements: (i) Initialization, (ii) Inputs, and (iii) Submodels. The initialization deals with how the environment and the individuals are created at the start of a simulation run. Environmental and economic conditions such as precipitation and product prices that influence all entities in the model are considered as "inputs". All submodels representing the processes listed above in "Process overview and scheduling" are presented and explained in detail. Additionally, as recommended by some ABM modelers (Le Page and Bommel, 2005; Richiardi, Leombruni et al., 2006), Unified Modelling Language (UML) diagrams are complementarily used with the ODD protocol.

9.1.2. Unified Modelling Language (UML) Diagrams

The UML is a family of graphical notations used in describing and designing object-oriented data modelling (Pukdeewatanakul and Komklom, 2005). Most UML tools are intended for an audience who will translate the UML diagrams into programming code, and most UML tools do not offer support for entering simple data to validate a data model (Schank and Hamel, 2004). The UML are classified into structural and dynamic diagrams.

Among structural diagrams, the static UML class diagram is always implemented to display the structure and relationship among components within a system (Fowler, 2004). The dynamic diagrams display the activities of objects in a system. It reveals the dynamic of the system. Two kinds of dynamic diagrams are often used for this purpose: activity and sequence diagrams. The activity diagram is used to model computations and workflows of an object. The sequence diagram is used to display an interaction, as a two-dimensional chart, between a vertical dimension showing time (the lifeline) and a horizontal dimension showing interacting objects (Rumbaugh et al., 1999).

UML class diagrams are used to show the structure of the model, thus completing the static representation in the Overviews of ODD protocol; UML sequence diagrams are used to elucidate the process overview and scheduling. In this case study, these diagrams were produced to represent the conceptual model to implement an ABM. As a result, the diagrams are too complicated to design a simple game. They were simplified to sufficiently cover the specific objectives of each RPG implementation.

9.2. Description of the Successive Role-Playing Games Used in This ComMod Experiment

9.2.1. The First RPG Session

9.2.1.1. Overviews

The purpose of the first RPG session was to validate the research team's understanding of land/water use and labour management on the different farm types, and to train assistants to prepare and run ComMod field workshops. This RPG was structured by four main groups of entities: spatial group (2D game board), operators (moderator, job broker and market manager), passive group (annual rainfall conditions and map of Thailand), and player as shown in the UML class diagram (Figure 9.1).

Low state variables were rice production cost (7,500 baht per ha) and daily labour cost. Daily labour cost for hired workers from other villages at transplanting was 250 baht per person, and 300 baht per person at harvesting, as indicated by Ban Mak Mai farmers. The five main steps of the game were designed to correspond with as many key stages of the rice-production cycle, as displayed in Figure 9.2. Four successive crop years were played. The gaming process and scheduling were driven by the change of events operated by the moderator as shown in the UML sequence diagram (Figure 9.3).

9.2.1.2. Design Concepts

The players' adaptation had to be observed when the very dry year card was drawn as the players may change the respective sizes of glutinous and non-glutinous rice areas. The lower rice yields and low incomes were designed in the very dry year, and thus more migrant workers were expected to generate more income and compensate the rice production losses through off-farm employment. The interaction among the players across households had also to be observed when the players looked for additional farm workers during transplanting and harvesting periods.

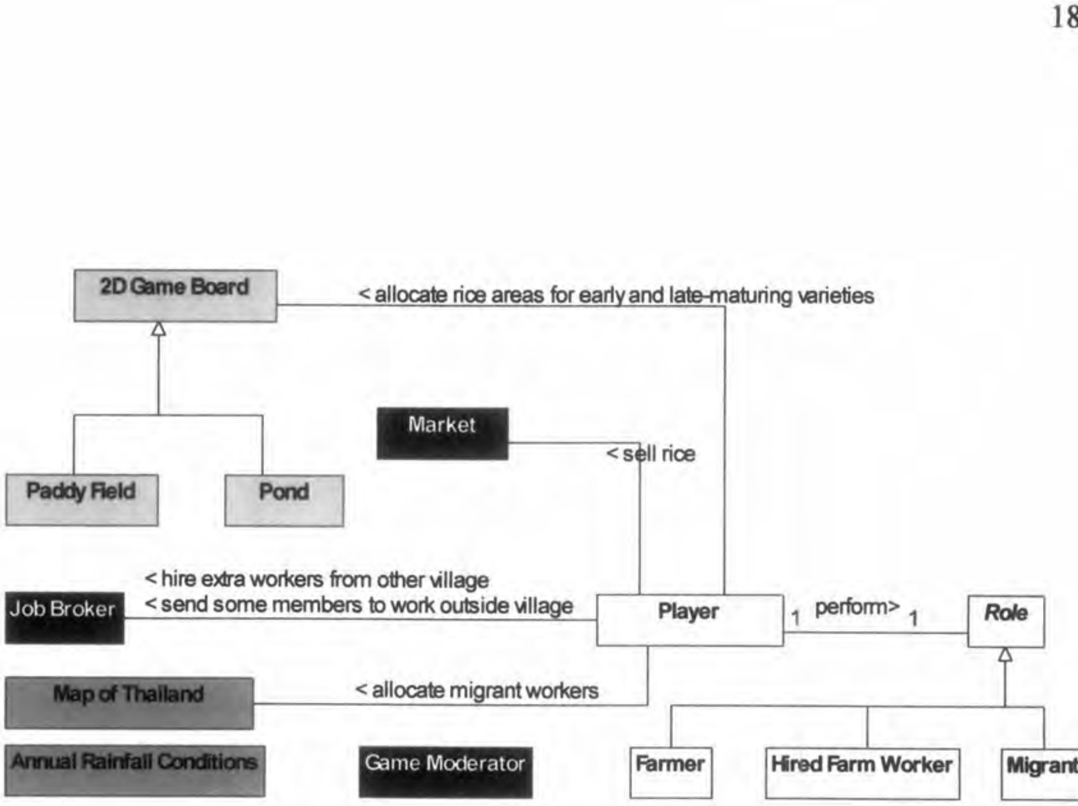

Figure 9.1 The first RPG conceptual model in a UML class diagram displaying key entities and their relationships.

Figure 9.2 The five successive steps in the first RPG.

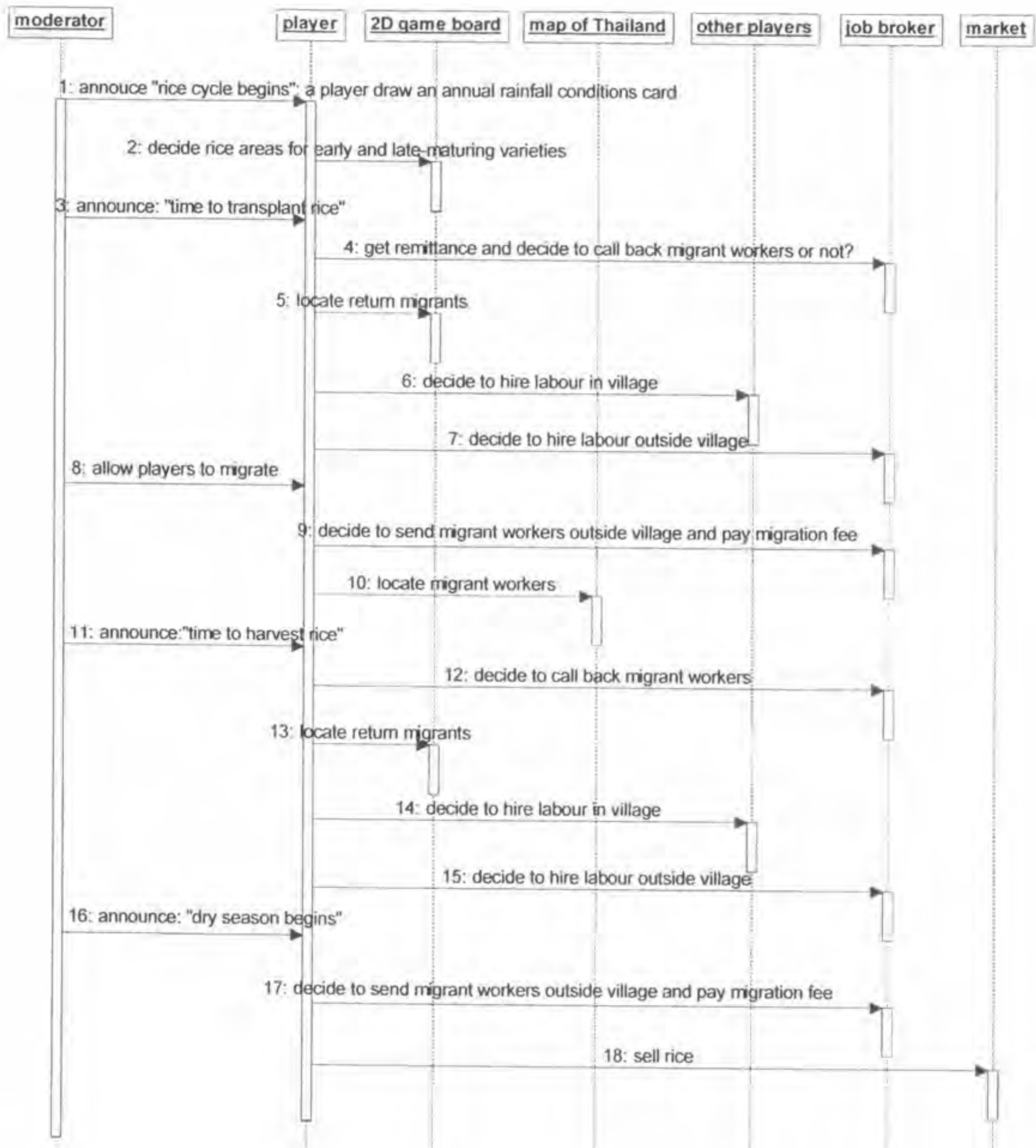

Figure 9.3 UML sequence diagram of the first RPG showing the successive activities implemented by the different game entities throughout a crop year.

The stochasticity was predefined for two annual rainfall conditions (wet and very dry), and three chance cards that stipulated the level of wage received (low, moderate or high). These wage level chance cards were designed to take into account the risk of varying economic returns on migration. A low wage card led to a low remittance later on. The rainfall and wage variables were drawn by players during the gaming session. The diversity of farmer types was taken into account when two villages were assigned into groupings of five and six households respectively in the gaming session.

9.2.1.3. Details

Initialization

The initialization had five households in village 1, and six households in village 2. Each household had different means of production as specified in Table 9.1. One household had two players. There was no type C farmer in village 1 because a sub-type C1 farmer did not come. The gaming session started; the players allocated family members to be on-farm workers on a 2D game board, and migrant workers on a map of Thailand. The gaming room was set as shown in Figure 9.4. The players in each village were separately located on the players' benches.

Table 9.1 Players' characteristics at initialization.

Village	Player	Farm type	Farm land area (ha)	Farm pond (m^3)	Household size
Village 1	1	A1	1.6	no farm pond	3
	2	A1	2.6	300	6
	3	A3	3.2	1,350	4
	4	B1	9.0	2,400	6
	5	C2	8.8	3,840	5
Village 2	6	A1	2.4	144	5
	7	A2	3.2	500	5
	8	A2	1.6	158	4
	9	A3	4.8	240	8
	10	A3	4.0	450	9
	11	B2	6.7	2,200	5

Inputs

Wet and very dry conditions were annual climatic inputs. The sale price of glutinous and non-glutinous (8 baht per kg for non-glutinous KDML 105 variety) at market was based on information obtained from local farmers.

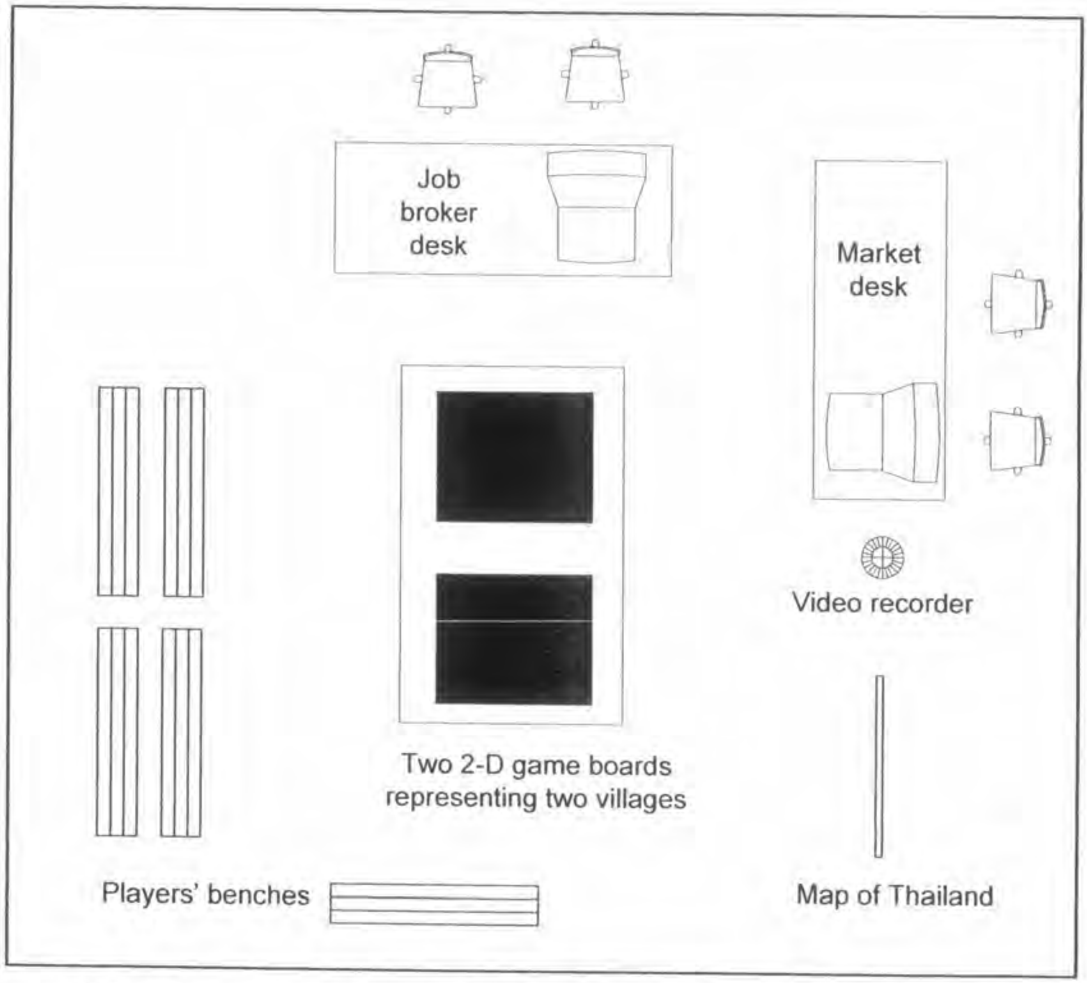

Figure 9.4 Setting of gaming room for first RPG session on 9-10 July 2005 at Ban Mak Mai school, Det Udom district, Ubon Ratchathani province.

Submodels

The submodels correspond to the five main steps played by participants during one round of play in the session (Figure 9.2). In this RPG session, the annual rainfall conditions card was drawn by a player at the beginning of each crop year.

Allocation of rice areas

Players allocated the size of their paddies for glutinous and non-glutinous rice. A game assistant recorded each player's decisions on a notepad (one game assistant per two players; see Figure 9.5).

Figure 9.5 The first RPG gaming session on 9-10 July 2005 at Ban Mak Mai school, Det Udom district, Ubon Ratchathani province, **Top left:** a player drawing an annual rainfall condition card; **Top right:** the 2D game board to allocate rice areas and on-farm workers. **Bottom left:** a game assistant locating migrant workers on map. **Bottom right:** players' decisions recorded by game assistants on stickers and pasted on the players' notepads.

Labour at transplanting and receiving remittance

The moderator announced that it was time to transplant. To manage labour, players were allowed to contact other players to get additional farm workers if needed. If none of them was available, players who needed extra labour had to hire labour from other villages at the job broker desk. Once a player finished managing labour for transplanting, he/she went to the job broker desk to receive remittance if there were migrant workers in his/her household (Figure 9.6).

Figure 9.6 The first RPG session on 9-10 July 2005 at Ban Mak Mai school, Det Udom district, Ubon Ratchathani province, **Top left:** a player receiving remittance at the job broker desk; **Top right:** Excel spreadsheet operated by the job broker to manage labour and compute remittance and migration fees. **Bottom left:** a player selling rice at the market desk; **Bottom right:** Excel spreadsheet operated by the market manager to compute income generated from rice sales.

Transplanting rice, and allocating on- and off-farm labour

After completing transplanting during this step, players were able to allocate their members to work outside the village via the job broker desk. The players were also supposed to pay migration fees (travel and job application costs etc.) if they decided to send someone to work outside of the village, but this minor step was missing during the gaming session. The players then had to designate a receiving destination for each migrant worker, and draw a wage level chance card. All decisions and cards drawn were recorded in a pre-designed Excel spreadsheet used by the job broker (see in Figure 9.6).

Labour at harvest and paying migration fees to job broker

Labour management at harvest was similar to the transplanting stage. At the end of the harvesting, the players were able to allocate members who wanted to migrate at the job broker desk. The migration fee was paid and a wage level card was drawn if someone in a household decided to migrate. All decisions were recorded in the job broker Excel spreadsheet (Figure 9.6).

Computing household income at market desk

Rice yields were computed according to the rainfall conditions in a pre-designed Excel spreadsheet used at the market desk (see in Figure 9.6). Rice yield was 2.5 $t{\cdot}ha^{-1}$ in a wet year and 1.8 $t{\cdot}ha^{-1}$ in a very dry year. Based on individual harvested rice areas, different data for total rice produced were given to each player, and he/she had to decide how much rice they wanted to sell at the market desk. Fake money was paid to players for rice sales. All data were kept in the market Excel spreadsheet. After all players had completed the sale of their rice, a new crop year could begin.

9.2.1.4. Results from the First RPG Session

The diversity of farming systems plays a major role in maintaining the local labour market since different farm types have different cropping calendars and farm sizes. Due to their small paddies, type A farmers can complete their transplanting and harvesting faster, and are thus able to be hired by their neighbours. In the gaming session, it was found that interactions between large and small farm players occurred when they had to negotiate labour costs. The players belonging to type A farmers (small holders) were hired by the players belonging to farm type B who had a high farm size per labour ratio. With this available employment opportunity, a few of the farm type A players decided to migrate after transplanting had been completed.

The farm type C player managed his family labour without hiring extra farm workers when rice was produced. His strategy was to grow various rice varieties. According to the different agronomic traits of each rice variety, the harvest time is different. The type C player distributed his family labour accordingly. Permanent migration was found in type B and C farming households. Even though the payment of migration fees after transplanting was not simulated, those players said that this missing minor step did not affect their migration decision.

Players' adaptation under different climatic conditions: change of rice area allocation, number of migrants and migratory patterns.

Regarding rice production in relation to climatic conditions across the farm types, players did not change the proportions of their glutinous and non-glutinous rice paddies when playing in the wet year condition. Such a change was observed when the very dry year card was drawn in the fourth year (Figure 9.7).

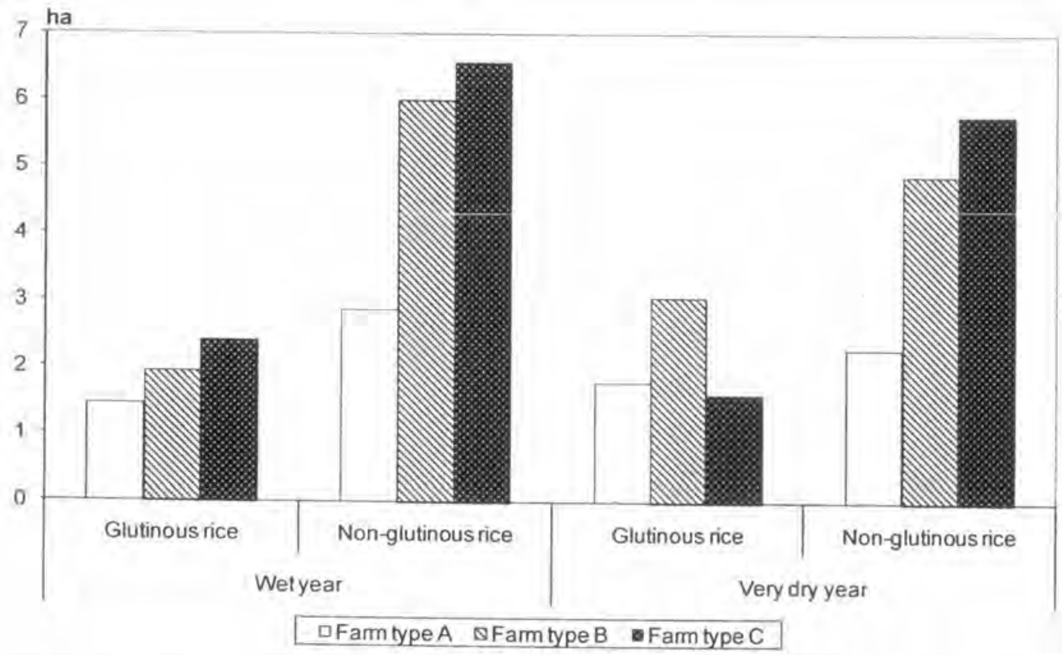

Figure 9.7 Amount of area allocated to different rice varieties in relation to climatic conditions across farm types in the first RPG session on 9-10 July 2005.

More glutinous rice for consumption was planted and less non-glutinous rice for sale as a general strategy to reduce the risk of drought on rice productivity and household food security. The priority of these players, who are of Thai-Lao ethnicity, is to secure family food stocks if they believe that rice yields may not be enough as a result of drought for example. However, only the type C player decreased both glutinous and non-glutinous rice-growing areas. With more market oriented objectives, the type C player usually sells both rice varieties. When facing very dry years, both varieties were produced less to minimize the risk of productivity loss, but the glutinous rice produced was still enough for family consumption.

Regarding labour migratory patterns in relation to climatic conditions across the farm types, all participating farmers decided to send their members to work more in the very dry year because of inadequate water availability for farming (Figure 9.8). In this situation, the players lost their income generated from rice sales. Thus, the off-farm income from migrant workers was needed to compensate income losses. Type A players indicated that they recalled seasonal migrant workers to help produce rice because of the financial burdens of hiring additional labour.

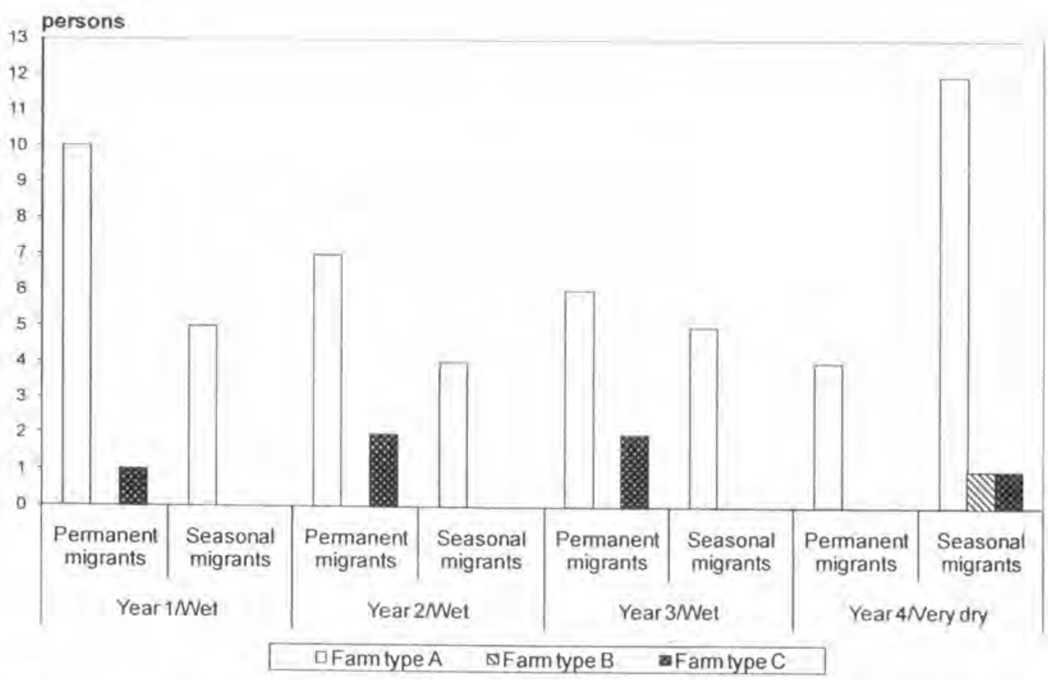

Figure 9.8 Number of migrant workers categorized by migratory patterns in different annual climatic conditions across farm type in the first RPG session.

Because type B players had higher land per labour ratio, none of their family members were migrant workers in the wet year condition. The migratory pattern was more-permanent on farm type C as migrant workers did not return to help family during the rice production cycle. However, a seasonal migrant belonging to the type C player was found in the very dry year, a year in which the player had no permanent migrants. The player explained that this was because the permanent migrant worked aboard and it was the end of a 3-year working contract. He had to return home in the very dry year, so he decided to seasonally migrate to work in non-farm sectors. This reflected the fact that the participating farmers played the game according to what they would actually do in reality.

The results from this RPG were used to enrich the original conceptual diagram. Based on the modified conceptual diagrams, a prototype ABM was constructed to represent stakeholders' decision-making processes. During the plenary session, the players suggested to have another workshop with new types of players: migrants returning home during the Thai New Year in 2006. Besides that, variations in water availability (prolonged drought and water resource improvements) were not explicitly introduced in the first RPG session. The second RPG session was organized to investigate the impact of variations in water availability on players' farm and labour management decision-making processes and to consequently improve the conceptual model. The participants' requests were also taken into account.

9.2.2. The Second RPG Session

9.2.2.1. Overviews

The purpose of the second RPG session was to (i) validate the research team's understanding of land/water use and labour management with a new migrant player, and (ii) investigate the players' decision-making processes under two successive very dry years, and irrigation canal scenarios. The state variables and scale, as well as process and scheduling was similar to that of the first RPG. This time, a sequence of six successive rounds of play with different rainfall conditions was performed: a first wet year, followed by two successive very dry years, and then a wet year, followed by a dry and very dry year with access to an irrigation canal respectively.

9.2.2.2. Design Concepts

The design concepts were also similar to that of the previous RPG. To take into account the unpredictability of rainfall conditions, a rainfall card was drawn after the players had already allocated rice areas for each variety. The purpose was to observe how players managed unpredictable rainfall conditions after allocating rice areas. The number of migrant workers was expected to decrease as the players adapted their farming strategies to produce more farm commodities when the irrigation canal scenarios were played.

9.2.2.3. Details

Initialization, inputs and submodels were not different from that of the first RPG. For the irrigation scenario, an irrigation canal was presented, and I presumed that the water was always available for the players.

9.2.2.4. Results from the Second RPG Session

This participatory modelling workshop was organized on 20-21 April 2006 after a period of prolonged drought (2004-2005 crop year). Most of the village's migrant workers did not return since RLR production could not start. Thus, only one returned migrant could join this workshop. The returned migrant player's farm and labour management decisions were not different from decisions made by his parents who had participated in the first RPG session. He explained that the farm and labour management decisions were usually made with the input of household members. In particular, it was a collective agreement if someone in his family was sent to work outside of the village.

Unlike the first RPG session, rice areas allocated for each variety were not different in the first wet year and in the second very dry crop year of the second RPG session. However, similar rice area allocation to that of the very dry year of the first RPG session was found in the subsequent very dry year (third year of the second RPG session). The players explained that they would not be able to adjust rice areas to fit the very dry conditions of the second year played after the rainfall card was drawn because the nursery was already established. In this case, it was thought that a second nursery establishment would be needed if the rice seedlings died as a consequence of the drought. But once they experienced the unfavourable conditions, they adjusted their rice areas in the following year (forth year of the second RPG session) to grow more glutinous but less non-glutinous rice. The reasons given for this course of action were the same as those of the first RPG session.

The introduction of an irrigation canal in the fifth and sixth crop years stimulated the players to think more about the opportunities of growing cash crops and vegetables in the dry season. The results (see in Figure 9.9) show that type A players were the most responsive users under this scenario, growing vegetable crops after rice. Farm type B and C players became more responsive in the sixth year because they had observed that more dry-season crops were produced by other players in the fifth crop year. However, they could not plant their desired amount of dry-season crops because the main source of labour supply, type A farmers, was actively engaged. Thus, the improvement of water infrastructure alone may not efficiently support all farmers in their attempts to intensify their farm production because it may induce problems of labour scarcity.

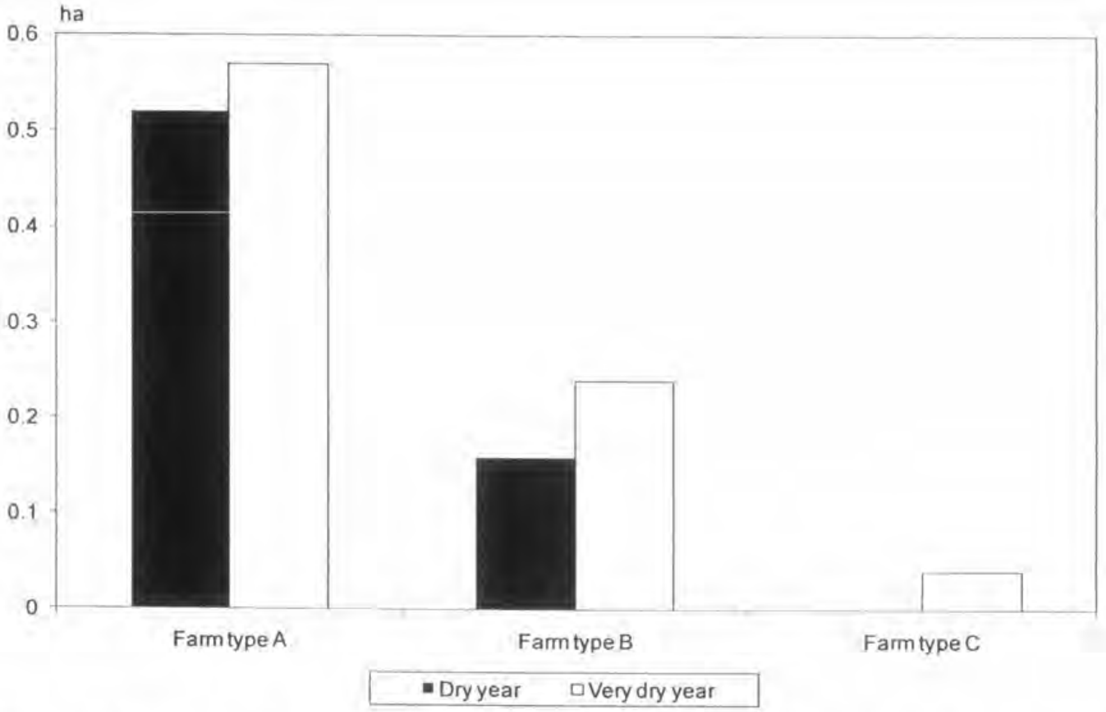

Figure 9.9 Average dry season crop area across farm types after the irrigation canal scenarios were played in the 5th and 6th crop years in the gaming session on 20-21 April 2006.

The number of migrant workers also decreased when the irrigation canal scenarios were played (Figure 9.10). This was because players needed farm workers once they decided to produce more farm goods (vegetables, cash crops etc.) in the dry season. The type C player had no migrants in the fourth year because migrant workers returned home after their job contracts abroad ended. But a member decided to sign another work contract and migrate to work in the fifth year. The game rules were slightly modified: the wage level chance card was removed in the irrigation scenario gaming sessions because the players did not take different wage levels into consideration when deciding to migrate.

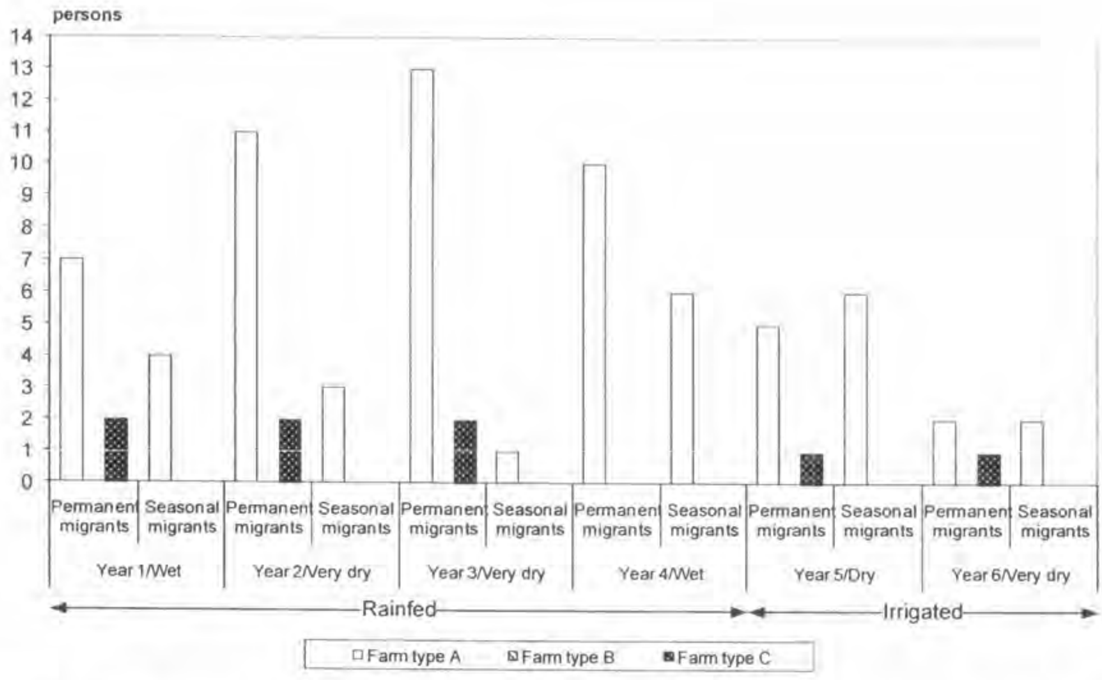

Figure 9.10 Number of migrant workers categorized by migratory patterns across farm types under different water availability conditions in the second gaming session on 20-21 April 2006.

During the individual interviews, players asked to replace the irrigation canal with farm ponds and artesian wells; this was considered to be a more feasible, realistic water improvement scheme for their village. Broad annual rainfall conditions did not allow the research team to investigate the dynamics of each main rice-growing activity, especially the players' water use strategy. In actual circumstances, rainfall distribution is more important than its total volume because the players make timely decisions under current rainfall conditions as to when a given activity should be performed. I also found difficulty in validating the decisions to use water from players' water sources to alleviate drought effects in this RPG session. Because of this limitation of the initial gaming sessions, a new RPG was designed to better represent the interaction between water dynamics and farm management (rice practices and labour use).

9.2.3. The Third RPG Session

9.2.3.1. Overviews

The purposes of the third RPG was to (i) to improve understanding of players' water uses and labour migration strategies across farm types under different water availability conditions, (ii) use that knowledge to improve agents' water use rules in the Lam Dome Yai model, and (iii) introduce players to learning through simulations of scenarios prior to introducing full ABM simulations. The game was designed to be as simple as possible so that 11 households (21 players) could play it with little help from two game assistants. No Excel spreadsheet was used. Players directly recorded their decisions on three pre-designed sheets: crop establishment, harvesting, and dry season sheets respectively.

The size of a community pond was a new state variable. It was 20 times larger than a standard farm pond (1,260 m^3) built by the ALRO, Ministry of Agriculture and Cooperatives. All players were able to freely access water from this community pond. The three main steps of the game are shown in Figure 9.11. The process and scheduling of the third gaming session is shown in the UML sequence diagram (Figure 9.12). The game scheduling proceeded on a weekly basis. Weekly rainfall conditions were displayed by pasting related pictograms on the calendar board; players were asked what decision they made regarding rice production after looking at the weekly rainfall conditions. Two scenarios were played as follows: (i) individual farm ponds under a succession of wet, very dry and dry years respectively, and (ii) free access to a community pond in a dry year followed by a very dry year.

9.2.3.2. Design Concepts

Farm type A players were expected to adapt to produce more farm goods during the community pond scenarios. Fewer migrant workers were also expected because of the demand for more labour to produce more farm products once water was made available. It was also expected that water sharing strategies would emerge during the community pond scenario.

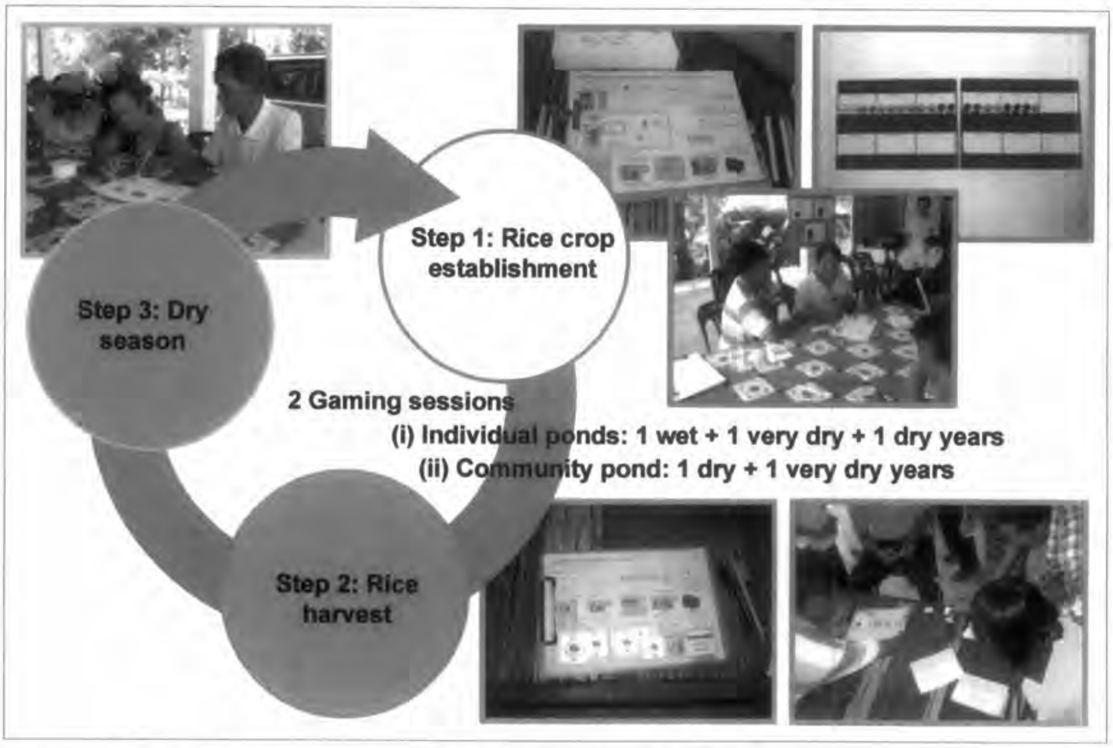

Figure 9.11 The three main steps designed in the third RPG.

9.2.3.3. Details

Initialization

Figure 9.13 shows the setting of the gaming room. To promote knowledge exchange, players were located around a table. The players from the second RPG participated again in the third RPG session. Players drew the sizes of their paddy fields by painting glutinous rice areas red (early maturing) and non-glutinous (late maturing) rice areas black on the crop establishment sheet, shown in Figure 9.14. After all players had completed their drawings, the moderator began to reveal rainfall conditions week by week. The moderator explained how to draw water levels by using a paddy and farm pond water levels bulletin board that depicted five quantitative water levels with qualitative descriptions in Thai (Figure 9.15). For instance, the players drew the water level at half of the pond's volume (before pumping) if they believed that there would be enough water to be pumped to supply their nursery.

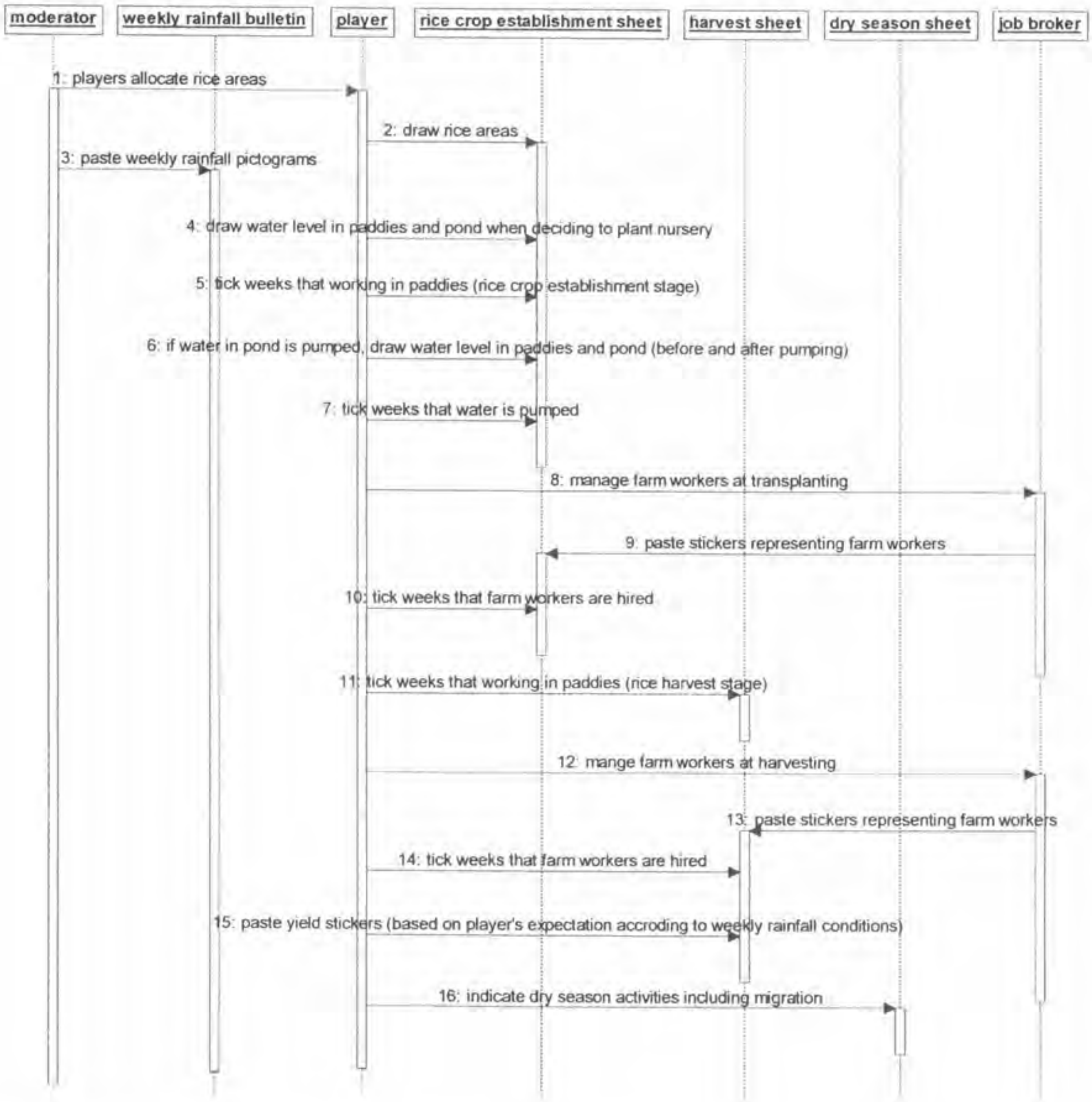

Figure 9.12 UML sequence diagram of the third RPG showing successive activities among its entities throughout a crop year.

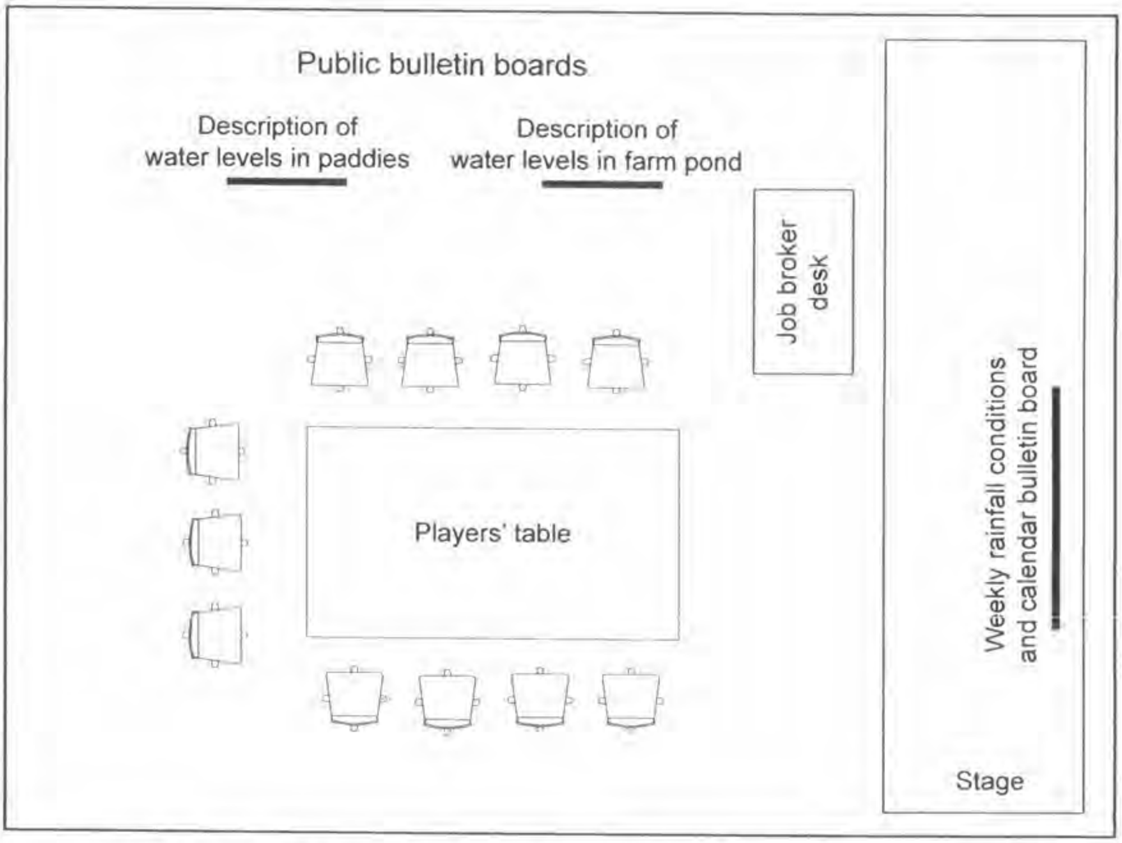

Figure 9.13 Setting of the gaming room for the third RPG on 10-11 October 2006 at Ban Mak Mai community building, Det Udom district, Ubon Ratchathani province.

Inputs

Weekly rainfall conditions shown as pictograms were pasted on the 52 week calendar board (Figure 9.15). The amount of weekly rainfall quantity determined four climatic conditions based on thresholds as shown in Figure 9.16. These thresholds were defined according to the average of 27 years of actual rainfall data in the wet season (April to September) obtained from the regional meteorological centre located in Ubon Ratchathani province. Rainfall data in the dry season was not used because the rainfall quantity during the dry season is very low (almost zero). If it had been used, the threshold values would have been too low. Based on climate records, three years of actual rainfall data were selected: 1972, 1975 and 1989 to represent wet, dry and very dry years respectively. To help players memorize weekly rainfall conditions, weekly rainfall pictograms were not removed from the calendar.

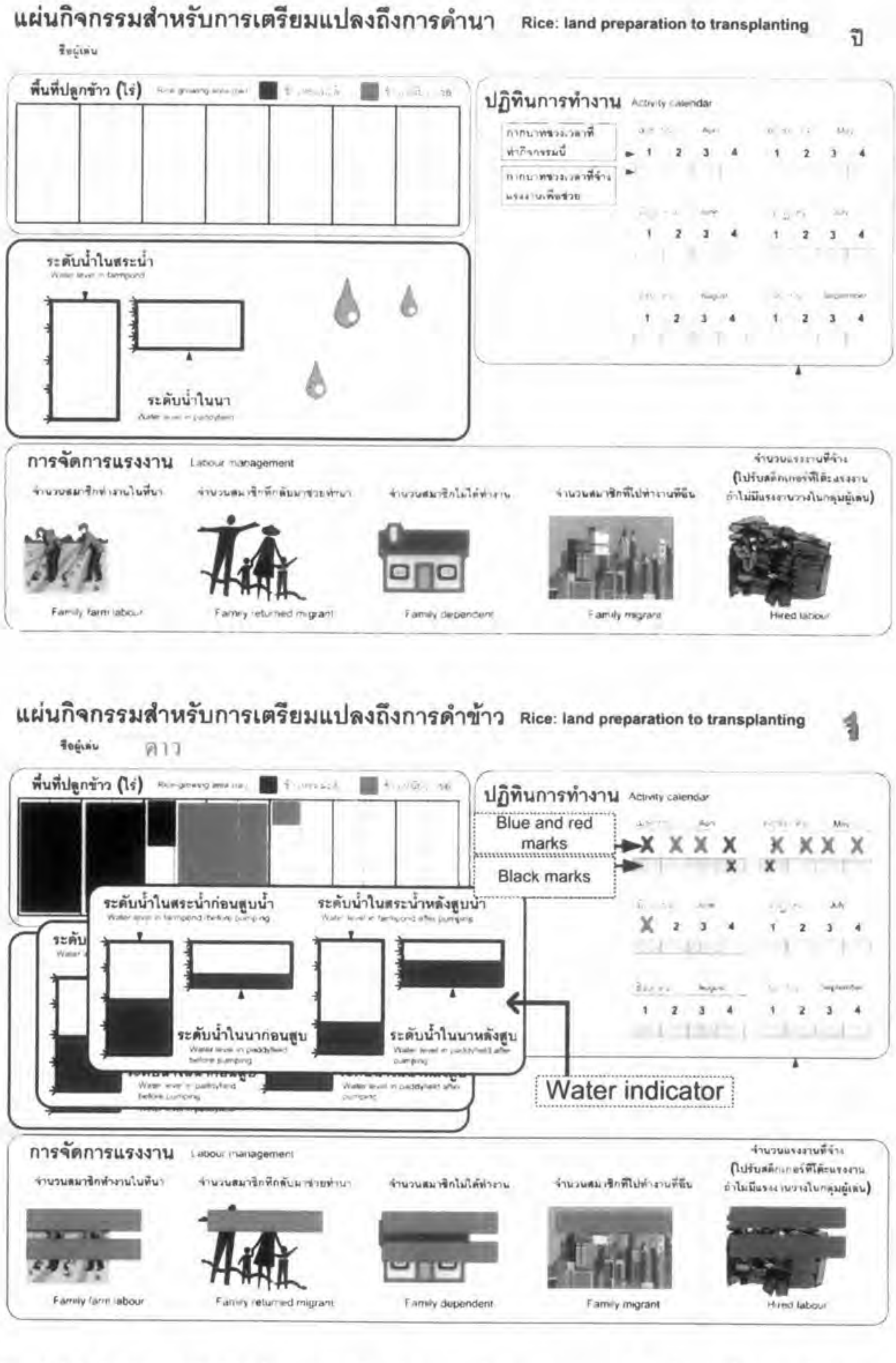

Figure 9.14 Crop establishment sheets used to record a player's decisions from nursery establishment to transplanting, **Top:** a blank sheet. **Bottom:** a sheet completed by a player.

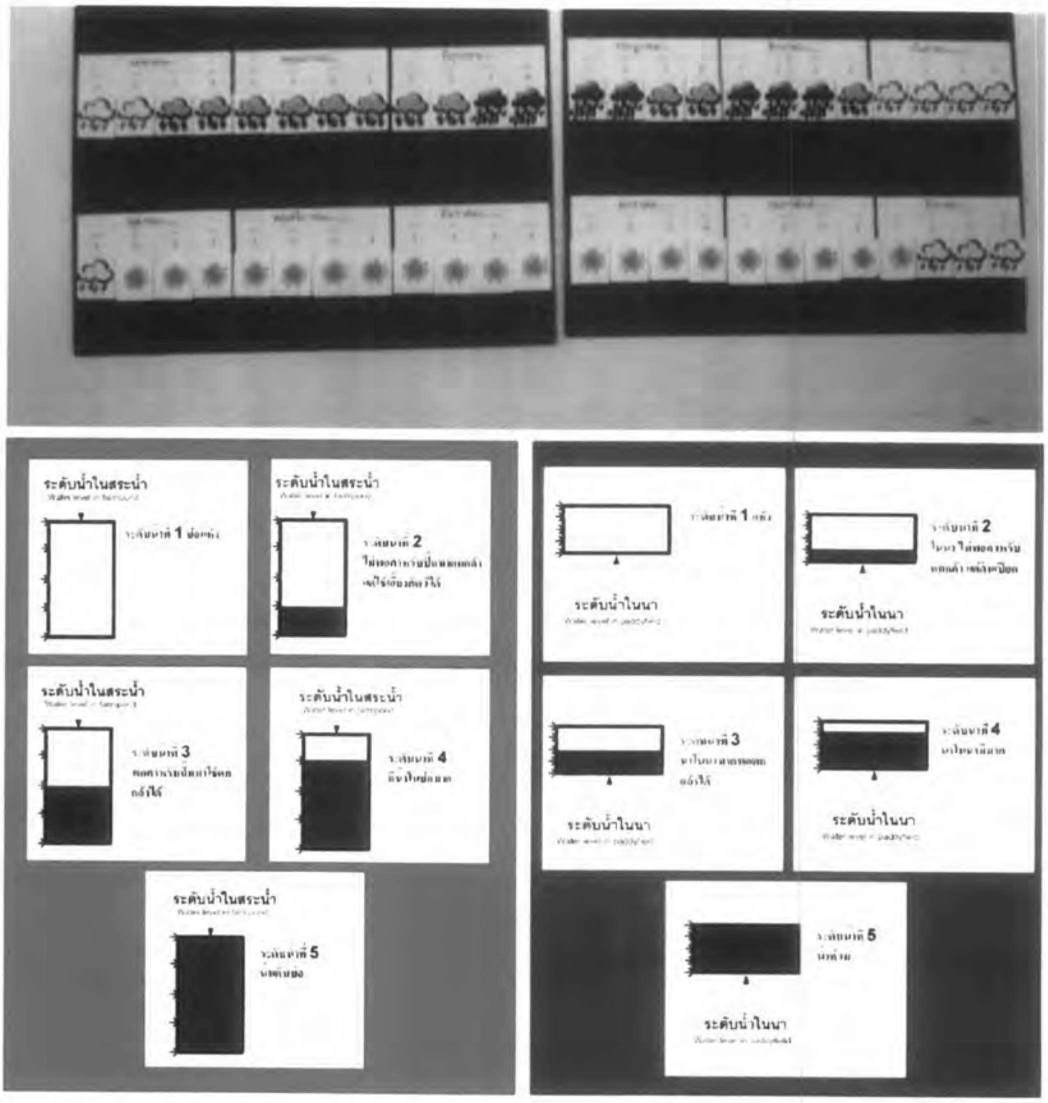

Figure 9.15 Bulletin boards used to provide information to the players, **Top:** weekly rainfall pictograms on a calendar. **Bottom:** descriptions of water levels in pond (left) and paddies (right) under different situations.

Weekly rainfall threshold (mm)	more than 180	between 90 and 180	between 70 and 90	lower than 70
Weekly climatic conditions	very wet	wet	dry	very dry
Pictogram used				

Figure 9.16 Thresholds used to characterize weekly climatic conditions and pictograms used in the game.

Sub-models

Rice-crop establishment

Each simulated week, players were asked what they would do after weekly rainfall conditions were announced. Once the players decided to work in their paddies, they had to indicate whether they wanted to use water from their farm pond or not. If water was pumped, a blue mark had to be made on the activity calendar section of the crop establishment sheet. Once the blue mark was drawn, players needed to define water levels in their pond and paddies before and after water was pumped. The players received small pieces of paper, which were called "water level indicators", so that they could overlay a new "water level indicator" on the previous one when they decided to pump water more than one time. The number of the water level indicators related to the blue marks in the calendar section, indicating how many times a player pumped water from the pond. If no water was used but players were working in their paddies, a red mark was made (Figure 9.14). Another black mark was drawn in grey boxes indicating that players hired labour in that week.

Family workers were managed by the players with specific colour stickers for each household. The light blue stickers are shown in figure 9.14. One sticker was equivalent to one worker. Players were able to hire other players as extra labour. A player who was hired had to paste his/her sticker in the hired labour box of his/her employer. If additional labour from other villages was hired, players had to manage this situation through the job broker. Special stickers with two colours were used to indicate labour from outside the village.

Rice harvesting

Similar procedures were used as above. Once players decided to harvest rice, they had to indicate their working weeks by red marks, and define the source and number of farm workers by using coloured stickers on the harvesting sheet shown in Figure 9.17. Players had to indicate how much water remained in the farm pond before harvesting rice and estimate their rice production at the end of crop year by pasting specific stickers on the harvesting sheet.

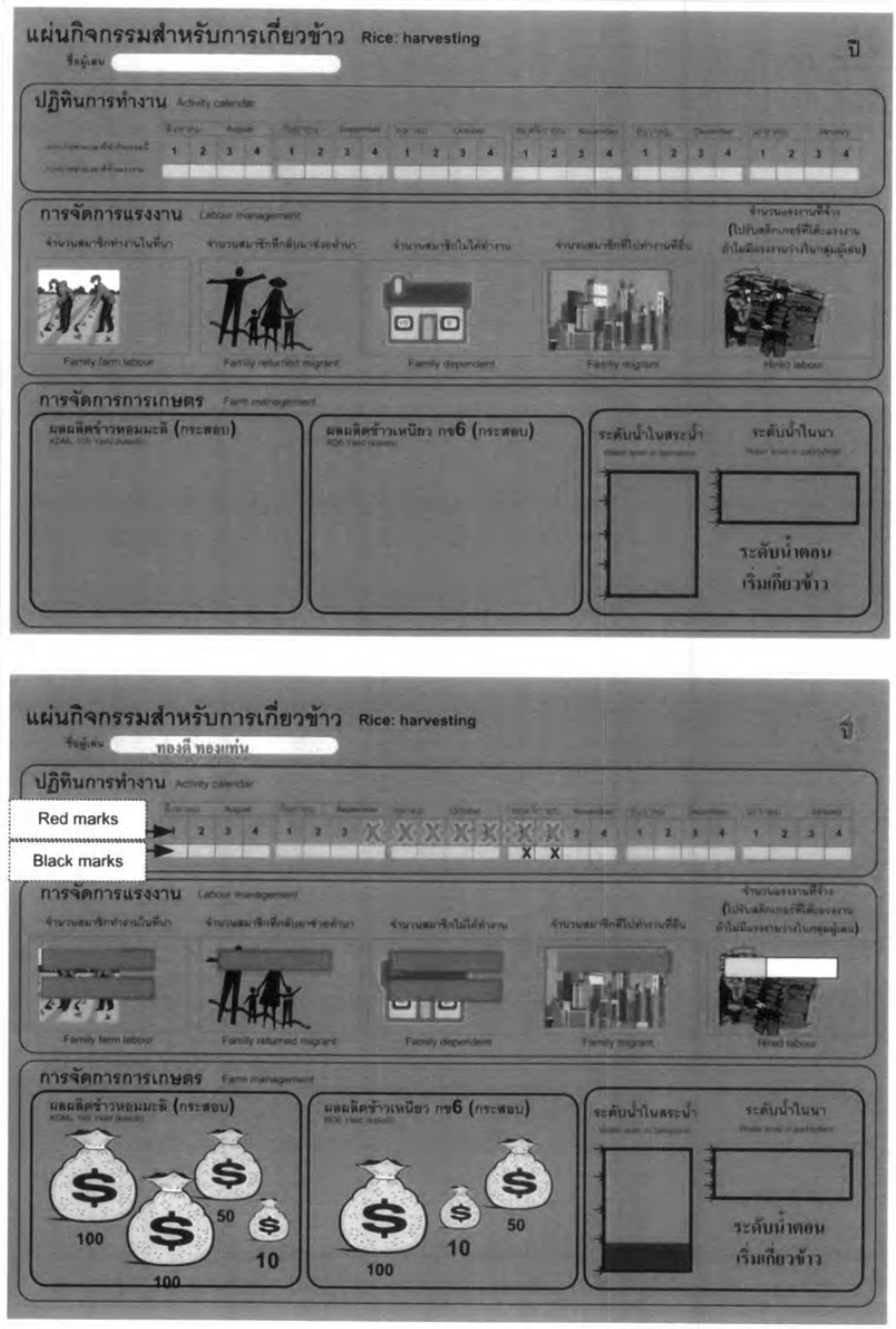

Figure 9.17 Harvesting sheet used to record a player's decisions during rice harvest. **Top:** blank sheet. **Bottom:** a sheet completed by a player.

Dry season activity

The focus of this step was labour management and farm production in the dry season. Players were asked to allocate family labour into three categories: working in village, migrating to the city, and just staying at home, as displayed in Figure 9.18. Players who wished to produce farm goods indicated key information on the dry season sheet (number of livestock heads, size of vegetable garden etc.). At the completion of the dry season activity, the moderator collected all the decision-making sheets, and started a new crop year. The same process and scheduling was used for the community pond scenario. However, instead of playing the game individually, players discussed how high the water level should be in the community pond. Players also had to negotiate how to best use the water from the community pond.

9.2.3.4. Results from the Third RPG Session

Water use strategies across farm types

Figure 9.19 shows the frequency of water pumping across farm types, with the exception of the sub-type A1 players who did not have farm ponds. The sub-type A2 players conserved water in individual farm ponds to mitigate possible drought effects on rice-seedlings. Less frequent water pumping from farm ponds among the sub-type A2 players was also noticed. However this was not the case for sub-type A3 players. Farmers belonging to this sub-type, by and large, have less water constraints in reality than other type A farmers. This sub-type A3 player, for instance, has farm land located in lower paddies, where water is ample enough to be used more often in the dry and very dry year. How sub-type A3 players played the game reflected their actual practices. Consequently, type A farmers' water use strategies varied depending on where their paddy fields are actually located in reality and the water availability typically available in those locations.

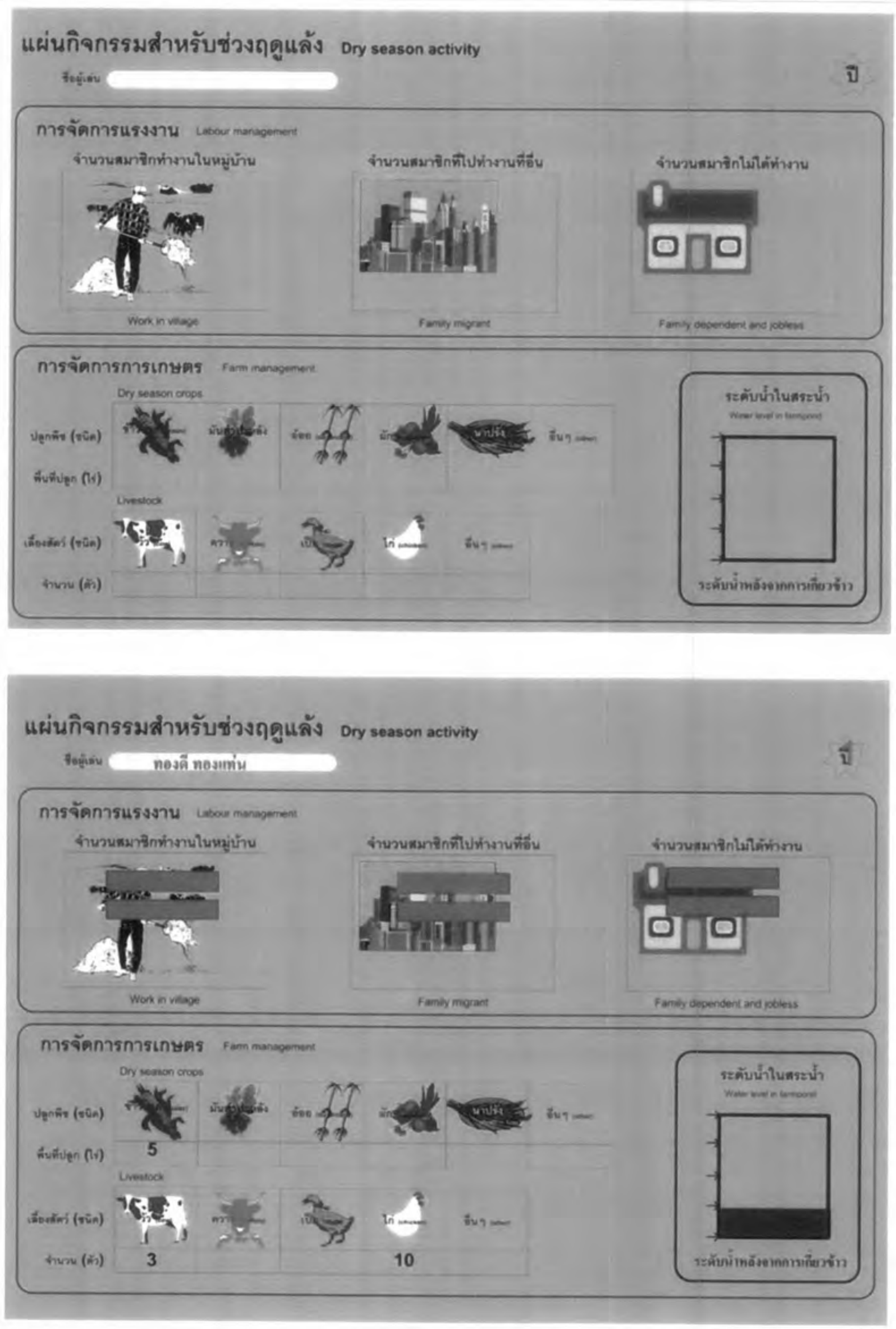

Figure 9.18 Dry season sheet used to record a player's decisions after rice harvest. **Top:** blank sheet. **Bottom:** a sheet completed by a player.

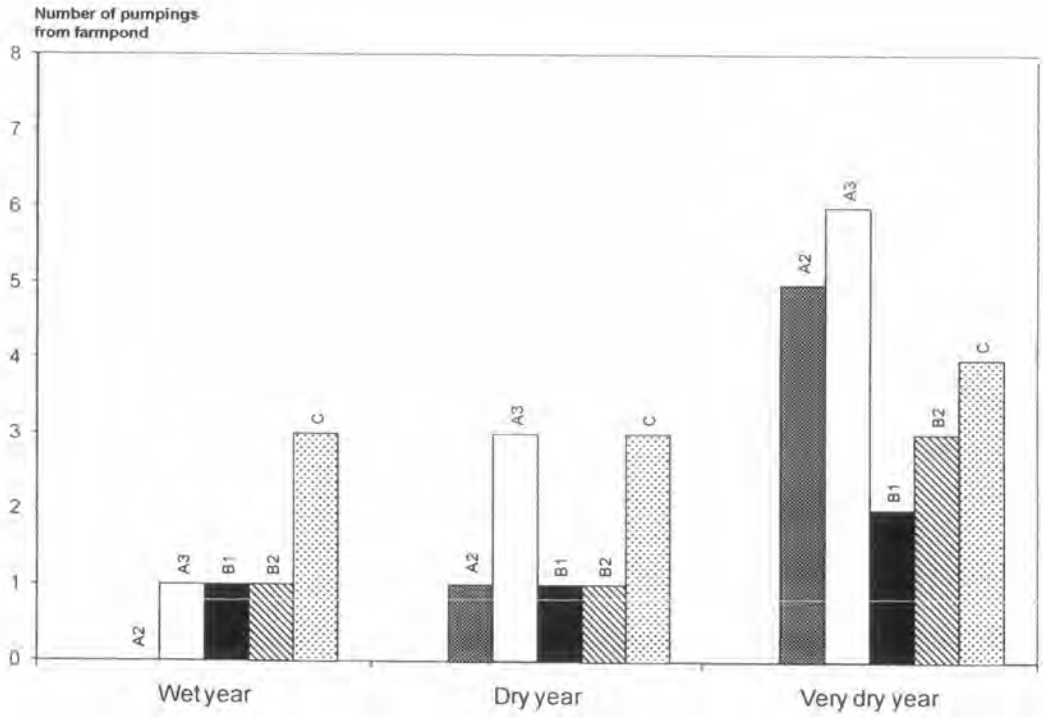

Figure 9.19 Water pumping from farm ponds across farm types in relation to climatic conditions during rice crop establishment (April to August) in the third gaming session on 10-11 October 2006.

Farm type B and C players used water from their farm ponds more frequently to grow healthy rice seedlings no matter what the climatic conditions were. However, the results from the very dry year shows that water was pumped on fewer occasions than for type A players. This was because the type B and C players had to manage large paddy fields and diversified non- rice farm products. They had to use water carefully to ensure that they would have enough for their farm production.

During the gaming session, it was observed that players directly discussing with each other what water levels would be required for the paddies and pond once deciding to establish a rice nursery. The description of water levels on the paddy and farm pond bulletin board helped the players to determine what water level they had to draw on the decision-making sheets.

Different decision-making processes in the individual and community pond scenarios

Figure 9.20 shows the results of the individual farm ponds compared to a new water infrastructure, a community pond. In the individual farm pond scenario, the water use strategies were different across farm types, which lead to different patterns of rice crop establishment. The farm type B and C players who had less water constraints than type A players decided to establish a nursery earlier, even in the very dry year. In the community pond scenario, all players had to discuss their perceptions of the water level at the time (simulated weekly) and collectively agree upon pumping water from the community pond. Almost all of the players decided to use water at almost the same time. This was because they were afraid that there would be no water left for them in the subsequent crop year.

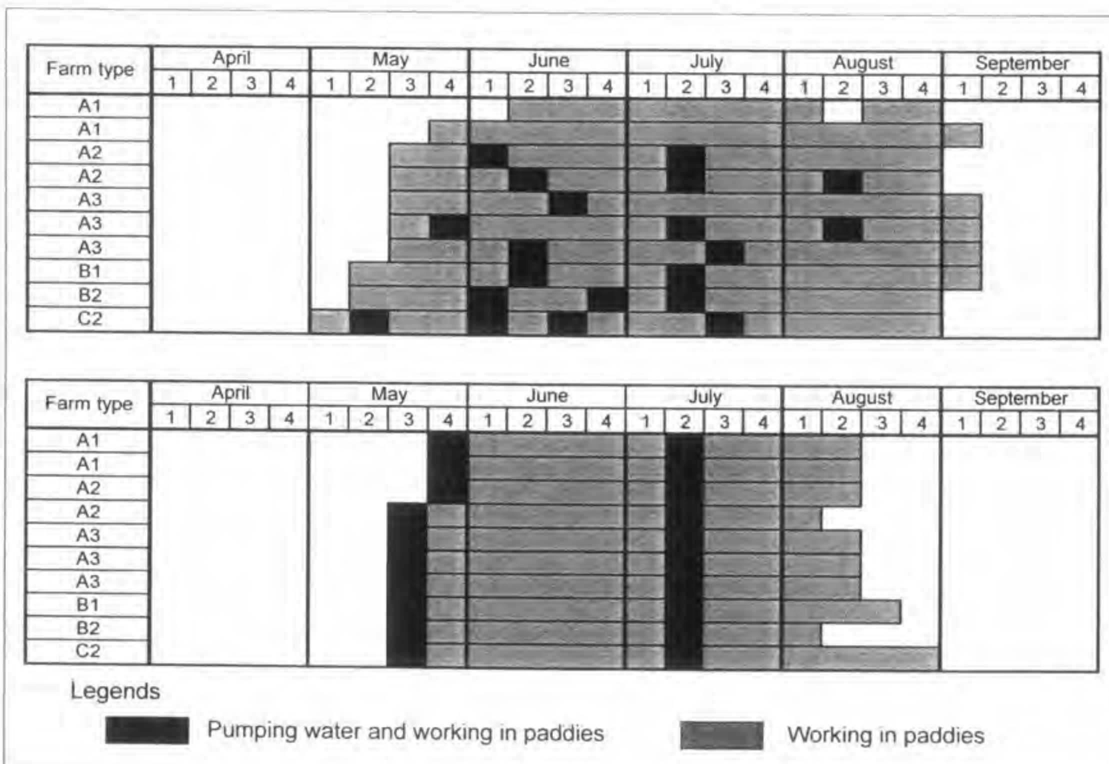

Figure 9.20 Water pumping from farm ponds and working in paddies over the weeks and months across farm types for the two scenarios, **Top:** individual pond use in the very dry year scenario. **Bottom:** community pond use in the very dry year scenario.

Nonetheless, three type A players decided to pump water one week after other players (they all discussed that move before telling us their decision). Because they had small areas of land (less than 3.2 ha), they needed less water to grow rice. They also wanted to be hired by their neighbours before starting their rice production so that they would have additional cash to spend on their rice production. This confirmed my preliminary findings that type A farmers considered wage as an important source of income, and that they are a key source of hired labour in this village.

The improved water availability through a community pond seemed to stimulate more dry-season crop cultivations for farm type A and B players (Figure 9.21). But smaller production areas were observed among type B players, a situation brought about by labour constraints. Only the type C player perceived that water in the community pond would not be enough to produce dry-season crops. The risk of growing dry-season crops with an inadequate water supply was too high, and he was simply not interested. Besides, he receives a high remittance from migrant workers. There is no financial pressure, especially the repayment of debts, pushing him to produce more farm commodities in the dry season.

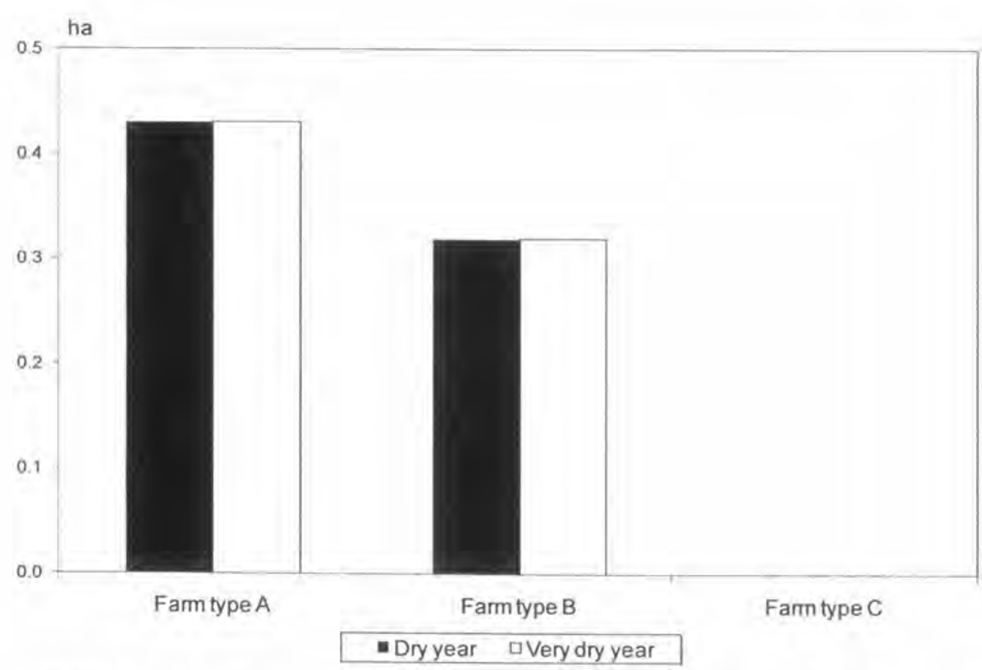

Figure 9.21 Average dry season crop area across farm types after the community pond scenario was played in the third gaming session on 10-11 October 2006.

By the end of the third RPG session, farmers acknowledged that it was easy for them to relate the simulated games to the reality of their situations, mainly because of the delivery of weekly rainfall information. Since the local farmers have experienced being participants in the "player-based simulations" of the RPG sessions, they are expected to be able and comfortable following and discussing computer simulations; they will be able to relate the "agent-based simulations" with their experiences. However, the weekly time step controlled by the moderator through the announcement of weekly rainfall was still too broad to examine participating farmers' decision-making processes because they make decisions to grow rice in relation to labour and water availability on a daily basis. Furthermore, the standard calendar based on the solar (western) system was not easy for them to follow because they are accustomed to using the traditional one based on the lunar system. These concerns were taken into account when building the ABM. To create better communication, this calendar needs to be modified to the lunar system, which is traditionally used by local farmers. To efficiently investigate the decisions and actions of local rice farmers, the weekly time step has to be replaced by a daily time step. However, the daily time step could limit the use of an RPG because the RPG would be too detailed, taking a very long time to play out. An ABM might be a promising tool to overcome this limitation.