Role-playing games to understand farmers' land-use decisions in the context of cash-crop price reduction in upper northeast Thailand

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The undulating landscape of upper northeast Thailand forms a succession of adjacent mini-watersheds occupied by lower and upper paddy fields and upland cash crops. The last decade has seen the expansion of small-scale sugarcane plantations into the upper and even lower paddy areas as farmers responded to market demand and the government sugar price support policy. How extensive is this expansion and how will farmers adjust if the sugarcane price decreases are key questions in order to better understand the effects of this recent change in land use on the agroecosystem and household livelihoods. Moreover, the collection of sugarcane requires coordination among various stakeholders: different types of farmers and quota leaders, and sugar mills. Field research was carried out to better understand farmer decision-making regarding land use and the interactions among key stakeholders involved in the sugarcane production and marketing system.

Following the construction of a conceptual model based on existing knowledge representing farmer decision-making as seen by the research team, role-playing games (RPG) and focus-group discussions backed by individual interviews were the main investigation tools used in this study. A three-dimensional playing board and game rules were conceived based on actual circumstances and the preliminary findings of three gaming sessions undertaken with multiple stakeholders are presented. Under a scenario simulating a drop in the market price of sugarcane, the study found that glutinous rice remained dominant in lowland paddies while sugarcane plantations occupying the upper paddy area were replaced by other crops, except rice. In general, rice is doing poorly in such a drought-prone landscape position and farmers decided to experiment with alternatives such as integrated farming and an increase in cattle rearing. The collection of sugarcane at harvest required an active role by small-scale quota leaders at the village level since not all cane growers can look after their plantations and harvest sugarcane by themselves. This last operation requires important cash expenses and an ability to manage hired labor. Large sugarcane quota leaders from outside the village who hold more capital acted as a second type of sugarcane collector but did not take part in any price competition with local collectors to get access to the product.

This RPG enabled researchers to observe the local pattern and dynamics of land use and the interactions among stakeholders since players imported many

aspects of their real circumstances into the game. However, because this RPG focused on individual choices based on one's actual situation, the players suggested few new rules. Ultimately, the new knowledge and decision-making rules gained from the RPG should be inserted into an associated multi-agent computer model. Following its validation with users, this model could be used to run time-efficient simulations of different scenarios of land use and price movements. This endeavor requires ample investment in building an interdisciplinary team.

In the upper part of northeast Thailand, the undulating land forms a succession of adjacent mini-watersheds. The low terrace is occupied by lower paddies usually planted to the staple glutinous rice. The uplands are planted to industrial cash crops, mainly cassava and sugarcane, and the transition zone, sometimes referred to as the upper paddies, is traditionally planted to nonglutinous rice in wet years and to drought-tolerant cassava or left idle in dry years (Limpinuntana 2001). In this region, farmers face infertile sandy soils and an erratic distribution of rainfall. Rainfed lowland rice is the main subsistence crop, whereas cash earnings come mainly from industrial crops and nonfarm employment (Thomas 1988). The last decade has seen a gradual expansion of sugarcane into areas occupied by upper and even lower paddies. This expansion of area planted to sugarcane is raising concern among scientists about its ecological effects, especially soil erosion and soil losses in upland fields and a possible decline in rice production and local household food security. A recent study on land use in upper northeast Thailand found that farmers have been applying a high level of chemical fertilizers in their upland fields (an average of 625 kg ha^{-1}) to compensate for nutrient loss. Soil loss from upland fields is a problem commonly found in areas where monocropping is practiced in the upper land unit connecting the paddies with the upland subecosystem (Vityakorn et al 2004).

The expansion of sugarcane in this region is directly related to government policy for the sugar industry. Unlike rice or cassava, sugarcane production and price have been managed by the Sugarcane Board since 1984. The production, collection, and processing of this industrial crop involve multiple stakeholders: farmers, different types of quota leaders, sugar mills, etc. Annually, Thailand exports a total of about 2.1 million tons of sugar, while another 1.7 million tons of white sugar covers domestic consumption. Sugar production is an important economic activity as more than 700,000 farmers are engaged in mostly small-scale sugarcane planting, and a total of 1.4 million people are taking part in some kind of sugar-related activity (Thailand Development Research Institute 1994). The commodity board also helps to manage the profit-sharing system. At the end of the production cycle, the annual profit from the sugar industry is shared between cane growers and sugar mills on a 70:30 basis. Under this system, cane growers have to register with a sugar mill and be a member of the Cane Grower Association to be able to participate in this end-of-the-season profit-sharing system. The official price of sugarcane is negotiated and must be approved by the cabinet before its official announcement to the public prior to the harvesting season. Consequently, the primary price of cane can be negotiated and stabilized, the volume of sugarcane production is controlled, and cane producers are divided among registered and independent growers.

In 1989, the government allowed existing sugar mills in search of raw material from the western region to relocate to the northeastern part of the country to stimulate the local economy of this poorest part of the kingdom. As a consequence, the total area planted to sugarcane in the northeastern region jumped from 40,000 hectares in 1973 to more than 300,000 ha in 2002, and the number of sugar mills in the region increased from 7 to 13 during the same period. More than 50,000 farmers registered with these mills and supplied them annually with more than 20 million tons of cane (Office of the Cane and Sugar Board 1999). Confidence in the price negotiation system is a powerful incentive for farmers to remove bunds and convert upper paddies into more drought-tolerant sugarcane plantations.

Is this trend going to continue? Will the expansion reach a critical stage at which lowland rice production would be significantly affected? And, if the cane price cannot be supported anymore because of changes in the context of international trade, can local farmers adapt their production system by integrating new alternatives? In addition, because the collection of sugarcane is organized through quota leaders, how do farmers manage this phase of the production cycle that involves multiple actors? These questions require a better understanding of land-use dynamics and interactions among the concerned stakeholders: independent small-scale growers, different kinds of quota leaders, and sugar mills. Within this context, the authors attempted to understand farmers' decision-making regarding land use when facing a reduction in the farm-gate price of sugarcane. The innovative modeling concept of multi-agent systems and an associated role-playing game (RPG) were used to represent the interactions among multiple stakeholders under a given set of rules and for researchers to observe the exchanges and gain new knowledge on the systems under various circumstances.

This article presents the construction of the initial conceptual model and its related RPG, as well as its use with stakeholders. First, the study method and site are described. The RPG features and rules are introduced and three successive gaming sessions are presented. The results of this experiment are analyzed and a final discussion deals with the lessons learned and comments on the methodology.

The study method

Resource management is complex and is constrained by both biophysical and socioeconomic conditions. Human interaction is an important determining factor of patterns of resource use. This involves multiple stakeholders with different needs, objectives, strategies to achieve them, and perceptions. The integration of diverse stakeholders' perceptions and behaviors in the study process is essential to gain a collective understanding of the problem to be examined. Conventional methods of study such as individual interviews and group discussion, rural appraisal, and goal-seeking modeling are not adequate to conceptualize the interactions among stakeholders and the integration of resource management in space and time. We need a tool that helps to capture stakeholders' decision-making, and, moreover, their coordination at the same time. Multi-agent systems (MAS) modeling could be seen as a state-of-the-art approach to do just that. MAS is suitable for analyzing complex systems since it represents an environment of autonomous agents that can act locally in response to stimuli or communicate with other agents. Based on the observation of the effects of

changes in the system, one can examine the relationships among agents under various circumstances. To make the process more iterative, one can implement these relationships in a computerized MAS model. For more information on this step, readers can refer to other articles on MAS simulations presented elsewhere in this volume.

The use of MAS with stakeholders can also be supported by other tools. Recent experiences in various parts of the world have shown that the joint use of RPG, individual interviews, and MAS facilitates communication among stakeholders facing a common natural resource management problem, and helps to empower them when looking for "solutions" (Bousquet et al 2003, D'Aquino et al 2003, Dare and Barreteau 2003). The study method used in our case involves a review of secondary data, a rural assessment, stakeholder interviews, role-playing sessions, and MAS modeling. In this way, the model is gradually developed in a participatory and iterative way, and the whole methodology is also referred to as "companion modeling" (Bousquet et al 2003).

In Senegal, scientists used RPG and MAS to help multiple stakeholders (farmers, herders, fishermen, hunters, and national park officers) to reach collective decision-making in land use. The study process started with a stakeholder-designed RPG followed by MAS modeling. A game was organized after several workshops involving stakeholders. The RPG facilitated dialogue among stakeholders and led to collective decision-making. Afterward, a real situation was modeled. The RPG was used to support computer modeling and a geographic information system (GIS). It is important to note that this methodology does not aim directly at the selection of a solution to the problem under study, but at stimulating the joint identification of alternatives to the current situation and their discussion to facilitate collective decision-making (D'Aquino et al 2003).

By using an RPG to study negotiation processes in irrigated systems of the Senegal River Valley, Dare and Barreteau (2003) found that the RPG was accepted among stakeholders as a good representation of their reality. They also found that the social background of the players interfered with role-playing during the sessions. However, the RPG could be used to investigate social relations among people in combination with sociological interviews and analysis of videos and other materials used to record information during gaming sessions, and to facilitate a negotiation process (Dare and Barreteau 2003).

The methodology adopted in our case study follows the experiments of collective modeling in which the model is created from existing knowledge and additional information can be gathered during the RPG and individual interviews with the players. Before interactive experiments can take place, researchers integrated knowledge from various sources to obtain an understanding and first representation of the agents' behavior within the system. The players taking parts in gaming sessions were selected in collaboration with local institutions. We looked for farmers who grow rice and sugarcane but without a quota, farmers having a sugarcane production quota, quota leaders who do not grow sugarcane in the village, and leaders in the local farming community.

The whole methodological process can be divided into three main phases:

1. *The role-playing game.* The objective is to assess whether the features and rules of the game proposed by the researchers constitute a fair representation of farm-

ers' actual circumstances, and whether the same kind of event emerges from the interactions among players. The RPG is also used to gather new knowledge by encouraging the players to modify the game during successive sessions. Problems are identified and scenarios can be simulated and their results collectively discussed.

2. *Individual interviews with the players*. The objective is to better understand how they played during the gaming sessions, and to what extent the RPG is related to their real circumstances.
3. *MAS modeling*. A simple computer model with features and rules similar to the RPG and integrating the knowledge gathered during the interviews could be developed and presented to the players to stimulate the identification of scenarios of land-use change, simulate them, and collectively assess their results. The common-pool resources and multi-agent systems platform (CORMAS, for more details, see the article describing this MAS simulation tool in the last section of this volume) was used by an external modeler to build a preliminary version of the computer game simulating the first and second gaming sessions, but it is not presented in this article.

Conception of the role-playing game

Knowledge synthesis and development of a conceptual model

Prior to game development, an interdisciplinary group of researchers gathered secondary information and conducted a series of interviews with several key stakeholders to improve their understanding of farmer decision-making processes regarding the allocation of different crops to different landscape units and marketing of sugarcane production. Data on resource exchange patterns, minimum land areas for rice or sugarcane production, and returns for the main crops were collected to be used in the conception and calibration of the game. For example, the minimum sugarcane price reported by small-scale growers could be as low as US$10 per ton. It is important to note that this price level is about 45% lower than the price negotiated at the commodity board level for the 2003 crop year.

Diagrams were used to assemble, display, and verify the consistency of knowledge acquired on these decision-making mechanisms. The unified modeling language (UML) was used to allow interdisciplinary exchanges on agent identification, farmers' decision-making rules, and conditions for them to become quota leaders. Examples of possible land-use patterns were also prepared. In the lowlands, although glutinous rice production is dominant, sugarcane may encroach if the family is self-sufficient in rice and the price for sugarcane is high. In the upper paddies, farmers make cropping decisions between nonglutinous rice and two major commercial crops, cassava or sugarcane. In the uplands, only sugarcane or cassava is a possible choice. Figure 1 displays a UML activity diagram representing the general farmer decision-making process for the allocation of crops to different landscape units.

Farmers' decision-making to become a quota leader or not depends on two main determining factors: access to capital (cash and transportation equipment) and marketing networks that usually originate from social networks made up of relatives or friends. Some sugarcane growers who are able to shoulder the harvesting costs

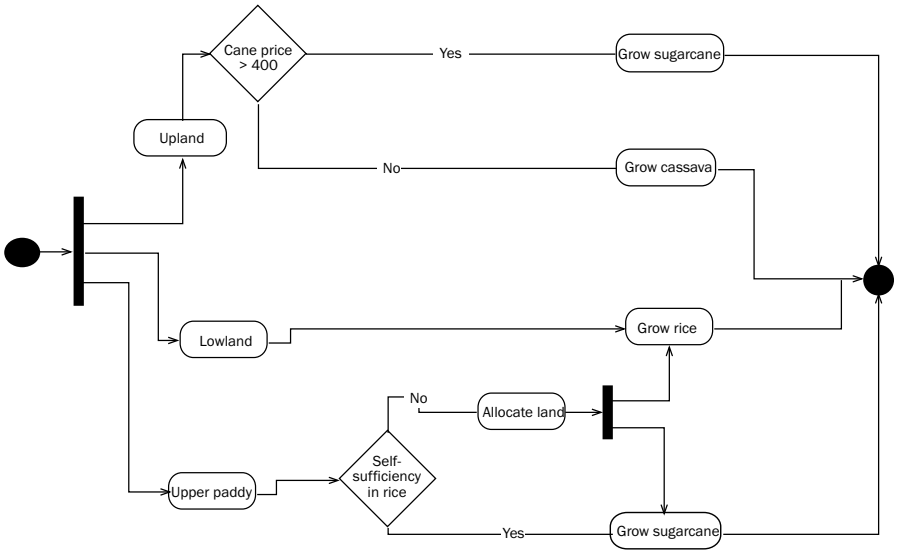

Fig. 1. UML diagram displaying a decision-making tree regarding crop allocation to land by farmers in Nam Phong District of Khon Kaen Province, upper northeast Thailand.

and have good connections with a quota leader may sell their crop under the leader's name and thus benefit from the end-of-season profit-sharing arrangement. Figure 2 represents the relationships between cane growers and the two main kinds of quota leaders and the conditions to be met to be able to obtain a sugarcane quota from a given mill.

It is also important to identify the possible interactions among different agents and to represent them in the RPG, for example, the interactions between quota leaders and small growers after the sugarcane planting season. The agents deal with the purchase and sale of sugarcane crops before harvest when the small farmer does not have sufficient resources (cash for fertilizer, labor for weeding, etc.) to look after the plantation. Price negotiations for these plots of sugarcane purchased as "green" start soon after the crop is planted. After the deal is concluded, crop maintenance and harvesting are the buyer's responsibility.

Site selection and description

Located some 50 km north of Khon Kaen City, the village of Ban Pung Tui in Nam Phong District of Khon Kaen Province was chosen for this experiment because its landscape has the common combination of lowlands and uplands separated by a transition zone. The conversion of paddy fields into small sugarcane plantations has been extensive and key information on the households' farming activities was available. Out of a total area of about 770 ha, the lowlands, uplands, and transition zone occupy 25%, 40%, and 35% of the village territory, respectively. Key informants indicated that more than 25% of the land exploited by the 259 local farming households had already been converted from paddy land into sugarcane fields. The average farm size is 4 ha, but it varies within a range of 1 to 15 ha. A large sugar mill and two cassava

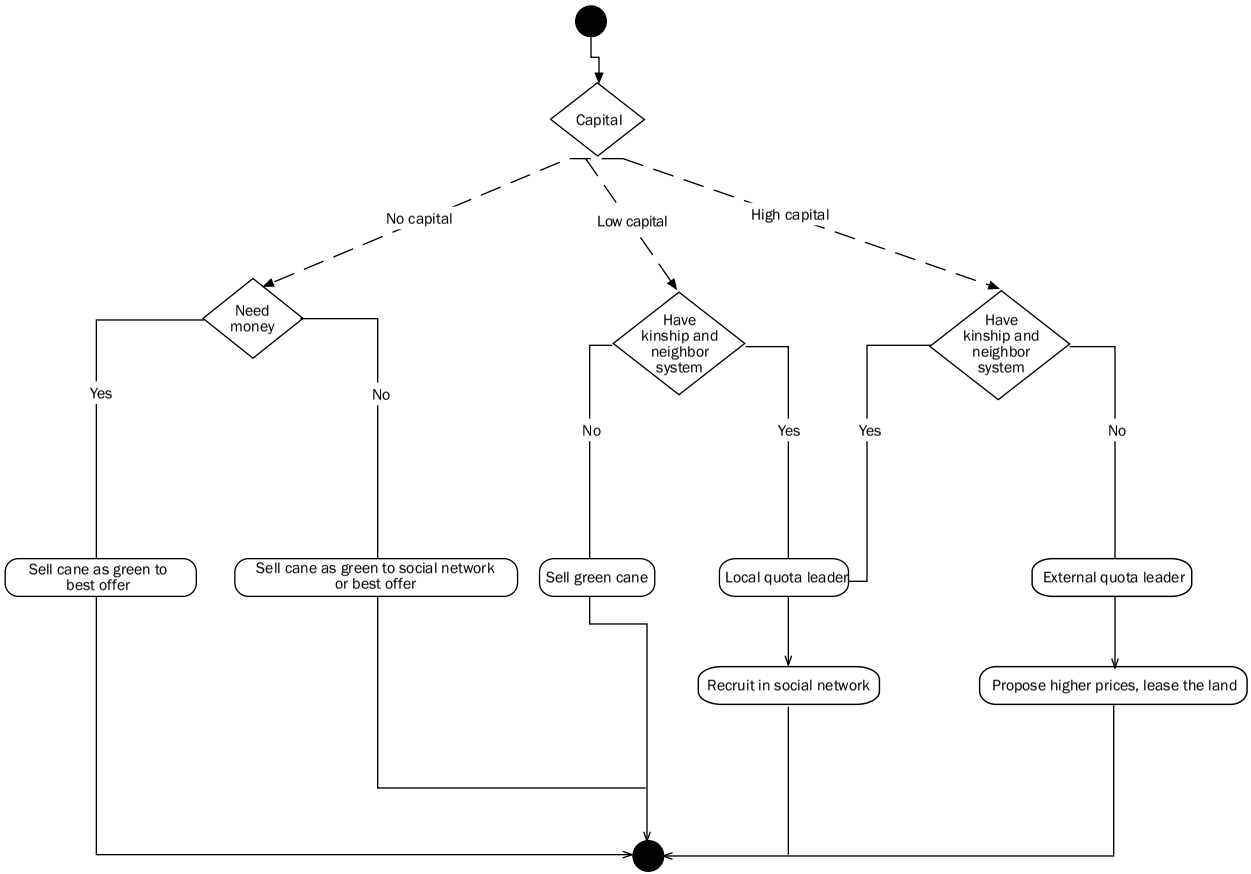

Fig. 2. UML diagram for the identification of sugarcane quota leaders in Nam Phong District of Khon Kaen Province, upper northeast Thailand.

processing plants operate nearby. Each year, more than 60% of the farming households grow sugarcane, but only 10 to 15 farmers register as quota holders with the mill. Focused interviews were carried out to record farmers' perspectives on the land conversion issue. Farmers' decision-making regarding land use is related to perceptions on rice self-sufficiency, the expected price of sugarcane, and farmer interactions with quota leaders.

Role-game preparation

The playing environment of the agents is a 3-dimensional board model that represents a typical local landscape with its main heterogeneities (3 levels of land units). Preparation highlighted that one important factor influencing agents' decisions is the topographical position of the plots (Fig. 3). This is supposed to be similar to the real landscape experienced by the players, but is not an exact representation of any particular site. The purpose is to capture the main land-use processes and such a board is supposed to be used in other villages.

Design accessories of the game are farm plots, crop yields and price lists, and sticky colored papers (Post-Its) predefined for each crop and medium of exchange. For instance, strips of white paper represent the farmers' plots of different land areas. Each block of fields is divided into subplots or "cells" corresponding to 0.8 ha each. The size of a cell is based on the minimum plot size for rice production that is sufficient to support an average household made up of five people. Different colored Post-Its represent different types of crops. When the land allocation to players is predefined, it mimics the actual heterogeneity in size among the local landholdings.

The game is designed for 10–15 players taking part in each gaming session. It can be played with more people but then time management could become a problem. Only three players can gather around the board at one time to make decisions and three assistants are needed to help them. Each time a farmer chooses a crop for a given cell, the assistant writes the cell number and time-step of the game on the Post-It. At

Fig. 3. General view of the 3-dimensional board used in the role-playing game.

the initialization of the game, the role of sugarcane quota leaders is allocated to a few players and the others are independent growers. In some cases, players are allowed to choose their own roles.

In this study, each player allocated different crops to his/her plots. After all players planted their crops, those who planted sugarcane started informal discussions with quota leaders and bargained the cane price at which they were willing to sell some of their crop as "green" cane (Fig. 4). When an agreement was reached, the exchange price was written on the Post-It to be collected later by the buyer. This procedure resembles reality in that buyers are the ones who harvest the fields so in the game they removed the cane represented by the Post-It to sell it at the sugar mill at the end of the cropping season.

Two organizers played the role of the sugarcane mill and of the market (to buy or store other crops). At the end of each time-step, players collected their Post-Its and sold their production to the mill or on the market. Information provided on Post-Its was recorded on spreadsheets for further detailed analysis of the full set of decisions made during a given gaming session. At each time-step, all crop yields were dependent on the weather randomly defined by the game organizer after all the crops were planted. Toward the end of each simulated "crop year," the sugarcane price was announced shortly before harvesting. Prices for other crops were determined on the market. If a player wanted to store rice, the market would keep its corresponding Post-It but would not return any cash to this player.

Organization of the gaming sessions

Before the interactive experiment, this RPG was tested with students to calibrate each successive step of the game and to verify the effects of the game rules and the duration of a gaming session corresponding to a minimum of 4–5 "crop years." Several game assistants were also trained at that time. One week before each gaming session, 12

Fig. 4. Price negotiation among players during the purchase of sugarcane fields sold as "green" cane.

farmers (including a few quota leaders) were invited to participate. This experiment consisted of three successive gaming sessions conducted in the same village. The first and second ones were implemented on the same day in May 2002, whereas the third one occurred in September 2002. The preparation of these experiments followed the following schedule:

- Day 1. Confirm the invitation of players representing farmers with small and large landholdings, and farmers with and without sugarcane quotas at the mill.
- Day 2. Role-game implementation in the village: one game session simulating 3–5 crop years lasts about 2–3 hours.
- Day 3–4. Synthesis of the game results, and individual interviews with the players. When possible, a companion MAS model simulating the RPG is developed.
- Day 5. Plenary meeting with the players: presentation of the game results and the model, and discussion about scenarios.

All three gaming sessions were conducted at the office of the subdistrict administrative organization near the selected village. The first session aimed at testing the representation of the system proposed by the research team and farmers' decision-making processes regarding their crop choice for different landscape units. Therefore, plot location, game rules, and lists of crops were provided. This first session is called the "researcher-controlled" game. In the second gaming session, we allowed the players to select the location of their farmland on the gaming board and to add more crop variety and other enterprises (such as pasture and livestock rearing) among the possible activities carried out on their cells. The players were also able to choose their role, so any one could register as a quota leader during this second game. This was done to allow players to create new rules and to experiment with some of their projects, such as becoming a quota leader. This game is referred to as the "farmer-controlled" game. The third gaming session was implemented with a new combination of stakeholders, including a large quota leader who is not a resident of this village. Some of the players who joined in the previous games played again in this one. The rules of this last game were more flexible and coordination among multiple stakeholders could be observed. This game is called the "multistakeholder" game. A comparison among the three gaming sessions is shown in Table 1.

Results from the role-playing game

The researcher-controlled game

In this game, players were farmers in the study village, of whom a few were local quota leaders. They played their own roles in the game. There were 12 players, of which six were defined as quota leaders (100–200 tons of cane each). Each player was given farmland of 2.5 to 9.5 ha on the board. The allocation of farmland across the three different zones materialized on the board was 20% in the lowlands, 50% in the uplands, and the rest in the transition zone. The position of each player's farmland, the list of possible crops, and all crop yields and prices were all predefined based on secondary data. For example, rice yield was 2.5 t ha^{-1} and sugarcane was 62.5 t ha^{-1} in a normal climatic year. In a dry year or for ratoon crops, all sugarcane yields were assumed to be one-half lower. Three rounds of play, corresponding to as many crop years, were played over 2.5 hours. The game started with the land allocation to crops.

Table 1. Comparison among the three games played in Nam Phong District of Khon Kaen Province, upper northern Thailand.

Game name	Researcher-controlled	Farmer-controlled	Multistakeholder
Players	- 12 farmers, - 3 local sugarcane quota leaders	Same as in the previous game - 1 large quota leader	- 8 farmers - 3 local quota leaders from outside the village
Land allocation to players	Predefined	Players defined	Predefined
Set of crops	Predefined	Players added more choices	Players added more choices
Registration as quota leaders during the game	No	Yes	Yes
No. of rounds of game ("crop years") played	3	3	5
Scenario	Drop in sugarcane price	Drop in sugarcane price	Drop in sugarcane price

Trading of "green" sugarcane fields began after all crops were planted. During the game, an announcement about good or bad rainfall conditions was made. The rainfall conditions were used to determine crop yields and prices provided at the market. When the harvest of all crops, sales on the market or at the sugar mill, and the payment of gross income to the players were completed, the round of play was finished. A drop in the price of sugarcane was the main scenario simulated in this game. The cane price started at US$15 per ton; after two time-steps, it was announced that the price of sugarcane dropped to the critically low level of $12.50 per ton. The main game results were as follows:

1. All players kept glutinous rice in their cropping systems. Rice was still planted in the lower paddies and kept for home consumption, while cash crops were planted in other zones. A few players planted and sold nonglutinous rice.
2. After the fall of the sugarcane price, players planted short-duration field crops, such as maize and watermelon, in the transition zone, but they did not grow more rice.
3. All sugarcane growers sold their crops as "green" cane to predefined quota leaders. They did not have to look for buyers since quota leaders came to growers to seek their production.
4. Bargaining for higher prices occurred among players. Some players sold to those offering the highest price, others decided to stick to the same quota leader as they do in their real circumstances.
5. Quota leaders planted sugarcane to fulfill their quota and earned more from the purchase of "green" sugarcane from other growers since they could supply the mill with an amount of cane exceeding their given quota.

These observations confirmed the farmers' strong preference for seeking maximum cash income from sugarcane production while preserving the glutinous rice production for family needs. When the sugarcane price dropped, farmers turned

to other annual cash crops rather than switching back to rice because rice was less productive in the transition zone or because it was already sufficient to meet family needs. In addition, players without quotas who planted sugarcane could earn a substantial income because of the high demand for sugarcane. A price competition for "green" sugarcane fields occurs since quota leaders could supply sugarcane to the mills in excess of their predefined quota.

The farmer-controlled game

In this game, players were allowed to choose the location of their fields on the 3-D block model. They allocated their given amount of land and number of plots to capture different topographical positions on the board. Players were also given a wider choice of crops and the possibility to establish farm ponds. Players could also request new sugarcane production quotas. The sequence of successive steps in the game was the same as in the previous one.

We found that players located a smaller proportion of their farmland in the lowlands compared with that provided by the research team in the first game. This is because they wanted to earn a higher income from sugarcane. They also tried to experiment with new activities on their land, such as initiating beef-cattle rearing on pastures or intensive fish production. Except for small landholders having only 1.6 ha, most players selected farm ponds on their plots. In each time-step, all players retained sugarcane in their crop combinations. Three more players registered as new quota leaders in addition to the predefined ones. Interestingly, they requested the lowest possible quota of 100 t since they had no problem supplying more than this amount, but would have to pay a penalty if they could not meet their quota.

As the price of sugarcane dropped, the land-use pattern became more diverse than in the previous game. Players inserted "integrated farming" activities around small farm ponds, livestock grazing fields, orchards, and cassava plots. In this gaming session, sugarcane planting was not as extensive as in the previous one. Selling sugarcane as a "green" crop was less frequent than in the researcher-controlled game since most players looked after and harvested their own crops to meet their own quotas. As suggested by the players, quota leaders could reduce the size of their registered quota before the harvesting season. Most of them did this as they proceeded to the following round of play because they anticipated a fall in the price of sugarcane. In the final time-step, the sugarcane price dropped to $10 per ton. Sugarcane growers obtained less cash and quota leaders lost money since some of them purchased part of their amounts as "green" crops at a higher price. The interactions among the players were less frequent in this game because of the increased number of quota leaders.

The multistakeholder game

Thanks to the previous games, we had gained a good understanding of farmers' decision-making regarding crop choice and of the nature of their interactions with local quota leaders. In this third gaming session played in September 2002, the presence of other stakeholders, such as a large quota leader who is not a villager, was introduced. A large quota leader is an investor who can obtain much more production quota than he/she can plant on his/her own land. These leaders usually reside in town and invest their money in buying "green" sugarcane fields to complement their own production.

The large quota leader from outside the village who played in this game obtained a 10,000-t production quota and is producing only 10% of that amount on her own land. She came with her son, who is a member of the sugarcane growers association. We also invited an extension worker from the sugar mill, and a member of the Bangkok-based Cane and Sugar Fund, an organization that is instrumental in determining the official price of sugarcane. While the large quota leader played the game, these last two new stakeholders were observers.

The farmers who already played in May 2002 were visited to learn whether they were interested in playing again or not, and whether they thought that modifications to the game were necessary. Four players decided to join in this new RPG session. Those who did not come back said they were not available at that time. One said that it was better to allow new people to come and to learn how we use this RPG in the study.

The game procedures were similar to the farmer-controlled game except for land location, which was predefined. Among the 12 players, the large quota leader did not hold any land in the game. The results of this multistakeholder gaming session can be summarized as follows.

Regarding cropping decisions, we found that the farmer-players planted 45% more sugarcane than in the previous games possibly for the following two reasons. First, they could have been influenced by the presence of observers linked to the promotion of sugarcane production. The second reason was that, with a large-scale external quota leader taking part in the game, all the players knew that she would look for sugarcane to purchase. But the cropping decisions were also as flexible as in the second game. Glutinous rice and a small proportion of nonglutinous rice were planted, mostly for family consumption and in the lower paddies, while cash income was sought through sugarcane plantations in the uplands and upper paddies. When the price of sugarcane fell, most of the players switched to cassava, livestock and pastures, or integrated farming around an on-farm reservoir, but not to an increase in rice production.

For the exchange of sugarcane, we observed that one of the players who helped invite farmers to participate in this game was an influential person at the village level. He also acted as the first-level collector of sugarcane for the large-scale external quota leader. As a consequence, the players were already familiar with the network of this invited large quota leader. She also purchased "green" sugarcane from her agent in the game. The external quota leader did not try to compete with the price offered by the local quota leaders. She let the local network of quota leaders function, and bought sugarcane when she was interested or when people came to her offering a good price. She also did not want to buy ratoon crops because of their lower yields. By using the same strategy as in reality, she ended up buying less in the game than local quota leaders. She had to pay for "green" sugarcane in cash, whereas a local quota leader could pay only half of the cost during the crop cycle and settled the remaining part of the payment after selling the crop to the sugar mill.

Aggregated results

To analyze the results of land use, areas planted to different crops and for each land unit in each game were entered on a spreadsheet. The proportion of each crop grown

in each land unit was compared from one time-step to another. The results from the three games displayed a similar land-use pattern, with rice in the lowlands and field crops prevailing in the uplands. More land-use dynamics were found in the upper paddy area corresponding to the transition zone. Based on the results of the multi-stakeholder game, we found that, at the beginning of the game, sugarcane was planted in all landscape units and in particular in the higher ones. Figure 5 shows that, as the game proceeded and the sugarcane price dropped, the land-use pattern became more diverse, with more orchards, livestock and grazing land, and integrated farming systems, but not more rice. In general, the decision to convert a sugarcane field into another type of crop was delayed by one year because farmers waited after the harvest of the ratoon fields in the second year.

The pooled data of all crops regardless of location differences indicate that the land-use pattern based on the farmers' point of view was more diversified than the aggregated data on land use provided by the District Agricultural Office (Fig. 6). The average planted area of glutinous rice during 1998-2002 in Nam Phong District covered about 30% of the farmland and smaller shares were found for sugarcane and cassava. In spite of the main scenario simulating a drop in the price of sugarcane, the aggregated data from the three games showed a larger proportion of sugarcane than the district statistics. However, the proportions of the total farmland under rice were found to be similar in the games and according to these statistics. This may be because the current rice areas in this district have already dropped to subsistence levels as shown in the game when most players planted rice mostly for home consumption as soon as the sessions began.

Discussion of the game results

All players expressed positive opinions on the 3-D board, the game accessories, and the rules of this RPG. They said that the gaming conditions were close to reality. For example, the heterogeneity of the gaming landscape was similar to that of their village territory. They also had to make crop choices before knowing the rainfall conditions during the cropping season, and could sell sugarcane as a "green" crop before the announcement of the official price of sugarcane for a given year. As in reality, sugarcane quota leaders were important actors in the exchange system that was used during the gaming sessions.

Most of the players acted individually when choosing crops to be allocated to their fields without any prior collective discussion. As in reality, the players considered all the different factors (physical, biological, household needs, and crop prices) related to such a choice, and decided by themselves so that in the game they did not need to request detailed information and could make their crop choices without hesitation and based on their actual circumstances and way to do things without being forced or influenced to do so. For example, at the beginning of the second session, they selected the location of their plots on the 3-D board similar to their actual locations in the village territory and so that they could gain access to at least two different landscape units. But some players used the RPG to test their personal projects, such as the creation of a fish-raising option that was not originally specified at the start of the game.

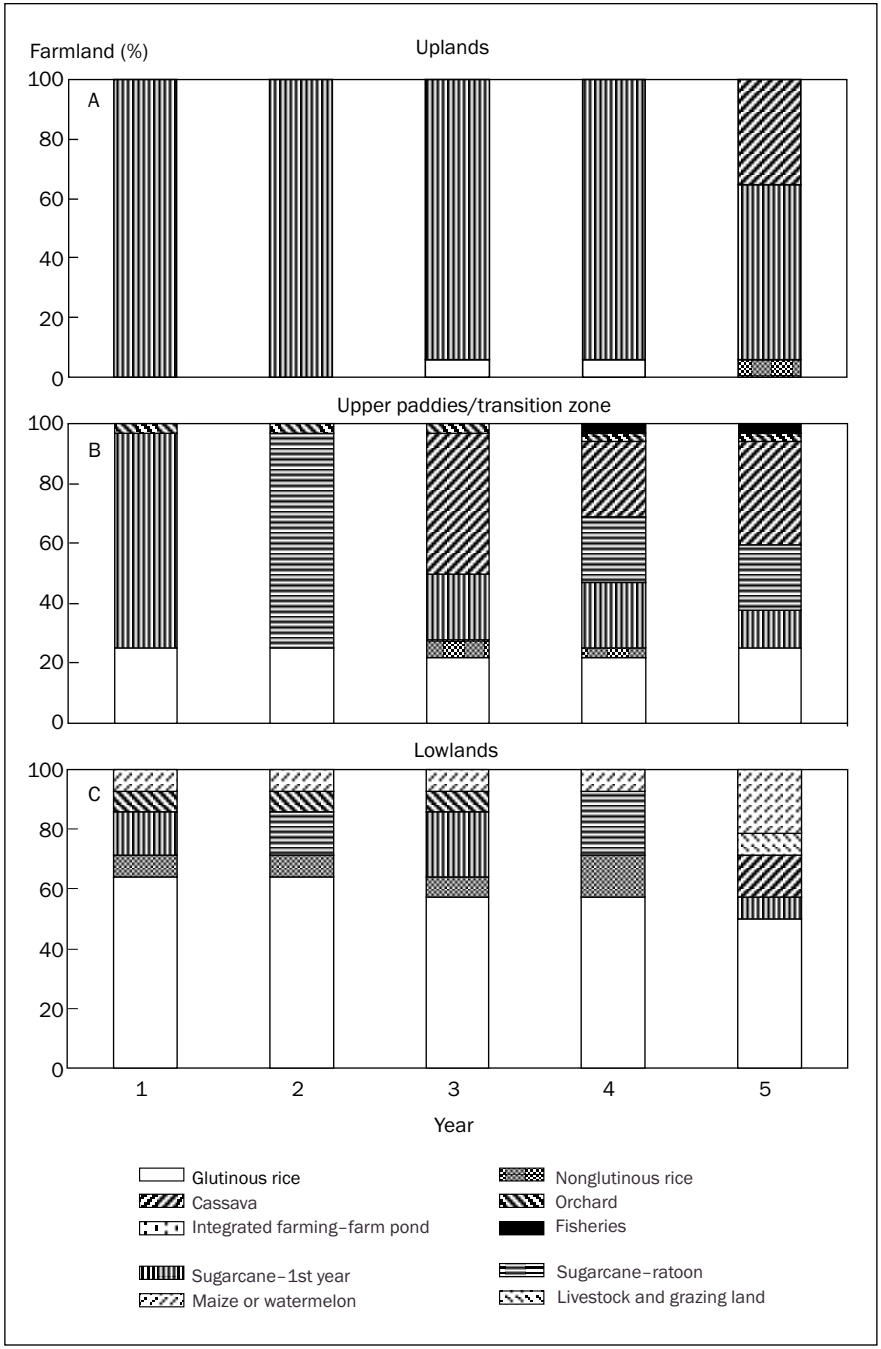

Fig. 5. Dynamics of land-use patterns for each landscape unit during the multistakeholder game.

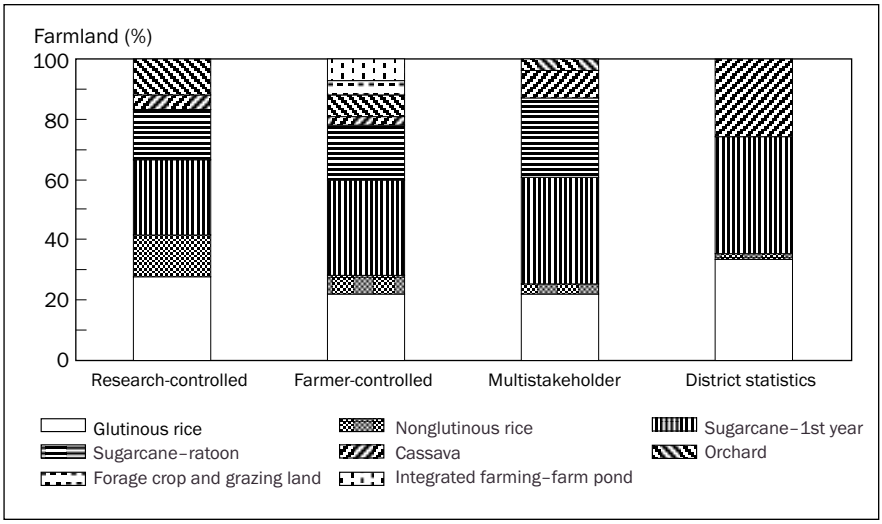

Fig. 6. Respective shares of the total farmland occupied by each main crop in the three games (pooled data) and according to the statistics of the District Agricultural Office.

At the beginning of each game, the land-use pattern was very much dominated by sugarcane plantations (Fig. 5). It was quite obvious that assured yields and expected returns from sugarcane were the main incentives. One farmer said, "I could plant 1 rai (equivalent to 0.16 ha) of sugarcane and earn enough to buy enough rice for one year, an amount of paddy that is equivalent to the production of about 4 rai of rice." Another farmer stated that "planting rice in the upper paddies is risky. If there is a dry spell, I may not get any yield, but by growing sugarcane at least I see the plants." Prior to the game, we got the impression that rice could be abandoned for more profitable cash crops such as sugarcane, but the results of the different gaming sessions showed that the extent of the paddy area could be reduced, but not beyond the level guaranteeing enough rice production to satisfy local needs for the staple crop. At the start of the games, players could be seen "planting" enough rice to be sure to meet their household needs. Thus, the proportion of rice land in the whole catchment did not change much as the game proceeded. This finding is also supported by the experimental observation indicating an increase in lowland rice yields in fields located below sugarcane fields receiving significant amounts of chemical fertilizers, part of them being carried by runoff from uplands fields to lowland paddies (Vityakorn et al 2004).

During the plenary discussion that followed the gaming sessions carried out in May 2002, we realized that it was difficult for farmers to envision a drop in the government-supported price of sugarcane. Farmers believed that large quota leaders would not let the cane price drop thanks to their strong bargaining power. As one farmer put it, "If the quota leader gets a good price, we will also get a good price for our 'green' cane." But, in September 2002, when our team came back to implement the third gaming session, the farmers said that, after learning about the ongoing nego-

tiations on international trade, now they were aware of a possible drop in cane price. They reacted to such a scenario by producing a more dynamic and diverse pattern of land use over that third game showing that a drop in the price of sugarcane could lead to diversification, especially in the transition zone.

Although the marketing risk for sugarcane growers was limited by the existing quota and benefit-sharing system, a wider exchange system was brought about when the sugar mill allowed the participation of small-scale quota leaders, which seemed to benefit small-scale growers. This can be seen from the multistakeholder game in which the large external quota leader, using the old marketing network and strategy, earned less because more small-scale quota leaders were competing for the purchase of "green" sugarcane and bought the ratoon crop. This is possible because, at present, sugar mills allow quota leaders to supply more than their registered amounts. In real circumstances, the large quota leader gets many more sellers from other villages since she is well equipped with capital and transportation equipment to buy from her network or from walk-in sellers. The follow-up interview found that she was also well aware of the likely future price fluctuation for sugarcane and was also considering the planting of alternative crops on her own land.

In the RPG, farmers were able to try out their own projects without consultation with others. This is because they are knowledgeable about physical conditions and crop choice is individual. The UML diagrams prepared before the game were also validated during these gaming sessions, while decision-making processes regarding land use were confirmed by the game results: the price negotiation process for "green" fields of cane was verified and the RPG showed clearly that rice subsistence is still a small farmer's top priority despite higher returns from sugarcane. Regarding the sugarcane exchange system, the characteristics of the marketing network could be observed thanks to the interactions among actors in the last multistakeholder gaming session. When some rules were changed during the game, such as allowing players to register as small quota leaders, at least half of the players did not request a quota from the factory even though they did not have to invest any money or change their crop choices in the game. From the follow-up interview, those who did not become quota growers in the game said they had never done that in reality and expressed their concerns about labor management difficulties at harvest and transportation costs. Players were afraid to assume roles in the RPG that they thought they could not have access to in reality. This is a further indication of the very strong linkages established by the players between their behavior in the game and their actual circumstances and way to manage their productive resources. This observation could lead to useful information for future sugarcane quota policies at the mills willing to limit the number of growers to those who can register a production quota. However, modification of this game is needed if we want to involve new stakeholders such as sugar mill managers for the purpose of sharing knowledge and learning about the sugarcane supply chain.

The role games were found to be effective for stimulating discussion and exchange of views as they allow multistakeholders to interact in the study process at the same time. Besides being entertaining, the games helped farmers to reflect on their (and their neighbors') decision-making on land use in a timely manner. After realizing that the price of sugarcane could drop someday, farmers said that this made them think and heightened awareness of that possibility. Players also said that in the

RPG they learned about what others were thinking and planning to do. However, collective discussion about land-use pattern did not occur. One reason is that the game is based on real situations and focused on individual players' choices so players could apply their actual way of doing things in their own situation. This also indicates that in northeast Thailand farmers have been producing their crops individually and they are price takers. The latter point is based on the observation that players did not argue about the determination of crop prices made by the sugar mill or the market.

Conclusions

This RPG experiment was a preliminary step toward the development of a related MAS model. Beyond the confirmation that rice remains a key subsistence crop in this region despite high economic incentives to expand area under industrial crops such as sugarcane, the gaming sessions showed that a reduction in the price of sugarcane could lead to diversification in upper paddy area.

By using the RPG tool, particularly in the multistakeholder game, researchers were able to observe the pattern of coordination among actors of the sugarcane supply chain and this knowledge could be used in the subsequent phase of MAS modeling. A key observation from the game is that small quotas of sugarcane benefit small-scale growers and make the local market more competitive.

The farmer-players validated the features and rules of this RPG and imported their reality into the game. However, this RPG is too focused on individual crop selection and did not enhance collective discussions on land-use issues at the community level. Nevertheless, the RPG was flexible enough to allow several players to experiment with their different projects, especially during the second more open session. These gaming sessions were not designed to promote the active participation of higher-level stakeholders such as sugar mill or government officers; their presence in the third game was influential but not participatory. Beyond this first experiment, it would be interesting to explore how the game could be adjusted to focus on the sugarcane exchange system with a more active involvement of key stakeholders, particularly sugar mill managers.

Although role-playing games are useful for observing interactions, representing reality, gathering data, and sharing knowledge, this tool requires ample preparation, the availability of an interdisciplinary team and assistants made up of some half a dozen people, and careful management of this tool in the field to be able to record what happens and, later on, be able to carry out a detailed analysis of each gaming session. Follow-up interviews were found to be essential to confirm players' strategies, to obtain more explanations of the game results, and for researchers to improve their understanding of the system under study. Ultimately, knowledge and rules gained from the RPG should be built into associated computational modeling in order to allow more time-efficient simulations of possible land-use scenarios. Such a model could also be applicable to multiple locations across this subregion. For this, the reinforcement of the interdisciplinary team with a computer scientist will be required.

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Notes

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