COMPARISON OF LOWLAND RICE IRRIGATION SYSTEMS IN THE RED RIVER BASIN (VIETNAM)

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Abstract

This paper describes rice irrigation system around the Red River in Vietnam from the farmers' point of view. The farmers are the principle element for water management in this area, with a strong influence on water consumption as well as water quality. In a survey of hundreds of irrigation farmers in the Red River basin, two hundred farmers answered questions about their rice paddy areas, the character and quality of irrigation canals, their scheduling of irrigation and other characteristics. Ten survey points were used to describe irrigation practices. The average distance between each of these points was 40 km; all of them being situated a maximum of 1.1 km from the river. Some data obtained depends on the position of the research point in relation to the river (water flow), some other values are influenced by survey point specificities. In areas with a deficit of water it is recommended to increase the regulation of paddy inflow by all farmers, or to find new water source if necessary. The survey has mainly shown problems of irrigation water quality.

Key words: rice irrigation, water management, rice, Red River, rice farmer

INTRODUCTION

Rice is one of the most important and most planted crop-plants of the world. For a half of the world population rice makes up about 80% of their dietary intake. Thanks to its flexibility and adaptation to natural conditions, rice is planted in about 113 countries of the world (Rice is life, 2005). The most important limiting factor of rice growing is a lack of water, though a surplus of water has no negative influence on rice yields, and this is often a cause of the uneconomic use of water. On experimental plots it takes between 1 100 and 1 200 litres of water to produce 1 kg of rough rice (Rice is life, 2005), but in many cases water consumption is several times greater. In many water-rich places this is not a significant problem, however in places where water must be pumped, it increases electricity costs; in places with limited water supply it can define territorial development limits.

Hand-tool technology is still the most widely-used method for rice cultivation, and also irrigation regulation. The technology is usually "inherited" and can be sometimes considered as being rather obsolete. To calculate the large area water balance it is firstly necessary to recognise the practices at the small units (paddy fields). This must be thoroughly researched to find the proper solution. This is the reason why some aspects of irrigation practices implemented by farmers around the Red River were subject to the survey and are described in this article.

Reference review

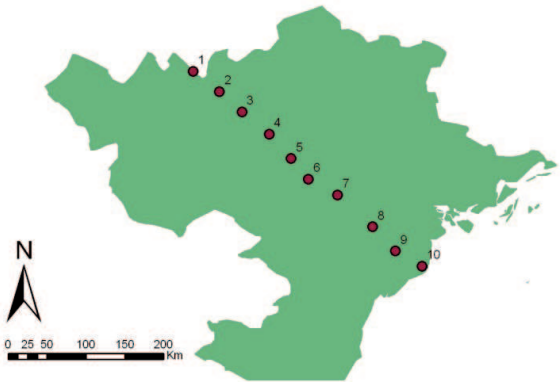
Vietnam has 7 201 thousand ha of irrigated rice paddy (Results of the 2006 rural, agricultural and fishery census, 2007), mostly situated around two rivers: the *Red River* and the *Mekong River*. The average annual precipitation in this area is about 1 800 mm, however with uneven distribution – about 80% of rain falls during the wet season (Harris, 2006). At this time the rainfall is the most important water source for summer-rice. During this period, especially in the deltas, irrigation canals often have an opposite function and are used for water drainage. Spring rice is usually planted in the February–June period. The average precipitation in the Red River delta, and minimum rice crop water requirements are 582 mm (Dong, 2000) and 1 300 mm (Bouman, 2007) respectively. The probability of conflicts due to the water supply (conflicts among farmers) occurring in this season is therefore much higher. From the water source management point of view, monitoring farmers' customs through the spring rice period is more important than during the summer period. A new technology of rice water management (Wu, 1998), to decrease water demand and increase of yield at the same time, can reduce problems with a lack of irrigation water and positively influence the farmer's level of living. The distribution of water in the main irrigation canal – especially in the Red River delta – is ensured by irrigation companies (Harris, 2006). The regime and

scheduling according to water distribution in this system has an extreme influence on water consumption. It is necessary to know the actual water need for the correct distribution of water among the main canals and field systems. The water regime of rice paddies is closely related to the emissions of greenhouse gases (Bouman, 2007), so the behaviour of farmers in the climate change debate can play an important role.

MATERIALS AND METHODS

The area of the survey is located around the Vietnamese part of the Red river. This river originates in China; its total length is about 1 175 km, and its average flow 577 m^3/s in the Red river delta (Rusínová, 2000). The research activities have been done on paddy fields situated around 360 km along the Vietnamese portion of river, but their highest concentration is in the Red river delta.

Figure 1: Location of research points



Ten research points were used to describe the farmers practice. Figure 1 shows their location. The distance between each of these points is around 40 km and all of them are situated at a maximum distance 1.1 km from the river flow (see Figure 1). Twenty questionnaires with 14 questions were used to communicate with farmers in each research point. All questionnaires were completed by real farmers with the assistance of the first author of this paper.

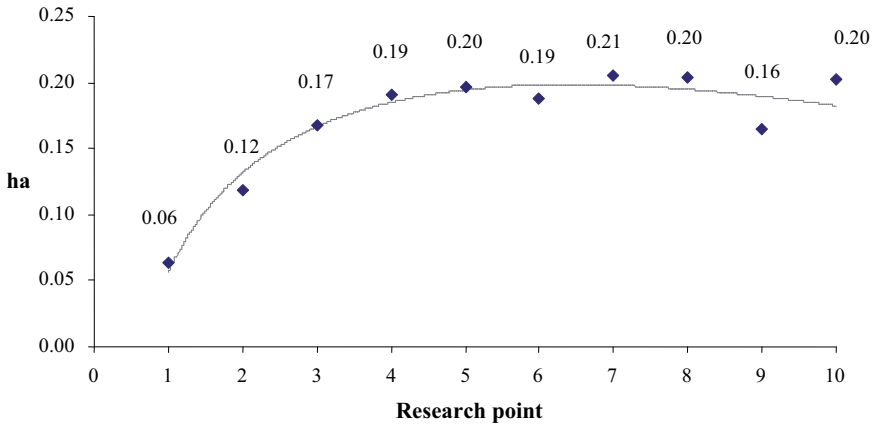
The information gained through the questionnaires was than quantified and processed statistically. The methods used for statistical data processing are: arithmetic mean, nonlinear regression analysis and correlation coefficient. The results were formulated and discussed on the basis of the data gained and processed (see next chapter).

RESULTS AND DISCUSSION

Paddy area managed by one farmer

The average area of a paddy in each research point is 0.17 ha. Figure 2 shows the growth of area under paddy in the first half of the graph. This regional topography is relatively hilly and therefore the wetland areas around the river are absent. The greater maintenance requirement, due to planting rice on a higher slope is probably the second reason for the decreasing paddy area. For the trend description the nonlinear regression analysis was used where the average paddy area represents dependant variables and research point position represents independent variables. The parameters of the curve equation (*area = a*point**b + c*point + d*) was Estalished as a = –78.736, b = –0.00178, c = –0.021 and d = 8.81 (correlation coefficient 0.95). This equation can be used for all paddy area where estimating around the Red River flow.

Figure 2: Average paddy area managed by one farmer (ha)



Irrigation water

The maximum distance from the Red River flow of each research point is 1.1 km, but Figure 3 shows the Red River as a source of irrigation water for only the sixth and further research points. In the first five research points, the main water sources are the other rivers or streams, the Red River and wells are only used by ten farmers at these points. The unique water source for the second five research points is the Red River. Some farmers used to have more sources of water, therefore the sum (water source coverage) in each research point does not reach 100%.

Problems with irrigation water deficiency at spring rice planting are shown in Figure 4. In the hilly areas the gravity water of streams is the only source of irrigation water (Figure 6). Especially during the long lasting rainless periods, the decreasing stream flow creates an irrigation water deficit. This problem is real for about 30% of the farmers in those parts of the research area. In lowland areas the water deficit can be caused by poorly sloping irrigation canals or inadequate water management. This problem is real for about 8% of the farmers in this area.

Many references describe the problems of irrigation and drinking water quality especially in the Red River delta. The pollution is mainly caused by people, animals, industrial and pesticide wastes and residues (Red River delta, 2003). No literature describing the problems with irrigation water quality in this particular area was found, and this issue deserves to be researched because it represents a serious problem. The farmers´ answers regarding this issue are shown in Figure 5. On average 52% of

Figure 3: Irrigation water sources at research points

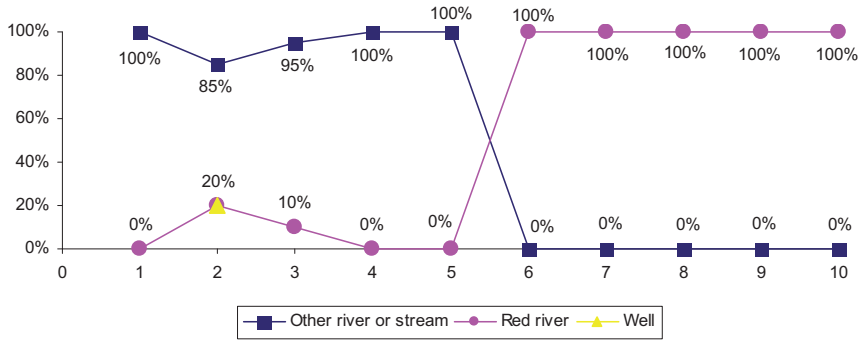


Figure 4: Problems with irrigation water deficit at spring rice

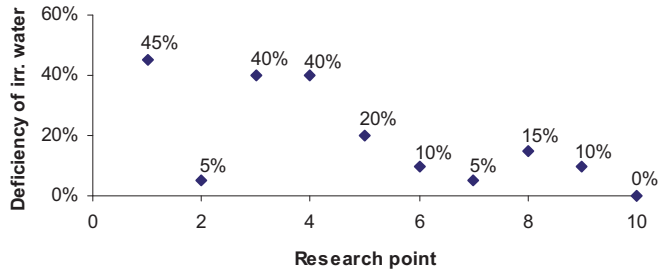
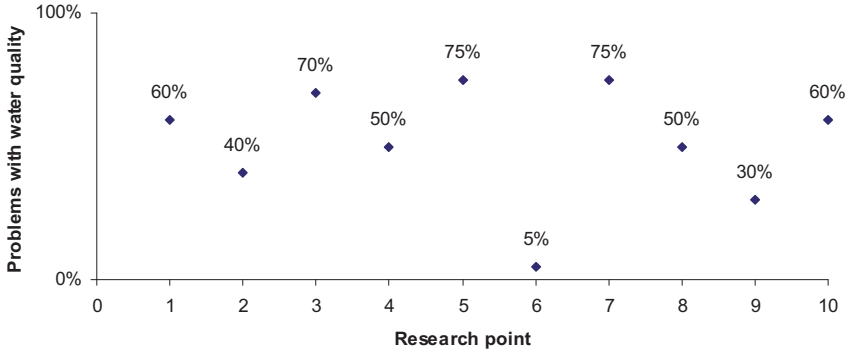


Figure 5: Problems with water quality



them have problems with water quality whereby there are no essential differences between the research points.

Irrigation scheme

The irrigation water is applied to the paddy fields through canals (gravity water), through electric or petrol pumps, or by means of watering bags transported by men. Figure 6 shows the use of gravity, pump and hand transported water (the columns show the participation of hand transport to the full line). Research points 6–10 are in the plain known as the "Red River delta". This area produces 18% of Vietnamese rice and therefore the rice water requirements can be achieved only by a strong water source – by the Red River, with requirements for water elevating or damming.

The total length of irrigation canals in the Red river delta is 97 510 km (Result of the 2006 rural, agricultural and fishery census, 2007) and most of them are small canals. From the point of view of water management, it is important how the water is delivered to the fields. The irrigation channel commonly used is constructed above the groundwater level. In the case of periodic-irrigation, the loam channel body is not continuously saturated with water, which can cause increased water loss, and thus, water consumption. The maintenance requirements are lower with channels made of concrete, and their banks are very often used as a pathway; but they also have negative effects. For example by using non-natural material, depressing land permeability for patty animals, remaining in place after their useful life time, and their aesthetic value, is normally less, compared to loam canals. The third possibility is that of providing the irrigation water by pipelines. Use of these three supply facilities by farmers is shown in Figure **7**. On average, the most used facility in the mountainous areas is the concrete channel (72%). The reason for this is that probably they are more stable on steeper slopes. The loam channel is the second in rank and it is especially used in flatlands – probably because it is easy to build and requires low capital investments (78% of cases). Water pumps are used only for water transport between two canals of different elevation. Therefore water delivered by pipelines (under pressure) is only noted in 2% of the cases. No uniform trend to use different channel types was observed.

Figure 8 shows an evaluation of irrigation channels quality by farmers. It is not objective, but it provides rather good information for a certain (fast) conclusion. Farmers choose their answers from four quality categories: good (4 points), some problems (3 points), bad (2 points) and

Figure 6: Using of pumping, hand transport or gravity water

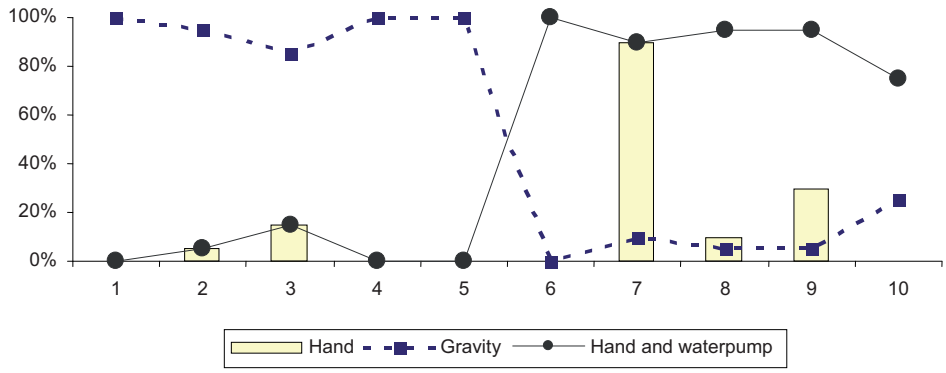
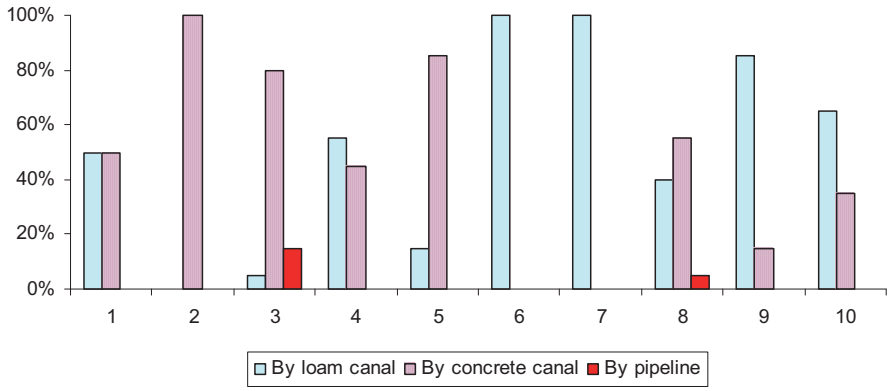


Figure 7: Water is delivered to paddy fields by loam or concrete channels, or pipeline



very bad (1 point). The average point value was 3.24. It indicates quite good channel quality and functionality of maintenance in the whole Red River area. There is almost no relationship between the quality value and the research point position.

The service and repair of irrigation schemes in the proximity of paddy fields is performed by the rice farmers (22% of cases), together with other farmers (29% of cases) and by an irrigation system provider (49% of cases). Figure 9 shows the time the farmers or community of farmers spend on irrigation system maintenance per week. On average, the involved entities spend 4.06 hours per week repairing or servicing their irrigation facilities. This value is higher in hilly areas – probably due to higher kinetic energy of flowing water and building difficulties on sloping terrains. There are no data available from the research point 1 (misunderstanding of this question by farmers). Maintenance on research point number 5 is only performed by the provider.

The daily frequency of water regulation (water volume inflow on the field) by farmers is another important indicator. Farmers choose one of the following possibilities: regulation many times per day (value 2), one regulation per day (value 1), weekly regulation (value 1/7), monthly regulation (value 1/30) and regulation once per growing period (value 1/90). A summary of this data is shown in Figure 10. The average value of frequency of regulation for all observed fields is 0.59 per day. The dependency on water deficit (Figure 10), or use water pumps has not been proved (correlation coefficient 0.55 and –0.6 respectively).

Figure 8: Evaluation of irrigation channel quality by farmers

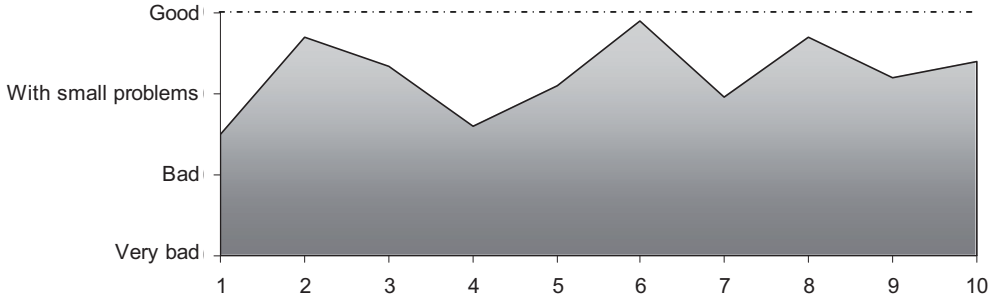


Figure 9: Weekly duration of irrigation system maintenance by farmers

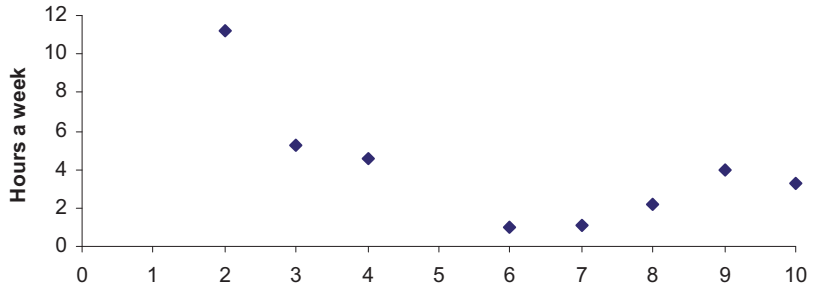
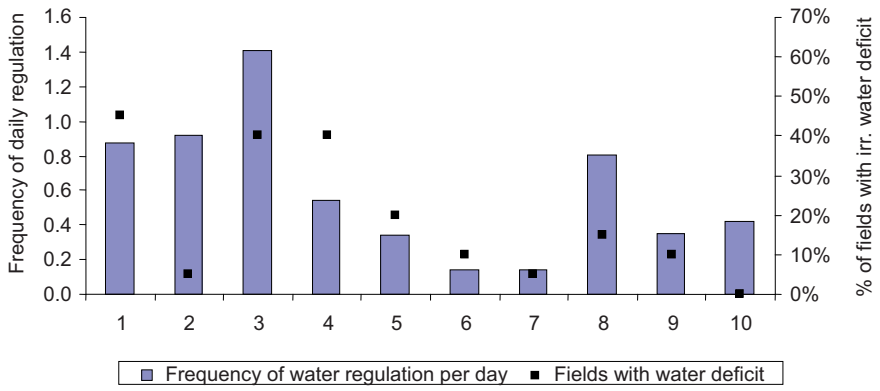


Figure 10: Frequency of water regulation per day



Primary irrigation water is also used by many farmers for other purposes. On average, 6% of farmers use irrigation water in the kitchen, 22% for washing and 36% as water for livestock, but this data has a strong relationship between households and the irrigation channel position. Usually the water fees value is fixed to the irrigation water use. Farmers pay a fixed seasonal fee which is based on a five-year sliding average of the seasonal rice yields in the province. The fee has been fixed at approximately 8% of average rice yields (Harris, 2006). In reality no relationship was found between paddy area and irrigation fee. The average annual fee for irrigation water is 58 000 VND (about 2.30 € per year). At research point number 4, no fee requirements have been fixed. At research point number 7, the farmers uniformly pay 30 000 VND (about 1.20 € per year).

CONCLUSION AND RECOMMENDATIONS

The minimum and maximum rice paddy area is 0.06 and 0.21 ha, the arithmetic mean of all values is 0.17 ha. The main water sources in the first five research points are small rivers or streams; the Red River is used in the sixth and further research points. In areas with a water deficit (research points 1, 3, 4, 5) it would be possible to reduce water waste by use of impermeable canals, and to decrease water demand with water safety cultivation methods or with the addition of another water source. More than 50% of farmers have problems with water quality, but it is not clear to what measure this problem is significant for rice growing. Another research proposal to study pollution of irrigation water is recommended. Water comes in a gravitational way to rice paddies in the first five research point areas. In the Red River delta, elevating or damming of the water is necessary. The character of the canal material has no connection to the location of the research point. In areas without irrigation water deficit, it is recommended to use loam canals. This research proved a very good state of irrigation canals. The maintenance of canals is carried out by irrigation system providers in about a half of the cases, by farmers themselves in about a quarter of the cases, as well as by farmer groups. Improving communication between water providers and consumers (especially on the main canal) is recommended for water waste reduction. In means every second day farmers regulate the paddy water inflow. In areas with water deficit, it is recommended to decrease this water regulation interval by all farmers. The usage of water from irrigation canals for other purposes shows a strong relationship between the location of the households and the irrigation canal. One in three farmers used this water for livestock, one in five for washing, and only one in twenty for cooking and drinking. The fee for irrigation water is not dependant on its volume. This was usually the reason of more water consumption, but all research points are located around the water flow, and therefore the increased water consumption, especially by gravity water, is not so bad.

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Received for publication on December 21, 2009
Accepted for publication on February 3, 2010

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