

Field layout for large rice field construction in the red river and Mekong river deltas, Vietnam

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• **Abstract:** Rice production plays an irreplaceable role in Vietnam's agriculture - the backbone of the economy where 70% of the population live in the countryside and nearly 50% of the national labor force working in the agricultural economy. However, at present, Vietnam's rice sector is facing many difficulties and challenges, especially low productivity and high production cost due to land fragmentation.

This report analyzes the layout of farm road, irrigation canal, field size and agricultural machinery workability in the Red River Delta and the Mekong Delta, recommending the scheme for farm land consolidation that is suitable to present condition of farm land ownership, agricultural mechanization, irrigation canal and farm road arrangement as well to the future condition of land accumulation, rural labor shortage and higher power agricultural machinery.

Result of field survey on the size of 700 field plots, currently underwent land grouping, in the Red river delta reveals that, because of small farm size, more than 80% of the plots having width of 20-40 m and more than 90% of the plots having length of 50-100 m. Meanwhile, survey on 800 field plots in the Mekong river delta shows that more than 70% of the field having width of 20-50m and 65% of the field having length of 150-300 m. An economic analysis of efficiency of land preparation and harvesting machines, popularly used in the two deltas, shows that the machine effective working range is larger than 50 m.

To improve land and labor productivity, field plots are recommended to be large enough to meet machine effective working range as well as having direct access to irrigation and farm road. At present, the sizes of paddy field should be 20-40 m by 50-100 m and 20-50 m by 150-300 m, respectively, for the Red River Delta and Mekong River Delta. In the future of land accumulation, the field can be enlarged, by simply removing short size bank of the present field, to become Nx(20-40) mx100 m for the Red River Delta and Nx(20-50)mx(150-300) m for Mekong River Delta

• **Key words:** Farm land consolidation, irrigation and farm road arrangement, farm size, land ownership, agricultural mechanization

1. Introduction

Rice production plays an irreplaceable role in Vietnam's agriculture - the backbone of the economy where 70% of the population live in the countryside and nearly 50% of the national labor force working in the agricultural economy. However, at present, Vietnam's rice sector is facing many difficulties and challenges, especially low productivity and high production cost due to small farm size and land fragmentation.

Since 2011, the Ministry of Agriculture and Rural Development has launched a movement to build large-scale rice fields and agricultural production linkage, toward large-scale commodity production closely linked with processing industry and market. Following the government's policies, provinces have actively promulgated and implemented resolutions, decisions, plans and schemes on agricultural production planning, exchange of agricultural land plots and farm land consolidation and construction of large rice fields. Although the effectiveness of the large rice field model is clear, the upscaling of the model is modest due to many obstacles, such as fragmented land, unable to form large-scale commodity production areas, poor on-farm irrigation systems, failing to meet the requirements of intensive farming and crop diversification and narrow on-farm roads not suitable for mechanized farming.

This report, based on the survey on large rice fields covering over 1500 field plots, in 2015-2016, on the construction of large rice fields in Thai Binh, Nam Dinh, Hung Yen, Vinh Phuc provinces of the RRD, and Dong Thap, An Giang, Hau Giang, Soc Trang provinces of the Mekong Delta, analyzing the actual situation of land consolidation and construction of large rice fields in the Red River Delta and the Mekong Delta, thereby proposing a technical field layout for efficient construction of large rice fields in these two plains.



Figure. 1.1 Location map of survey provinces province

2. Current Status of large rice fields construction in the Red River and Mekong River deltas

2.1. Farm land consolidation and construction of large scale rice fields in the Red River Delta

According to the year of 2013 statistics of the Ministry of Natural Resources and Environment, the total natural area of the RRD is 1,495,773 ha (accounting for 4.5% of the country's natural

area), the rice area of the region is 580,195 ha (accounting for 14.2% of the country's rice land area). The Red River Delta is a small farm size and fragmented field plot area, where 98% of households having a farm size less than 0.5 ha, about 65% of households having a farm size less than 0.2 ha, yet divided into many plots. The area of each plot varies widely from 100-6000m².

i) Arrangement of on-farm canals and roads in farm land consolidation and construction of large scale rice fields

In the Red river Delta, the land collectivized for

centralized management, from 1959-1981, was equipped with well-designed irrigation system. The on-farm tertiary canals were laid regularly by a space of 100 m. This on-farm system is remaining, even after land privatization and redistribution to farm household for long use (Doan et. all, 1996)

The result of survey show that on-farm irrigation network (tertiary and quarterly canals) in the surveyed provinces is mainly dual irrigation and drainage canals. The distance between tertiary canals is 100 m and between secondary canals, depending on topography, is 300-800 m (Table 2.1)

Table 2.1 Distance between on-farm channels

TT	Province	Distance between on-farm channels (m)	
		Secondary canal	Tertiary Canals (in-field canal)
1	Nam Dinh	450-800	100
2	Thai Binh	300-600	100
3	Hung Yen	250-350	100
4	Vinh Phuc	-	-

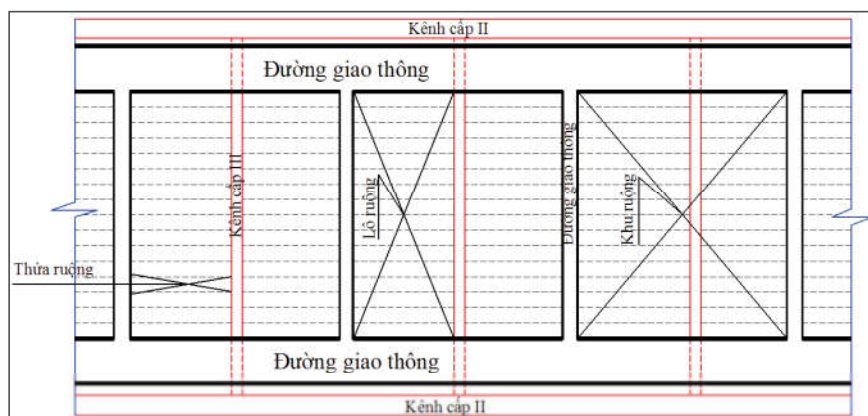


Figure 2.1. Field scheme with both sites irrigation and drainage supply in the Red River Delta

After 10 years of implementing the new-countryside program and farm land consolidation, many main on-farm roads, running along secondary canal, have been concreted or asphalted with surface widths ranging from 3.5 to 5 m. However, the on-farm side roads, located along tertiary canals, and in many cases, also between the two canals, are small, mainly made of soil, not solidified.

ii) Size of farm, plot, field and farm block

In the surveyed provinces, after many years of land consolidation, the average number of plots/household has decreased significantly, the field has become less fragmented, the area of the plot is more suitable for intensive farming

Table 2.2. Farm size and number of plots/household before and after farm land consolidation in Red River Delta provinces

TT	Province	Number of communes completed farm land consolidation	Farm size (ha/hh)	Number of plot/hh	
				before land consolidation	after land consolidation
1	Nam Định	200	0.13	6.96	2
2	Thái Bình	263	0.18	5.5	1.7
3	Hưng Yên	120	0.15	5.5	1.5
4	Vĩnh Phúc	0 /112	0.1- 0,15	7.8	

(Note: Vinh Phuc has not started farm land consolidation)

The evaluation results show that the farm size ranges from 0.1-0.2 ha / household. As some land is used for gardening, the rice land ranging from 700-1400 m²/hh (Fig. 2.2). Thank to farm land consolidation, the average number of plots/household decreased significantly, from 5.5-7.8 plots / household to 1-2 plots / household, brought high economic efficiency for land users (Table 2.2).

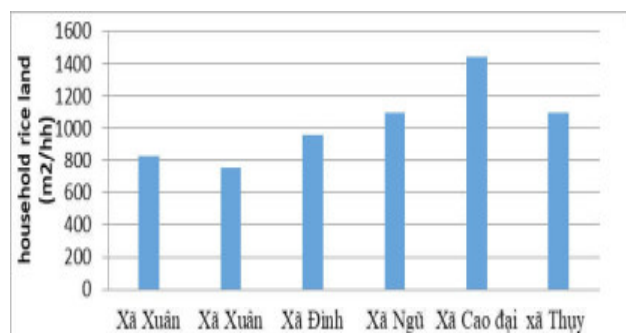


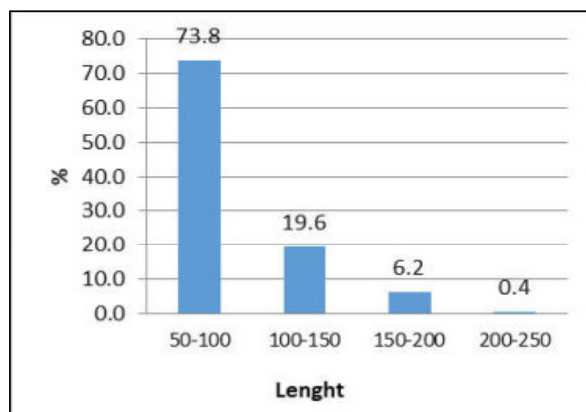
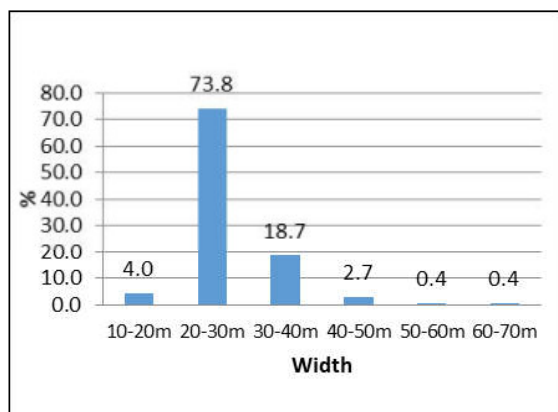
Fig 2.2. Rice land area of the households in some surveyed communes

During cooperative land management, a typical field plot had a rectangular shape with long side running from a tertiary canal to another, the distance of which is 100m (Doan et. all, 1996). In land consolidation process, at some area, a small path (on-farm side road) is added between the two canals (Fig. 2.1). As a result two common types of block width of 50 m and 100 m are formed. The block length depends on the distance between 2 secondary irrigation canals, which are 450-800 m, 300-600m and 250-350m in Nam Dinh, Thai Binh and Hung Yen respectively

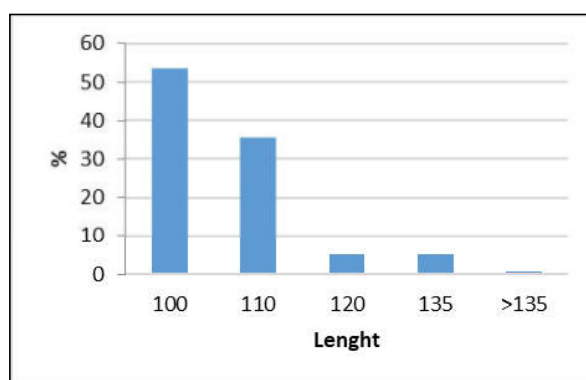
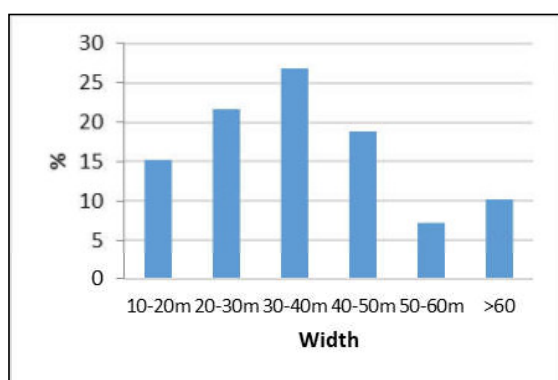
Fig. 2.3 shows the distribution of plot size in the surveyed provinces. More than 80% of the plots having width of 20-40 m and more than 90% of the plots having length of 50-100 m. As the farm land consolidation has been based on the layout of old canal system, the length of the field plot changes little. The width of the plot, depending on the size of the household's area, varies from 20-40 m

Table 2.3. Size of field block after farm land consolidation at surveyed sites

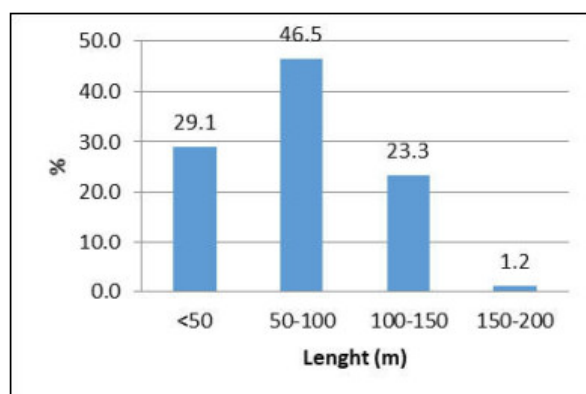
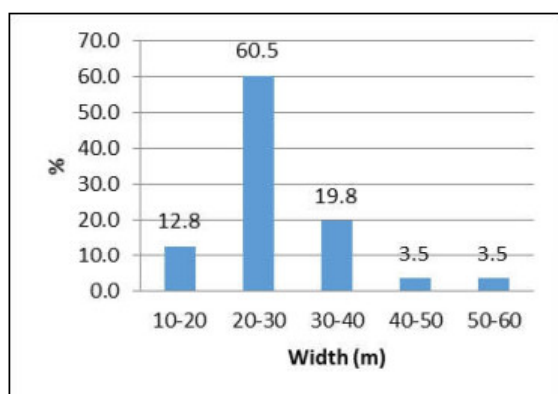
TT	Surveyed sites	Field block (m)	
		Length	Width
1	Xuan Kien commune, Xuan Truong district, Nam Dinh Province	450-820	50
2	Thuy Van commune, Thai Thuy district, Thai Binh Province	300-600	50-100
3	Dinh Du commune, Van Lam district, Hung Yen Province	250-350	100-130
4	Ngu Kien commune, Vinh Tuong district, Vinh Phuc Province	200	50-100



Xuan Tien, Nam Dinh



Lac Dao, Hung Yen



Thuy Van, Thai Binh

Fig. 2.3. Distribution of field plot length and width

To sum up, in the red river delta, the land consolidation and construction of a large rice field was based on the existing canal system, due to the small size of the household, most of the field plot has a length of 50-100 m and a width of 20-40 m. The field block has a width determined by the distance between the two tertiary canals (or between a tertiary canal and a plot site road) which is the length of the field plot (50-100 m). The block length is the distance between the two upper level canals, on average 300-600 m long. Thus, the field usually has a size of 3 - 6 ha

2.2. Construction of large fields in the Mekong Delta

The total natural area of the Mekong Delta is 4,057,658 ha (12.3% of the country's natural area),

the area of rice land of the region is 1,912,789 ha (accounting for 46.9% of the rice growing area. country). In the Mekong Delta, the number of households having a farm size less than 0.5 ha accounts for approximately 40% of the total households of the region. Although the number of households having a farm size larger than 0.5 ha accounts for approximately 60%, most of the land is also scattered into several plots.

i) *On-farm irrigation and road system in large fields.*

The primary, secondary and tertiary canals are basically adequate and meet the irrigation and drainage needs. The lack of on-farm quaternary canals lead to plot to plot irrigation, affecting the households' independent farming.

Table 2.4. Size of field block, plot and on-farm irrigation and drainage canals

TT	Province	Field block (m)		Field plot (m)		On-farm road width (m)	
		Length	Width	Length	Width	Main road	Side road
1	An Giang	1000-1500	50-300	50-300	30-100	10-May	3.5-5
2	Hau Giang	500	200	200	May-65	15-Jul	10-May
3	Soc Trang	800	50-300	50-300	35	n.a	4.5
4	Đông Thap	500-700	250-300	250-300	25	4-Mar	1-1.5

Note: n.a: Not available

Currently, the field block is constructed with the width based on the distance of two on-farm canals (tertiary canal) and the length is the distance between the two upper level canals.

Average distance between tertiary canals is about 150-300m. The length of the field block is the distance between secondary canals, which is 500 - 1500m (Table 2.4)

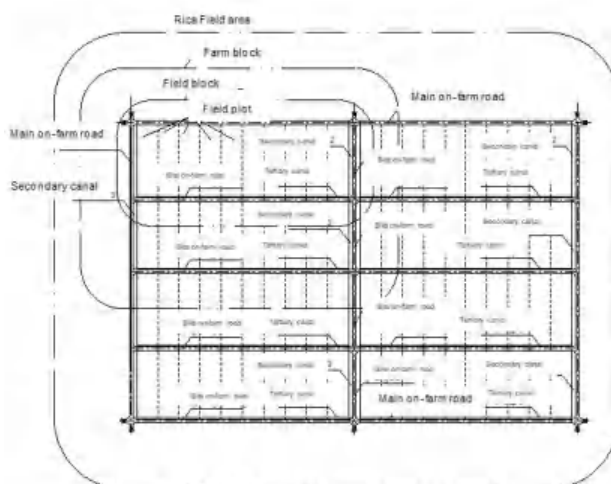


Fig 2.4. Arrangement of field area irrigated from one side of the Mekong Delta

Agricultural production is transported basically by water way. On-farm road network is rather poor, making of rough canal embankment, difficult for machines to move.

ii) Farm size, plot size

In the Mekong Delta, the land has been owned, traditionally, by farmers for a long time, so the land consolidation has hardly been implemented.

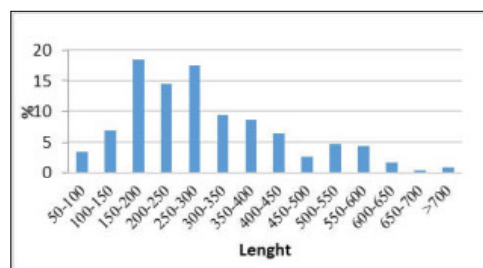
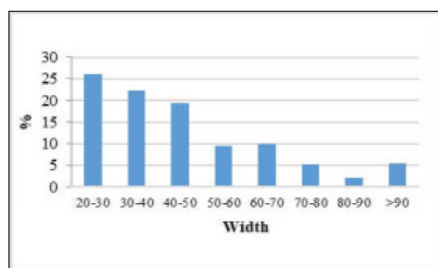
Table 2.5. Farm size, field plot size in the Mekong River Delta

TT	Provinces	Farm size (ha/hh)	Field plot size (ha)	Number of plot/hh
1	Dong Thap	4.1	1.1	3-Feb
2	An Giang	2.2	0.7	3-Feb
3	Hau Giang	1.2	0.7	2
4	Soc Trang	2.1	0.9	3-Feb

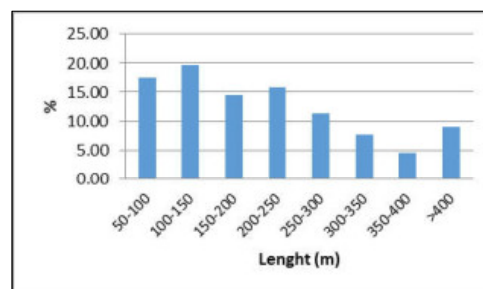
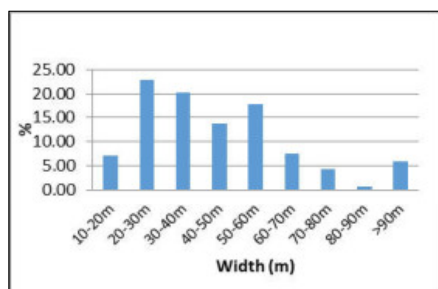
Field survey data show that the average farm size is 1.2-4.1 ha/hh, divided into 2-3 plots of 0.7-1.1 ha (Table 2.5).

While about 80% of the field plots having width of 20-50m, the length varies widely, from 50-300 m, occupies 85% of the total plots surveyed in An Giang and from 150-300 m, occupies more than 50% of the total plots, in Dong Thap province.

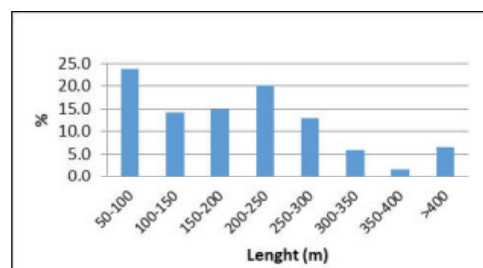
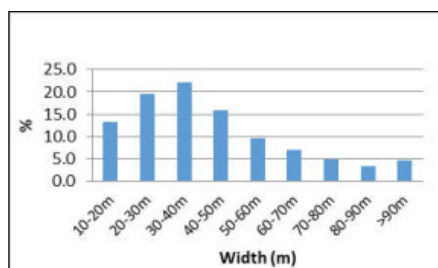
The distribution of field plot width and length in survey sites are shown in Fig. 2.5.



Phu Cuong, Dong Thap



An Binh, An Giang



Vong Tue, An Giang

Fig. 2.5. Distribution of size of width and length of field plots

To sum up, currently, the field block is constructed with the width based on the distance between two on-farm canals (tertiary canal) and the length is the distance between the two higher level canals. Average distance between tertiary canals is about 150-300m. The length of the field block is the distance between 2 secondary canals, which is 500 - 1500m.

The construction of a large rice field is based on the existing canal system so most of the field plot is 20-50 m wide and 50-300 m long. The field block has a width determined by the distance between the last two canals and is the width of the block is 150-300 m. The plot length is the distance

between the two higher level canals, on average 500-1500 m.

2.3. Machine work and size of field plots

An important factor affecting the efficiency of machines, used for rice farming, is the length and the width of field plot. When using a large agricultural machine, if the plot size is not in an effective machinery working range, the idle time is long and efficiency is low.

Currently, in Vietnam, two popular types of agricultural machines used in rice cultivation are soil tillers and harvesters.

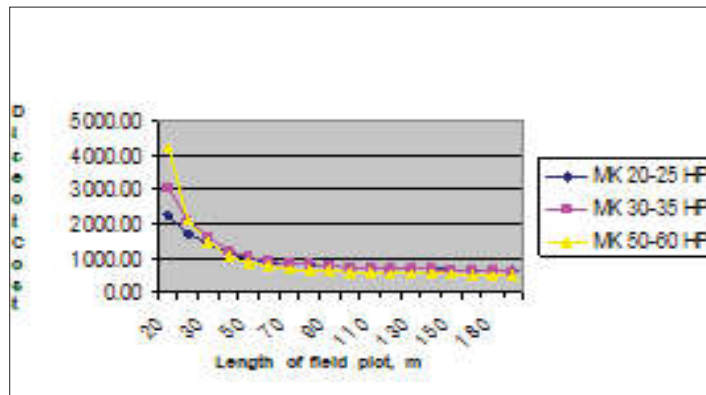


Fig 2.6. Relationship between soil tillers direct cost (1000 VND)/ha and length of plots (m)

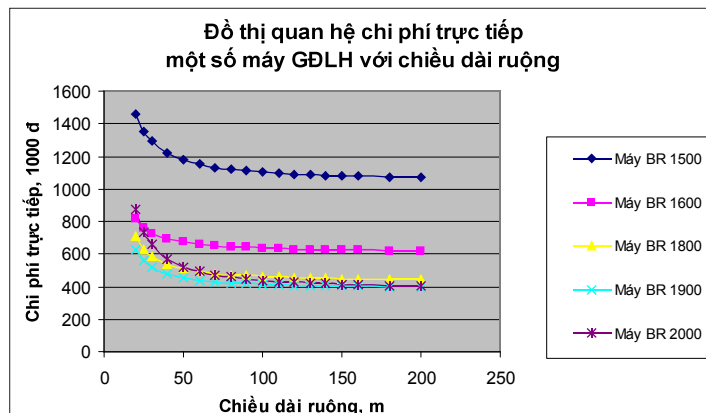


Fig 2.7. Relationship between harvesters direct cost (1000 VND)/ha and length of plots (m)

3. Recommendation for large rice field Planing

3.1 Field plan arrangement of field plot and block

Construction of a large rice field requires a huge investment in road and irrigation infrastructure. Once constructed, it is not easy and very costly to destroy and then renew.

Planning for field rearrangement is recommended

to follow two phases on the basis of careful analysis of the current conditions of agricultural land ownership, mechanization possibility, production organizations, as well as considering the future condition, when demand for agricultural labor force reduced substantially and land accumulation is possible, resulting in the increase in demand for mechanization with larger capacity.

i) Phase 1- the immediate period. Field planning suitable with the current reality of localities and mechanization systems.

Criteria	RRD	MRD
Area (ha)	Specialty rice >= 10 ha	>= 100 ha
	Commercial rice >= 50 ha.	
Size of field plot	B xL= (20-40) mx(50-100) m	B xL = (20-50)mx(150-300) m
Size of field block	B = (50-100) m,	B= (150-300) m.

B: Width, L: Length

Basing on specific conditions of canals, fields, embankments at the site and considering factors that determine sizes of field block and plots such as (i) farming facilities such as agricultural machinery, (ii) water management conditions such as irrigation operations, (iii) topographic conditions such as slope, (iv) socio-economic conditions such as the ability to collect land, the level of cooperation, and the percentage of unused land, the length and width of the fields are recommended to be (20-40) m by (50-100) m and (20-50)m by (150-300) m for the Red River Delta and Mekong River Delta respectively (Table 3.1). The field block length is limited by the distance between secondary irrigation canals or main on-farm roads.

ii) Phase 2. Field planning for the future, when conditions for land accumulation are met, mechanization is applied at a high level to serve commodity production

In order to increase labor productivity by agricultural mechanization, it is essential to expand field plots, build on-farm roads to meet machinery workability. This should be implemented at same time with the improvement of the existing irrigation and drainage system so that independent and flexible irrigation can be carried out for each field.

In the future of land accumulation, the field can be enlarged, by simply removing short size bank of the present field, to become Nx(20-40) mx100 m for the Red River Delta and Nx(20-50)mx(150-300) m for Mekong River Delta (Table 3.2).

Criteria	Red River Delta	Mekong River Delta
Area (ha)	100-200 ha	300 – 500 ha
Size of field plot	B xL = Nx(20-40) mx100 m;	B xL = Nx(20-50)mx(150-300) m
Size of field block	B = 100 m	B= (150-300) m

From the view point of rice exporting enterprises, for commodity production, the rice production areas, should be ranging from 300 to 500 hectares or more and increase in subsequent years. The large rice field area there fore needs to expand from 300 to 500 ha correspondingly.

3.2. Arrangement of on-farm roads and canals

i) On-farm roads

The main on-farm roads can be arranged along the main irrigation and drainage canals, along residential areas and contiguous to the farm block.

Ideally, the main on-farm road should be arranged in two lanes runing along main irrigation canal. In conditions of limited land not allowing two lanes, one lane can be arranged but every 150-200 m there must be a car avoiding point so that vehicles in the opposite direction can avoid each other. On-farm side road can be arranged along tertiary canal, between 2 tertiary canals.

Considering the width of machines working at the farm, the width of main and site on-farm road are recomended as shown in table 3.3

Road type	Total width (m)	
	Surface	Edge of the road
Main on-farm road	3,5 (3,0)	0,75x2 (0,5x2)
On-farm site road	2,5 (1,5)	0,5x2 (0,5 x2)

(2.5): Min value

The arrangement of on-farm irrigation canals should ensure independent water supply and drainage, for independent and intensive farming and cost savings. Basing on the current layout of irrigation system, farm size and land collection possibility in the two delta, the following are recommended for on-farm canal planning:

a) Independent irrigation and drainage (canal system) area

Field irrigation and road system can be arranged, with a distance between irrigation canals at 100-200 m for the Red River Delta and 300-600 m for Mekong Delta and the distance between the drainage canals at 100-200 m for the Red River Delta and 300-600 m for Mekong Delta, in two options:

(a.1) One side irrigation and drainage, each field block having a set of independent irrigation and drainage canals ensuring each plot having water supplied and drained individually (Fig. 3.1.)

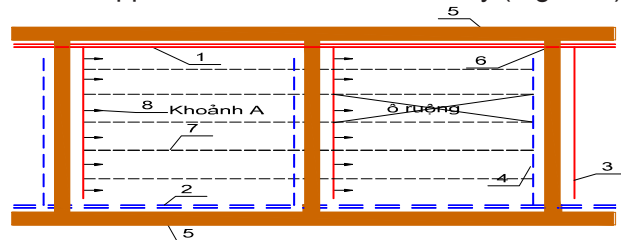


Fig 3.1. Irrigation and drainage canal in one side irrigation and drainage scheme

Notes:

- 1 & 2: Secondary irrigation and drainage canals
- 3 & 4: Tertiary irrigation and drainage canals
- 5 & 6: Farm Block and field block roads

(a.2) Two sites irrigation and drainage, each field irrigation canal and each drainage canal provides and drains water for 2 field blocks (Fig. 3.2).

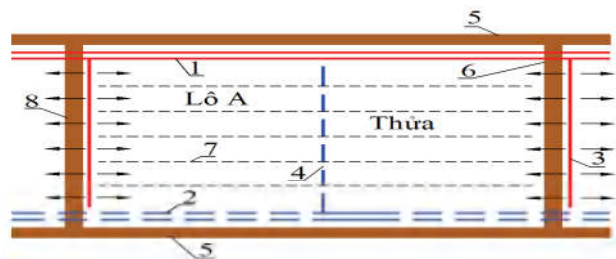


Fig 3.2. Irrigation and drainage canal in 2 side irrigation and drainage scheme

Notes:

- 1 & 2: Secondary irrigation and drainage canals
- 3 & 4: Tertiary irrigation and drainage canals
- 5 & 6: Farm Block and field block roads

b) Dual irrigation and drainage (canal system) area

• A canal is laid at the middle between 2 on-farm canal. The distance between dual irrigation-drainage canals is 100m (in RRD); 150-300 m (Mekong Delta).

b) Dual irrigation and drainage (canal system) area

- A canal is laid at the middle between 2 on-farm canal. The distance between dual irrigation-drainage canals is 100m (in RRD); 150-300 m (Mekong Delta).

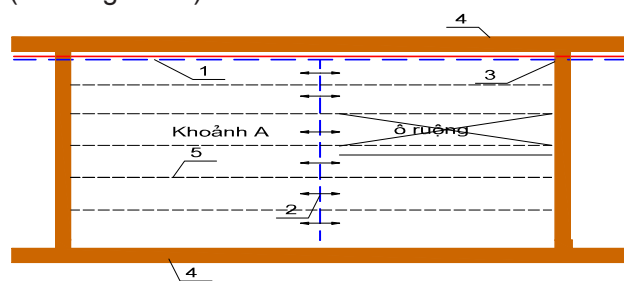


Fig 3.3. Dual irrigation and drainage canals scheme

Notes:

- 1: Dual Secondary irrigation and drainage canals
- 2: Dual Tertiary irrigation and drainage canals
- 3 & 4: Farm Block and field block roads
- 5: plot bund and intakes into plot

4. Conclusions

Rice production plays an unreplaceable role in Vietnamese agriculture. To solve the problem of small, irregular farm size and small production, low labor productivity, it is required in land consolidation and large paddy field construction. Because of high cost, once constructed, it is not effectively to destroy and reconstruct the large paddy field. Field scheme should be laid out in a way that suited to present condition of land ownership, mechanization and production arrangement as well to the future condition of land accumulation, rural labor shortage and higher power agricultural machinery. The result of the study shows that, for independent access of irrigation and drainage and agricultural machinery to each field, on-farm road and canal should be laid along short and long size of the paddy field. At present, it is recommended that, the sizes of paddy field should be 20-40 m by 50-100 m and 20-50 m by 150-300 m, respectively, for the Red River Delta and Mekong River Delta. In the future of land accumulation, the field can be enlarged, by simply removing short size bank of the present field, to become $N \times (20-40) \text{ m} \times 100 \text{ m}$ for the Red River Delta and $N \times (20-50) \text{ m} \times (150-300) \text{ m}$ for Mekong River Delta

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