AGRICULTURE AND IRRIGATION SYSTEM DEVELOPMENT IN JAVA DURING THE CULTIVATION SYSTEM

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INTISARI

Pengaruh pelaksanaan Tanam Paksa terhadap perkembangan sistem irigasi dan pertanian di Jawa, merupakan pokok bahasan tulisan ini. Bahan-bahan untuk analisis dalam tulisan ini diperoleh melalui penelusuran pustaka serta laporan-laporan yang tersedia.

Hasil analisis menunjukkan bahwa pelaksanaan Tanam Paksa telah secara nyata merubah pola pergiliran tanaman serta produksi tanaman pangan di lahan sawah beririgasi. Perubahan ini sebagai akibat dari terlalu lamanya lahan sawah dikuasai oleh pabrik gula untuk tanaman tebu, prioritas pembagian air untuk tebu dan pabrik gula serta pengerahan tenaga kerja petani yang berlebihan untuk kegiatan-kegiatan yang berkaitan dengan produksi gula.

Disamping itu, pada satu sisi, Tanam Paksa telah mendorong berkembangnya sistem irigasi modern di Jawa yang mempunyai ciri-ciri sistem keteknikan dan manajemen yang berbeda dengan sistem irigasi tradisional. Akan tetapi pada sisi lain, semakin menghilangkan hak dan keterlibatan petani dalam kegiatan-kegiatan operasional sistem irigasi modern.

INTRODUCTION

The Cultivation System (SC) which was initiated by the Dutch Colonial Government (DCG) under Governor General van Den Bosch and implemented in Java in early 19th century, was particularly designed to reactivate the ailing finance of the Netherlands. Principally, the objective was to be achieved through the sale of tropical export crops mainly sugar, indigo, coffee and tobacco which were produced cheaply by means of compulsory use of land and labour of the Javanese peasantry. From the view of the DCG, the implementation of the CS in Java for more than three decades was technically and economically successful. This is indicated by the total revenue from export of the crops during the period of 1840 – 1859 (Table 1). For the Javanese peasantry, however, it was a bitter period in history.

A series of critical articles and literatures concerning the historiography and socio-economic aspects of the CS have already been made by many researchers (Day, 1904, Furnival, 1944; Sievers, 1974, Fasseur, 1975; Elson, 1978; Fernando, 1980; Onghokham, 1984; Van Schaik, 1986; Kartodirdjo and Djoko Surjo, 1991). They are, in general, separated into two groups. The first group concluded that the CS had so excessively exploited land and labour of the Javanese peasantry for export crops production that it jeopardized indigenous agriculture and caused the Javanese peasantry fall into poverty. The second group concluded that the CS had increased economic activities in the country and has promoted village economy and farmers' welfare through a modern agricultural production system.

In spite of the two polarized historiography and criticism in moral aspect of the CS, most of the historians and socio-economic researchers reached a conclusion that the CS had considerable influence on the socio-economic conditions of the Javanese peasantry and brought about the development of large state-run estate agriculture in which European entrepreneurs were involved. Under the CS, three principal resources in agriculture, Viz.land, water and labour, were intensively exploitated and controlled by the Dutch Colonial Government (DCG) through local bureaucracy.

Table 1. Revenue from export of crops production in Java 1840 – 1859 (x 1000 Dutch Gulden)

Comodity	1840 – 1849	1850 – 1854	1855 – 1859
Coffee	+ 64,827	+ 77,540	+ 105,599
Sugar	– 4,082	+ 3,385	+ 33,705
Indigo	+ 15,562	+ 6,759	+ 5,855
Cohenille	+ 499	+ 445	– 44
Pepper	+ 191	+ 205	+ 203
Tea	– 2,181	– 2,841	– 2,449
Tobacco	– 95	– 5	– 61
Total	+ 74,911	+ 85,498	+ 142,808

Source: Fasseur, 1975 p: 119 – 120

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One of the important issues which has not been discussed fully by the social researchers, is the effect of the CS on the development of modern irrigation system in Java. This article is intended to explore this issue from the socio-technical perspective.

CHANGES IN CROPPING PATTERN AND SQUENCES

Before the CS was introduced, the entire sawah land in Java had been commonly planted with paddy rice in the rainy season and it had been followed by non-rice food crops named *palawija* as the second crop. Second cultivation for rice crop was limited due to scarcity of water. The common rice variety planted in sawah land was *padi dalem*, a long maturing rice variety which requires 6 – 8 months in the field.

With the introduction of sugarcane and indigo plantations in sawah land, the preceding crop rotation was radically disrupted. The disruption was not due to the large proportion of the sawah land reserved for sugarcane plantation as it only about 10 – 15% of the available sawah land in all Java. But it was because of the longer growing period of the sugarcane in the field. Beside that, large amount of farmers were absorbed in sugarcane plantations and sugar factories. Intensive labour of about 400 – 600 mandays was required per hectare for planting and crop tending alone (National Achieve, No. 27/7/1877).

Officially, according to the written regulation, a block of sawah land was reserved for cane plantation by rotation method once only in three years. In practice, the estates occupied the land for more than one year, since sugarcane crop takes 16 – 18 months in the field. Farmers, therefore, had to forego not just their rice crops, but also palawija harvest (Boomgaard and J.L van Zanden, 1990 and van Schaik, 1988). In practice, the consequence was far reaching, because the sawah land had to be delivered for land preparation for sugar cane in April, and not handed back to the owners until July the following year. After the land had been handed back, the owners had to cultivate the land which needed greater land preparation, and field irrigation channels had to be reconstructed in order to make it suitable for paddy rice or palawija cultivation. Indigo cultivation even left the sawah land severely depleted (Boomgaard and Z.L van Zanden, 1990).

Time available for growing food crops in a reserved sawah land depends on the assigned rotation cycle (Figure 1). For two years cycle, farmers were allowed to grow only one rice and half of palawija crops in two years. For three years cycle, farmers in sugared districts were allowed to grow two wet monsoon rice and half palawija crops for three years. Note here that one of the rice crops was short-growing variety or locally named *padi genjah* which was usually lower in yield. Meanwhile, for non-sugar areas, farmers were allowed to grow three wet season *padi dalam* and three palawija crops in three years.

Thus, the introduction of sugarcane as the other crop in irrigated sawah land has significantly disturbed the previous cropping pattern and squences, particularly in sawah areas reserved for sugarcane plantation.

FARMERS AND SUGARCANE PLANTATION

Appart from land, labour was the second resource which was intensively exploitated by the DCG during the implementation of the CS. During the period, the Javanese peasants were very heavily absorbed in export crop plantations and factories through compulsory works regulation. The compulsory work was assigned as the replacement of land taxes.

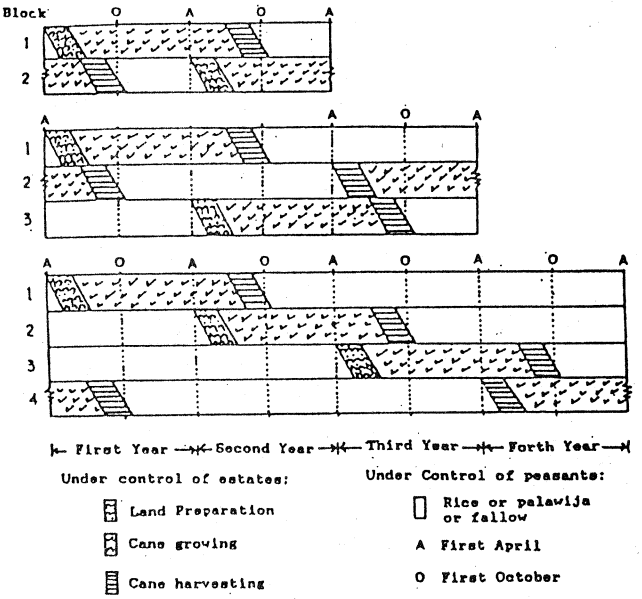

Figure 1. Rotation cycle of sugarcane crops grown in irrigated sawah land

The corvee works for sugarcane or indigo plantations was called Kultuurdiensten, which means corvee work for cultivation of export crops. Although the works was paid, the wages was at a very low rate and were sometimes deducted from their land taxes (Elson, 1978; Niel, 1988). Beside this work, there were additional works for public

services such as construction and maintainance of roads and other infrastructures named *hierediensten*, and works for local aristocrats, named *pancendiensten*, that were normally related to building of facilities for sugar industry (Elson, 1978; Alexander, 1979; Kartodirdjo and Djoko Suryo, 1991).

The extent of labours engaged in cane plantation and other necessary sevices related to sugar industry, can not be examined in general term for the whole Java as they vary greatly from region to region. In heavily sugar oriented districts or villages, the labour absorption in sugar industry might have been at very high proportion that could jeopardize the peasants' crop cultivation. In the "sugared district" such as Cirebon, Tegal, Pekalongan, Surabaya and Pasuruan, more than 50 percent of the total available labour force was engaged in sugar industry. In Cirebon for example, more than 65% of the total population in the residency was involved in sugar industry as labourers between 1837 and 1845 (Table 2). Indeed, not all of these workers were

Table 2. Percentage of population involved in export crops cultivation, 1835 – 1845

Residency	1837	1840	1845
Banten	76	92	48
Priangan	86	65	67
Cirebon	73	69	54
Tegal	51	44	36
Pekalongan	57	59	55
Semarang	35	29	25
Jepara	37	35	35
Rembang	35	31	25
Surabaya	29	32	33
Pasuruan	77	59	64
Besuki	40	47	54
Pacitan	60	72	63
Kedu	86	79	97
Begelen	35	81	62
Banyumas	77	68	74
Kediri	59	61	61
Madiun	60	59	51

Source: Djoko Surjo, 1989.

farmers who operate sawah land. But, it is safe to say that the intensive absorption of labour in sugar plantations and factories reduced the labour availability for rice farming quite significantly.

The reports mentioned in the Archives of the Minister of Colonies narrate some stories about labour mobilization for coffee plantation which also requires much workers for land preparation, crop tending, harvesting and processing. This large labour force was filled through mobilizing farmers from densely populated sawah area in the lowland. Farmers often had to walk several kilometers from their home villages to the coffee plantations that are normally lacated in the upland. For example, in Madiun, farmers had to walk about 7 kilometers, in Jepara about 8 kilometers and in Cirebon even more than 10 kilometers (Archieve of the Minister of Colonies: 1828 – 1849). Moreover, it was also reported that some farmers even had to leave their home-villages and stay for several months in a very temporary and simple shacks around coffee plantations (van Sevenhoven in Elson, 1988).

Statistics indicating peasants' toils and hardships in commercial crops production under the CS are ubiquitous. In Pasuruan, one of the important "sugar districts", in 1840, each household in the sugar villages had to muster about 180 corvee-days per year for sugar cultivation (Alexander and Alexander, 1979). In Pekalongan, a farmer who engaged in indigo cultivation had to spend 176 days per year for land preparation, crop tending, harvesting, and about 76 additional days for working in the factory (Knight, 1982). While in Yogyakarta region, in 1890, about 20 years after the CS had been abolished, each household still had to provide 150 corvee-days for sugar plantation and construction works, and spent five nights a week on guarding duties in cane fields and factories (Selosoemardjan, 1962).

These figures imply that more than 50 percent of available time of the Javanese villagers were absorbed into sugarcane or other export crops plantation, while labour for rice farming which also requires intensive care for land preparation, crop tending and irrigation was greatly disrupted. Therefore, it is understandable that some historians said that the implementation of the CS had more or less jeopardized indigenous farming systems in sawah land of Java.

IRRIGATION DEVELOPMENT AND PRODUCTION OF RICE AND SUGARCANE

In the context of irrigation development during the CS, there are two distinct arguments concerning who benefitted by the intensive development. The first argument says that sugar plantations and factories were much benefitted by the irrigation development, because the development was intended mainly to serve sugarcane plantation. While admitting this historical fact, the second group argues that rice farming was much more benefitted by the irrigation development because irrigated sawah accounted for more than 2 million hectare as compared with the more 200.000 hectare of sugarcane plantation during the period of the CS. Both the arguments may contain partial truth, but they may have to be examined more carefully. In this section, the role of irrigation on rice and sugarcane production will be analyzed.

There was a dramatic increase in sugarcane production during the period of the CS (Figure 2). From only about 1,375 tons in 1815 it became 11,00 tons in 1835 and 30,000 tons in 1840, only ten years after the inception of the CS. The highest sugarcane production during the period of the CS was attained in 1855, with total production of 34,375 tons and thereafter the production fluctuated. Sugarcane contributed f.20.123 million or about 42 percent of the total export value of f.48.024 million to Netherland in 1845 (Furnival, 1967). The sugar production increased after the termination of the CS in 1870 to reach the record high in 1880.

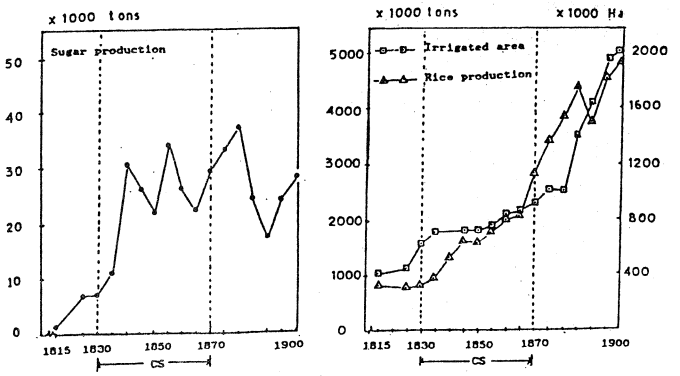

Figure 2. Sugarcane and rice production in Java, 1815 – 1900

It is no doubt that the increase in production was attained partly by the increase in area in sugarcane, which exhibit the increase of about 18 percent during the periode of 1833–1861. It is notable that for the same period, sugarcane yield per unit area tripled (Figure 2). This suggests that improvement of cultivation practices played major role in the increase in sugarcane production, including soil preparation, fertilization, plant breeding and crop protection from pests and diseases. The role of irrigation in the increase of yield per unit area, however, is not notable. This in indicated by the very low coefficient of determination (Table 3).

Regarding rice production as shown in Figure 2, total production increased steadly more or less in pararrel with the increase in irrigated sawah area. For the period of sixty years, the irrigated sawah land increased steadily from only 517 thausands hectare in 1815 to 922 thausands hectare in 1875, and reached 2 million hectare in 1900. It is very notable, however, rice production had shown only slight increase during the CS from 1830 to 1860. The increment of the rice production during this period is not comparable with the sugarcane production.

After 1865 when the CS had started to be abolished gradually, both rice production and irrigated sawah area show a dramatic increase. This presumably indicates the recovery of farmers' capability in rice cultivation. The role of irrigation on the increace in rice yield per unit area was found to be significant with a high coefficient of correlation ($r = 0.68$ at 5 percent level, Table 3). This means that at least 46 percent of the observed variation in rice yield by residencies can be explained by irrigation factor alone.

Table 3. Rice and sugar production and irrigation ratio, Java, 1855 – 1865

Residency	Rice (qt/ Ha)	Sugar pikul/ bau	Irrigation ratio (1865)	Residency	Rice (qt/ Ha)	Sugar pikul/ bau	Irrigation ratio (1865)
Cirebon	16.7	36.6	0.75	Kediri	22.5	34.4	0.57
Tegal	22.9	34.3	0.71	Surabaya	11.7	46.2	0.45
Pekalongan	6.9	37.4	0.69	Pasuruan	32.4	56.1	0.65
Semarang	15.6	30.3	0.49	Purbolinggo	25.6	47.2	0.56
Rembang	7.6	30.2	0.21	Besuki	30.1	46.2	0.69
Banyumas	10.8	25.0	0.59	Banyuwangi	34.1	na	0.79
Begelen	18.8	na	0.67				
Kedu	23.4	na	0.58				
Madiun	19.2	40.0	0.73				
Irrigation ratio correlated with: Rice yield, r = 0.68; sugar yield, r = 0.27							

Rice yield quintal of dry stalk per hectare, 1856 – 1865. Sugar yield in pikul per bau of refined sugar in 1856 – 1865. Irrigation ratio = ratio of irrigated sawah to total sawah land, in 1865.

Source: Booth, 1988; van Schaik, 1986 and Boomgard Z.L. van Zanden, 1990.

The result of the analysis reveals that the irrigation development during the period of CS, eventhough it was mainly designed to serve sugarcane plantatations, up to some extent, also increased the rice production in Java. In regard to this, the statement asserted by Boeke (1955) and van Schaik (1988), that irrigation development during the period of the CS has no influence to the rice farming and production, should be reexamined carefully.

SUGARCANE PLANTATION AND WATER DISTRIBUTION

The conflict over water distribution between sugarcane and rice growers was one of the favorite topics of debate among historians and social scientists. Many of the historians argued that peasants' agriculture was destroyed not only by the control of land and labour but also monopoly of water by sugarcane estates and factories during the CS that were backed by the government's policy to promote the export industry. This argument, however, is more or less based on statistics of irrigated area and crops production in certain

sugar districts or residencies, while analysis of technical sides of irrigation and water distribution under various cropping pattern and squences is missing totally.

The following section discusses the influence of sugarcane plantations on irrigation water distribution on peasants' farming in a given command area.

Firstly mention is made to the physiological and biological characteristics of sugarcane. Agronomically, sugarcane can be grown on any suitable land and requires less irrigation water than rice crop, as it not a "greedy" crop as far as water is concerned. In many places, it is grown in rainfed areas. Java may be exceptional where all sugarcane was irrigated and grown in sawah land.

The water requirement of sugarcane varies according to type of soil, crop season and age, method of soil preparation and irrigation. Sandy soil generally requires more irrigation than finer soils. Age and late season crops do not need irrigation. *Rynoso system* of land preparation requires different depth of irrigation water as compared with the *brujulan system.*

For medium soil texture, rynoso requires irrigation water at the rate of 0.7 – 0.9 lt/sec/ha, as compared with about 0.9 – 1.2 lt/sec/ha for *brujulan* (Nota Irrigatie, 1895). Whatever land preparation methods are selected, total amount of irrigation water required for one cropping season of sugarcane should theorically be less than rice.

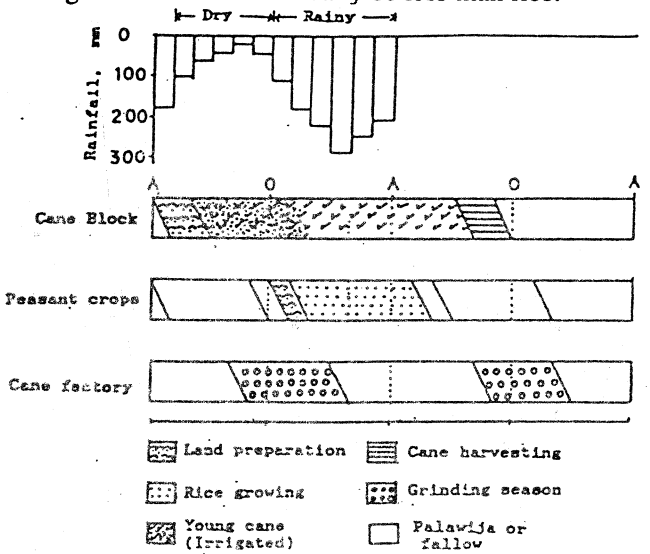

Figure 3. Cropping calendar in relation with water availability and milling season

Figure 3 shows typical cropping calender of both sugarcane and rice crops and normal working season of sugarcane factories. It can be recognized that the peak water requirement occurs from early August to late November when young cane demands maximum water and farmers start land preparation for main season rice cultivation, while sugar factories divert a considerable amount of water from irrigation canals for driving grinding machines and cooling system. It is reported that most of the machines were water-driven before 1980s (van Shaik, 1986), and they demanded a large water discharge, often larger than irrigation requirement for sugarcane.

According to some sources, some sugar factories in Tegal and Pasuruan demanded from 1,000 to 2,000 l/sec to drive the machines (van Berckel and Liefrink, 1891; and Report from Director of BOW to Governor General, in various years). Assuming that the figure is correct, and we take 1,500 l/sec as the average water requirement for driving the grinding machines, one factory consumes as much water as irrigating 1,500 ha of rice or sugarcane. To ensure the need of water, some factories diverted the required water by "power" (van Gorkhom in van Schaik, 1986). The water for driving the machines can be reused in downstream farms if the factories are located in the upstream, but unfortunately most of the factories were built along rivers in the downstream areas such as in Cirebon, Tegal, Pekalongan and Pasuruhan, wherein irrigated sawah land were concertrated.

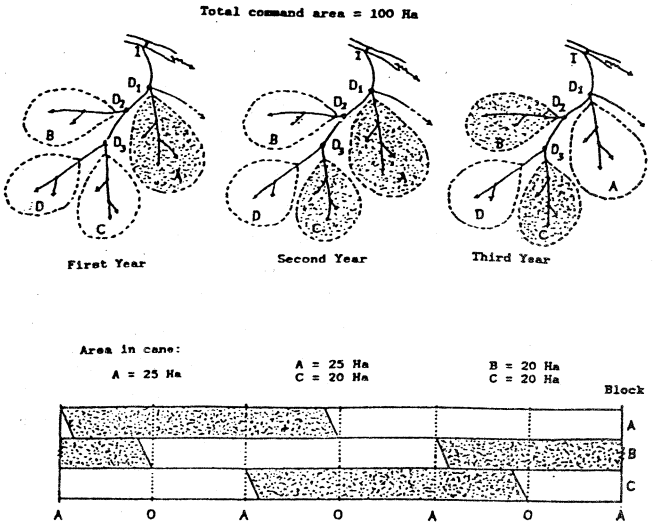

Figure 4. Three years rotation of sugarcane planting in a given irrigated command area

Figure 4 indicates croping sequences and irrigation water distribution in three-year rotation system. Normally, irrigation water is taken in at a diversion structure (I), and

conveyed through open channels to assigned fields. It is assumed here that the total irrigation command area is 100 ha, which is divided into four irrigation blocks, of which one fifth of the area in blocks A(25 ha), B(20 ha) and C(20 ha) is reserved for sugarcane plantation considering land suitability and accessability to irrigation water. Irrigation water for each block is diverted through secondary offtake structures (D1, D2 and D3). It is also assumed here that a sugarcane factory diverts water through offtake D1 when it requires water during the milling season.

The cane cultivation starts normally in late April as soon as rice in the preceding season is harvested. The sawah land is cultivated first for sugarcane planting. Around June or July, after the land has been flooded and ploughed, the cane cuttings are planted along the rows. Waiting for the arrival of the rainy season in the between October and December, the young plant is irrigated and weeded. The crop is harvested in July or August the following year, and the land is handed back to the peasants in late August or early September.

Meanwhile, in non-sugar blocks, farmers grow palawija from April till July or August, and prepare land for rice planting in October to November. Since farmers select long maturing rice varieties, rice matures after 6 – 7 months in April or May. Rice plus sugarcane or sugarcane plus palawija cropping patterns prevail in the given command area as shown in the Fig. 4.

The young sugarcane crop in the block A requires irrigation water of about 0.7 – 1.0 l/sec/ha at least for the first three months of its growing period, starting in late July up to late October or early November. Meanwhile, the sugar factory diverts about 1,000 l/sec water from the canal through D1. In blocks B, C and D, peasants grow palawija in between April to September, and prepare land for rice in late October to early November. Palawija crops do not need irrigation water as much as rice, but they still require at least one to two irrigation during the growing period. Land preparation for rice needs maximum water requirement of about 1.0 – 1.2 l/sec/ha. As noted earlier, the maximum demand for water occurs between August and November, as being the late dry season to the start of the monsoon.

For the second year, an even larger area is occupied by sugarcane than the first year. From April up to October, while block A is still under cane, block C has to be brought to land preparation and planting of cane in its first rotation cycle. Thus, more than 40 percent of the total command area will be under the sugar estate. Two other blocks B and D may suffer from water shortage as a result of priority water allocation to sugarcane blocks. Under scarcity of water in the dry season, sugar estates and factories usually use their "power" to control irrigation water, as has been asserted sharply by some historians and social scholars (Fasseur, 1975; van Schaik, 1986; Lukman Sutrisno, 1988).

Anticipating such as unreliable water supply, farmers then have to make some "adaptation" or adjustment of their cropping practices (Fasseur, 1975). But some of them had no chance and capability to do their farming, so they left their land uncultivated, and some of them even left their land and tried to stay in a remote area to escape from exsessive obligatory works. Typical "adaptation" practised by farmers included the selection of short-maturing but less productive rice varieties (Javanese: *padi genjah*) and substitution by palawija such as corn and cassava which require less water (Fernando, 1980).

This "adaptation" may be reflected in the considerable decrease in rice production per hectare in Java between 1830 – 1840 (Fasseur, 1975). Frequent crop failures triggered famine in some sugar districts such as in Cirebon, Semarang, Demak and Grobogan (Fernando, 1980; Kartodirdjo and Djoko Surjo, 1991).

From the forgoing discussions, it is clear that the CS significantly changed the preceeding cropping pattern and food crop production, and disturbed irrigation water distribution.

DEVELOPMENT AND CHANGES IN IRRIGATION SYSTEM

1. Irrigation During pre-Cultivation System

Historical development of irrigation in Java has run as long as the history of rice cultivation. Rice farming in irrigated sawah land is a typical attribute of agriculture in Java since pre-colonial era. The historical evidences indicated that ancient Javanese farmers have already familiar with irrigation works such as weirs, dikes, tunnels, channels and causeways. Those irrigation structures would have been as a simple construction (van Setten van der Meer, 1978).

During the pre-colonial, irrigation system in Java has been developed through two different ways. First, farmers either individually or in a group and sometimes organized by a village, constructed small dams or weirs across a stream using local material such as bamboo, tree trunks and stones. Often baskets of wooven bamboo filled with stones were used to dam small rivers. The water was diverted through an outlet to small open channels or bamboo pipes for irrigating rice fields.

The irrigation schemes developed by farmers (communal irrigation) generaly simple in technology using local available material and therefore, they were sensitive to local environmental changes and need regular maintenance or reconstruction. The schemes were generally developed in sloping areas for serving small areas of rice field. The irrigation water was distributed with simple method and arrangement depending on water availability and cropped area.

From the management point of view, the schemes were developed and managed by farmers and no such intervention from outside institutions. In term of water management, the developed irrigation schemes were usually separated each to other. Farmers were the only owner of the schemes so that any decision regarding agriculture and irrigation activities were made by themeselves based on local needs and tasks.

The second way of the development was that a legion of workers organized by the rulers, constructed relatively larger stone dams, causeways and sluices. The rulers were mostly the Hindu-Javanese kingdoms. They concerned with irrigation as they required revenue from agricultural production for financing government administrative, military and relegion ceremony.

In contrast with the irrigation schemes developed by farmers, the irrigation structures developed under intervention of the rulers were relativeley more advance in technology of construction, larger in size and constructed firmly to serve larger command area. The role of the rulers were significant, but limited only in mobilizing legion of workers and providing funds and materials for construction and organizing construction activities. After construction, farmers have freedom to do their farming and irrigation as long as they pay such an *obligation* to the rulers.

2. Irrigation during Cultivation System

When the DCG introduced sugarcane and indigo as others crops planted in irrigated ricefields through plantation system, the government developed irrigation system in Java by constructing irrigation facilities, developing an irrigation agency as the institution to manage irrigation, and introducing new regulations in water right, water use and distribution.

The existence of sugarcane as the other crop in sawah land which also requires irrigation water, has more or less influenced the DCG's orientation in the development of irrigation system in Java. The orientation imprinted some characteristics in the design concept as well as management system which significantly differ from those farmer "traditional" irrigation system. The indigenous irrigation system in Java then started to be intervened and changed.

The development and changes was however, not very dramatic. The assertation by some historians and social researchers that the improvement of irrigation system were for only serving the requirement of the sugarcane plantation would better be reserved because of the following technical reasons regarding irrigation. First, sawah land used annually for sugarcane plantation during the CS era was not more than 10% of total irrigated sawah land in Java. Second, only irrigation structures at main system were improved and developed by the DCG, while the tertiary system substantially untouched. The development of the irrigation facilities were done gradually and regionally, depending on the requirement, suitability and accessability of the command area for crops production. Third, the main structures were designed to accomodate flow capacity of maximum water demand, that was rice-based cropping.

Disregarding the arguments concerning the development proces of irrigation system in Java during the CS period, the "technical" irrigation system developed by the DCG accomplished some distinct characteristics as follow:

(1) The head structures (dam, weir and intake structures) were mostly constructed firmly and relatively larger. Some of them were provided by water control structures and water measurement devices. The selected type of the structures were adapted to the development of large farm of sugarcane plantations in downstream and plain area.

(2) The developped or rehabilitated irrigation schemes were generally devided into secondary and tertiary blocks. The blocks were set-up not on the basis of village or communal boundaries, but mainly of topographical and operational considerations. The management of the developed schemes were, accordingly, transfered from the user or communal management to project or agency specialized in irrigation. This shift detached the irrigation system from village communities.

(3) The indigenous water distribution method was basically *supply-oriented*, where a constant volume of water was supplied in proportion to irrigable areas through fixed or proportional water division structures. In contrast, the modern "technical" irrigation systems distribute variable amount of water by *on-demand* basis according to actual crop water requirement and the cropped area. The method imprinted consequences in the design and operation system of the irrigation

structures. Adjustable or fixed water division with water measurement devices such as Romijn or orifice types were introduced. These types of structures accordingly, require trained or skilled personnel to operate and maintain the structures. Adequate data regarding the cropping area, crop water requirement and water availability were also needed. Thus, further alienated village community to handle the system.

(4) The development of modern, large irrigation system was delegated to provincial autorities. Their operation and maintenance (O & M) was in turn, delegated to the irrigation agency at district level. Further the actual O & M was assigned to irrigation organizing units that were formed on the basis of district level O & M units.

(5) The developed and rehabilitated irrigation schemes were mostly separated from each others and from the existing indigenous irrigation schemes, and adapted to the size and location of the sugarcane plantations. For the purposes of construction works and irrigation O & M, the DCG through the Irrigation Agency introduced new hierarchy in irrigation networks namely primary, secondary and tertiary system. This hierarchy has consequences in irrigation design and operation. Irrigation structures within one irrigation scheme should be designed, as an interdependent system and therefore, they should be constructed and operated interdependently between each to others. Adjustable water division structures and measurement devices for water flow accordingly, should be constructed.

The development or irrigation system in Java during the CS has imprinted substansial influence over irrigation system during post CS even the post independence up until the *Pelita* era, in the following aspects.

(1) modern "technical" irrigation system in Java even on other islands.

(2) The categorization of irrigation system into Government-managed of "technical" irrigation system and villages managed "sederhana" system can be dated back to the CS period. This categorization although rather subjective and bias, is still presistent up to nowadays. This categorization has resulted in low farmers participation for maintaining facilities of the government-managed irrigation systems since the post CS period.

(3) The right of water use which formerly belong to the village as communal right was taken over by the government since the CS. This has paved the way for the government to firmly control water in the post CS period. The irrigation water distribution method which is connected to the cropping callendar in the field and has been practiced in Java up to nowadays can also be dated back to the CS period.

(4) By the change in management status of the developed irrigation schemes, almost all important decision concerning agriculture and irrigation activities were made by the Irrigation Commission in which representativeness of farmers as the water user is very limited. This means that there is only little room available for farmers to involve in the decision making process concerning irrigation.

CONCLUSIONS

The CS practiced in Java for about three decades has significantly influenced the development of agriculture and irrigation system. The introduction of sugarcane and indigo in irrigated sawah land has disrupted the former cropping pattern and sequences in two ways. One was due to priority use of land and water by sugarcane crop, and the other was to labour shortage that resulted from the compulsory mobilization of villagers for working in sugarcane plantations and factories.

Modern 'technical' irrigation system was developed extensively during the CS, mainly to serve the requirement of sugarcane plantations, but the same system was also used for improving rice cultivation. The developed system were characterized by a standard set of 'western' irrigation technology, larger in command area, centralized management system, controllable and measurable water flow and technical or rational baundaries of irrigation units. This development, however, alienated farmers to be the owners and managers of their own land water resources, instead, become more labour and water users.

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LITERATURES CITED

Alexander, J. and P. Alexander, 1978. Sugar, Rice and Irrigation in Colonial Java. Ethnohistory, 25, 1978 pp. 207 – 223.

Boeke, J.H, 1953. Economic and Economy policy for rural societies as examplified by Indonesia. New York.

Boomgard, P. and Z.L. van Zanden, 1990. Changing Economy in Indonesia. Vol. 10, Food Crops and arable land, Java 1815 – 1942. Royal Tropical Institute, Amsterdam.

Booth, A. 1988. Agricultural development in Indonesia. Asian Studies Association of Australia, Sidney.

Djoko Surjo, 1989. Sejarah Sosial Ekonomi Pedesaan Karisidenan Semarang 1830 – 1900. Aditya Media, Yogyakarta.

Djoko Surjo and S. Kartadirdja, 1991. Sejarah Perkebunan di Indonesia. Kajian Sosial Ekonomi. PAU Study Sosial, Universitas Gadjah Mada.

Director of BOW, 1895. Nota Irrigatie No. 9/3/1913 – 1599. Report of the Director BOW to the Governoor General.

Elson, R, 1978. The impact of government sugar cultivation in the Pasuruan area, East Java during the Cultivation System. Review of Indonesian and Malayan affair, 12, 1978, pp. 26-25.

———, 1979. Sugar and Peasant: the social impact of Western sugar industry on the peasantry of the Pasuruan Area, East Java, from the Cultivation System to the great depression. Ph.D thesis, Monash University.

_____, 1988. Peasant Poverty and Wealthy during the Cultivation System in Java (Ind) in Booth, A, W.J. O'Malley and A. Weidemann (Eds). Sejarah Ekonomi Indonesia. LP3ES, Jakarta.

Fasseur, C. 1975. Kultuurstelsel en koloniale baten. Ph.D. thesis, University of Leiden.

_____, 1978. Some remarks on the Cultivation System in Java. Acta Historiae Nedherlandicae, Vol. 10, 1978 pp. 143 – 162.

Fernando, R, 1980. Famine in Cirebon Residency, in Java 1844 1850. A new prospective on the cultivation satem. Working paper No. 21, 1980, Departement of Hystory, Monash University.

Furnival, J.S, 1967. Netherlands Indie. A study of plural economy. Cambridge University Press, Cambridge.

Geertz, C. 1963. Agricultural involution: The process of ecological change in Indonesia. University of California Press, Barkeley.

Horst, L. 1984. Irrigation water management in Indonesia. International Journal for Development Technology, No. 2, p. 211-22.

Kartodidjo, S, 1974. Bureaucracy and Aristocracy. The Indonesian experience in the 19 th Century. Archiepel No. 7, 1974 pp. 151 – 168.

Knight, G.R, 1988. Peasant and Sugarcane Cultivation in Java in the Nineteen Century: A case Study of Pekalongan Residency 1830 – 1870 in Booth, A, W.J. O'Melley, A. Weidemann (Eds). Sejarah Ekonomi Indonesia, LP3ES, Jakarta.

Kuntowijoyo, A. Darban, N. Setiawati, Budiyanto and M. Effendhie, 1989. Social Change in Villages: Oral History of Surakarta 1930 – 1960 (Ind). Inter-University for Social Studies, Gadjah Mada University, Yogyakarta.

Loekman Sutrisno, 1980. The sugar industry and rural development: Impact of cane cultivation for export on rural Jaava, 1830 – 1934. Ph.D thesis, Cornell University.

Mansvelt, W.M.F and P. Creutzberg, 1975. Changing economy in Indonesia, Vol. I. Indonesia Export crops 1816 – 1940. The Hague, Amsterdam.

Onghokham, 1984. Social Changes in Madiun in Nineteenth Century: Land Tax and it Influence to LandaTenure System (Ind) in: Tjondronegoro, S.M.P and Gunawan Wiradi (Eds). Dua Abad Penguasaan Tanah. Yayasan Obor Indonesia, Jakarta.

Selo Soemardjan, 1962. Social Changes in Yogyakarta. Cornell University Press, Itacha, New York.

Sievers, A.M, 1974. The Mystical World of Indonesia. Baltimore, John Hopkins University Press.

van Niel, R, 1978. Measurement of change under the Cultivation System in Java, 1837 – 1851. Indonesia No. 14, pp. 89 – 109.

_____, 1988. Warisan Tanam Paksa bagi Perkembangan Ekonomi berikutnya (Ind), in Booth et al (Edts): Sejarah Ekonomi Indonesia. LP3ES, Jakarta.

van Schaik, A. 1986. Colonial Control and Peasant Resources in Java. Ph.D. thesis, University of Amsterdam.

van Setten van der Meer, N.C. 1979. Sawah Cultivation in ancient Java. Aspects of development during the Indo-Javanese period. Oriental Monograph Series No. 22. Australian University Press, Cambera.