Productivity of Rice Cropping and Irrigation in Thailand

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Vast sums have been invested in the construction, maintenance and rehabilitation of irrigation infrastructures in Thailand. They dominate the government's budget for agriculture. But irrigation is not only about agriculture. The advocates of irrigation projects claim supplementary benefits of hydroelectricity, flood control, fishery, tourism, among others. It will be a good thing if, to show for it all, it can be convincingly demonstrated that the mean yield of Thailand's staple crop has been raised by a significant margin under irrigation too. We look for the evidence on the ground, using data from the villages.

This paper explores the village census (NRDC)[1] database for evident changes in the mean productivity of Thailand's rice cultivation over time, and for the evident differences and shifts in the mean paddy yields of the country's major geographic regions. Further, the village profiles of the NRDC database also allow for comparisons to be made on the respective productivity in paddy cropping of villages with access to irrigation facilities, and of those with no such access. Such comparisons are pertinent to the ongoing efforts of the government to provide more surface irrigation water for paddy cropping, principally by building large dams and reservoirs. Infrastructures for irrigation have typically accounted for about 40 percent of the total budget of the Ministry of Agriculture and Cooperatives in any given year. The NRDC data on yields and access to irrigation are therefore empirically pertinent to the assumptions used in cost-benefit analysis of irrigation projects. Appraisals of such projects normally and crucially include claims of expectable increases of paddy yields when farmers switch from rain-fed practices to systematic irrigation. The assumed incremental yields—the margin of difference in outputs before and after—justify the case for investments in irrigation.

As we shall see, increases in the mean yields per unit area of paddy cropping have secularly diminished over the past decade. Returns on investments in irrigation facilities for paddy cultivation have become empirically marginal. The economic justification for capital accumulation in irrigation based on expectable increases in crop yields can no longer be taken for granted. Moreover, the importance of surface water from community irrigation facilities has slipped: the existing infrastructures are now less capable of matching the delivery of water to the needs of farmers. The true performance and the real net benefits which can rightly be expected from huge outlays in budgetary resources for the provision and delivery of free irrigation water for paddy cultivation—as the system is now designed and practiced—should be thoroughly reappraised.

PADDY PRODUCTIVITY—MEASUREMENT AND TREND

Productivity is rated by unit weight of yield per unit area of cultivation. The traditional unit weight in Thailand for paddy is *tang,* equal to 10 kilograms, and the traditional unit of cropping area is *rai,* equal to 1,600 square meters. A conversion multiplier value of 0.0625 gives the equivalent metric tons per hectare for any given *tang* per *rai* yield figure. The NRDC database of biannual census data spans the years from 1984 to 2001, although the chosen benchmark year for marking changes over the last decade is 1992. The chosen representative yield indicator is the median rather than the average, to allow for unvetted census data which may distort the value of the sample mean.

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Figure 1

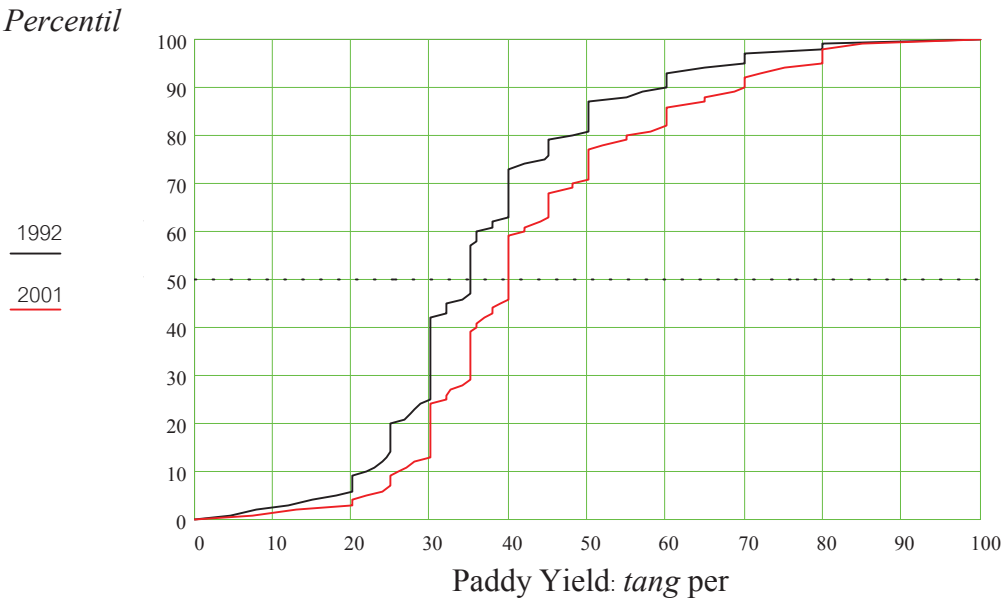
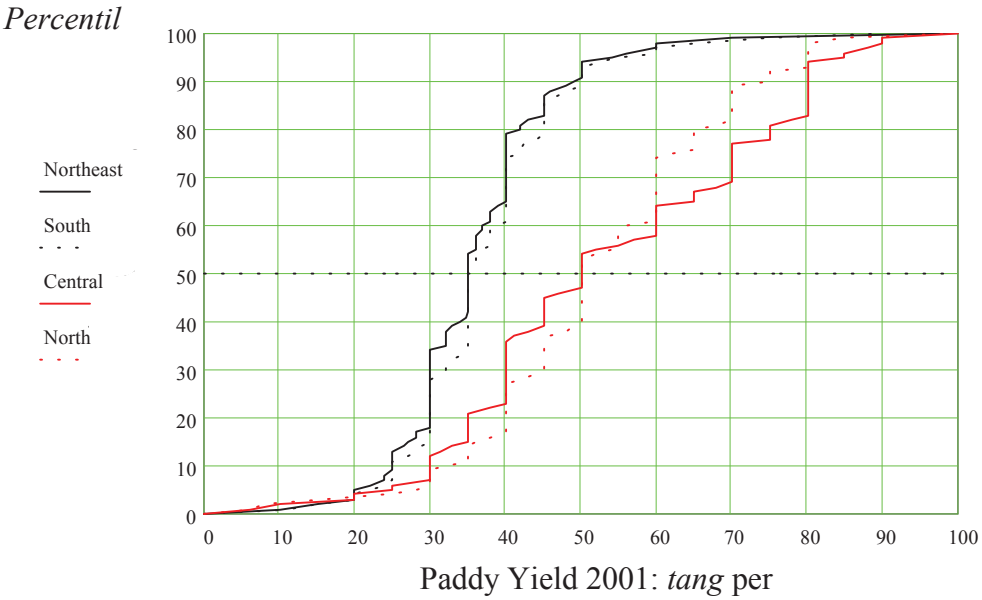


Figure 1 shows the percentiles of yields on the vertical axis plotted against *tang* weight per *rai* on the horizontal axis, from the data on typical paddy yields for the years 1992 and 2001. The rightward shift of the 2001 percentile schedule relative to the 1992 schedule in crossing the 50th percentile marker represents an increase in the median productivity of paddy cropping over the decade, from 35 to 40 *tang*—an increase of 0.3 tonnes per hectare, across the country in all villages with paddy-cropping households.

REGIONAL DIFFERENCES IN PADDY YIELD

The same set of NRDC data on paddy yields can be used to show yield differences between the main geographic regions. The paddy-producing villages in the database are classified by their area code into regional groupings. Figure 2 plots the paddy yield percentiles against productivity similarly measured in *tang* per *rai* for villages in the Central, North, Northeast and South regions in 2001.

Figure 2



As in Figure 1, the median productivity value in Figure 2 is shown to be where each region's respective percentile schedule crosses the 50th percentile marker on the vertical axis. The Central and the North regions are the more productive with equal median yields of 50 *tang* per *rai* or 3.1 tonnes per hectare, in comparison with median yields of 35 *tang* per *rai* or 2.2 tonnes per hectare for the Northeast and the South.

IRRIGATION OF PADDY-CROPPING VILLAGES

The NRDC database contains individual village profiles bearing on the physical infrastructures, provision of government services and facilities, and other characteristics which the census questionnaire—not always the same from year to year—is designed to inform. The profiles can thus be used to classify villages by selected criteria to show cross-sectional differences between different groups and different geographic areas at a point in time. Or, if questions on particular aspects or characteristics of the villages are repeatedly asked from one census year to another, the NRDC data on those observations become a time series, giving a time profile of the dynamic changes occurring between two or more census dates.

To examine the changes in paddy yield and the correlation of yields with the provision of irrigation facilities, paddy-cropping villages are grouped into those with and without 'important' surface water source from man-made reservoirs (dams or storage tanks), delivered via the main system structures (irrigation canals, weirs, dykes, or watergates). Those villages with such facilities delivering significant irrigation water resource are classified as 'irrigated'; the rest are 'non-irrigated'. From the 2001 NRDC village census data, paddy-cropping villages with irrigation facilities providing significant water resource—described inclusively as the most important and the second and third most important sources of surface water—accounted for only 17.6 percent of all the villages. The residual 'non-irrigated' villages accounted for 82.4 percent. Out of the total number of 4.8 million paddy-cropping households in the 'irrigated' villages, only 0.85 million or 17.7 percent could be said to have significantly benefited from community irrigation infrastructures.

THE DISTRIBUTION OF PRODUCTION

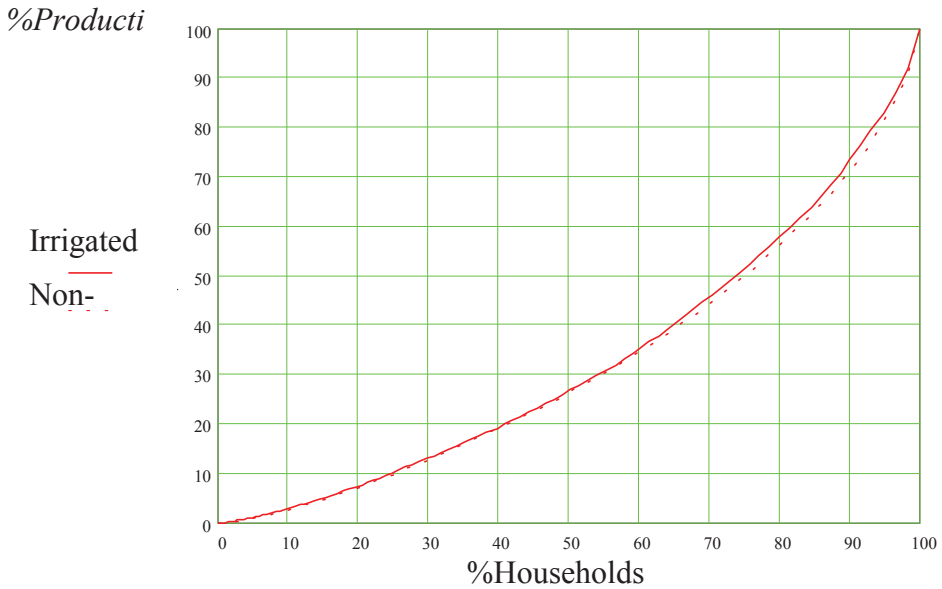
Production distributions under different production regimes also indicate the relative efficiency or productivity of the regimes. The effectiveness or efficiency of irrigation will be the greater if the incremental yields can be achieved and distributed not only to raise the overall mean yield but also to reduce productive inequality among affected groups of the population.

From the NRDC village census, paddy output is given by the typical yield and cropping area of the village. Output distribution is compiled from the villages' respective outputs by kilogram weight. The population distribution is given by the number of paddy-cropping households of the respective villages.

The productivity in rice cropping is represented in Figure 3 by plotting the percentages of physical outputs on the vertical axis against the percentages of paddy-cropping households on the horizontal axis. The households are grouped into those from 'irrigated' villages and from 'non-irrigated' villages, as defined in the previous section. The paddy outputs of the two categories are plotted against the number of respective paddy-cropping households in percentage terms. The X-Y plot for each category represents output distribution among the households and their relative productivity.

The two curves in Figure 3 are production-households distributions of rice cultivation in 2001: one represents production of households in villages with irrigation infrastructures delivering significant water resource ('irrigated'), and the other of households with no community irrigation facilities ('non-irrigated').

Figure 3



There is very little difference between the two distribution schedules, although the productivity level is slightly in favor of the irrigated villages. Reading from the vertical axis, Figure 3 shows that in the irrigated villages, 74 percent of the farming households produce half the quantity of paddy output, whereas in non-irrigated villages 76 percent of the households produce half of the output. Putting it another way and reading instead from the horizontal axis, Figure 3 also shows that half the farming households in irrigated villages produce 28 percent of the output, whereas in non-irrigated villages half the households produce 27 percent of the output.

THE DECLINING IMPORTANCE OF IRRIGATION

Surprisingly, it is found that at the end of the decade a lesser number of villages—not more—chose to describe the irrigation facilities to which they had access as being 'important' in providing for their water needs. By the definition previously adopted, an 'irrigated' village with access to irrigation infrastructures and facilities must also define them as 'important' sources of water supply for the village. The benchmark NRDC census in 1992 marking the start of the decade showed a higher percentage of 'irrigated' villages at 27.0 percent in the total number of paddy-cropping villages; and the corresponding percentage of resident paddy-cropping households with access to irrigation infrastructure was 28.5 percent of the total number of paddy-cropping households.

Both the percentages and the numbers of villages and paddy-cropping households under the 'irrigated' category were higher in 1992 than in 2001. The decline in importance of irrigation infrastructures as water sources for the villages that had access to them was persistent for all regions in all the census years from 1992 to 1999, the trend being only partially reversed in 2001. Over the decade, the number of paddy-cropping 'irrigated' villages which described their irrigation infrastructures as 'important' surface water sources fell, from 13,283 villages in 1992 to 9,577 villages in 2001. The numbers by category and by year are shown in Tables 1 and 2.

Table 1 shows the number and proportion of paddy-cropping villages and Table 2 the number and proportion of households classified as 'irrigated' or 'non-irrigated' from 1992 to 2001 for all regions. The numbers of villages under each classification for each year constitute the sample sizes for the yield estimates in the following section.

Table 1 Paddy-Cropping Villages

Region	Classification	1992	1994	1996	1999	2001
Central	Irrigated	3,699	3,747	3,613	2,618	2,473
	Non-Irrigated	6,548	6,386	5,845	7,330	7,884
North	Irrigated	2,852	2,532	2,374	2,076	2,306
	Non-Irrigated	7,330	7,545	7,811	9,476	9,761
Northeast	Irrigated	5,726	4,803	4,505	3,324	4,109
	Non-Irrigated	18,307	19,446	19,457	23,741	23,849
South	Irrigated	1,006	759	658	594	689
	Non-Irrigated	3,648	3,786	3,476	3,669	3,397
All Regions	Irrigated	13,283	11,841	11,150	8,612	9,577
	Non-Irrigated	35,833	37,163	36,589	44,216	44,891
Total Villages		***49,116***	***49,004***	***47,739***	***52,828***	***54,468***
Central	*Irrigated*	*7.5%*	*7.6%*	*7.6%*	*5.0%*	*4.5%*
	Non-Irrigated	*13.3%*	*13.0%*	*12.2%*	*13.9%*	*14.5%*
North	*Irrigated*	*5.8%*	*5.2%*	*5.0%*	*3.9%*	*4.2%*
	Non-Irrigated	*14.9%*	*15.4%*	*16.4%*	*17.9%*	*17.9%*
Northeast	*Irrigated*	*11.7%*	*9.8%*	*9.4%*	*6.3%*	*7.5%*
	Non-Irrigated	*37.3%*	*39.7%*	*40.8%*	*44.9%*	*43.8%*
South	*Irrigated*	*2.0%*	*1.5%*	*1.4%*	*1.1%*	*1.3%*
	Non-Irrigated	*7.4%*	*7.7%*	*7.3%*	*6.9%*	*6.2%*
All Regions	**Irrigated**	*27.0%*	*24.2%*	*23.4%*	*16.3%*	*17.6%*
	Non-Irrigated	*73.0%*	*75.8%*	*76.6%*	*83.7%*	*82.4%*
Total %		***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***

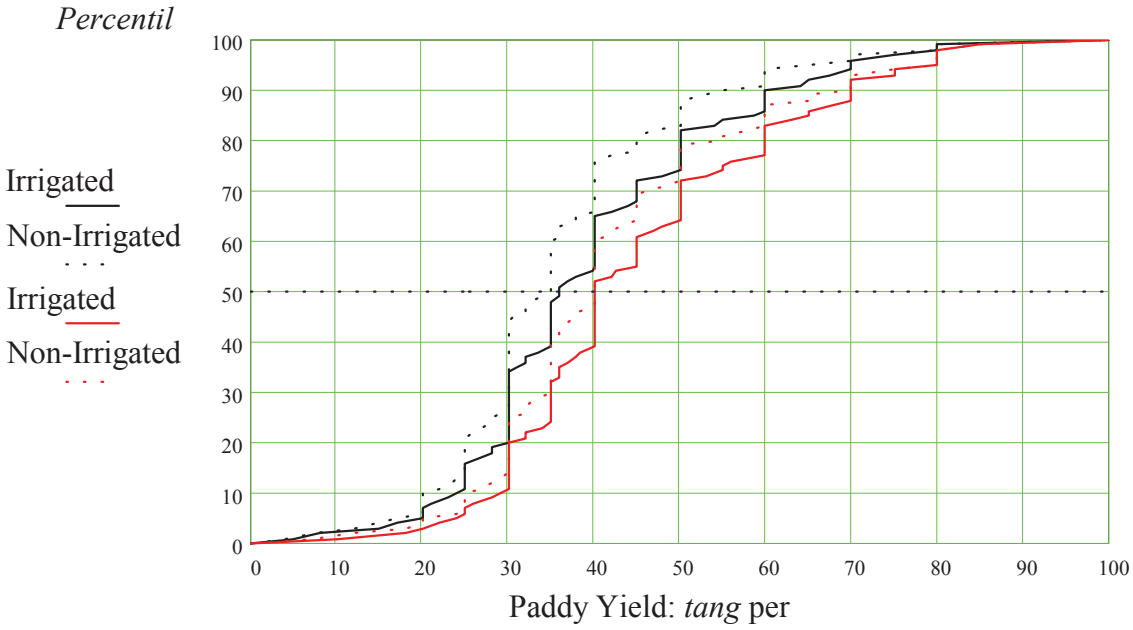
Table 2 Paddy Cropping Households

Region	Classification	1992	1994	1996	1999	2001
Central	Irrigated	199,959	199,496	194,179	132,309	121,315
	Non-Irrigated	296,490	290,375	278,827	321,134	362,013
North	Irrigated	308,990	264,308	254,970	207,802	234,248
	Non-Irrigated	672,481	703,600	765,501	863,806	881,196
Northeast	Irrigated	577,261	489,808	486,421	339,820	435,000
	Non-Irrigated	1,706,321	1,839,643	1,947,634	2,337,259	2,438,765
South	Irrigated	88,393	66,434	57,619	53,955	60,339
	Non-Irrigated	269,257	287,981	266,844	277,800	263,929
All Regions	Irrigated	1,174,603	1,020,046	993,189	733,886	850,902
	Non-Irrigated	2,944,549	3,121,599	3,258,806	3,799,999	3,945,903
Total Households		***4,119,152***	***4,141,645***	***4,251,995***	***4,533,885***	***4,796,805***
Central	*Irrigated*	*4.9%*	*4.8%*	*4.6%*	*2.9%*	*2.5%*
	Non-Irrigated	*7.2%*	*7.0%*	*6.6%*	*7.1%*	*7.5%*
North	*Irrigated*	*7.5%*	*6.4%*	*6.0%*	*4.6%*	*4.9%*
	Non-Irrigated	*16.3%*	*17.0%*	*18.0%*	*19.1%*	*18.4%*
Northeast	*Irrigated*	*14.0%*	*11.8%*	*11.4%*	*7.5%*	*9.1%*
	Non-Irrigated	*41.4%*	*44.4%*	*45.8%*	*51.6%*	*50.8%*
South	*Irrigated*	*2.1%*	*1.6%*	*1.4%*	*1.2%*	*1.3%*
	Non-Irrigated	*6.5%*	*7.0%*	*6.3%*	*6.1%*	*5.5%*
All Regions	*Irrigated*	*28.5%*	*24.6%*	*23.4%*	*16.2%*	*17.7%*
	Non-Irrigated	*71.5%*	*75.4%*	*76.6%*	*83.8%*	*82.3%*
Total %		***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***

CORRELATION OF YIELD AND ACCESS TO IRRIGATION FACILITIES

Figure 4 compares the respective yields of irrigated and non-irrigated paddy-cropping villages for the years 1992 and 2001. Although the yields of irrigated villages are generally higher at other percentiles (as might be expected), the median yield of 40 *tang* per *rai* or 2.5 tonnes per hectare is the same for both categories—irrigated and non-irrigated—in 2001. For the benchmark year of 1992, the median yield of irrigated villages is 36 *tang* per *rai* (2.3 tonnes per hectare) as against 35 (2.2 tonnes per hectare) for non-irrigated villages. The margins of difference in the median yields between the two categories by region generally increased up to 1996 but since then have diminished or vanished.

Figure 4



The data plotted in Figure 4 correspond with the median yields data shown in Table 3, which show the secular diminuation of the differences in the median yields of irrigated and non-irrigated villages for all regions and for all years since 1992. The smaller the difference in the median yields of irrigated paddy-cropping over non-irrigated areas, the lesser are the marginal benefits of investments in irrigation, and the smaller the economic returns relative to the costs. To sustain government expenditures on irrigation on the condition of acceptable economic return, the policy and design of irrigation programs will need to be re-adjusted. The aim should be to deliver better marginal performance by better delivery of water resources, and to reverse the trend in the diminishing margin of difference between the median yields of paddy in irrigated and non-irrigated areas. Under-achieving performance of the existing facilities corresponds with the declining relative importance of irrigation infrastructures as water source in the perception of the villages despite huge sums having been spent acquiring them.

Table 3 Median Paddy Productivity in Kilograms per *rai* for Villages With and Without Irrigation

Region	Classification	1992	1994	1996	1999	2001
Central	Irrigated	410	450	450	600	510
	Non-Irrigated	400	400	400	450	500
North	Irrigated	500	470	500	500	500
	Non-Irrigated	420	400	450	500	500
Northeast	Irrigated	300	300	320	350	350
	Non-Irrigated	300	300	320	350	350
South	Irrigated	350	340	350	360	360
	Non-Irrigated	320	328	350	350	350
All Regions	**Irrigated**	**360**	**350**	**400**	**400**	**400**
	Non-irrigated	**350**	**330**	**350**	**380**	**400**

CONCLUSION

Taking at face value the NRDC data which cover some 60,000 rural villages, the overall median paddy yield in Thailand has risen by 14.3 percent, from the benchmark year marking the beginning of the last decade of village data censuses in 1992 at 56 tonnes per hectare, to 64 tonnes per hectare in 2001. No difference in the median productivity is evident in 2001 between rice cropping with and without access to irrigation infrastructures. Regional median yields for the North and the Northeast for villages with and without irrigation facilities have stayed at the same level since 1999. In all the regions and in almost all the years since 1992, the margins of differences in the median paddy yields of villages with and without irrigation infrastructures have secularly diminished.

In the light of the empirical evidence, the policy and design with regard to community irrigation infrastructures and facilities in Thailand will need new thinking. The benefits of the government's spending to irrigate rice crops should be subject to review and be rigorously re-appraised, for cost-effectiveness and adequate return on investment.

The physical infrastructures of irrigation are popularly seen as icons of development, to help Thai rice farmers increase their productivity and income. On economic grounds, the policy goal should not be pursued at whatever costs. The evidence on the ground suggests that the presence of irrigation infrastructures and facilities in themselves do not ensure that farmers generally get the amount of water and its delivery as and when needed. The relative importance that is attached by the people to such infrastructures as had been provided by the government has diminished. Infrastructures associated with large-scale irrigation schemes are less to be relied on than in the past as dependable and systematic water sources for cropping, despite having been the overwhelming part of the government's agricultural spending in past years.

[1] **Technical Notes**

NRDC is acronym for the National Rural Development Committee. The NRDC data are compiled from answers submitted to the village census questionnaire, technically known as the NRDC 2C form. The census is taken every two years beginning in 1984, but was deferred in 1998 by one year and the series was resumed in 1999. The Department of Community Development, of the Ministry of Interior, is responsible for the organization, collection, and compilation of the data which are returned by all rural villages in Thailand. *All* villages are technically rural if outside of urbanized municipal areas and so-called sanitary districts. The 1992 NRDC census listed 59,640 rural villages; in 2001, a total of 66,193 were listed.

A village is the smallest administrative unit of a province: the village headman represents officialdom at the local level. He sits in a committee of colleagues from neighboring villages called the *tambon* council, which represents a group of about 10 villages forming the next unit up in the administrative hierarchy. The *tambon* council is entrusted with the collective responsibility for supplying the correct information, specific to each village that the council represents, on the NRDC 2C form.

Data on rice cropping used in this paper are taken only from villages supplying full information as required by the NRDC 2C form with regard to typical yield and price, cropping area, and the number of cropping households. Community irrigation infrastructures are dams, reservoirs or storage tanks, irrigation canals, weirs, dykes, and watergates. The presence of such infrastructures are recognized only if the village identifies them as being the most important ('surface-2'), the second most important ('surface_4') or the third most important ('surface_6') surface water category for the village, which is then classified as 'irrigated'.