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Rainfed Revolution in Northeast Thailand

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Abstract

The Northeast is still the poorest region in Thailand, but over the past two decades it has experienced underappreciated major economic growth. This growth has not been confined to urban areas, and living conditions in rural villages have improved. Using Thai Government data and other sources, this report describes and analyzes changes that have occurred. More people now work in non-agricultural jobs, both permanently and part-time with agriculture, and remittances from emigrants working outside the region have been of great help. But in farming households agricultural income has so far remained a very major part of overall income, a principal reason why the majority of the population has stayed in agriculture and rural villages became better off. We argue that this occurred primarily because of agricultural breakthroughs after the adoption of the glutinous rice variety RD6, with the non-glutinous variety KDML105 playing a complementary commercial role. Increased agricultural income helped make the villages more attractive settings for residence, joint investments and remittances, all of which ramified beyond the villages to help lift the economy of the region, and of the nation.

Keywords: Northeast Thailand, economic change, agricultural development, rainfed rice, RD6, KDML105, remittances

Introduction

The popular view of Northeast Thailand (Isan) seems to have changed little over the years. As still portrayed in the media, impoverished farmers forever battle with poor soils, droughts and floods that devastate their subsistence rice crops upon which their livelihood depends. While the rest of Thailand develops, the Northeast lags behind, trapped in rural poverty and increasingly disadvantaged.[1)]

Droughts and floods notwithstanding, this stereotypical view is much less true today

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1) In December 2007 the Ministry of Social Development and Human Security announced the results of its new Human Security Index (similar to quality of life). The press was very surprised to hear that the Northeastern provinces on average were rated the highest in the country [*Bangkok Post* 2007]. In a day or two the issue seemed to fade from notice.

than in the past. Northeasterners are still, on average, less wealthy than those in other regions, but indicators such as GDP per capita probably overstate the difference (and the labor productivity gap has also been exaggerated) [Ikemoto and Takei 2004]. The region is not, and may never be, a location of major industrial growth. Also, it has no seashore and fewer scenic mountains and forests that attract residents, businesses, visitors and retirees to other regions of Thailand. But this region, although still largely agricultural, has not been stagnating. In fact, it has had "one of the fastest growing economies in the world," markedly slow only when compared to places with very high growth like Bangkok and some East Asian countries [NESDB and World Bank 2005: 5, 31–32].[2)]

Economic growth in the Northeast has been most noticeable in cities and their expanding suburbs, but rural villages have participated as well. In fact, cities and rural villages no longer exhibit enormous differences in living conditions. Fig. 1 shows some of the more striking changes. Almost all village households now have electricity, color televisions and electric fans. Most have piped water (and safe drinking water, usually rainfed), and almost all have private bathrooms.[3)] Like their urban counterparts, many

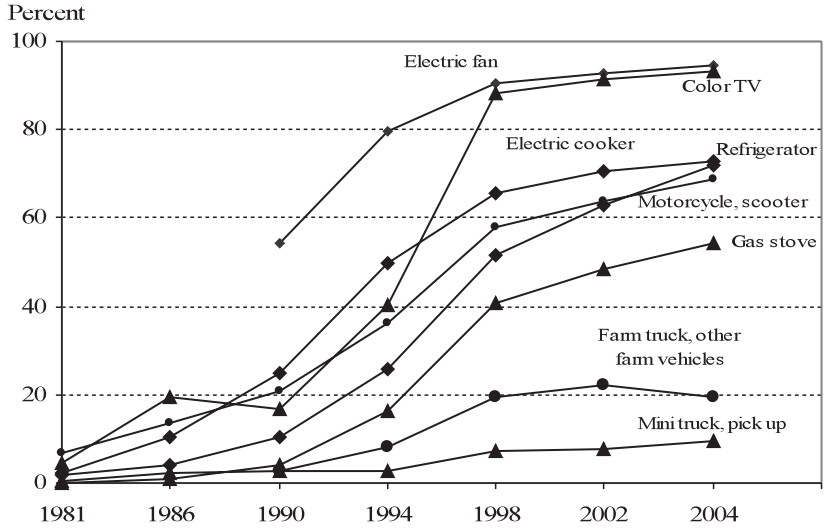

Fig. 1 Percent of Village Households in Northeast Thailand by Selected Durable Goods Owned

Source: Appendix Table 1

2) List of acronyms used in this report can be found at the back, after the main text.

3) SES [2004]: 77.5% of Northeastern village households have piped water and 98.9% have private indoor bathrooms. PHC [2000: 2]: 90.2% of all households in the Northeast have safe drinking water.

people have mobile phones.[4] Nearly three-quarters have refrigerators. Wood and charcoal are still used in cooking, but over three-quarters also use electric cookers and over half have gas stoves.[5] A large majority now own some type of motor vehicle, mostly motorcycles, but pick-up trucks are on the rise. Most rural houses have been noticeably improved, and half or more have been reconstructed or newly built in a more modern, urban-type design.[6]

The plots in Fig. 1 generally show near-sigmoidal patterns—gradual change in the 1980s, followed by rapid change up to the time of the economic crisis in 1997, followed by gradual change thereafter. This timing suggests major changes in the rural Northeast may have been tied into Thailand's breakthrough period of industrial growth. But how? The changes were not the result of the long-awaited industrialization in the Northeast. There are some new factories in the Northeast, but the vast majority of factories employing large numbers of people are still in the Greater Bangkok Metropolitan Region (GBMR) and vicinity and the Eastern Seaboard [Grandstaff 1990: 3; DIW 2008; also see Ichikawa 1991 and Hussey 1993]. Efforts to promote this kind of growth in the Northeast have generally met with failure [NESBD and World Bank 2005: 60, 200; Glassman and Sneddon 2003]. Neither were these changes a result of the disappearance of the major constraints inhibiting agricultural development in the region. The rolling, fragmented terrain and shallow watershed gradients are unchanged. The vast majority of agricultural land is still primarily rainfed and the severe limits on major irrigation works still apply today.[7] The soils are still problematical—areas with salinity may have even expanded (anecdotal accounts). The highly variable rainfall, floods and droughts seem the same as ever, if not worse.[8]

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4) CDD [2003]: 29% of rural village households in the Northeast reported having at least one mobile phone, compared to 34% for all such villages in the country. CDD surveys villages designated as poor, which includes most rural villages in the Northeast.

5) PHC [2000]: Villagers still cook primarily with charcoal (33%) and wood (30%).

6) PHC [2000] put the portion of rural house made of cement and brick at 14%, cement/brick and wood 30%, and otherwise permanent 49%. SES [2004] reported 20% cement and brick, 41% cement/brick and wood. Visual impression from recent widespread observation in Northeastern villages suggests a large majority of houses have been improved [see also Grunbuhel *et al*. 2003: 68 footnote 15].

7) Even with full development, only 16% of cultivatable land in the Northeast could be serviced by a major irrigation system, because of limitations of the type of terrain and water sources in the region [AIT 1978; Limpinuntana *et al*. 1982: 53–54; also see Long 1966: 357 and Pendleton 1962: 148]. By 2006, less than 7% of agricultural land in the Northeast was serviced by a large or medium sized system, the lowest of all regions in the country [calculated from OAE 2006: Tables 127 and 129; 2007: Table 128]. Somrith and Awakul [1979: 113, Table 1] estimated 90% of the paddy land in the region was "shallow or intermediate rainfed land" and only 8% of it was irrigated.

8) Rainfed rice fields in Northeast Thailand are "rainfed shallow drought– and submergence-prone" and "rainfed shallow drought-prone type II" [Mackill *et al*. 1996: 4–10]. In most areas both types can be found at the local level. "Drought is the major problem in rainfed areas"↗

Data patterns like those in Fig. 1 and elsewhere in this report suggest major, qualitative change resulting from crossing some sort of threshold or tipping point in the late 1980s, after which a set of factors interacted in a mutually-amplifying positive-feedback process [Maruyama 1963]. This report identifies and assesses the main factors involved and infers how they interacted, relying primarily on Thai Government statistical data and Thai and English language publications and reports, but also on expert opinions and all four authors' experience around the Northeast over the past thirty years. Available sources do not have all the data most needed, but nevertheless, a general assessment can be made.[9)]

In the following analysis it will be seen that there have been major changes in Northeast Thailand in four general types of factors: (1) increased non-agricultural employment within the region; (2) joint investments, remittances and commitments to those within rural villages from relatives working in non-agricultural jobs both inside and (primarily) outside the region; (3) increased seasonal off-farm work, both inside and outside the region; and (4) agricultural breakthroughs. In analyzing changes, timing and apparent proximate connectives in more detail, we will argue that agricultural breakthroughs were probably the most critical to improving living conditions within the region. They led to increased income from both farm and non-farm work for a very large number of households, which then helped generate other types of local employment. Improving and sustaining agricultural employment also helped make the villages attractive settings for joint investment and support from those working elsewhere. Central to the agricultural breakthroughs were two particular rice varieties—RD6 and KDML105, with RD6 being the last "missing piece." After its arrival in the Northeast, agricultural factors interacted with each other and with non-agricultural factors to produce the positive feedback process that saved the family farms and contributed largely to rapid economic growth within the region.

Without the agricultural breakthroughs, a far different outcome might have occurred, as has happened in other times and places and many have predicted would happen here as well. Major emigration in response to employment opportunities generated by rapid industrialization and urbanization outside the region might have resulted in spiraling decay of Northeastern towns and villages and a lower living standard for the rural inhabitants who stayed behind.

The organization of the rest of this report is influenced by the government data

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↘ [Pushpavesa *et al*. 1986: 168]. When rainfall is scarce, as it frequently is, drought is widespread within the affected area. Flooding occurs less often, but many of the "lower paddies" that are typically part of farm holding are flood prone as well. ("The drought-prone area in the northeast is subjected to submergence from time to time" [Pushpavesa *et al*. 1986: 169].)

9) The principal numerical data underlying the analysis in this report are included in the tables and in the appendix, but the analysis here stops short of mathematical modeling and statistical testing.

sources used, upon which the analysis depends. In the first of three major sections we overview the changes in population, employment and household types in the region. We start with the population changes in cities and villages, then discuss those who gained non-agricultural employment within the region, then those who left the region, then the growth of support they provided for those remaining behind. We then turn to the changing employment characteristics of the agricultural households, including their seasonal off-farm work. This sets the stage for the next major section to discuss agricultural changes centered on rice agriculture. Then in the third and final major section we summarize and highlight particular findings and discuss interrelationships and implications.

Population and Employment

Table 1 shows summary data on population and employment over the past quarter century from six different government sources, in the six major sections of the table. Data differ among sources primarily because of different definitions and collection schedules. In any one of the six sets, where additional data points in time were available, the ones presented here were selected for cross-source comparison and multi-source analysis. Putting this information in a single table allows for ready cross reference when we discuss the data, and should also be useful for readers who may wish to pursue the information further.

Cities and Villages

Despite net emigration (discussed below), population in the Northeast grew by nearly a third between 1980 and 2000, from 16 million to 21 million people (Table 1, lines 1.1, 3.1). Although more definitive data are unavailable (see Table 1, note 1), observation clearly shows that substantial population growth has taken place in and around major urban areas. Available data show that non-village population nearly doubled between 1980 and 2000, from 1.8 to 3.5 million people, while village population increased by a quarter, from 13.9 to 17.34 million (Table 1, lines 2.5 and 2.7). But urban growth has expanded across municipal boundaries and many villages have now become urban suburbs. So some, or perhaps even all of this village population growth was actually peri-urban growth.[10] By

10) Village data are now called "non-municipal" because in 1999 everything non-municipal except villages (i.e., urban and rural sanitary districts) was moved to the municipal category. However, in order to keep the same categories clearly identified for comparison over time, in this report we simply keep to the old definition of "village" (even though some are now suburbs) and group all others as "non-village" (see Table 1, notes 1 and 2). Changing definitions make it more difficult to measure urban growth (e.g., the "municipal" registered population jumped from 1.32 million in 2000 to 3.28 million in 2002, in Table 1, line 1.2). Nevertheless, real, evident, widespread substantial urban growth has certainly taken place.↗

Table 1　Population and Employment in Northeast Thailand (all figures in millions except percentages)

Year	1980	1983	1986	1988	1990	1993	1994	1998	2000	2002	2003	2004
1. 1.　all registered pop	16.20	17.22	18.55	19.25	19.83	20.17	20.54	21.31	21.40	21.61	21.66	21.27
1. 2.　municipal regis pop	0.69	0.99	1.08	1.12	1.13	1.12	1.25	1.33	1.32	3.28	3.26	3.27
1. 2. 1.　(as % all regis)	(4%)	(6%)	(6%)	(6%)	(6%)	(6%)	(6%)	(6%)	(6%)	(15%)	(15%)	(15%)
1. 3.　non-mun regis pop	15.51	16.23	17.47	18.14	18.70	19.06	19.29	19.98	20.09	18.33	18.40	18.00
1. 3. 1　(as % all regis)	(96%)	(94%)	(94%)	(94%)	(94%)	(94%)	(94%)	(94%)	(94%)	(85%)	(85%)	(85%)
2. 1.　all census pop	15.70				19.04				20.83			
2. 2.　all census hh's	2.72				4.05				5.07			
2. 3.　municipal pop	0.63				1.11				n. d.			
2. 4.　non-municipal pop	15.07				17.93				n. d.			
2. 5.　non-village pop	1.80				2.78				3.49			
2. 5. 1.　(as % all cens pop)	(11%)				(15%)				(17%)			
2. 6.　non-village hh's	0.33				0.64				0.91			
2. 6. 1.　(as % all cens hh's)	(12%)				(16%)				(18%)			
2. 7.　village pop	13.90				16.26				17.34			
2. 7. 1.　(as % all cens pop)	(89%)				(85%)				(83%)			
2. 8.　village hh's	2.39				3.41				4.16			
2. 8. 1.　(as % all cens hh's)	(88%)				(84%)				(82%)			
2. 9.　all working persons	8.34				11.41				12.07			
2. 10.　working in agric	7.43				9.80				9.20			
2. 10. 1.　(as % all work pers)	(89%)				(86%)				(76%)			
2. 11.　ag households					2.83				n. d.			
2. 11. 1.　(as % all cens hh's)	(78%)				(70%)							
3. 1.　all population			16.0		19.4		20.4	20.8		21.1		n. d.
3. 2.　all households			3.3		4.3		5.0	5.1		5.1 *		n. d.
3. 3.　village population			14.3		17.0		17.4	17.3		17.5		n. d.
3. 3. 1.　(as % of all pop)			(89%)		(88%)		(85%)	(83%)		(83%)		
3. 4.　village households			2.9		3.7		4.2	4.2		4.3 *		n. d.
3. 4. 1.　(as % of all hh's)			(88%)		(86%)		(84%)	(82%)		(84%)		
3. 5.　ag households (% of all hh's)			70.6%		64.4%		44.5%	48.6%		39.4%		37.2%
3. 5. 1.　ag hh's on own land (")			(58.1%)		(55.1%)		(37.3%)	(40.4%)		(30.7%)		(28.0%)
3. 5. 2.　ag hh's on rented land (")			(5.2%)		(3.1%)		(2.5%)	(3.8%)		(2.8%)		(3.9%)
3. 5. 3.　ag laborer hh's (")			(7.3%)		(6.2%)		(4.7%)	(4.4%)		(5.9%)		(5.3%)
3. 6.　business/trade hh's (")			8.3%		7.8%		10.6%	11.5%		11.7%		12.5%
3. 7.　professional hh's (")			5.3%		3.6%		5.0%	5.1%		6.4%		7.1%

3. 8. non-ag laborer hh's (")			2.4%		2.7%		3.8%	0.8%		1.6%		1.2%
3. 9. clerk/sales/service hh's (")			4.0%		6.1%		7.2%	7.6%		8.4%		8.5%
3. 10. factory/construction worker hh's (")			4.0%		5.3%		10.8%	10.3%		9.3%		9.6%
3. 11. "supported" hh's (")			5.4%		10.1%		18.1%	16.1%		23.2%		23.9%
4. ag holding "hh's" (ahh)	1.79	1.94	2.08	2.12	2.13	2.25	2.26	2.42	2.61	n. d.		2.70
5. 1. ag holding "hh's" (ahh)		1.90		2.18		2.50		2.59			2.65	
5. 2. ahh w/income agric only		n. d.		n. d.		1.14		0.90			0.48	
5. 2. 1. (as % all ahh)						(46%)		(35%)			(18%)	
5. 3. ahh income mostly non-ag		n. d.		n. d.		0.45		0.62			0.76	
5. 3. 1. (as % all ahh)						(18%)		(24%)			(29%)	
5. 4. ahh hiring temp ag workers		n. d.		0.83		1.04		1.65			1.78	
5. 4. 1. (as % all ahh)				(38%)		(42%)		(64%)			(67%)	
5. 5. persons in ahh		10.84		11.01		11.44		11.05			10.65	
5. 6. persons employed in ahh		6.96		8.35		8.33		7.34			7.72	
5. 7. any ag work on own holding		6.86		8.12		7.93		7.22			7.27	
5. 8. only ag work on own holding		5.55		7.17		5.48		4.01			3.44	
5. 8. 1. (as % pers empl in ahh)		(80%)		(86%)		(66%)		(55%)			(45%)	
5. 9. ag part-time on own holding		1.31		0.95		2.43		3.20			3.77	
5. 9. 1. (as % pers empl in ahh)		(19%)		(11%)		(30%)		(44%)			(49%)	
5. 10. mostly on own holding		n. d.		n. d.		1.75		2.14			2.65	
5. 10. 1. (as % ag part-time own holding)						(72%)		(67%)			(70%)	
5. 11. mostly on other holdings		n. d.		n. d.		0.11		0.15			0.26	
5. 11. 1. (as % ag part-time own holding)						(5%)		(5%)			(7%)	
5. 12. mostly non-ag		n. d.		n. d.		0.57		0.92			0.86	
5. 12. 1. (as % ag part-time own holding)						(23%)		(29%)			(23%)	
5. 13. work only off own holding		0.10		0.23		0.41		0.12			0.51	
5. 13. 1 (as % pers empl in ahh)		(1%)		(3%)		(5%)		(2%)			(7%)	
6. 1. pers in labor force wet season		9.50	10.10	11.09	11.52	11.67	11.65	11.24	11.29	11.59	11.56	11.80
6. 2. pers employed in wet season		9.32	9.63	10.59	11.17	11.36	11.42	10.78	10.81	11.33	11.35	11.62
6. 3. pers empl in ag in wet season		8.12	8.34	9.03	9.58	9.07	8.82	8.02	7.66	7.39	7.46	7.24
6. 3. 1. (as % empl in wet season)		(87%)	(87%)	(85%)	(86%)	(80%)	(77%)	(74%)	(71%)	(65%)	(66%)	(62%)
6. 4. pers in labor force dry season		8.26	9.23	9.81	n. d.	10.67	10.39	10.49	10.65	10.63	10.69	10.84
6. 5. pers employed in dry season		6.17	7.18	8.08	n. d.	9.16	8.64	8.73	8.99	9.52	9.98	10.05
6. 5. 1. (as % empl in wet season)		(66%)	(75%)	(76%)		(81%)	(76%)	(81%)	(83%)	(84%)	(88%)	(86%)
6. 6. in ag in dry season		4.13	5.01	5.85	n. d.	4.93	4.79	4.50	4.65	4.49	4.75	4.58
6. 6. 1. (as % empl in dry season)		(67%)	(70%)	(72%)		(54%)	(55%)	(52%)	(52%)	(47%)	(48%)	(46%)
6. 6. 2. (as % empl in ag wet season)		(51%)	(60%)	(65%)		(54%)	(54%)	(56%)	(61%)	(61%)	(64%)	(63%)

Table 1—continued
Sources and Notes:
*(Asterisks on these two figures means they are estimates recalculated by the authors, explained in note 3b below.)

1. Lines 1.1–1.3.1. DOPA/DOLA as reported in NSO annual Statistical Yearbooks. NB: For data from 2001: all sanitary districts were upgraded to municipal status, thus municipal and non-municipal data from 2001 cannot be compared with corresponding data before 2001. (The upgrade was in 1999 but 2000 data on these lines did not yet reflect the change).
2. Lines 2.1–2.11.1 NSO Population and Housing Censuses [PHC] Table 1 (1980, 1990, 2000) for lines 2.1–2.8 and 2.11; and Tables 25 (1980), 23 (1990) and 13 (2000) for lines 2.9 and 2.10. "People were counted on the basis of their usual places of residence, including those away no longer than 3 months, and temporary residents (less than 3 months) having no other places of residence…" [PHC 2000: Annex 1, "Coverage"]. Type of employment is based on time spent during preceding year, unless equal time with other occupation, in which case based on major source of income (cash+in-kind). N. B., on lines 2.3–2.8.1, PHC [2000] used the new definition of municipal (see Note 1 above), but we have retained the term "village" instead of re-labeling it "non-municipal" and called the new municipal data "non-village" and retrieved the same classes of data from the previous censuses so they can still be compared.

3a. Lines 3.1–3.11. Computed from NSO Household Socio-Economic Surveys [SES]. Lines 3.1–3.4.1 from SES [1986: 16; 1990: 45; 1994: 55; 1998: 7; 2002: 7]. Population figures in lines 3.1 and 3.3 are government projections, and households in lines 3.2 and 3.4 are those figures divided by average household sizes within SES samples. N. B., therefore, caution should be exercised in using these particular figures, especially the household figures because any error in the population figures would be compounded by any error in the average household sizes from the survey samples. Percents in employment categories in lines 3.5–3.11 are calculated within the SES sample, from Tables 10.1 (1986, 1990), 12.1 (1994, 1998) and 11.1 (2002, 2004). These figures are independent of the figures in lines 3.1–3.4.1 and thus do not have the same drawbacks. Categories were defined by main source of income (cash+in-kind), unless two are equal, in which case based on most time spent. Ag households does not include households where agriculture is practiced but not main source of income, probably including many "supported" households ("economically inactive"—more than half income from remittances, pensions, etc.). Agricultural employment includes owners, renters and agricultural laborers. (The last category, ag laborers, not used in land-based definitions from other sources.)

3b. SES computation of number of households in the Northeast and in villages in the Northeast may not always be accurate (see note 3a above). In particular, data for 2002 seemed to need adjustment (5.65 and 4.6 million regional and village households respectively), because these figures were apparently calculated using household sizes that seem too small (3.7 and 3.8 persons/household, respectively), compared not only to other sources but also to data before and after within the same source. 2000 PHC reported 4. 11 and 4. 17 respectively; 2003 ACIS was 4.02 for agricultural holding households; 2003 CDD Village Profile was 4.2, and 4.1 in 2005. Within the SES, household sizes were 4.1 for both overall and villages in 1998, and 4.05 for both in 2004 (NSO, personal communication). Using the population projections on lines 3.1 and 3.3 in Table 1, if average household size was 4.1 in 2002, the number of households would be 21.1 M/4.1 = 5.1 million for the whole region, and 17.5 M/4.1 = 4.3 million for the villages.

4. Line 4. Office of Agricultural Economics [OAE] Agricultural Statistics of Thailand, Crop Year 1986/87, Table 121; 1992/93, Table 141; 1997/98, Table 135; and Report of Agricultural Household and Labor Socio-economic Study, Crop Year 2004/05 (in Thai), Table 3.1. Agricultural holding "households" here based on land management, similar to Line 5.1 from Agricultural Censuses.
5. Lines 5.1–5.13.1. NSO Agricultural Censuses and Intercensal Surveys [ACIS]. 1983: Tables 5.1, 5.2, 5.3; 1988: Tables 4.2, 4.1, 3.4, 4.4; 1993: Tables 10.1, 9.1, 8.4, 9.5; 1998: Tables 16.1, 13.1, 14.4, 13.6, 13.7; 2003: Tables 18.1, 15.1, 16.3, 15.6. Data are confined to "agricultural holding" households which includes owners and renters but may also include others using land for free (e.g., a father-in-law's land). It does not include households with only agricultural laborers, since they are not "holders." See line 3.5.3 for SES data on what percents of all households fit that category. Lines 5.3 and 5.3.1 were calculated from "mainly from other sources" plus one-half of "equally from agriculture and other sources," the latter being 0.18M in 1993, 0.13M in 1998 and 0.41M in 2003. The larger number in 2003 is probably due to recognized increased, major dependence on non-farm income but being unable to assess it precisely, (e.g., difficulty valuating home-produced food, etc.). If so, the true number ought to be higher than computed here (up to 0.96M, or 36%, if all of them actually had more income from non-farm). In lines 5.10–5.12 "mostly" means in terms of relative time worked. N. B., data do not distinguish the type of off-own-farm job (mostly agriculture or non-agricultural) for those who work mostly on own holding. In line 5.13, work only off own holding is very largely non-agricultural (breakdown not shown here).
6. Lines 6.1–6.6.2. NSO Report of Labor Force Survey [LFS]. Seasonal (Feb, May, Aug, and recently quarterly) "snapshots" by time spent in the week before the survey. Persons unemployed (not shown) in each period= labor force minus persons employed (lines 6.1 minus 6.2 and 6.4 minus 6.5).
7. In general, working persons and employment figures in this table are only among those persons age 11 years+ in 1980s, 13 years+ in the 1990s and 15 years+ from 2000. Persons in the lowest age groups represent only a small percent. E.g., in line 5.6, if earlier data were adjusted to include only those 15 years and over (to make them fully comparable with 2003 data), the 1993 figure would be 8.05 instead of 8.33 and in line 5.8 it would be 5.28 instead of 5.48 [computed from ACIS 1993, Table 9.5]. The percentage in line 5.8.1 would be approximately the same (66%). And the absolute decrease in persons employed in agriculture from 1993 to 2003 was only marginally an artefact of minimum age redefinition (5.48 − 3.44 = 2.04, 5.28 − 3.44 = 1.84). A more detailed examination of year-by-year labor force figures (like those used in lines 6.1–6.6) also shows no sudden changes after age eligibility redefinition.
8. Throughout this table, "pop" means "population," "pers" means "persons," "hh's" means "households," "ag" means "agriculture" or "agricultural," "ahh" means "agricultural holding household."
9. Minor inconsistencies within same data sets are due to rounding error.

some calculations, Northeastern population or village population may be beginning to level off (Table 1, lines 1.1, 1.3, 3.1–3.3). If so, growth in and around cities should be accompanied by population loss in more remote villages. Nevertheless, while households may be getting smaller, this has not yet led to any major consolidation of agricultural holdings or abandonment of houses in rural villages, and there are reasons for that which will be discussed below.

Because of the upgraded road networks and transportation in the Northeast, a great many villages would seem to be candidates for becoming city suburbs. In a sample of the Village Profile [CDD 2003], over a quarter of rural villages and population in the Northeast were within 15 minutes of the nearest town or city by the most common mode of public transportation, and over 80 percent within 30 minutes.[11] But many small Northeastern towns are not major growth centers.[12] Villages covered by CDD [2003] contained 13.1 million people in 3.1 million households, vs. about 17.5 million people in 4.3 million "village" households estimated from an adjustment of the Socio-Economic Survey [SES 2002] (see Table 1, line 3.3 and Table 1, note 3b). In effect, these CDD villages were selected for being rural, so if that is taken as a very rough measure of rural vs. suburban, about three-quarters of the "village" population and households would still be in a rural setting, with the rest becoming suburbs. The overall urban/suburban population would be over a third and the rural population nearly two-thirds of the total regional population and households (divisors in Table 1, line 3.1 and 3.2).

Non-Agricultural Employment

There have been many changes in employment over the past 20 to 25 years, consistent with the population changes described above. By 2002 about 1.9 million households or about three-eighths of the roughly 5.1 million households earned most of their income from occupations other than agriculture, up from 0.7 million households in 1986, a rise of over a million households (Table 2). The number of clerks, construction and factory worker households increased from less than a third of a million households in 1986 to close to a million (staying at about 18% of all households since 1994). But employment

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↘ It is not the *result* of changing definitions.

11) Computed from CDD [2003] (already rural biased) data. 4,430 villages were sampled (representing 14% of all villages in the Northeast and containing 15% of population [calculated from DOPA 2007b]). All provinces were non-randomly sampled. Within the province, districts were selected and all villages within the district sampled. All provincial capital districts were selected but also intentionally offset by choosing one or two of the districts in the province that were most remote from every capital district (i. e., remote from capitals in neighboring provinces as well).

12) As one villager in Selaphum District, Roi Et Province, complained about the lack of employment opportunity, "We really need someone to come and build a factory here." Even some whole provinces may lack urban-type employment opportunities, e. g., Yasothon [see Funahashi 1996: 626–627; DIW 2008].

Table 2　Households in Northeast Thailand by Main Source of Income
(million households and percent of all households in the Northeast)

	1986	1990	1994	1998	2002	2004
1. Clerks, construction and factory workers	0.3	0.5	0.9	0.9	0.9	n. d.
1. 1. (percent)[a]	(8.0)	(11.4)	(18.0)	(17.9)	(17.7)	(18.1)
2. Business, trade and professionals	0.4	0.5	0.8	0.8	0.9	n. d.
2. 1. (percent)[b]	(13.6)	(11.4)	(15.6)	(16.6)	(18.1)	(19.6)
3. General laborers (non-agricultural)	0.1	0.1	0.2	0.0	0.1	n. d.
3. 1. (percent)[c]	(2.4)	(2.7)	(3.8)	(0.8)	(1.6)	(1.2)
subtotal of above (non-ag occupations)	0.7	1.1	1.9	1.8	1.9	n. d.
(percent)	(22.4)	(25.5)	(37.4)	(35.3)	(37.4)	(38.9)
4. Agricultural earners	2.3	2.8	2.2	2.5	2.0	n. d.
4. 1. (percent)[d]	(70.6)	(64.4)	(44.5)	(48.6)	(39.4)	(37.2)
5. Mainly from outside support	0.2	0.4	0.9	0.8	1.2	n. d.
5. 1. (percent)[e]	(5.4)	(10.1)	(18.1)	(16.1)	(23.2)	(23.9)
All households in Northeast[f]	3.3	4.3	5.0	5.1	5.1 *	n. d.
	(100)	(100)	(100)	(100)	(100)	(100)

Sources and Notes: [a] Table 1, lines 3.9+3.10; [b] Table 1, lines 3.6+3.7; [c] Table 1, line 3.8; [d] Table 1, line 3.5; [e] Table 1, line 3.11; [f] Table 1, line 3.2. Number of households in each line are calculated using percents of all households at the bottom of the table, rounded to the same precision.
*Number of all households in 2002 is author estimate——see Table 1, note 3b. In this table, "income" refers to cash plus in-kind. Minor inconsistencies due to rounding error.

growth outside agriculture has not been confined to lower-paying occupations. The number of professionals and business operators (mostly small ones) more than doubled to about a million households and appears to be still increasing. For the lower-earning occupations, the percentage of general (non-agricultural) laborer households did not increase—it fell from 2.4% to 1.2% and has stayed small even in absolute numbers. Also note that most of these increases occurred in one short burst during 1990–94. Percent of households with income primarily from non-agricultural work rose from 25.5% to 37.4% of all households during this short period (subtotal of lines 1–3 in Table 2).

Most of those employed mainly in non-agricultural jobs live in cities and suburban villages. Within households with agricultural activity, only about 5% of working household members work *solely* in non-agricultural jobs. Nearly twice that number work *mostly* outside agriculture and most of them probably also live in suburban villages (Table 1, lines 5.13 and 5.12).[13]

13) If they were away from home long enough to make more money from other sources than agriculture, they would probably have been away long enough not to have been counted as a household member by survey definition. In NSO censuses and surveys, if people stayed away for three months or more, they were usually not counted as living in the household, except in a probable minority of cases when they stayed away for three months or more but had no other "permanent residence" such as ship crews or traveling salesmen [e.g.,↗

Extra-Regional Long-Term Migration

As shown above, over a million additional households joined the ranks of those earning most of their income from non-agricultural employment within the Northeast since the 1980s. However, the widely held perception that most Northeasterners left the region in order to gain such employment is probably correct. The authors believe that this movement has actually been massive, and because of its importance, the evidence for this is derived here in the main text of this report.

Table 3 shows village age-class and selected age-cohort distribution. In village areas in 1980 there were 6.91 million people aged 5–24, but 10 years later in 1990 this cohort (then aged 15–34) had shrunk to 5.82 million people, a net loss of 1.09 million people. By 2000 this same cohort (aged 25–44) was only 5.57 million, even smaller than in 1990. With relatively low mortality at these age levels, it is thus likely that about a million people from this particular cohort were living outside the Northeast in the year 2000. Looking at the next younger cohort, there were 7.21 million people aged 5–24 in 1990. Ten years later there were only 5.86 million people aged 15–34, a net loss of 1.35 million people. In sum, well over 2 million people from Northeastern villages in these two prime-of-life cohorts—aged 15–44 in the year 2000—seem to have been living outside the Northeast in that year (1.09 + 1.35 = 2.44).

We can check on this estimate in another way. From NSO Statistical Yearbooks, between 1993 and 2006 there were 3.69 million live births in the Northeast and 1.51 million deaths, a net population gain of 2.18 million people through birth.

Table 3 Northeast Thailand Village Population Age Class and Selected Cohorts (million persons)

	1980	1990	2000
A. Age class			
0–4years	1.97	1.54	1.52
5–9	2.16	1.92	1.68
10–14	2.00	2.04	1.61
15–19	1.54	1.71	1.54
20–24	1.21	1.54	1.34
25–29	0.98	1.35	1.47
30–34	0.82	1.22	1.51
35–39	0.72	1.06	1.37
40–44	0.61	0.90	1.22
45–49	0.54	0.77	1.01
50–54	0.42	0.63	0.85
55–59	0.31	0.53	0.68
60–64	0.23	0.39	0.54
65–69	0.16	0.27	0.42
70–74	0.11	0.17	0.27
75–79	0.06	0.11	0.16
80+	0.05	0.10	0.14
Total	13.90	16.26	17.34
B. Selected cohorts			
5–24 in 1990		7.21	5.86
5–24 in 1980	6.91	5.82	5.57
15–34 in 1980	4.55	4.53	4.45
25–44 in 1980	3.13	3.36	3.08
35–54 in 1980	2.29	2.32	1.91

Source: PHC [1980: 13–19; 1990: 13–21; 2000: 13] (villages="non-municipal" in PHC [2000]). Part B computed from part A.

↘ ACIS 1993: 19], or stayed away for up to six months specifically for education or training outside the country [e. g., SES 2004: 31]. (N. B., the reader is cautioned to check the more detailed Thai language definitions in these publications in order to best understand these criteria.)

Registered population in 1993 was 20.17 million and in 2006 it was 21.38 million, a net gain of only 1.21 million people. Assuming most births and deaths nowadays are indeed registered and assuming no regional immigration, then subtracting the net gain in registration from the net population gain from births minus deaths should yield the number of Northeasterners who were there in 1993 but were no longer registered there in 2006, i. e., 0.97 million people.

But there *was* regional immigration as well as emigration. Between 1993 and 2006, 14.17 million people registered into a new address in the region, and 13.24 million registered out, i. e., 0.93 million more people registering in than out (14.17 − 13.24 = 0.93). Without regional migration, these two numbers would have been the same. So a net 0.93 million people must have been added to the regional population via immigration during this same period, meaning even more people who were there in 1993 must have left, i. e., a net total of 0.97 + 0.93 = 1.90 million people having left the region.

However, not everyone who leaves the region changes their registration to the new location, although this is less common today than in the past. But by the year 2000, there were still 0.57 million people carried on household registrations in the Northeast who did not appear in the 2000 Census. (21.4 − 20.83 = 0.57, from Table 1, lines 1.1 and 2.1.) This implies they were away at least much of the previous year. So the real total net emigration could be even higher. If we assume that even by 2006, there were still about 0.5 million Northeasterners living outside the region who had not changed their registration, then the estimated net emigration calculated by this second method would again be well over 2 million people (1.90 + 0.5 = 2.4).[14)]

These two methods thus yield similar figures. The second estimate is for a time period that is shorter, and later, but perhaps this was compensated for by the fact that it includes people of all ages, not just prime working age people.

In any case, these estimates are adequate for our purposes here. There were 4.16 million village households in the Northeast in the year 2000 and about 4.3 million in 2003

14) The year 1993 is used for the purpose of data compatibility because available data on the number of people registered in and out of the region only went back to 1993 on the government website [DOPA 2007a]. In the past, many Northeasterners stayed registered in the Northeast despite working year-round elsewhere, causing, for example, mass exodus from Bangkok prior to elections. For the year 2000, 21.40 million people were registered but only 20.83 appeared in the census [PHC 2000], less of a difference than in the past (Table 1, lines 1.1 and 2.1). There are now more incentives to change registration (e.g., to get children into school in the new location) and the process is now much easier than before. A one-stop household registration at the destination has been set up (starting in 1996) and is now available on-line at most district offices throughout the country. Nationwide, censuses have always missed a small portion of the registered population for one reason or another, but less and less over time. Censuses are conducted in the dry season when municipal populations swell, but this should not affect the findings here because the criterion is "usual place of residence" during the 12 months ending March 31.

(Table 1, lines 2.8 and 3.4). So on average, probably more than one person for every other village household seems to have been living out of the region in the early 2000s. *Rural* villages would be the more likely source of migrants, since they have less non-farm job opportunities than suburban villages. If they represent about three-quarters of villages (discussed above) and if most longer-term migrants do indeed come from such villages, then a clear majority of rural households in the Northeast could easily be involved.

This is consistent with the authors' perception in talking to villagers that most Northeastern rural households have a close relative now living and working outside the region. It helps explain the very large number of "supported" households discussed in the next subsection. The above estimates do *not* include shorter-term seasonal migration by people who are counted as members of the household, which will be discussed separately below in association with agricultural employment.[15)]

Supported Households

Strikingly, the number of households with income mainly from outside support ("supported households") increased by about six times, from about 0.2 million in 1986 to about 1.2 million households by 2002, or 24% of all households by 2004 (Table 2, line 5).[16)] This percentage is about twice as high as in the rest of Thailand.[17)]

Tables 4 and 5 illustrate changes in village income and expenditure.[18)] Averaged across all village households, the portion of income coming from remittances quadrupled

15) Analyses of seasonal and longer-term migration in this report are based on available data and partially arbitrary definitions of household membership (see footnote 13 above), and should not be assumed to necessarily imply qualitatively different work situations. (Working away from home for four months would not be much different than for three months, while working in a permanent job would be very different from working for only four months, etc.)

16) We use the term "supported" for what the SES calls "economically inactive" households, because, as we show, many of these households are *not* economically inactive, even though they received more than half of their total income from remittances, pensions or property income. In later years, data are reported on property income vs. the two others combined. In 2004, households receiving more than half of their income from remittances (and pensions) accounted for 23.4% of all households in the Northeast and property income 0.5%, and in villages 24.2% and 0.5% respectively [SES 2004: Tables 11.1, 11.3].

17) In 2002, 23% of the households in the Northeast had most of their income from support ("economically inactive households") (Table 1, line 3.11). The rest of the country without the Northeast had 13% [computed from NSO 2002: 7 and Table 11.1].

18) Income survey data may not be reliable enough for precise analysis, and averaging also obscures differences among survey units (e.g., "village" household data obscure differences between farm and non-farm households). Nevertheless, assuming a reasonable degree of continuity in survey methodologies, income and expenditure data can help reveal broad trends (with cross-checking, and, e.g., with special caution toward figures on home-produced, non-cash income). However, the reader is cautioned about using the data presented for purposes beyond these limited usages.

Table 4　Share of Northeastern Village Household Income by Source (percent)

	1981	1986	1990	1994	1998	2002	2004
1. Farm	30.3	27.1	25.1	16.4	18.8	17.9	19.0
2. Non-farm	21.3	27.1	30.1	39.4	40.2	40.9	42.2
3. Remittance	3.8	3.3	7.9	14.3	12.3	16.4	15.8
4. Home produced	32.6	28.6	23.8	14.7	15.5	10.7	8.0
5. Other non-money income	12.0	13.9	13.1	15.2	13.2	14.1	15.0
Total	100	100	100	100	100	100	100

Sources and Notes: SES [1981: Tables 4–4A; 1986: Table 4.4; 1990: Table 4.4; 1994: Tables 1–2; 1998: Table 4.4; 2002: Table 4.3; 2004: Table 4.3]. "Non-farm" income includes non-farm "profit" [income], wage and salary, current transfer other than remittance, property income, and other money receipts. "Other non-money income" includes rental value of own home.

Table 5　Average Expenditure of Village Households in Northeast Thailand (percent)

	1981	1986	1990	1994	1998	2002	2004
A. By Category of Expenditure							
1. Food and beverages	49	43	42	39	42	42	38
2. Clothing	9	7	8	6	4	4	3
3. Housing (incl rental value)	19	23	21	22	19	20	21
4. Transport and communications	6	8	8	12	11	13	17
5. All other consumption	13	13	13	14	12	11	12
6. Non-consumption	5	6	8	8	12	10	9
Total	100	100	100	100	100	100	100
B. Expenditure on Food/Bev by Source							
1. Home produced	58	50	46	32	37	27	23
2. Purchased	37	46	50	65	59	68	70
2. 1. (ready-to-eat as % purchased)	(17)	(12)	(18)	(18)	(26)	(29)	(38)
3. Received free	5	3	4	4	4	5	7
Total	100	100	100	100	100	100	100
C. Expenditure on Home Cereals							
As % food and bev	42	32	30	23	31	20	22

Sources and Notes: SES [1981: Tables 1–2; 1986: Tables 1–2; 1990: Tables 1–4; 1994: Tables 1–2; 1998: Tables 4–5; 2002: Tables 4–5; 2004: Tables D–E]. Business/farm expenses generally not included in this table. "Expenditure" includes both cash expenditures and the value of home produced items. "All other consumption" includes alcohol and tobacco (no noticeable trend), medical care, hygiene and cosmetics, recreation. Non-consumption includes taxes, insurance, gifts and gambling, interest on loans, etc. (Interest was highest in 1998 but even then less than 3% of total expenditure). In Section B, "home produced"＝nothing purchased, everything from home source. In this table, "purchased" also includes very minor amounts of items received as part of payments. "Ready-to-eat"＝food eaten out or taken home, neither ingredients nor preparation from home. In Section C, "Home cereals" are those prepared at home, whether or not ingredients were purchased.

to 16% of overall income (Table 4, line 3). (Even among active farm households, it more than doubled, discussed below.) The vast majority of these remittances comes from close relatives.[19] Note that this remittance share doubled in 1986–90 and then nearly doubled again in 1990–94, starting earlier than the changes in non-agricultural occupations discussed above, which changed most in 1990–94.

The huge expansion of supported households in Northeast Thailand has been overwhelmingly a village phenomenon and today the vast majority of supported households are in villages.[20] Supported households in villages practiced agriculture in the past, and an unknown but large number of them still do. Of the 1.2 million supported households in 2002, about 0.4 million had no income earners at all, but of the remaining 0.8 million it is likely that a sizeable majority still practice agriculture.[21] The percentage of economically active people in these households who work in agriculture is not much less than farm owning (and renting) households that reported the majority of their income from farming. However, their cash income from agriculture is far less, meaning most probably had much smaller than average holdings, or allowed others to use their land on

19) "Economically inactive households" are sub-classified as "receiving assistance or pensions" and "receiving property income." In the Northeast Region, the vast majority are in the first category, 98% of all households, 99% in "non-municipal areas" [computed from SES 2004: Tables 11.1, 11.3]. In the rural villages there are very few pensioners. (Before the 1990s, when there were few supported households in the Northeast, there would have been a greater percentage of pensioners among them, but mostly not in villages.) For example, of the income coming from "current transfers" ("assistance payments," "pensions and annuities" and "terminal pay") in all the "non-municipal areas" (including those that may have become suburbs), 94% came from "assistance payments" (95% including in-kind income "received free") [computed from SES 2004: Table 4.3]. It can be safely assumed that the vast majority of these "assistance payments," providing a majority of household income, came from close relatives (also consistent with additional data available only for 1990—see footnote 23 below).

20) In 2002, about 88% of the "supported" households in the Northeast were in villages: 0.241 x 4.3/(0.232 x 5.1) (4.3 and 5.1 from Table 1, lines 3.2 and 3.4; 0.241 and 0.232 from SES [2002: Tables 12.3 and 12.1]).

21) Based on calculations for the year 2002, a minimum of 0.45 million and a maximum of 0.81 million supported households had members still working in agriculture. Statistics used were: percent distribution of members of supported households by 10 year age intervals by household socio-economic class; percent of all household members age 15 and above for all households in the region; supported household members as a percent of all household members in the region; distribution of supported households by number of income earners in the household [all from SES 2002: 114]; percent distribution of household members by socio-economic class and occupation (agriculture, construction, etc.) [SES 2002: 119]; and number of population in the Northeast in 2002 (from Table 1, line 3 of the current report). Supported households have a much larger percentage of "economically inactive" members. In 2002, 34.9% of the males and 43.8% of the females age 15+ (vs. 11.8% and 20.1% for farm households). In 2004, it was 37.4% of the males and 44.4% of the females (vs. 12.0% and 19.8% for farm households) [SES 2002: Table 12.1; 2004: Table 12.1].

concessional terms.[22)]

From informal interviewing and observation, supported households in Northeast Thailand may be elderly parents, often taking care of grandchildren who are going to school, or sometimes a wife with children, often pre-school age, whose husband works away. These impressions seem consistent with local studies [e.g., Funahashi 1996: 629–630] and government data. Supported households have an average or slightly higher than average percentage of children under the age of 10, and also under age 20 (Table 6). But these households contain much fewer adults in the ages 20 to 49 (especially fewer men than women in their 30s). In 2004, 19.4% of males and 28.5% females were in this age group, vs. 42.7% males and 44.4% females in all other households. They also contain more older people than in other households, with twice as many of their household members above the age of 60, and twice the number of widows and widowers. Consistent with these figures, supported households have a much lower percent of "both head and spouse present" and more women as household heads, etc. The missing working age people and the greater number of widows and widowers make these households smaller than average. In 2002, they had 3.0 persons per household, vs. 4.0 for all others [SES 2002: Table 12.1].

When compared to the 1980s, supported households have changed in many ways similar to other village households, but in some ways they have stayed almost the same, presumably reflecting the same basic underlying conditions of remittance senders in good earning ages (20–49) and receivers usually being their parent(s), etc. In 1986 [SES 1986: Table 11], supported households had members 20/16% (M/F) over the age of 60 (compared to 22/23% in 2004) and 19/30% (M/F) between the ages of 20 to 49 (compared to 19/29% in 2004) (2004 data in Table 6).

Most of these 1.2 million supported households in the Northeast are likely to be receiving support from relatives outside the region, consistent with the above estimate of more than 2 million people having left the Northeast since the early 1990s. Within the region, in the 1990s an additional million households joined the category of those making most of their income from occupations other than agriculture (Table 2, discussed above). But not all these people are native Isan with relatives in Northeastern villages, so the

22) Income from farming was only 397 baht/month, vs. 3,532 for farm household mainly owning land whose income was mainly from farming [SES 2004: Table 4.1]. It is possible some of these supported households have no agricultural land but do agricultural labor and/or raise livestock (mainly cattle). Because of access to fodder from public and private land, raising livestock does not depend on agricultural holdings. For example, in 2003, 78% of all agricultural holding households raising livestock had less than 2 *rai* (0.32 ha.) of agricultural land [ACIS 2003: Table 18.2]. However, cattle raising is labor intensive, so probably not well suited to many supported households, because of their smaller size. And given their degree of support, they might be less interested in working for others as agricultural laborers than in looking after their own fields. For these reasons, supported households containing people who participate in agriculture are probably agricultural *holding* households.

Table 6 Selected Characteristics in "Supported" Households vs. in All Other Households in Northeast Thailand in 2004 (percent)

	Supported Households	All Other Households
Percent of all households in NE	23.9	76.1
One-person households	15.6	5.4
Two-person households	29.2	13.9
Both head and spouse present	44.8	75.7
One parent w/never-married children	18.6	8.7
Household head age 50+	70.6	48.0
Household head age 60+	46.4	22.5
Household head is a woman	46.1	21.7
Households without any income earners	32.0	0.0
Percent of all population in NE	19.5	80.5
Percent males	56.7	51.1
Percent females	43.3	48.9
Percent males under age 10	24.4	18.5
Percent females under 10	16.8	16.5
Percent males age 10–19	20.5	17.9
Percent females age 10–19	16.8	16.6
Percent males age 20–49	19.4	42.7
Percent females age 20–49	28.5	44.4
Percent males age 50–59	14.2	11.8
Percent females age 50–59	14.6	11.3
Percent males age 60+	21.6	9.4
Percent females age 60+	23.3	11.1
Percent males being widower	7.7	3.3
Percent females being widow	24.2	12.6
Percent males age 15+ econ inactive	37.4	12.5
Percent females age 15+ econ inactive	44.4	21.9
Percent males age 15+ in ag work	41.6	42.2
Percent females age 15+ in ag work	43.5	48.0

Sources and Notes: Calculated from SES [2004: Tables 12.1, 13, and 11.1].
("Supported"="economically inactive") Not shown: Percent of farm households with people age 15 and over (M-F) being mainly agricultural workers: own account farm households 61.3–70.5 (in own-account farm households) and 79.9–75.3 (in farm worker households). People age 15+ being mostly inactive or unemployed: 12.0–19.8 (own account households) and 9.2–19.8 (farm worker households).

potential sources of remittances from inside the Northeast are likely to be a somewhat smaller number, in any case easily outnumbered by the emigrants as potential sources of support. Relatives working in Central Thailand and on the Eastern Seaboard are also probably better paid on average, better able to send support.[23)]

23) For 1990, additional data are available on all the households who received assistance [SES↗

It is important to point out that when people living and working in other places provide major amounts of income to relatives living in the village, instead, for example, of older parents moving in with grown children in urban dwellings, people are not only getting insurance against losing jobs (as the crisis of 1997 showed), but also engaging in a joint strategy and division of labor among parents and children, husbands and wives, and siblings.[24] There may be relatively short-term goals, such as schooling children and grandchildren but, probably for most, also long-term goals. Maintaining domestic housing, land and social resources is an important part of long-term planning to return eventually to the village, to retire or take over farm management. Both senders and receivers have an interest in, and contribute income and labor to goals like these.

Agricultural Households

Despite the widespread perception that agricultural populations are decreasing as more and more people move out of agriculture and into urban jobs, that is not really what has been happening in the Northeast. The number of agricultural holding households has

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↘ 1990: Table 14]. This table includes any degree of assistance for all 10 types of households, not just "economically inactive households" (but a limitation is that at that time "economically inactive households" were only 10% of all households, compared to 24% in 2004 (Table 1, line 3.11)). In 1990, a total of 31.4% of all households in the Northeast received some degree of assistance, and nearly half of those (46%) were households whose income was mostly from their own farm land. (Own-farm households made up 55.1% of all households in the Northeast, and 26.3% of them received assistance payments.) In second place were the vast majority (88%) of the "economically inactive households" or 28% of all those receiving assistance. All other categories were less than 5% of all households receiving assistance. Of the total amount of money sent, "economically inactive households" received 57.6% (receiving households averaging 1,747 baht/month), farm-owning households 24.2% (averaging 451 baht/month), and the rest again with no category receiving more than 5%. Most households received assistance from outside the Northeast—about three-quarters overall, and slightly more for the own-farm households than the economically inactive ones. Most senders were sons and/or daughters, again about three-quarters overall and slightly more for the own-farm households. Second were from spouses, overall 12% but with the economically inactive households being much more characteristic of spousal support: 20%, vs. only 8% for the own-farm households. Almost all the remaining sources were other relatives. (It should be noted that payments were also sent out of Northeastern households, especially for children in the Northeast and Bangkok, etc., but from only 8.5% of households) [SES 1990: Table 15].

24) Villagers explained to Funahashi the strategy of "*baeng kan pai ha ngan*" —parents or close relatives taking over the work responsibility in a couple's rice fields while they go live and work elsewhere but remit cash, or taking care of the couple's children while they attend school. "As the parents grow older, the young couple (particularly the youngest daughter and her spouse) will return to the village" [Funahashi 1996: 628]. This phrase might be translated as "splitting up to go get work," but specifically for the purpose of helping each other to make a living as a family, in other words, a joint strategy.

actually increased, to 2.65 million households in 2003 (Table 1, line 5.1), but at the same time, household sizes have fallen.[25] The number of people living in agricultural holding households and working in agriculture went up in the 1980s and then fell a little since the early 1990s, but has stayed roughly the same over the years. There were 10.84 million people in agricultural households in 1983 and 10.65 million people in 2003 (Table 1, line 5.5). Of these, 6.86 million worked in agriculture in 1983 and 7.27 million in 2003 (Table 1, line 5.7). Overall, including landless agricultural laborer households, it is calculated that agriculture is practiced in about 2.8 million households, containing about 11.5 million people, a little over half of all the households and people in the Northeast, or about two-thirds of the "village" households and population.[26]

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25) From the PHC censuses, there were 5.7 persons per village household in 1980 and 4.2 in 2000 (computed from Table 1, lines 2.7 and 2.8). For agricultural holding households there were 5.7 in 1983 and 4.0 in 2003 (computed from Table 1, lines 5.1 and 5. 5). It might be thought that household sizes have fallen because of increasing preference for nuclear family housing, but there is little support for this in SES survey data: 76% of village households without any "sub-families" in 1990, 76% in 1994, 72% in 1998, 78% in 2002 and 77% in 2004. Average household sizes shrink when people have fewer children, but it is also probable it is because people leaving home and not returning have not (yet) caused any significant abandonment of houses. In most cases, at least someone is staying in the house and "minding the farm." This is also consistent with an increase in single person households: from 2.8% in 1990 to 6.7% in 2004.

26) ACIS shows "holdings" with agricultural activity as 2.59 and 2.65 million in the Northeast in 1998 and 2003 respectively (Table 1, lines 5.1), while OAE puts the figure at 2.61 million in the year 2000 (Table 1, line 4). These two different sources use similar definitions based on agricultural land management units and have data mostly compatible enough for some gross generalizations (compare Table 1, line 4 with line 5.1). However, counting holdings as households (people living together and sharing expenses) omits landless households who rely on their neighbors for agricultural employment, and can double count a household if, for example, a man living with his wife's parents separately manages some of the land. The latter situation is probably not common, or no longer common. For the landless, SES shows that the percent of Northeastern households whose main income comes mainly from "agricultural labor" has been about 5% for many years (Table 1, line 3.5.3), or about 0.059 x 5.1 = .30M households in 2002 (0.059 is the original datum rounded to 6% in Table 1, line 3.5.3, x 5.1 from line 3.2). These are households with most income from agricultural paid labor, no matter how paid and regardless of whether the household also owns or rents any agricultural land. So if some were also small holders, they would be listed as holders with income mostly from agriculture off-own-farm in the ACIS, which was about 0.09 out of 2.65M households [ACIS 2003: Table 18.1]. (ACIS 2003 and SES 2002 have very close, i.e., overlapping, annual data periods.) Therefore, 2.65 + 0.30 − 0.09 =about 2.86M households in agriculture, including the landless. Calculated from the same sources in a different manner: SES has 39.4% of all households with income mostly from agriculture and agricultural labor, 0.394 x 5.1 = 2.01M households. Calculated from the ACIS, 0.76 M households with agricultural holdings made more income from non-agricultural sources (see Table 1, line 5.3 and note 5). 2.01 + 0.76 = 2.77M households. From a third source, CDD [2003] reported 2.59 million village households growing rice. From ACIS, rice growers in 2003 were 91% of total agricultural holders, so 2.59/0.91 = 2.85M households in agriculture. Therefore, in 2003 there were probably about 2.8 million agricultural households, or about 11.5 million people (at 4.1 ↗

As might be expected from the household possessions shown in Fig. 1, the lack of growth in rural population and agricultural employment does not mean that rural household incomes or agricultural incomes have declined. The percent of all Northeastern households reporting agriculture as their main source of income first fell below 50% in the early 1990s and, except for the period immediately after the 1997 financial crisis, has been on a downward trend ever since (Table 2, line 4.1). But this is due to population expanding outside agriculture, not because agricultural population decreased or farmers earn less from agriculture. The number of farm families reporting most of their income from agriculture has not changed much over the years (Table 2, line 4). It does look like the number has been falling since the early 1990s except for immediately after the 1997 crisis, but compared to the 1980s it is almost the same—about 2.3 million households in 1986 and 2.0 million in 2002. Including the landless laborer households, by 2003 about 2.1 million Northeastern households (75% of the 2.8 million agricultural households) reported agriculture as their main source of income, cash plus in-kind.

What has changed, as will be seen below, is the type of agriculture being practiced and the way it is integrated with off-farm work, with more people working part-time off-farm, and for more of the year. For many people agriculture has become a part-time occupation. However, while people in agricultural households are earning more income from non-farm activities, at the same time, assisted by technological improvements including labor-saving machines and techniques, they have also been earning more from agriculture.

Real village household incomes have nearly doubled over the past 20 to 25 years, and real per capita household income has more than doubled.[27] Increased income has come from both on and off the farm (Table 4). Non-farm cash earnings have gone from 21% in

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↘ persons/household—see Table 1, note 3b), 55% of all households and people in the Northeast (65% and 66% of "village" households and people, respectively) (divisors in Table 1, lines 3.1–3.4). [For unknown reasons, this estimate is somewhat lower than in NESDB and World Bank [2005: 136–137] which reported that farming households in the Northeast were "over 60 percent of all Northeastern households" in 2002 compared to "42 percent... in the North," (their accompanying bar chart shows figures even higher than in the text, but the axis may be mislabeled). In their background study [Agrifood Consulting International 2005: 302], 58% grew rice compared to 31% in the North. These figures were attributed to a 2002 SES "supplement," a special additional survey requested by the World Bank, not publicly available from NSO (NSO Household Economics Statistics Group, personal communication August 2007).]

27) Village household income increased from around 2,200 baht/month in the early 1980s (2,289 baht/month in 1981; 2,165 in 1986) to 8,727 in 2004 in current value (not adjusted for inflation) [SES 1981: Table 4; 1986: Table 4.3; 2004: Table 4.3]. Using the same multipliers sourced for Table 7A below, in constant 1998 baht these would be about 4,400 and 8,000 baht/month, respectively. So real household income nearly doubled, but household size decreased from more than 5 to 4 persons (footnotes 25 and 26 above), so per capita household income more than doubled (4,400/5＝880; 8,000/4＝2,000).

1981 to 42% in 2004, and together with remittances account for over half of average total income. However, again, these averages also include the non-agricultural village households.

Table 7A shows real (constant price) gross cash income for only the agricultural holding households, which also doubled (quadrupled in current prices—see Appendix Table 8A for current price data). Surprisingly, agricultural cash income has kept pace with non-agricultural income in this table, roughly 50–50. Also the biggest increases in gross agricultural income occurred in 1986–91 (+39%, averaging +7.7% per year) and in 1991–95 (+37%, averaging +9.2% per year) (computed from Table 7A, line 1).

Expansion of gross farm income indicates agricultural improvement, but only net farm income directly measures the degree of economic gain for farm families. Table 7B shows *net* real agricultural cash income, i.e., after deducting cash expenditure on agricultural inputs (agricultural inputs discussed below). This net real agricultural cash income increased by over 60% between 1982 and 2004 (and increased 3.5 times in current prices—

Table 7A Average Cash Income of Farm Holding Households in Northeast Thailand by Source (in constant 1998 baht)

	1982	1986	1991	1995	1998	2004
1. Agricultural income	23,947	22,457	31,116	42,582	44,620	47,363
(as % of total cash inc)	(50%)	(56%)	(56%)	(43%)	(47%)	(49%)
1. 1 Rice sales	4,697	4,265	7,185	11,523	13,687	n. d.
(as % of ag inc)	(20%)	(19%)	(23%)	(27%)	(31%)	
1. 2. Other crop sales	12,636	10,501	11,542	13,152	11,300	n. d.
(as % of ag inc)	(53%)	(47%)	(38%)	(31%)	(25%)	
1. 3. Livestock sales	5,166	5,013	5,204	9,780	8,848	8,871
(as % of ag inc)	(22%)	(22%)	(17%)	(23%)	(20%)	(19%)
1. 4. Other own ag	261	221	3,564	3,215	4,979	2,861
(as % of ag inc)	(1%)	(1%)	(11%)	(8%)	(11%)	(6%)
1. 5. Ag off own farm	1,186	2,457	3,620	4,912	5,806	7,801
(as % of ag inc)	(5%)	(11%)	(12%)	(12%)	(13%)	(16%)
2. Non-ag income	23,624	17,953	24,049	56,551	51,056	50,253
(as % of total cash inc)	(50%)	(44%)	(44%)	(57%)	(53%)	(51%)
2. 1. Remittance	1,691	1,846	2,973	4,118	8,131	7,804
(% of non-ag income)	(7%)	(10%)	(12%)	(7%)	(16%)	(16%)
Total cash income	47,570	40,411	55,165	99,133	95,676	97,616
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

Table 7B Average Net Agricultural Cash Income of NE Farm Holding Households (in constant 1998 baht)

1982	1986	1991	1995	1998	2004
12,565	14,551	12,330	18,034	20,089	20,285

Table 7C　Cash Non-Farm Expenditure of NE Farm Holding Households (in constant 1998 baht)

	1982	1986	1991	1995	1998	2004
1. Food and beverages	9,727	6,405	11,663	12,054	11,267	14,714
(as % total cash non-farm exp)	(31%)	(25%)	(34%)	(23%)	(24%)	(27%)
1.1. Rice	n. d.	1,249	1,195	670	807	596
(as % food and beverages)		(20%)	(10%)	(6%)	(7%)	(4%)
(as % total cash non-farm exp)		(5%)	(4%)	(1%)	(2%)	(1%)
2. Clothing	2,966	2,047	2,186	3,075	2,057	2,060
(as % total cash non-farm exp)	(9%)	(8%)	(6%)	(6%)	(4%)	(4%)
3. Housing (incl rental value)	5,038	6,005	6,762	7,914	7,689	9,579
(as % total cash non-farm exp)	(16%)	(23%)	(20%)	(15%)	(17%)	(17%)
4. Transportation and energy	3,418	2,706	4,658	12,173	8,577	15,084
(as % total cash non-farm exp)	(11%)	(11%)	(14%)	(23%)	(18%)	(27%)
5. All others (approximate)	10,614	8,483	8,944	17,370	16,914	14,839
(as % total cash non-farm exp)	(33%)	(33%)	(26%)	(33%)	(37%)	(26%)
Total cash non-farm expenditure	31,763	25,646	34,213	52,586	46,504	56,276
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

Sources: Computed from current price data in Appendix Tables 8A–C. Constant price multipliers (percentages): 1982: 50.5; 1986: 55.1; 1991: 69.2; 1995: 82.8; 1998: 100; 2001: 103.5; 2004: 109.0. Multipliers for 1982–98 from OAE *Report of Agricultural Household and Labor Socio-Economic Study, Crop Year 2001/02* [2002: Appendix *ko*-2, Table 2/2] (in Thai). For 2004: *Report of Agricultural Household and Labor Socio-Economic Study, Crop Year 2004/05* [2005: 39]. For Notes: See Appendix Tables 8A–C.

see Appendix Table 8A for current price data). As can be seen from Table 7B, it increased most between 1991 and 1995 (+46%, averaging +11.6% per year), which is the same period non-farm expenditure increased most (+54%, averaging +13.4% per year) as well as gross *non*-agricultural income, which more than doubled in this period (computed from Tables 7A–C).

Net agricultural cash income cannot be compared directly with gross non-agricultural cash income (in Table 7A, line 2), but it can be compared with remittances (in Table 7A, line 2.1).[28] Despite the importance of remittances in the Northeast, in agricultural holding households, on average, they have never exceeded net agricultural cash income and even by 2004 were still less than half as large. This was the case even though remittances doubled by the early 1990s and in 2004 were over four and a half times those

28）Net agricultural cash income can only be directly compared with *net* non-agricultural cash income, but the latter cannot be calculated because only expenses on agricultural inputs were reported by OAE. The "inputs" (additional costs) incurred in earning non-farm income (transportation, meals, accommodation, etc.) were not separated out from other household expenses in the OAE data (summarized in Table 7C). For example, if a farmer earned wages from non-farm work, all those wage would be reported as non-agricultural income, without deducting, for example, the bus fares to and from the work site, an expense which would not have been incurred if the farmer had simply stayed home on the farm instead of going off to work.

of 1982 (in constant baht). The constant baht value of remittances increased 61% during the period 1986–91, coincidental with the beginning surge in industry and employment in GBMR and the Eastern Seaboard, and also coincidental with an increase in agricultural investments (possible connections among these to be discussed below). By far the biggest increase in remittances (averaging +32.5% per year) occurred between 1995 and 1998, when the Thai economy was peaking before the 1997 crisis.[29)]

In sum, agricultural cash income remained a major contributor to overall cash income. And this is only for cash income, whereas on the agricultural side there was considerable non-cash income, the two together probably exceeding non-agricultural income (discussed below and in footnotes 35 and 36).

One can conclude from these data that (still primarily rainfed) agriculture in Northeast Thailand improved to the extent that it continued to provide farmers a large share of income in a growing pie. However, there are some qualifiers. In Table 4, the farm portion of village household income has been dropping over time, but, again, this would be primarily due to the increasing share (growing to one third) of non-agricultural households in the village sample. However, a growing number of agricultural holding households, although still a minority (29%), say they are making more income from non-agricultural activities than they are from agriculture (Table 1, line 5.3). And a similar total percentage of their household members are working mostly or only in non-farm work (23% and 7% respectively), although there is yet no clear indication of an increasing trend (Table 1, lines 5.12.1 and 5.13.1). Finally, what has been true in the recent past may not be true in the future, even in the near future. Small family farm income is probably inherently unable to match non-farm income growth in a modern economy, and there are already some major sustainability issues which will be discussed at the end of the report.

So, while agriculture remained a major source of income among farm households, farm families increasingly spent more time and earned more income in part-time non-agricultural work. Rainfed agriculture is a highly seasonal occupation and today there are many more opportunities for people working in farming also to make money outside agriculture, both inside and outside the Northeast. In the 1980s, persons who worked part-time off their own holdings were a fifth or less of all employed persons in agricultural holding households. By 2003 this figure rose to about half (Table 1, lines 5.8–5.9.1). Even those most responsible for agricultural activities ("holders") were only somewhat less likely to work part-time off their own holding— 43% in 2003 [ACIS 2003: Table 15.4]. We know that people who worked *mostly off* their own farms worked mostly in non-agricultural jobs (Table 1, line 5.11–5.12.1). (And we suspect a large number of those

29) These increased remittances after the mid-1990s were probably used for housing improvements and taking care of aging parents (who were often also taking care of the grandchildren) and other non-agricultural purposes, as we argue below that the biggest agricultural changes occurred earlier.

working *mostly on* their own holdings also worked more in non-farm jobs than on other people's farms as well, but data are missing, so this issue is pursued in another way in the next subsection.) A trend toward increasing part-time non-farm work is also visible in data on income source. The percent of agricultural holding households receiving at least half their income from non-agricultural sources rose from 21% in 1993 to 36% in 2003, while those with income solely from agriculture fell from 46% to only 18% (Table 1, note 5 and line 5.2.1). By 2004, however, most farmers said most of their income still came from farming [ACIS 2003: Table 18.1].

There are other noticeable trends in Tables 4 and 5. Even in agricultural households people are purchasing more of what they eat. In Table 4, the share of income from home-produced dropped from 32.6% in 1981 to only 8.0% in 2004. Some of that drop is probably caused by the increasing share of non-agricultural households in the village sample, but probably not all of such a huge reduction. Percentage on food expenditures has begun to fall (Table 5, line A.1), as expected by Engel's Law when people earn more income. Proportion of expenditure on clothing fell (Table 5, line A.2), presumably for similar reasons, even though people purchase ready-made clothing. People have shifted from home-produced food to purchasing food, including ready-to-eat food (Table 5, lines B.1–2.1). The portion of village household food expenditure on ready-to-eat foods quintupled between 1986 and 2004. This is highly noticeable in Northeastern villages today and represents a major change in lifestyle. Modern convenience stores and noodle shops can now be found in most rural villages.[30] Fresh-food trucks (*rot kap khao*) and ready-to-eat food vendors make daily visits, just as in suburban communities and housing estates. This has resulted in a reduction in the consumption of rice, especially home-produced rice (for example, when people eat noodles instead of rice for lunch).[31] However, for most farm families, the rice they do consume they still grow themselves (Table 7C, lines 1.1 and 1.2).[32]

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30) Remarkably, CDD [2005] found a total of 171,183 shops and stores in 30,862 villages in the Northeast, an average of 5.5 per village. But more remote villages might have fewer stores.

31) With economic growth, there has been reduced consumption of rice in traditional rice-eating societies [e.g., Gehlhar and Coyle 2001: 10; Regmi *et al*. 2001: 21]. In South Korea, yearly milled rice consumption decreased nearly 30% between 1980 and 2000 (from 132 to 94 kg/person) [Nam 2002: 114 note 28]. In Thailand it apparently dropped 15% from 1990 to 2002 (from 119 to 101 kg/person) [Isvilanonda 2006: 3]. Among *villagers*, it fell to an average 114 kg/person–128 kg/person for the poorest 25%, 91 kg/person among the wealthiest 25% of village households. Even if we assume Northeastern farm families consume about 200 kg of unmilled paddy rice per person (133 kg milled—a little over Isvilanonda's highest villager consumption level of 128 kg), that would still be a saving of about 100 kg/person over the traditional Northeastern diet, which was about 300 kg/person for consumption alone, 400 kg for all purposes [see Fukui 1991: 528 and Suzuki *et al*. 1999: 58], although common estimates for traditional paddy rice consumption per person in Thailand were often lower than this [e.g., see Fukui 1993: 401 note 2].

32) Reduced consumption of home-produced rice means more rice can be sold instead, or some↗

Another noticeable trend is increased expenditure on transportation, communication and education, reflecting the growing importance of rural-urban connections and non-farm jobs (Table 5, line A.4 for villagers, Table 7C, line 4 for farm families).

Within Table 7A three other trends help account for the increasing real income in farm households: increasing percent of cash income from remittances (discussed above), from agriculture off ones own farm, and from rice sales. The portion of cash income from doing *agricultural* work *not* on ones own farm has grown somewhat, to 16% in 2004 (Table 7A, line 1.5).[33] This percent is only for the holding households and would be a little more if it included agricultural labor households. The share of agricultural work on other peoples' farms increased, although the numbers are unknown.[34] The percent of holders hiring temporary labor rose from 38% in 1988 to 67% in 2003 (Table 1, line 5.4.1), and expenditures on hired labor rose enormously (Table 10A, line 1 discussed below). This is consistent with many informal reports around the Northeast of vastly increased hiring of neighbors and others at increasing daily wages for temporary work in rice during peak periods. It might also partly reflect increasing part-time paid labor in a few other crops such as sugarcane.

Despite working only part-time in agriculture, most households still have diversified agricultural activities (including fishing, etc.) and many still combine rice growing with raising livestock and growing field crops or vegetables. For example, in 2003, 46% of agricultural holdings raised both crops and livestock [ACIS 2003: Table 18.2]. Income from livestock has increased over the years, keeping pace at about 20% of cash income (Table 7A, line 1.3), consistent with expected dietary changes in Thai society with economic growth [e.g., Pingali 1997]. There have been noticeable trends within field crops, especial-

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↘ paddy land might be used for other things. However, the ability to sell more rice as a result of reduced home consumption should not be thought of, in and of itself, as raising farm family income. Instead, it is the other way around. Rising incomes allow people to diversify their diets—more meat and dairy products, more noodles for lunch, etc., and less rice. But rice needed for social purposes is still not sold, and might even still be nearly 100 kgs/person/year (400 minus 300, see footnote 31 above). This can be so important that Leach [1960: 52–53] saw it as a principal factor in maintenance and change in ethnic identity. Highland rice-growing peoples, more heavily dependent on swidden agriculture, could not change to the ethnic identities of lowlanders unless they were also able to adopt agricultural practices that would give them greater rice surpluses to meet social obligations expected under Theravada Buddhism.

33) Agricultural wage labor replacing exchange labor accompanied the transition process. While 11% from off-own-farm cash income in 1986 (Table 7A, line 1.5) seems a little high, it may reflect off-season agricultural work in other regions that was partly characteristic of that era (e.g., cutting sugarcane in Kanchanaburi, harvesting irrigated rice in Central Thailand).

34) The number of people in agricultural holding households who worked *mainly* on other farms is known but they were only a very small percent, although it has been increasing, especially among small holders (Agricultural Census data, not shown). The unknown number who do such work, but less than "mainly," is unknown but undoubtedly much higher.

ly sugarcane partly displacing cassava. But apparently, on overall average, real earnings in constant baht from non-rice crops have not increased, and their contribution to cash income has fallen over the years—from half down to about a quarter (Table 7A, line 1.2).

Perhaps most surprising of all, despite a recent data gap, the portion of gross agricultural cash income coming from rice seems to have grown by half or more and is possibly passing up *all* other cash crops, combined (Table 7A, lines 1.1 and 1.2). In 1998 it was the biggest item in agricultural cash income, and the second largest item in overall income (after non-agricultural income). But it is likely that only about half the rice was (directly) sold so there is a sizeable amount of in-kind income as well.[35] When this and other in-kind earnings are taken into account, net agricultural income should rival and may well exceed non-agricultural income.[36] That would be consistent with the majority

35) Since the early 1990s, rice sales have been about half of total rice production: 56% in 1994, 45% in 1995, 39% in 1998, 44% in 2001, 50% in 2002 and 54% in 2004 (production data from Appendix Table 4; data on rice sold available in OAE [1989–2005]. This is consistent with percent of rice sold in case study data (49% in 2000 from Pholthanee *et al*. [2002: 106]; 48% in 1991–92 from Nakada [1996: 616]), although there is a great deal of local variation. For the whole of Yasothon Province, for example, rice sold as a percent of rice produced in the same year was over 80% in 1995 and 40% in 2001 (same OAE source). Farmers cope with variation in rainfall, for example, by waiting to see how the next crop is doing before deciding to sell the excess glutinous rice being stored for subsistence purposes [Nakada 1996].

However, some of the rice produced is seemingly still unaccounted for, which could mean higher total income from rice. If the data on rice consumption (footnote 31) are calculated out, even assuming no reduction in rice used not for direct consumption purposes, by the early 2000s there should still be about 70% left for sale, more than the 50–60% sold. If the data are substantially correct, what happened to the "missing rice"? Some of it was probably bartered for other goods, a common traditional practice still used in the village [e.g., Nakada 1996: 624–625] and often not adequately accounted for by survey methods. It is also highly likely rice is being taken away by absent relatives not defined as household members by survey definitions. There are many informal reports from people going back on a short visit who "fill the vehicle" with sacks of milled rice for the return trip. Over time, this rice may be directly consumed (and used for social purposes). As one long-time Bangkok taxi driver from the Northeast said, "I have never had to buy rice." But much of it was surely also cooked and sold in value-added form, especially with *somtam* and *kai yang* ("papaya pok pok" and grilled chicken) [cf., Funahashi 1996: 627, 634–635]. It is highly likely that the right to take rice away in this manner, for whatever use, is one of the prime features of "joint investment" as discussed in this report.

It might be argued that since most rice sold was non-glutinous while most rice not sold was glutinous, that the additional in-kind income could not have matched the income from rice sales. Non-glutinous has had a higher unit baht value, but from 1990 onwards, glutinous price was above 80% of non-glutinous in most years, similar enough for the in-kind income to nearly match the average income from sales, even if all the rice sold had been non-glutinous, which was never the case.

36) We can agree with the farmers in the ACIS 2003 survey that the majority of overall (cash and in-kind) *net* income (not just gross income) of agricultural holding households came mainly from farming, with rice playing a central role, if we agree to a few assumptions,↗

of farmers saying most of their household income is still mainly from agriculture [ACIS 2003: Table 18.1].

On average for these households then, agricultural earnings seem to have kept up with off-farm earnings, and this seems to be primarily because of rice. The value of rice sales increased much more than livestock did in constant baht, from less than 5,000 baht average per farm holding household in 1982 to over 13,000 baht in 1998 (Table 7A, line 1.1) and probably much more thereafter (because in 1998 more rice had to be consumed at home to feed returnees from the economic crisis). Note that unlike some other patterns discussed above, big increases in rice sales occurred in *both* 1986–91 and 1991–95, +68% and +61% respectively (computed from Table 7A, line 1.1). In any case, if rice sales had stayed the same, agriculture could not have kept its share of overall cash income, and overall cash income would have been that much smaller.

This surprising finding seems to be at the heart of the transition in rural Northeast Thailand, and will be analyzed below. It fits with what others have noticed about the increasing commercialization of rice [Ruaysoongnern and Suphanchaimart 2001; Vityakon *et al.* 2004].[37] It is also consistent with the data in Table 8, which show more and more

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↘ using the information in Tables 7A and 7B. First, assume the net rice income from sales in 2004 was equal to about one third of net cash income in Table 7B (estimated from the trend of percentages under line 1.1 in Table 7A). Then, if about half the rice was not sold (footnote 35), net agricultural income would increase by about a third due to in-kind income from rice contribution—raising net income to about 27,000 baht (in constant 1998 baht), without having to deduct any additional expenses because all agricultural expenses have already been deducted. Next assume that, while rice was the main source of in-kind income, many others (fish, poultry, vegetables, both natural and farmed, and occasionally pigs and cattle, etc.) also contributed, if only half as much as rice. That would raise the total to 30,000 baht (from 27,000). Next, note that the net agricultural cash income came to 43% of the agricultural cash income (20,285/47,363), meaning agricultural expenses came to 57%. It is very likely that all business expenses, not just agricultural expenses, rose over the years, with rising incomes. Cash expenses incurred for non-agricultural work, usually away from home (transportation, housing, prepared food, etc.) should be high as the farmer usually has to shift temporarily from a semi-subsistence rural home environment into a much more monetized urban economy. If we assume those expenses were 50% of wage earnings (lower than agriculture's 57% of gross cash sales), net non-agricultural income would be about 25,000 baht (1/2 of 50,253), which is less than the 30,000 baht estimated for agriculture, and less than the 27,000 baht estimated from including only rice as in-kind income.

Two further considerations are relevant. First, the tendency for under-reporting income and over-reporting expenditure in survey data of this type is commonly known. Therefore, real net agricultural income is likely to be greater than computed in this report. Second, trends in gross agricultural income are also indicative of net agricultural income, because of assumed economically rational behavior of the farmers themselves. They would not have kept making these agricultural investments unless net agricultural income had remained positive, or kept increasing them without a promising trend.

37) Ruaysoongnern and Suphanchaimart [2001: 70–71] proposed the expansion in planted area of non-glutinous rice for sales purpose in the 1990s as the "beginning of commercial farming" of rice in the Northeast. In a case study of a village in Khon Kaen, Vityakon *et al.*↗

Northeastern farmers planting rice for sale as well as consumption (over 71% of farms in 2003), and fewer and fewer planting for consumption alone (29% in 2003). Despite lack of data before the 1990s, experience tells us that this was not the case in the past. Before the roads, transporting rice by oxcart was too costly except in areas near the railroad [Pendleton 1962: 152]. There were increasingly better roads by the late 1970s but by then, under population pressure, most farmers' main concern was to stock enough rice for their own consumption. Rice was first and foremost for consumption and field crops and off-farm work, etc. were for cash, and most farmers would not have said their purpose in growing rice was for both consumption and sale.[38)]

Table 8　Holdings and Rice Area Planted by Purpose in Northeast Thailand

	Number of Holdings (millions)			Rice Area Planted (million ha.)		
	1993	1998	2003	1993	1998	2003
For consumption	0.92 (40.8%)	0.82 (33.9%)	0.69 (28.5%)	1.56 (25.9%)	1.16 (19.8%)	0.89 (15.5%)
For sale	0.01 (0.3%)	0.00 (0.1%)	0.01 (0.2%)	0.02 (0.4%)	0.00 (0.1%)	0.01 (0.3%)
For consumption and sale	1.33 (58.9%)	1.60 (66.0%)	1.73 (71.2%)	4.44 (73.4%)	4.71 (80.1%)	4.84 (84.3%)
Total	2.25 (100%)	2.42 (100%)	2.42 (100%)	6.01 (100%)	5.88 (100%)	5.74 (100%)

Sources and Notes: ACIS [1993: Table 5.1; 1998: Table 5.1; 2003: Table 6.1]. Data not available for 1983 and 1988; minor inconsistencies due to rounding error.

↘ [2004: 458, 460] characterized the changing rice varieties and increased sale of rice during the period 1987–94 as a new substage in increasing commercialization of farming in the Northeast. Others have studied related aspects. Miyagawa [1996] studied the spread of KDML105 as a cash crop in the early 1990s (discussed below). Nakada [1996] studied dynamics of rice consumption and sales. The quantified, region-wide analysis in this subsection of the present report concerning income findings reveals the surprisingly large and growing role of rice as being the main cash crop (fieldcrops such as cassava having long been the main cash crops for most Northeasterners). Also unexpected is agricultural income keeping pace with non-agricultural, connected to the unexpected persistence of the small family farm. Agricultural growth is inherently slower than manufacturing, and much more so for rainfed agriculture on small family farms. The authors do not claim that these trends will or can continue (discussed at the end of the report).

38) In Table 8, note that the number of agricultural household planting rice *only* for sale was and has always been negligible (less than 1%). Author fieldnotes in the early 1980s stressed farmers' own family subsistence needs as their overwhelmingly main priority in growing rice. Fukui [1991: 528]: by the early 1980s, "rice has never become a commercial crop in this village." Rigg [1986: 38] in the two villages studied in Mahasarakham: "only one fifth of the households interviewed marketed (or were intending to market) any of their [rice] harvest in the 1982/83 crop year." As further evidence of how important Northeastern farmers thought rice was for direct subsistence purposes, Thomas [1988: 88, 98, 101] found that farmers saw a simple trade-off between [non-rice] cash crops and off-farm work (they ↗

Seasonal Off-Farm Work and Short-Term Migration

As mentioned above, the agricultural census gives us an incomplete picture of the scope and type of off-own-farm part-time work. In this subsection we rely on labor force figures to approach the subject in a different manner, and also use the data to help understand short-term circular migration.

We have seen above there are probably more than 2 million people from Northeastern households living longer-term outside the region, and they are not counted as Northeastern household members in government surveys. But if they are away for less than three months or have no other permanent residence, they are still counted as members of the household. This type of temporary absence, especially from among the approximately 2.8 million agricultural households mentioned above, is most likely to be seasonal.

Table 9 shows data which, with some assumptions and limitations (see table notes), help tell us about seasonal work and seasonal migration in the Northeast. People put seasonally out of work within the Northeast (as measured by total regional employment in the wet season minus that in the dry season) fell from a much larger number in the 1980s to 1.15 million in 2006 (Table 9, line 1). Dry season employment rose from 6.17 million in 1983 to 10.05 million in 2004, from 66% to 86% of the wet season employment level (Table 1, lines 6.5 and 6.5.1).[39)]

So it seems that many more people were able to get off-season employment within the region, but how? The opportunity for *agricultural* work in the dry season has apparently not increased much, if at all, as might be expected in a largely rainfed region (Table 1, line 6.6). In earlier periods, non-agricultural off-season work within the Northeast was infrequent and more dependent on government public works programs. Today, of those out of agricultural work in the dry season, fewer and fewer (in both percentages and absolute numbers) seem to have been made "seasonally unemployed"—falling from 1.91 million people in the dry season of 1983 to only 0.34 million in 2006 (Table 9, line 4). In other words, people working in agriculture in the wet season seem to have been increasingly able to find non-agricultural work in the off season within the Northeast. Of the 2.22 million people put out of agricultural work by seasonal change in 2006, about half of them apparently found other work within the region during the off season (last column in Table 9, lines 2 and 3 respectively). This is fortunate, because those 2.22 million people —31% of the wet season agricultural labor force—remain by far the highest seasonal

↘ simply picked the one they thought paid best at the time), but rice for subsistence purpose was so important that "no recorded opportunity costs are sufficient to reduce allocations of land and labor to rice."

39) As will be seen below, recent changes in agriculture allow people to be away more of the year. Peak periods for being away are in the dry season in January through April but also after planting and before harvest during the wet season (in September and October) [Miyagawa 1995: 196; Nakada 1996: 620 Fig. 4; Limpinuntana 2008].

Table 9　Seasonal Off-Farm Work and Short-Term Migration (million persons)

Year	1983	1986	1988	1993	1994	1998	2000	2002	2003	2004	2006
1. "out of NE work" in dry season	3.15	2.45	2.51	2.20	2.78	2.05	1.82	1.81	1.37	1.57	1.15
1. 1. (as % of empl in wet season)	(34%)	(25%)	(24%)	(29%)	(24%)	(19%)	(17%)	(16%)	(12%)	(14%)	(10%)
2. "out of ag work" in dry season	3.99	3.33	3.18	4.14	4.03	3.52	3.01	2.90	2.71	2.66	2.22
2. 1. (as % of ag in wet season)	(49%)	(40%)	(35%)	(46%)	(46%)	(44%)	(39%)	(39%)	(36%)	(37%)	(31%)
3. "off-farm NE dry seas workers"	0.84	0.88	0.67	1.94	1.25	1.47	1.19	1.09	1.34	1.09	1.07
3. 1. (as % of ag in wet season)	(10%)	(11%)	(7%)	(21%)	(14%)	(18%)	(16%)	(15%)	(18%)	(15%)	(15%)
4. "seasonally unemployed" in NE	1.91	1.58	1.23	1.20	1.52	1.30	1.18	0.85	0.50	0.61	0.34
4. 1. (as % of ag in wet season)	(24%)	(19%)	(14%)	(13%)	(17%)	(16%)	(15%)	(12%)	(7%)	(8%)	(5%)
5. "off-farm workers outside NE"	1.24	0.87	1.28	1.00	1.26	0.75	0.64	0.96	0.87	0.96	0.81
5. 1. (as % of ag in wet season)	(15%)	(10%)	(14%)	(11%)	(14%)	(9%)	(8%)	(13%)	(12%)	(13%)	(11%)

Sources and Notes:

1. Line 1 is all persons employed in the wet season minus those employed in the dry season (Table 1, line 6.2 minus line 6.5).
2. Line 2 is persons employed in agriculture in the wet season minus those in the dry season (Table 1, line 6.3 minus line 6.6).
3. Line 3 is line 2 minus line 1. For example, in 2006 there were 2.22 million workers out of agricultural work but only 1.15 million out of work overall, so the difference of 1.07 million ought to be those who switched to other occupations *within* the Northeast during the dry season.
4. Line 4 is persons unemployed in the dry season minus those unemployed in the wet season (in Table 1, the difference between lines 6.4 and 6.5 minus the difference between lines 6.1 and line 6.2). Data from same source are available on "waiting for seasonal work" but the calculation here is taken as a more explicit measure because data are based on a less judgmental answer to an interview question.
5. Line 5 is line 2 minus lines 3 and 4. These are workers presumed to have left the Northeast during the dry season, people out of agricultural work (line 2) minus the off-farm workers within the Northeast and the seasonally unemployed (lines 3 and 4). This is numerically the same as line 1 minus line 4, also the same as total wet season labor force minus dry season labor force (Table 1, line 6.1 minus line 6.4). Data as presented are to show the logic and the additional seasonal unemployment data.
6. Data in line 1.1 computed as percent of Table 1, line 6.2. Data in lines 2.1, 3.1, 4.1 and 5.1 computed as percentage of data in Table 1, line 6.3. Note that column percentages in 3.1, 4.1 and 5.1, plus 100 minus percent in Line 2.1 total 100% (except for rounding error), i.e., assumed to account for all persons in wet season agricultural employment.
7. All data for 2006 computed from same NSO Labor Force Survey sources as data used from Table 1, computed in the same manner.
8. *Assumptions*: In comparing wet season and dry season in this manner, it is assumed the same number of people are available for work within the half year difference in sampling times between February and August each year. In fact, the numbers are changing little by little over time due to demographic forces.
9. *Limitations*: All figures are affected by changing definitions of age eligibility but this is unlikely to cause major distortion (see Table 1, note 7). However, lines 1, 2, and 5 are significantly overestimated in the 1980s and early 1990s for other reasons. The years likely to be most affected are 1989 and 1992 (1989–92 omitted from the current table but can be seen in Fig. 7A, discussed later in this report). (To get a better idea of how different Labor Force and Agricultural Census figures were during what periods, make a bar chart of Table 1, line 5.7 and compare it with Fig. 7A.) Overestimates can occur because agricultural labor force figures for the wet season are a one-week "snapshot" in August each year, when, depending on the timing of the rainfall, transplanting needs may inflate the agricultural workforce to include persons who actually had non-agricultural jobs but who came back to the village for only a week or two to help out during a peak-labor period, and such people were not counted as members of agricultural holding households. (Long-term migration is also discussed in a different section in this report.) This limitation does not apply to lines 3 and 4, because any such bias would be subtracted out in the formulas used. However, some percentages shown in lines 3.1 and 4.1 are likely to be underestimates in the same period for the same reason. Textual reference to this table in this report has been carefully worded in light of these limitations, and readers wishing to make use of data in this table are cautioned to keep these limitations in mind.

agricultural displacement in the country.[40] The types of jobs showing the most dry season increase within the Northeast were in construction, trade and manufacturing (+0.36, +0.31, +0.28 million people, respectively [LFS 2006: Table 2]).

Note that the biggest increase in dry season non-agricultural employment within the Northeast seems to have occurred between 1988 and 1993, from 0.67 to 1.94 million people (Table 9, line 3). More precisely, from the original LFS data sources used (see Table 1, note 6) and calculated in the same way as in Table 9, we found that the biggest increase occurred from 0.82 million people in 1991 to 1.45 million in 1992, and the second biggest increase was in rising to 1.94 million the very next year in 1993. The 1.94 million people in 1993 was also the highest number in the entire series (1983–2006). Probable reasons for this will be discussed below.

Those who did not find other employment nor became unemployed apparently temporarily left the region (Table 9, line 5). The roughly 1 million apparent seasonal emigrant workers may have dropped a little since the early 1980s (but see Table 9, note 9), but for the most part has stayed roughly the same over the years, just as the total number of persons employed (including part-time) in agriculture and living in agricultural holding households has not fallen much over the years (but as further discussed below, they are probably spending more of the year in off-farm work). From around 7 million in the early 1980s it rose to 8 million in the late 1980s and early 1990s and fell back to a little over 7 million thereafter (Table 1, line 5.7). Since it is estimated that the seasonally increased population of Bangkok was roughly 1 million people in the early 1990s and most of those came from the Northeast [Chamratrithirong *et al*. 1995: 80], it is probable that the GBMR and Eastern Seaboard are the major destinations.

Of the roughly 1 million agricultural working persons who apparently found other work within the Northeast during the off-season, we do not know how many had to migrate *within* the region to get work, for example, to stay at urban construction sites, but it is likely to be a large percentage. If half of them had to live away from home to get work, total migration (within and to outside the region) would be about 1.5 million persons—or more than one worker for every other household (of the 2.8 million agricultural households estimated above).[41]

In sum, probably about 2 million people from the roughly 2.8 million farm households engaged in seasonal off-farm work, about half of them temporarily outside the region, and probably a large portion of the other half also moving temporarily away from

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40) The Northern Region had the next biggest difference, with 0.46 million people displaced from agriculture in the dry season, or 13% of the 3.42 million in the wet season [LFS 2006: Rounds 1 and 3].

41) In one village in Yasothon in 1992, half the people in the village (52%) were out during the off-season [Nakada 1995: 523], but this might be higher than average now. As will be discussed below, 1992 was in a transitional period for the Northeast when agricultural labor was particularly needed at key times, which may have led to an unusually large number↗

home to find work within the region.

However, the agricultural census found 3.77 million people working part-time on and off their own holdings in 2003 (Table 1, line 5.9). This much larger number implies there must be some non-seasonal off-farm work as well, and/or secondary work on other people's farms (discussed further below). For the probably much larger off-farm non-agricultural work, we could expect on average more than one person per agricultural household participating. A similar comparison for earlier years found this unaccounted difference (between Table 1, line 5.9 and Table 9, line 3) increased most between 1993 and 1998. It was 0.49 million persons in 1993 and 1.73 million in 1998, suggesting that off-farm work outside the dry season (during the agricultural season) may have increased enormously during this particular period. Note that this lagged the big changeover in off-farm employment in the non-growing season which took place in the early 1990s, as just discussed above. Possible reasons for this will also be discussed below.

As shown earlier, gross earnings from off-farm work outside agriculture rival gross cash income from agriculture (Table 7A), and probably for less time spent, since most people in farming still say they work most of the time on their own farms (Table 1, line 5.10). However, when all agricultural income is considered, including in-kind, especially from rice, and net income is estimated, then agricultural earnings may well be higher than non-agricultural. In any case, agricultural earnings have significantly increased over time and remained a very major part of overall income. This is why, for many people it has made sense, thus far, to stay in agriculture and combine it with off-farm work.

Changes in Rice Agriculture

In the above analyses, the factors of economic growth and increasing rural income in the Northeast have been overviewed, but we have not yet analyzed how it was possible for rainfed agriculture, with a key factor of rice sales, to maintain its income-earning position in a rapidly expanding economy.

Changes in Rice Production

The history of the Northeast for the past two centuries or more has been characterized by population movements to establish new villages by clearing wilderness and constructing new paddy land [see Fukui 1991: 526; 1993: 310, passim; Fukui and Naewchampa 1998: 431]. Authors observed remote upland areas still being cleared in the 1980s, mostly for field

↘ coming back to the village during the wet season. Also, rice farming in this village was relatively productive, perhaps making seasonal absence more likely than permanent migration [cf., Fukui 1996: 691]. But other income-earning opportunities were not within commuting distance [Fukui 1996: 690], so more people might have left, or stayed away longer than if there were more off-farm opportunities closer at hand.

crops, and new paddies being constructed in a few places still fairly remote at the time (e.g., Suwanakhuha District in what is now Nong Bua Lamphu Province). But by the early 1990s, expansion virtually ceased (e.g., Fig. 2).[42)]

As elsewhere in Asia, cities in Northeast Thailand are surrounded by relatively highly productive rice paddies which, as cities expand, are being converted to other uses. Having reached the end of the paddy-land frontier, the amount of paddy land should have begun to decline. But apparently paddy land lost to urban expansion by this time was so small compared to the vast paddy areas in the Northeast that it had little effect, or perhaps it was somewhat offset by marginal growth in remote areas.

Despite emigration, decrease in farm size and paddy holding size continued (Fig. 3). Average paddy area per household fell by about 12% from 1980 to 1990, and by 18% from 1990 to 2000 (3.2 hectares in 1980, 2.8 in 1990, 2.3 in 2000) (data for Fig. 3 in Appendix Table 3). Overall farm size fell by about 5% and 17% for the same periods (4.5 hectares in 1980, 4.3 in 1990, 3.6 in 2000). With the adoption of family planning which this process stimulated [Fukui 1993: 317–319] and with emigration, the process seems to be leveling off. As mentioned above, so far this has led only to smaller household sizes and not (yet) to a major drop in the population engaged in agriculture, nor the consolidation of holdings,

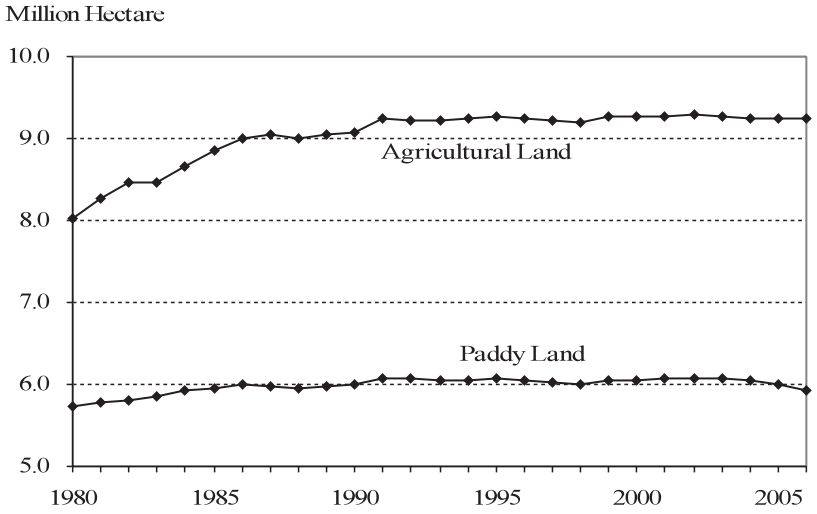

Fig. 2 Agricultural Land and Paddy Land in Northeast Thailand
Source: Appendix Table 2

42) In Fig. 2 (and Fig. 3), the high amount of total "agricultural" land compared to land actually used for various agricultural purposes should not be taken to mean agricultural land is vastly underutilized. For whatever reasons (e.g., poor soils), this category apparently includes large parcels of land not suitable for agricultural purposes.

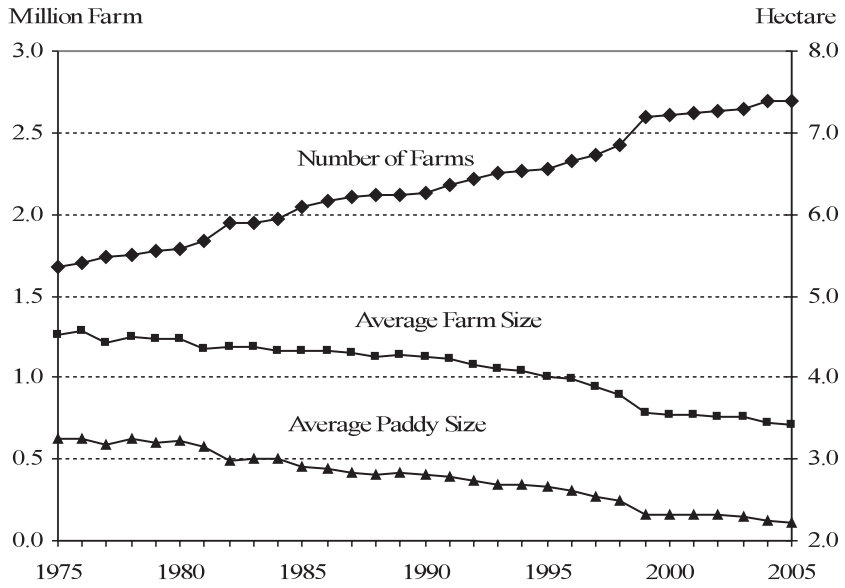

Fig. 3　Number of Farms, Average Farm (Hectare) and Paddy Land Size (Hectare)
Source: Appendix Table 3

compared to the early 1980s. Agricultural land and paddy land per person in agricultural holding households and per agricultural worker is roughly the same as it was in the early 1980s (from data for Fig. 3 in Appendix Table 3 and in Table 1, lines 5.5 and 5.7).

It would be expected that having reached the end of the paddy-land frontier, the area planted to rice in the Northeast would have begun to decline as urban growth consumed nearby paddy land, and yields might even drop since these were often some of the more productive fields. Instead, the reverse occurred. The amount of area planted to rice continued to rise (seemingly leveling off after 2000) (Fig. 4A). As can be seen in Fig. 2, this was not due to further expansion into wilderness or onto other land. Rather, we will argue below it reflects increasing ability to use existing paddies more fully, especially higher paddies on drier, sandier soil, many of which were previously reliably used only in years of good rainfall [e.g., Fukui 1993: 306ff]. Comparing the data for Figs. 2 and 4A (in Appendix Tables 2 and 4) shows the gap between total paddy land and paddy land utilized increasingly closing from the late 1980s on. For example, for the period 1980–88, in only one year (1983) were farmers able to plant over 80% of the total paddy land, whereas in 1989–2001 only one year (1991) failed to meet that criterion.[43)]

43）For some reason (possible data revision?), Fig. 2 shows a slight increase in paddy land between 1990 and 1991, while Fig. 4A shows a slight decrease in area planted to rice in that year. This slight increase in Fig. 2 is much less than the series of increases in Fig. 4A↗

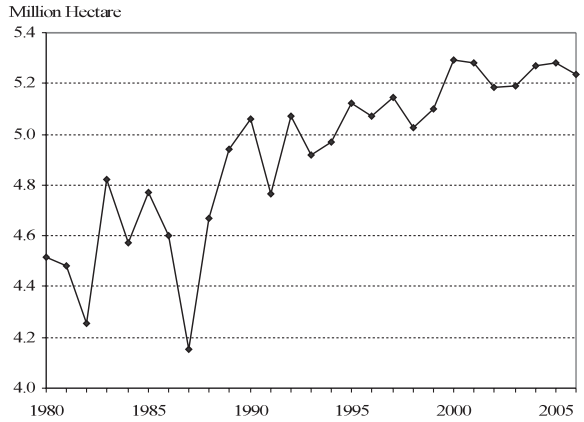

Fig. 4A Rice Area Planted in the Wet Season in Northeast Thailand
Source: Appendix Table 4

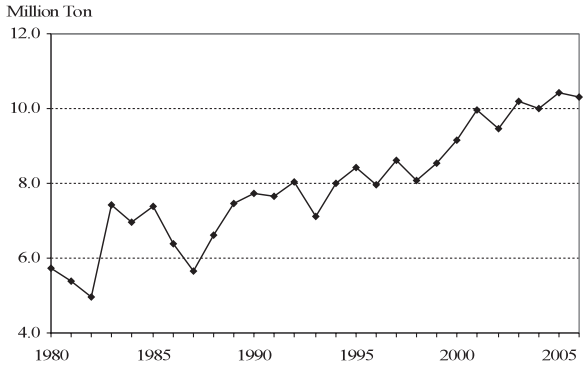

Fig. 4B Rice Production in the Wet Season in Northeast Thailand
Source: Appendix Table 4

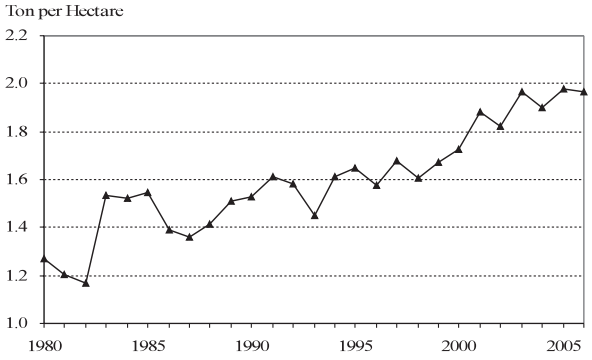

Fig. 4C Rice Yield for Area Planted in the Wet Season in Northeast Thailand
Source: Appendix Table 4

Comparing a recent period, 2003–06, with the period 1980–87, area planted rose by 15% or more (data for Figs. 4A–C in Appendix Table 4). This is one of two main reasons for an increase in rice production of about 65% or more (Fig. 4B). The second reason for increased rice production is increased yield per area, which rose by 40% or more during the same period (Fig. 4C). As can be seen from Figs. 4B–C, the trend seems to have started around 1988, but after 1997 growth accelerated further. The largest increase in both area planted (+22%) and production (+37%) occurred in one three-year period: 1988–90 (percentage increases by 1990 compared with 1987). Yield increased more gradually throughout the entire period.[44)]

So increased yield accounted for most of the increased production, but initially it was due more to increased area planted. If it had not been possible to expand the area planted (if the rise in production had come from increased yield alone), about a third of the actual production gain would not have been realized.

Note that year-to-year stability also substantially increased (patterns in Figs. 4A–C). Previously Northeasterners had to contend with widely varying rice production from year to year and this uncertainty was the dominant feature in their lives [e.g., Fukui 1991: 527–528]. After 1987 farmers seemingly became less ruled by the highly variable weather patterns. Drops in production still occasionally occurred but appear to be less drastic (Fig. 4B), and yields varied much less from year to year as they continued to rise (compared to the period before 1987 in Fig. 4C). The better yields and increased stability have allowed

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↘ beginning after 1987 (but comparisons over time prior to the period of increased stabilization are difficult—see footnote 47 below). In any case, if both tables are substantially correct, we can safely say that the increasing trend in rice area planted in Fig. 4A was not due to further expansion of paddy land.

44) The percentages used to compare recent times with the early 1980s in this paragraph are conservative estimates. If production data for 1981 and 2005 are used [points which are respectively just barely below and above the linear trend line for Fig. 4B], the production increase is 94% [Limpinuntana 2008]. If the trend line itself is used, production gain between 1980 and 2006 would be about 87%. However, it is not clear exactly what this means in the Northeastern context. Before the late 1980s, rice area planted and production in the Northeast were so variable from year to year that even averages over many years can be misleading [cf., Fukui 1993: 191ff]. For this report, we averaged two different periods, 1980–87 and 2003–06, and did a simple form of sensitivity analysis on the more variable earlier period as well, recalculating excluding 1987, a low production year (in order not to overestimate the increase), and again excluding 1983, a high production year (in order not to underestimate). Average wet season rice area planted in 1980–87 was 4.52 M ha, or 4.57 excluding 1987 or 4.48 excluding 1983, vs. 5.24 in 2003–06, a gain of 16%, 15% or 17% respectively. Similarly, average early wet season production was 6.24, 6.32 or 6.07 M tons, vs. 10.21 M tons in 2003–06, a gain of 64%, 62% or 69%. For the yields, in the early period it was 1.38, 1.38 or 1.35 tons/ha, vs. 1.94 in 2003–06, a gain of 42%, 42% or 45%. (Wet season data are used throughout this report because we are focusing on rainfed agriculture—dry season rice area planted in the Northeast has always been less than 3% of the wet season, at most; production always less than 5%, at most.)

many farmers to reduce the rice they store, e.g., from three years to one [author fieldnotes and Nakada 1995 as cited in Miyagawa 1996: 571].[45)]

The portion of glutinous vs. non-glutinous rice grown in the Northeast has also changed. After 1987 area planted to glutinous rice increased and held steady till 1991, while the area planted to non-glutinous underwent a very large increase (Fig. 5A). Then, in the early-to-mid 1990s, probably for the first time ever, or at least in hundreds of years, area planted to non-glutinous rice overtook glutinous, and has stayed ahead throughout the 1990s and beyond.[46)] Even more surprising, this was not just because of being able to increase the total area planted. The area planted to glutinous rice has actually somewhat fallen, before leveling off. Some paddy land must have been taken out of glutinous rice and used for non-glutinous rice or other purposes instead. But this was not done at the expense of glutinous rice production, which was not only maintained but somewhat increased (Fig. 5B). This was possible because of increasing yield, in both types of rice (Fig. 5C).

Note in Fig. 5B that earlier glutinous rice production stayed well ahead of non-glutinous, especially in bad years like 1987 when yields and area planted were low, until glutinous production had become relatively stabilized for several years in 1988–91. From 1991 through 1997, production of both types was fairly close, and after 1997 non-glutinous rice production surged ahead.

To explain these changes, we next need to examine the particular varieties involved.

Changes in Rice Varieties

> Therefore, as far as the poor are concerned, new technology is not the solution—unless by some miracle, the new technology turns out to be suitable for rainfed areas. [Siamwalla 1995: 173]

Some have suggested that increased production of non-glutinous rice in the Northeast may be partly a result of changing eating habits. But glutinous rice production has not fallen, and non-glutinous rice production has increased at a much greater rate than Northeastern population in the 1990s (e.g., compare Fig. 5B with Table 1, line 2.1). Perhaps Northeasterners working in urban settings or outside the region may be consuming more non-glutinous rice than before, but, if so, this would probably be offset by increased

45) This should not be taken to mean that variable rainfall is no longer damaging (especially floods). Figs. 5A–C contain regionally aggregated data, obscuring local variation, of which there is still a great deal, affecting local production from year to year (e.g., see footnote 35 above).

46) This has seemingly been true through 2006, but may not necessarily be true thereafter (discussed below). Data more recent than 2006 was available (including farmgate price data shown in Appendix Table 9) but we have not used it in this report. Very recent government data like this is usually forecasted or preliminary and subject to revision (N. B.).

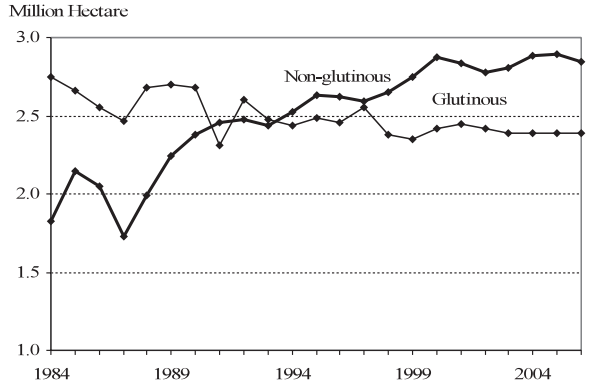

Fig. 5A Rice Area Planted in the Wet Season in Northeast Thailand by Type of Rice
Source: Appendix Table 5

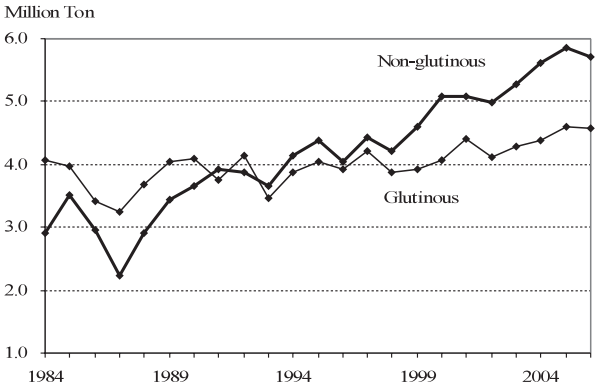

Fig. 5B Rice Production in the Wet Season in Northeast Thailand by Type of Rice
Source: Appendix Table 5

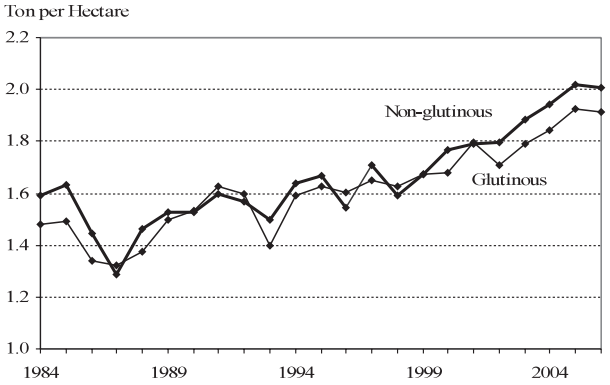

Fig. 5C Rice Yield for Area Planted in the Wet Season in Northeast Thailand by Type of Rice
Source: Appendix Table 5

glutinous rice sales from the enormously increased popularity of Isan food that accompanied their movements.

About three-quarters of the rice farmers in Northeast Thailand grow glutinous rice [e.g., ACIS 1993: Table 5.2]. For most of Northeast Thailand, except for parts of the southernmost provinces, glutinous rice was and still is the preferred staple, while non-glutinous rice has been preferred as a cash crop because it has had a higher price. As shown above, farmers have gained greater income from rice sales, so the increased production of non-glutinous rice is likely to be primarily for this reason.

The main non-glutinous rice variety now grown in the Northeast is KDML105 ("Khao Dawk Mali 105") and the main glutinous variety is RD6 (Figs. 6A–C). Together with small amounts of RD15 (a non-glutinous shorter-duration relative of KDML105), by 2005 they accounted for 86% of the wet-season rice production in the Northeast (data for Fig. 6B in Appendix Table 6). Farmers were able to plant less land to glutinous rice but still maintain or increase its level of production because they switched to RD6, a better yielding variety.

The expansion of RD6 and KDML105 in the Northeast was analyzed by Miyagawa in pioneering case study work in two villages (supported by key informant interviews in several hundred other villages) in the early 1990s [Miyagawa 1995; 1996]. In the rest of this section, we further explore this subject using governmental data and integrating information from these sources with a variety of others.

RD6 and KDML105 are not "high-yielding varieties" (HYVs). Both are strongly photoperiod-sensitive medium-maturing varieties [Miyagawa 1995: 196]. But under most rainfed conditions in the Northeast, they yield better than others, including other government distributed varieties. Their superior response to chemical fertilizer is one reason they have outproduced all the varieties they have replaced. But their photoperiod-sensitivity, so well adapted to the rainfall, is what makes them so suitable for the rainfed paddy fields of the Northeast.[47] And their superior drought tolerance and problem soil tolerance allows them to be more widely planted within

47) "Rainfall distribution is generally bimodal. The rainy season commences in mid-May with the southwest monsoon coming from the Indian Ocean on the western side of the peninsula. The monsoon trough gradually moves north.... It leaves a dry spell of 2–3 wk before it turns back, moving from north to south from August to the beginning of October" [Pushpavesa *et al.* 1986: 167]. Photoperiod-sensitive rice varieties are particularly adapted to tropical monsoon rainfed conditions: "among the photoperiod sensitive varieties, the lower the latitude of distribution, the higher the sensitivity..." [Vergara and Chang 1985: 18]. The principal advantage of photoperiod sensitivity is that it "ensures that the rice crop will flower near the end of the monsoon" [Pushpavesa and Jackson 1979: 139]. Among other advantages: photoperiod-sensitive rice "can be left in the seedbeds for prolonged periods... without serious damage," permitting transplanting when water is "closest to optimum... [and] land preparation and transplanting can be staggered..." [Pushpavesa and Jackson 1979: 139; also see Mackill *et al.* 1996: 8].

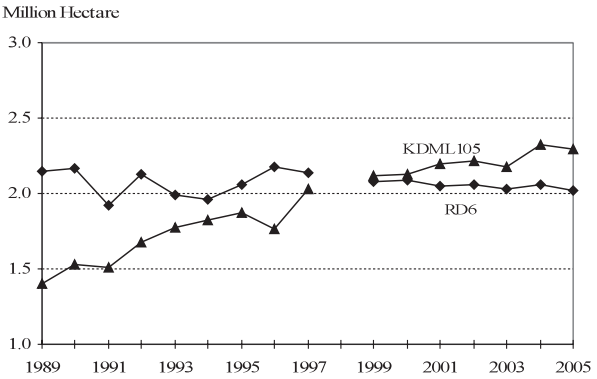

Fig. 6A　Rice Area Planted in RD6 and KDML105 in the Wet Season in Northeast Thailand
Source: Appendix Table 6

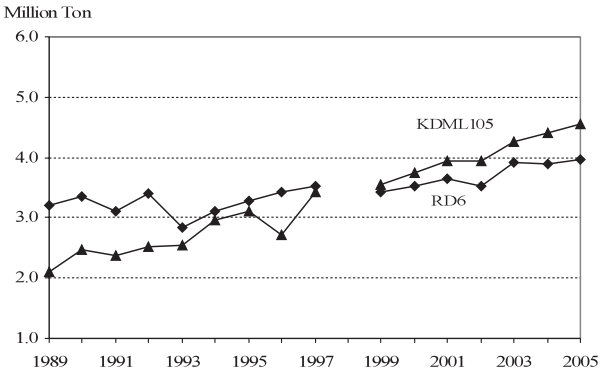

Fig. 6B　Production of RD6 and KDML105 in the Wet Season in Northeast Thailand
Source: Appendix Table 6

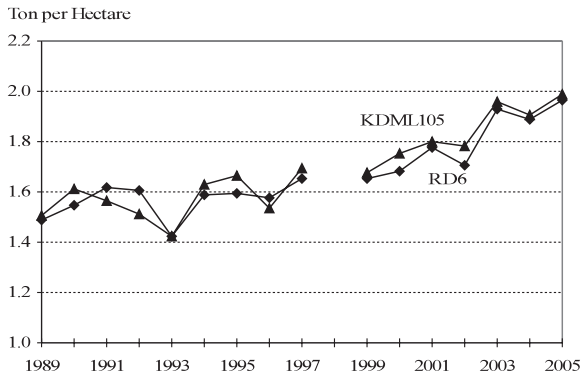

Fig. 6C　Rice Yield of RD6 and KDML105 for Area Planted in the Wet Season in Northeast Thailand
Source: Appendix Table 6

the holding.[48)]

There are good reasons why the HYVs of the Green Revolution never did well in the rainfed rice paddies of Northeast Thailand. In effect, they were bred not to. The HYVs are photoperiod-insensitive dwarf or semi-dwarf varieties designed to exploit highly controlled water and high chemical fertilization to rapidly put growth into the grain instead of the rest of the plant, at any time of the year. Harvest is high-yield, but more production is realized by being able to grow more than one crop per year. On the irrigated fields of Central Thailand, farmers say that as long as the government provides the water they can grow three crops a year or five crops in two years [Isvilanonda 2002: 213; Grandstaff and Srisupan 2004: 114]. But in Northeastern rainfed paddies, farmers found that HYVs performed disastrously, drowning, wilting, dying of thirst and wasting fertilizer [Grandstaff and Grandstaff 1987: 52–53].

The well-known KDML105 (White Jasmine, Tung Kula Jasmine, etc.) is a photoperiod-sensitive medium duration variety, developed by pure line selection in the new rice improvement program of the Department of Agriculture in the 1950s, and released for distribution in May 1959. This program, assisted by the United States Government, was directed by Dr. Krui Bunyasingh, with guidance from Professor Harry H. Love from Cornell University and other advisors [Love 1955: i–ii]. Dr. Love stressed the combined

48) RD6 and KDML105 have increased production by yielding better per area planted but also because they are better adapted to field conditions, allowing more paddy land to be used more of the time. Per area planted, yield of wet season glutinous rice in the Northeast in 2006 was 29% higher than in 1984–85, 39–43% higher than yields in 1986–88, and 27% and less for most of the years thereafter (data for Fig. 5C). We know that by 1989 RD6 accounted for most of the glutinous rice grown, so the data are consistent with RD6 providing a better yield, but variety-specific data are lacking and in any case it is difficult to say just how much better-yielding it was than varieties it replaced, since yields varied so greatly from year to year in the previous era. Under controlled conditions from three different tests in the Rice Department (in Thai language at DOA [2008]), RD6 had yield advantage of 17%, 27% and 29% over NSPT (Niaw Sanpahtawng), the most popular and reportedly best-yielding glutinous rice in the Northeast prior to RD6. Under test station controlled conditions, yields are almost always higher than farmers can expect in their fields, but relative differences among varieties ought to be more realistic. Since RD6 does better on problem soils, the two higher percentages seem more likely to represent the Northeast, and might be too low, depending on the soils used in the tests. But RD6 didn't replace only the better-yielding NSPT, which was planted only in the lower paddy areas with the better soils. It also replaced other poorer-yielding glutinous varieties, so the yield advantage over them would be higher still. Under controlled conditions, RD6 yields higher than KDML105, but as Fig. 6C shows, this is apparently not true in the farmer fields of the Northeast. In sum, it would seem that the 40% increase in yields of rice noted in the data for Fig. 4 can be attributed to the spread of these two varieties. In the Northeast today, RD6 does not yield appreciably better than "native" varieties *still in use*, but that is probably because in the few areas where those varieties were retained, they always yielded comparatively well, thus they were not displaced (e.g., in areas near the Mekong River with better soil and more reliable rainfall).

contribution and teamwork of all the people involved: “This is not the kind of effort that depends on only one or two individuals.”

KDML105 is considered a high-quality rice, selling at a better price than others. “It is a remarkable variety possessing excellent grain quality . . . well timed for the ending of the monsoon [in the Northeast]” (Dr. Ben R. Jackson, personal communication, June 7, 2005) [also see Miyagawa 1995: 196]. It is tolerant to drought and problem soils, such as the acidic saline soils of the Northeast [Jackson; DOA 2008]. Although KDML105 has been grown in smaller amounts around the Northeast for many years, only by the late 1980s did it become a very major crop within the region. This was not because it was unavailable earlier. Glutinous Niaw Sanpahtawng (NSPT), from the same government program, released in 1962, was widely adopted because it raised yields under Northeastern conditions. But non-glutinous KDML105 did not become a major crop in most places at that time because it was of only supplemental interest to most subsistence farmers of glutinous rice.

Glutinous RD6 was developed from non-glutinous KDML105. RD6 is a photoperiod-sensitive medium duration variety with similar tolerances to KDML105 [DOA 2008]. It is a high-quality, soft, fragrant, tasty glutinous variety that seems easier on the stomach and stays soft throughout the day.[49] It was developed by Mr. Pricha Khambanonda and colleagues using gamma radiation of KDML105 at Thailand’s experimental (small, peaceful) nuclear reactor in 1965. It was Thailand’s first fragrant glutinous variety and its first variety created using nuclear radiation [OAEP 1998]. Like KDML105, it is drought tolerant and similarly well suited for the ending of the monsoon in the Northeast and for the region’s problem soils. (The shorter duration non-glutinous RD15 was also developed by Mr. Pricha and his team in the same manner.)[50]

KDML105 had been grown in the Northeast for many years, especially in the southern parts by the consumers of non-glutinous rice. By the early 1980s it had spread as a minority variety into some otherwise glutinous areas. 1981 was a year of particularly good, regular rainfall for all types of paddy land in Na Muang subdistrict in Roi Et, and KDML105 was extensively planted on middle and higher paddies especially by farmers with large land holdings [Chindarsi 1982: 47, 110, 117]. In some places KDML105 was not yet found at all in 1981 (e.g., not found in Nakhon Phanom by Chindarsi [Chindarsi 1982:

49）RD6 qualities from authors’ experience, villager interviews, DOA [2008] and Miyagawa [1995: 192; 2003: 45]. Despite its phenomenal success, the authors believe not everyone thinks RD6 tastes better than traditional varieties, and having only one, uniform taste all the time can make people wish to eat a different variety at least occasionally.

50）KDML105 and RD15 together are often referred to as KDML but are officially designated as “Thai Hom Mali Rice” by the Ministry of Commerce in the Government Gazette (volume 118, special part 109d dated 2 November B. E. 2544) (A. D. 2001). This name and its trademark logo are registered with the Department of Intellectual Properties in Thailand and in the approximately 50 countries around the world to which these two varieties are exported.

103–104]). But by 1989 it accounted for 63% of the non-glutinous area planted and 28% of the total rice area planted (computed from data for Figs. 5A and 6A in Appendix Tables 5 and 6).

RD6 arrived later than KDML105. As a variety generated through the use of nuclear radiation, RD6 may have been a technological breakthrough a little "ahead of its time." It was not approved for release until May 1977, and appears to have taken nearly two decades from its initial creation in 1965 before becoming widely available in the Northeast. Before 1981, it had been promoted in some places (e.g., in Yasothon [Miyagawa 1995: 191]), but it was reported as among those for which government seed distribution had been very limited, "having no effect on increasing the rice yield" [NEROAC 1983: 35]. In 1981 "even buying it was difficult" [Suphanchaimat *et al*. 1984: 5]. Author fieldnotes for June 1981 recorded that farmers in the NERAD Project subdistricts (scattered around the Northeast) knew about RD6 and wanted to obtain it but were unable to. In 1981 in Ban Hong in Roi Et for example, farmers said they were trying to get it to test on upper paddies. In 1982 it was becoming more widely planted, but usually as only a minor part of the mix of varieties grown [Chindarsi 1982: 49, 104, 112; Rigg 1985: 486; Fukui 1993: 175, 389 note 15; Miyagawa 1995: 191, Table 1; 2003: 44]. By the mid-1980s, we have numerous instances in Khon Kaen Province where RD6 became a more significant part of the mix [e.g., Jintrawet *et al*. 1985: 20]. In 1984 in one village near Khon Kaen City, it was grown on both upper and lower paddies by 16 of 17 households studied, but 11 of the 16 were also growing other glutinous rice varieties at that time [Suphanchaimat *et al*. 1984: 9, 18–20].[51)]

Once RD6 was in major distribution around the Northeast, farmers rapidly reproduced it by the well established process of getting seed stock from other farmers via grain exchange [e.g., Suphanchaimat *et al*. 1984: 16–17; Miyagawa 1995: 192]. Figs. 6A–C show the progression for the whole Northeast from 1989, but the two or three years before that (missing data) would logically have shown an enormous expansion. Some case studies flagged the major expansion of RD6 at around this time [e.g., Miyagawa 1995: 192]. 1987 was a year of particularly heavy production loss, so it is possible that observations made by farmers about how comparatively well RD6 did during that year convinced them to dramatically expand this variety at the expense of other glutinous varieties they were planting for subsistence purposes. By 1989 RD6 accounted for about 80% of all glutinous rice planted area in the wet season in the Northeast, and stayed mostly in the range of 80–85% thereafter, but rising into the 85–90% range in 1996, 1999, 2000 and 2002–04 (computed from data for Figs. 5A and 6A in Appendix Tables 5 and 6).[52)]

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51) Since the Khon Kaen Rice Testing Station was a major tester of RD6, villagers nearby were probably among the earlier adopters. In research training the authors conducted in several villages in Phra Yuen District, Khon Kaen Province in 1990, villagers claimed a total switch to RD6 from all other glutinous rice varieties had already been completed by that time.

52) In 221 villages contacted by Miyagawa where glutinous rice was grown in the early 1990s, 90% grew RD6 and 30% grew no other glutinous rice crop at that time [Miyagawa 1995:↗

It is highly probable that increased planting of KDML105 in the late 1980s (missing data) accounts for the noticeable expansion of non-glutinous rice planted area in that period (Fig. 5A). But a major expansion of KDML105 also occurred after RD6 had leveled off (Fig. 6A). In 1989, area planted to KDML105 was about a third less than area planted to RD6, increasingly closing the gap until it overtook RD6 around the late 1990s. Because of this, area planted to non-glutinous rice overtook glutinous by 1994 and stayed ahead thereafter while further increasing the gap (except for 1997) (Fig. 5A).[53] By 1994 KDML105 accounted for 72% of all non-glutinous rice area planted, increasing to around 80% in 2002–05 (all in this paragraph computed from data for Figs. 5A and 6A in Appendix Tables 5 and 6).[54]

Farmers clearly saw advantages in both varieties and the superiority of RD6 over the native varieties they used to plant. Farmers said both do well on upper paddies, but both varieties can be planted widely and nearly interchangeably, with more flexible timing, right next to each other (they "get along well"), and KDML105 can be harvested just before RD6.[55] RD6 and KDML105 cannot perform at Green Revolution level, but they have outperformed and displaced virtually all other varieties in the majority of rainfed paddies in Northeast Thailand. Their drought tolerance makes them superior to others on upper paddy fields, while their medium duration means they can be planted equally well on lower paddies [Limpinuntana 2008].

From the above data and discussion, it is highly probable that the expansion of these two varieties, so well adapted to conditions in Northeast Thailand, was what allowed not only the increased yield but also the increased use of existing paddy land that led to the productivity gains described above. In the three-year period 1988–90, area planted to rice increased dramatically and then continued on a generally rising and more stable trend (Fig. 4A), while the overall area of paddy land stayed about the same (Fig. 2). We know from the previous planting patterns that, due to weather extremes, some paddy land was planted only in some years, but with these two varieties apparently more of the land could be planted more of the time.

↘ 191]. So 60% of villages must have been growing some other glutinous varieties somewhere in the village, but from the government statistics, it should have been on only a small percentage of the rice land.

53) The price of glutinous rice rose unusually in 1997 and 1998 (Appendix Table 9), presumably because of the economic crisis of 1997 which forced so many people to return home. Presumably more glutinous rice was planted and less was sold for that reason, in order to be able to feed the returnees.

54) In a non-random sample survey around the Northeast in the early 1990s, Miyagawa [1996: 554] found "KDML" (not all KDML105, but surely mostly) was the main non-glutinous variety in 79.9% of the villages, the only non-glutinous variety in 32.4% of them, and only 6.9% of them did not grow any KDML at all.

55) In North and Northeast Thailand, the recommended harvest date for KDML105 is November 15 and for RD6 November 21 [DOA 2008].

In 1988–90 area planted to glutinous rice stabilized and held steady for three years at a level already a little lower than a high point in 1984 (Fig. 5A), and apparently lower than in some other years as well (glutinous rice being the main crop in the overall rice data trends in Fig. 4A). After 1990, the area planted to glutinous rice started a generally downward trend (Fig. 5A). In 1987, non-glutinous rice accounted for 41% of all rice planted area in the Northeast, already rising to 52% in 1990, and then generally kept rising in the 1990s (computed from data in Appendix Table 5). This suggests that some of the area used for this expansion could easily have been at the expense of glutinous rice area planted, made feasible because glutinous rice *production* continued to rise (Fig. 5B). It is highly likely the planting of RD6 and KDML105 accounts for these trends. The trends in Figs. 6A–C are consistent with this pattern (although data is available only from 1989), except that the area planted to RD6 did not decrease while these major increases in KDML105 were taking place. Instead, it was largely stable (decreasing slightly after the mid-1990s), even while its production was steadily increasing (Figs. 6A–B). With the amount of total paddy land staying relatively steady (Fig. 2), it would seem highly likely some of the paddy land formerly used for *other glutinous* rice varieties, before RD6, was planted to KDML105 instead.

While formal surveying and more informal interviewing are needed to tell a fuller story, it seems likely that the higher yield and more stabilized production of glutinous rice, via the change to RD6, assured many farmers, probably for the first time, that they could count on the increased production and stability of this variety to secure their family rice subsistence needs. The vast majority of farmers who consume mainly glutinous rice in the Northeast have always been and still are convinced they must produce sufficient glutinous rice for their own consumption (and economic crises like the one in 1997 only reinforced that conviction [Limpinuntana 2008]).[56] Prior to the widespread adoption of RD6, glutinous rice production was very unstable and not always successful.

56) At the time these changes took place in the late 1980s and early 1990s, switching to planting only KDML105 and buying glutinous rice for consumption would have been seen as far too risky. However, this is not to say that more glutinous rice farmers could not later adopt such a strategy (but if glutinous rice becomes more in demand on the market, the price would rise and more of it would be grown for the purpose of sale). Percent of Northeastern agricultural holding households planting only non-glutinous rice for the main, wet-season crop increased from 22% in 1983 to 25% in 1988, 26% in 1993 and 1998 to 28% in 2003 [computed from ACIS Tables 3.1 (1983), 7.1 (1988), 5.2 (1993), 5.2 (1998), 6.2 (2003)]. This gradual expansion would logically have started in the southernmost areas where non-glutinous rice is the main staple, but more recently spread up into the Tung Kula area among some of the glutinous rice eaters as well. In any case, these changing percentages are apparently *not* a differential demographic phenomenon, i. e., if the non-glutinous rice eating population had expanded relatively faster. The village population in the four provinces where non-glutinous rice eaters are most concentrated (Nakhon Ratchasima, Buriram, Surin and Sisaket) has remained at about 33% of regional village population over the years [from PHC 1980; 1990; and 2000].

One way the increased glutinous rice production benefited farmers was in not having to store as much rice, or buy it or trade for it, etc. KDML105 could be grown on more of the upper paddies more of the time than previous varieties, due to its better drought tolerance. But RD6 also stabilized subsistence rice at a higher than formerly average level, apparently releasing some of the land formerly used for or reserved for glutinous varieties, probably especially on upper paddies, some of which were formerly used only intermittently, depending on the weather. Some of the rice land could then be used for other crops instead, including cash-cropping of KDML105.[57] These are two proximately connected ways that these two varieties, after the arrival of RD6 in the Northeast, seemingly contributed to economic growth within the region. But RD6 and KDML105 also contributed to economic growth in other ways, as will be seen in the next subsection.

Other Changes in Farm Technology and Management

Changes in varieties were accompanied by other changes in technology and management practices that continued long after the initial period of varietal change in the late 1980s. (Yields of both RD6 and KDML105 rose by 32% between 1989 and 2005 (data for Fig. 6C in Appendix Table 6)). In this subsection we examine these other changes in farm technology and management.

Table 10A shows cash expenditures on agricultural inputs over the years. By far the biggest period of change was between 1986 and 1991 in this table, when the total (in constant baht) more than doubled (+138%), averaging +27.5% per year. The second biggest change followed that, between 1991 and 1995, rising over 30%, averaging 7.7% per year (calculated from totals in Table 10A). In both periods, the three biggest categories of expenditure were hired labor, fertilizer and equipment. All three rose most steeply in the first period. Interest payments were a relatively very minor expenditure, but they did rise very steeply in the first period, increasing five fold from 1986 to 1991.

In the authors' opinion, farmers were aware that production of RD6 and KDML105 could be increased by chemical fertilizer application. Heavy fertilization is counterproductive, but RD6 and KDML105 respond better than the varieties they replaced to moderate chemical fertilizer application.[58] The data in Tables 10A–C suggest that this

57) KDML105 also probably benefited from the later reduction of area planted to RD6, not just the earlier reduction of area planted to or reserved for former glutinous rice varieties. The downward slope of the linear trend line of a scattergram of area planted to RD6 and KDML105 for the period 1989–2005 indicates an inverse relationship (using data in Appendix Table 6).

58) Former Rockefeller Foundation/IRRI plant breeder (with the Thai Government Rice Division for many years) Ben R. Jackson, PhD (personal communication, June 7, 2005): "I do not consider either of these varieties to be HYV because if large amounts of fertilizer are used they become leafy and tall and do not produce the amount of extra yield. However, if a modest amount of fertilizer is applied they do very well in the impoverished NE soils." See also Naklang [1997: 131] and Nakamura and Matoh [1996: 586]. RD6 and KDML105 respond↗

Table 10A Average Cash Expenditure on Agricultural Inputs of Agricultural Holding Households in Northeast Thailand (in constant 1998 baht)

	1982	1986	1991	1995	1998	2004
1. Hired labor (incl food, etc.)	224	1,755	7,051	9,868	9,134	10,293
1. 1. (as % of total ag inputs)	(2%)	(22%)	(38%)	(40%)	(37%)	(38%)
2. Fertilizer	1,341	1,592	2,954	3,873	4,203	4,817
2. 1. (as % of total ag inputs)	(12%)	(20%)	(16%)	(16%)	(17%)	(18%)
3. Pesticides	83	212	262	297	340	325
3. 1. (as % of total ag inputs)	(1%)	(3%)	(1%)	(1%)	(1%)	(1%)
4. Equipment	n. d.	1,162	2,640	2,630	2,364	2,799
4. 1. (as % of total ag inputs)		(15%)	(14%)	(11%)	(10%)	(10%)
5. Land purchase	n. d.	670	1,166	1,066	1,593	1,483
5. 1. (as % of total ag inputs)		(8%)	(6%)	(4%)	(6%)	(5%)
6. Animal stock, feed, medicine	2,152	1,151	2,045	2,365	2,557	2,858
6. 1. (as % of total ag inputs)	(19%)	(15%)	(11%)	(10%)	(10%)	(11%)
7. Interest payment	513	172	1,045	897	1,281	1,658
7. 1. (as % of total ag inputs)	(5%)	(2%)	(6%)	(4%)	(5%)	(6%)
8. All other (approximate)	n. d.	1,192	1,623	3,551	3,059	2,855
8. 1. (as % of total ag inputs)		(15%)	(9%)	(14%)	(12%)	(11%)
Total agricultural inputs	11,382 (100%)	7,906 (100%)	18,786 (100%)	24,548 (100%)	24,531 (100%)	27,088 (100%)

Sources and Notes: Computed from current price data in Appendix Table 8B. Constant price multipliers used (percentages): 1982: 50.5; 1986: 55.1; 1991: 69.2; 1995: 82.8; 1998: 100; 2001: 103.5; 2004: 109.0. Multipliers for 1982–1998 from OAE *Report of Agricultural Household and Labor Socio-economic Study, Crop Year 2001/02* [2002: Appendix *ko*–2, Table 2/2] (in Thai). For 2004: *Report of Agricultural Household and Labor Socio-Economic Study, Crop Year 2004/05* [2005: 39]. Line 4 includes purchase, rental, maintenance and fuel. In this table, "1982" means "crop year 1982/ 83," etc. Minor inconsistencies due to rounding error.

Table 10B Fertilizer and Direct Seeding in NE Agricultural Holding Households

	1985	1987	1991	1995	1997	2004
1. Fertilizer kg/household	126	129	185	299	339	288
2. Fertilizer kg/ha planted	54	65	85	133	156	148
3. % of planted area fertilized	65%	65%	76%	90%	90%	91%
4. Fertilizer kg/area fertilized	83	100	112	148	174	162
5. Direct seeding % area planted	3%	7%	12%	26%	24%	38%

Sources and Notes: Number of households same data/source as Table 1, line 5.1. All other data by email from OAE Center for Agricultural Information (prcai@oae.go.th), 10 October 2007. In this particular table "fertilizer"=chemical fertilizer.

Table 10C　Selected Other Agricultural Inputs in NE Agricultural Holding Households

	1983	1988	1993	1998	2003
1. 1. Two-wheel tractors (millions)	0.04	0.18	0.45	1.01	1.25
1. 2. % households owning 2-wheel tractor	2%	8%	18%	39%	47%
1. 3. % households using 2-wheel tractor	7%	22%	54%	84%	89%
2. Water buffalo per household	2.20	2.00	1.58	0.75	0.51
3. % households using draft animal	n. d.	n. d.	45%	15%	4%
4. % households using power pumps	7%	7%	13%	27%	27%
5. % households hiring temporary labor	n. d.	40%	42%	64%	72%
6. % households using mechanized thresher	1%	4%	31%	58%	66%
7. % households using combine harvester	0%	n. d.	1%	n. d.	14%

Sources: Number of agricultural holding households same data/source as Table 1, line 5.1. All other data computed from ACIS [1983: Tables 6.1–6.3; 1988: Tables 9.3, 10.1–10.2 and 4.1; 1993: Tables 6. 4, 12.1–12.3 and 9.1; 1998: Tables 10.5, 12.1–12.3 and 13.1; 2003: Tables 11.3, 14.1–14.3 and 15.1].

was indeed one of the first things farmers did. Between 1986 and 1991, real (constant price) expenditure on fertilizer application nearly doubled (Table 10A) (see Appendix Table 8B for current price data). However, fertilizer usage per household and per hectare increased more in the early 1990s (Table 10B, lines 1–2), during the period when the area planted to KDML105 was expanding (Fig. 6A).[59)]

Equipment costs (including rentals) doubled between around 1986 and 1991 (Table 10A, line 4), as use of two-wheel tractors expanded, starting to replace animal traction (Table 10C, lines 1–3). The two-wheel tractor, adapted specifically for use in small rice paddies and powered by a removable engine produced for this and other small farm purposes, had become available in the Northeast by the early 1980s. In 1983 there were about 40,000 of them around the Northeast, but in only a small percent of farm households (Table 10C, line 1.1–1.3). By 1993, more than half the agricultural households were already using them, and by 1998 more than 1 in 3 households owned them and almost all of the rest could afford to hire them.

Hired labor costs quadrupled between 1986 and 1991 (Table 10A, line 1). In the past, growing a collection of varieties meant labor for transplanting and harvesting could be distributed over time, whereas with just these two varieties, labor became much more concentrated in shorter periods [Miyagawa 1995; Limpinuntana 2008]. Of the two, harvesting was the more necessarily concentrated because of close timing of photoperiod-

↘ similarly and reportedly received equal fertilizer when applied (Fig. 6C, author interviews, also Wijnhoud *et al.* [2003: 124]).

59) It is unclear why chemical fertilizer costs should increase more in the late 1980s but usage increase more in the early 1990s. But if all the data in both Table 10A line 2 and Table 10B line 1 are correct and represent the same number of holding households in any given year, then the cost per kilogram of chemical fertilizer increased between around 1986 to 1991 but then decreased between 1991 and 1995, so this might help explain the seeming discrepancy.

sensitivity of the two varieties. Timing of transplanting, although influenced by variation in rainfall, could be somewhat more spread out, but within limits [Pushpavesa, personal communication; Miyagawa 1995: 196; 2003: 46]. The expansion of planted area (discussed above) further increased labor demands, as did the greater planting density and larger seedbeds found by Miyagawa [1995: 197, 199]. Hired labor helped to solve these problems, as did the two-wheel tractor.

As RD6 and KDML105 became widely used within the holding and in the village vicinity, more pressure was put on the millions of absent family members to return to help with transplanting and harvesting. This was widely noticed in the late 1980s and the effect is shown in Fig. 7A. The number of people employed in agriculture in the wet season labor force sample in August in the Northeast rose from 8.2 million in 1987 to 9.9 million in 1989 (data for Fig. 7A in Appendix Table 7). After 1992, this number declined fairly consistently throughout the 1990s (except immediately after the 1997 crisis). Northeasterners taking time off work to return for transplanting and harvesting found themselves faced with long hours and hard work, made even more difficult by their absence from farm labor. People were also increasingly getting jobs where it was more difficult to get time off. So, many or most decided to send money home instead.[60] People with two-wheel tractors (as mechanical plows) were hired for field preparation, and purchase of two-wheel tractors increased.[61] The speed of mechanical plowing also allowed transplanting under more ideal moisture conditions [Miyagawa 1995: 194]. After the early 1990s many more people were increasingly hiring mechanized threshers (and even combine harvesters on flatter land) (Table 10C). Cooperative labor arrangements had become no longer workable, but with higher wages, more people living nearby were willing to work as daily laborers during peak periods.[62] By the late 1990s the agricultural labor force seemed to be leveling off at around seven and a half million (Fig. 7A), not much lower than the roughly eight million in the early 1980s, but as discussed above, many involved part-time.

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60) More people were working in jobs where it was difficult to get off work, especially on short notice, and this was probably the main reason for sending money instead. But it might be argued that the concentrated timing of the harvest period, known in advance, could actually have improved the chances of getting a brief leave from non-farm work.

61) In Table 10A it seems likely that some of the expenses for hiring a mechanical plow and its operator were reported as hired labor (in line 1) instead of as equipment rental (subsumed in line 4).

62) As a woman in Sakon Nakhon said, "My kids work overtime in the factory so I work overtime, too" [making a joke of it, using the slang term "*tham o*" — "o" for overtime]. In a village in Khon Kaen, even a relatively well-off headman and his wife said they did part-time wage labor on their neighbors' farms. According to villagers in Roi Et, it is considered doing a favor for a neighbor so they were paid a little more than an outsider (e.g., 160 instead of 140 baht/day). Trucks also come from other villages not yet finished harvesting, looking to hire people already finished with their own harvesting.

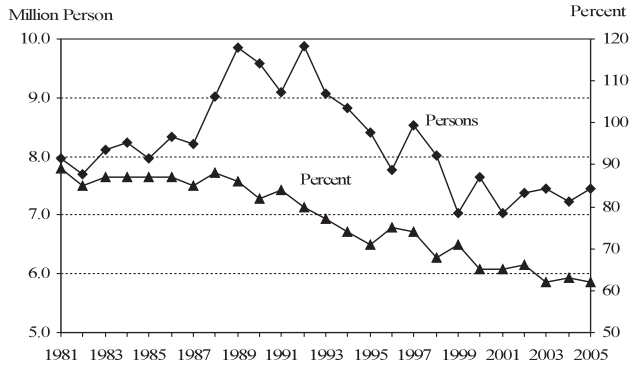

Fig. 7A　Labor Employed in Agriculture and Its Percent of All Employed Labor in the Wet Season in Northeast Thailand
Source: Appendix Table 7

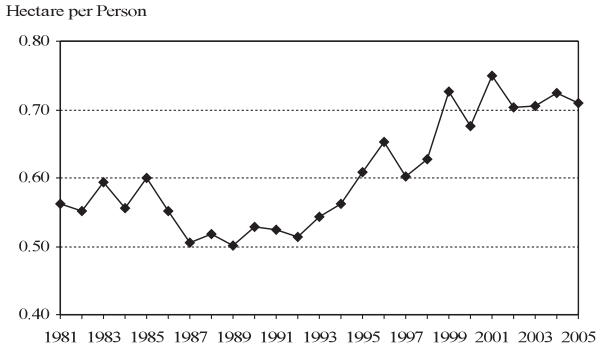

Fig. 7B　Rice Planted Area per Labor Employed in Agriculture in the Wet Season in Northeast Thailand
Source: Appendix Table 7

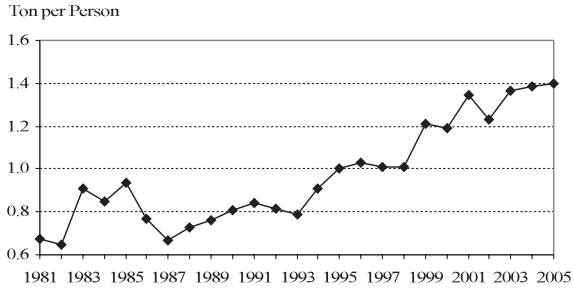

Fig. 7C　Rice Production per Labor Employed in Agriculture in the Wet Season in Northeast Thailand
Source: Appendix Table 7

Two particular changes—direct seeding (broadcasting) and greater use of power pumps—took longer to adopt and were still not in majority usage by the early 2000s (Tables 10B and C). Northeastern part-time farmers working most of the year in Bangkok frequently cite direct seeding as a major help in reducing the time they need to spend on farm. ("Go up in June, get it all done in a few days, then don't go back again until harvest.") Direct seeding has greater timing flexibility and needs much less labor than transplanting from nurseries, but is not always or everywhere advantageous [see Pandey *et al*. 2002; Naklang 1997; Konchan and Kono 1996; Funahashi 1996: 632]. In the Northeast, limited natural water sources for pumping mean that farm ponds may have to be constructed. But even for those able to get assistance for pond construction, it is still a major investment, removing rice paddies to build ponds. Farmers may have wanted to wait to accumulate enough experience with the new cropping practices before taking such a major step. Farmers reported supplemental watering from these ponds was instrumental in getting rice through dry periods and this was one of the reasons people invested in the ponds [Prapertchob and Bhandari 2004: 77; Suphanchaimat *et al*. 2007: 173]. So the use of power pumps increased (Table 10C, line 4). As expected, pesticide use remained relatively low in this environment with single season rice cropping (Table 10A, line 3).[63)]

Kay [2002: 1096] argued that the costs of agricultural change in Asia (for seeds and fertilizer, etc.) were lower than in Latin America where larger commercial farms needed more expensive inputs. But Brookfield [1984: 38] pointed out that "even. . . the application of simpler, directly productive innovations" requires producing a surplus.[64)] In Northeast Thailand, acquiring seeds was at very low cost, but Rigg [1986: 37, 43] cited income constraints as a major impediment to the purchase of chemical fertilizer. Northeastern farmers may have had little savings or initial surplus, but they had cash income from other crops and off-farm employment [e.g., Miyagawa 2003: 45]. As was commonly observed at the time, for temporary additional labor they could call their sons and daughters back to the farm from Bangkok and other places. The growing agricultural possibilities also made joint investment strategies more attractive, and prolonged absence from family to undertake work in other locations may have become a more focused part of farm investment strategies. Remittances to farm holding households increased by about 60% in constant baht between 1986 and 1991 (computed from Table 7A). Agricultur-

63) Rainfed rice fields are seasonally fallowed (or planted to other crops), unlike many irrigated fields planted to rice throughout the year. Pests are therefore usually less of a problem. Additionally, in many of the mini-watersheds, local water impoundment (fish ponds) at the bottom of the slope would be polluted by run-off from the fields above. The rice paddies themselves are also an important source of many natural foods [Somnasang *et al*. 1988], such as fish, frogs, crabs and snails, which could be harmed or contaminated.

64) Northeastern farm families stored rice from a good harvest to make up for the bad years in between, but this was not an expendable surplus.

al loans were also available from the Bank of Agriculture and Agricultural Cooperatives, as well as from other sources.

Growing only two varieties with such similar growing characteristics also facilitates economies of scale often found with specialization. It costs less to hire threshers when all the rice is harvested at the same time, and planting at the same time makes it cheaper to contract for mechanical plowing than it would to do it at several different times. And labor-saving devices like the two-wheel tractor could be used for other economic purposes as well as rice field preparation (e.g., plowing cassava fields, hauling and transportation, etc.), further justifying investment.

As Miyagawa [1995: 196] pointed out, when villagers changed to growing mainly or only RD6 as their glutinous rice crop, instead of a collection of varieties, the concentrated rice labor allowed them more time for off-farm work during the growing season. This was also the case when growing KDML105 along with RD6, because of the close timing in the growth of the two varieties. Limpinuntana [2008] found, and confirmed by crop calendar analysis in different periods, that farmers used the extra free time for short-term non-farm jobs within the vicinity and for other on-farm crops as well. Table 7A shows that upland field crops (and livestock) continued to be significant parts of agricultural income.

Therefore, facilitating economies of scale and releasing labor during the growing season (both via close crop timing) are two more ways that specializing in this particular pair of rice varieties seems to have contributed to the growing income of agricultural households in the region.

However, our seasonal labor analysis above suggested that off-farm labor outside the dry season may have undergone an enormous increase in the mid-1990s, well after the adoption of the two-crop combination in the late 1980s, and also after the rise in net agricultural income in the early 1990s.[65] This is consistent with Figs. 7A and C. Only after 1993 did the rice production per labor begin its major rise. What we do not know precisely without further fieldwork is why (but interrelationships discussed further below).[66]

In any case, the timing of these changes suggests the effect of the nearly concurrent growth periods of the two rice varieties on off-farm income may have been initially a less important contribution to farm family income than the increased rice production and sales, which then helped justify other on-farm changes that rapidly increased production per labor. Eventually (by the early 2000s), the production per labor rose so high it nearly

65）This effect might logically have occurred earlier in villages close to major cities, like Don Daeng, which Miyagawa studied, where nearby off-farm work was already available.

66）The timing and details of a technological change (not reflected in the data in Tables 10B–C) would be worth looking into: the changes in the transmission gearing for the two-wheel tractor. It may have allowed more women to operate it and perhaps greater use for local hauling and transportation, easier and cheaper than having to remount the engine in an *itaen* farm truck.

doubled that of the late 1980s (data for Fig. 7C in Appendix Table 7).

In general, the rising value of labor encourages the adoption of labor-saving measures [e.g., Pingali 1997: 629], as long as productivity and/or prices of agricultural produce justify the expense. It has been argued by Isvilanonda [2002: 220–221, 233] that price elasticity of the rice supply for Thailand was low, and that investment in rice research and irrigation development were the main sources of labor productivity growth and rice production growth for the country. We have argued that the Northeast, despite its environmental limitations, was able to boost rice production primarily due to a changeover to two particular varieties which were of higher productivity in the challenging Northeastern setting. The result was to increase both the area planted and rice production per person working in agriculture (Figs. 7B–C).[67]

Differences by Size of Land Holdings

Most of the above discussion dealt primarily with averages and percentages of households and people, without directly addressing how the changes may have affected differentially endowed agricultural households. For example, were farmers on very small holdings able to participate—could they afford the inputs needed to achieve higher yields? Data needed to address this type of issue are not available for all the changes discussed above, but some data are available by land holding size class (2003 data in Table 11). We

67) With respect to productivity per labor at various times, data for Figs. 7A–C are based on overall agricultural labor, not rice labor (data not available at regional level), and the "seasonal" labor force data are based on a weekly snapshot, which included people who came back only for a short period. If the rice labor figures had been used, the production per person-hour might have been higher than implied in Fig. 7C, and the rise in later years might have been *relatively* higher compared to the initial changeover when more people came back to help transplant and harvest. With respect to the influence of the price of rice, the index trend in rice prices from late 1980s through the 1990s may have been slightly positive but with wide fluctuations, while wage rate kept rising [see Isvilanonda 2002: 218 Fig. 1]. Constant farmgate price of KDML seems to have been rising slightly over time, exhibiting a moderately increasing trend (Appendix Table 9). It did rise in 1988 and 1989 but went consistently down thereafter until 1996 when it started on another upward trend for a few years, slightly passing the 1989 level in 1997, 1998 and 2004. The rice premium (export tax) was eliminated in 1986 and international exports of KDML apparently were first recorded in 1988 [Rice Exporters Association 2008], but it is unlikely that had a major effect on farmgate prices at that time. The price of glutinous rice also followed a similar pattern in those years, with negligible exports. Rice production suffered in 1987 (e.g., Figs. 5A–C), so that may have been the cause of higher prices for a year or two thereafter. The fact that KDML105 is a higher-value rice that seems to achieve its best quality when grown in the Northeast has helped make up for the still relatively lower yields inherent under rainfed conditions in the region. But that was nothing new in the 1980s—fragrant rice had long been higher-value, and KDML105 itself was released in 1959. And RD6 was widely expanded primarily for the purpose of subsistence consumption, rather than sale (as discussed in the current report). In sum, it is very unlikely that farmgate prices could have been a major cause of a massive changeover to RD6 and KDML105 in the late 1980s.

Table 11 Selected Characteristics of NE Agricultural Holding Households by Holding Size Class in 2003

	Holding Size Class (*rai*)								
	＜2	2－5	6－9	10－19	20－39	40－59	60–139	140＋	total
1. Percent of holders (% of members)	2 (2)	13 (12)	15 (14)	33 (33)	27 (28)	7 (7)	3 (3)	0 (0)	100 (100)
2. Percent of agricultural land	0	3	6	23	37	16	12	4	100
3. Percent holders owning all land they worked	90	84	83	80	75	74	71	50	79
4. Holders growing rice as % of class	13	87	94	94	95	93	88	62	91
5. Wet Season rice yield (ton/ha.)	2.3	2.2	2.1	2.0	1.8	1.8	1.7	1.8	1.9
6. Wet Season rice product *per member* (kg)	150	370	590	920	1,450	1,980	2,350	3,050	1,090
7. Chemical fertilizer on rice (kg/ha)	360	239	212	191	171	153	144	148	178
8. Chemical fert… as % rice area planted	92	91	93	93	93	92	91	82	92
9. % Holders work part-time off own farm	59	51	48	45	42	41	40	37	45
10. % Holders income mainly from own agric	38	54	62	69	76	80	82	86	68

Sources and Notes: Calculated from ACIS [2003: Tables 4.1, 5.1, 6.3, 6.5, 9.3, 13.2, 15.4, 16.3 and 18.1]. 1 *rai*＝0.16 hectare. "Members"＝all persons in agricultural holding households (including holders). Fertilizer usage different source from Table 10B and data here for rice only. "Work part-time off own farm" is 100% minus "engaged in agricultural work on the holding only" in original source. "Income mainly from own agric"＝"agriculture only"＋"mainly from agriculture" ＋1/2 "equally from agriculture and other sources" in original source. Minor inconsistencies due to rounding error.

discuss these here and also summarize recent history (unless otherwise cited, from the sources for Fig. 8 and ACIS [1983: Table 2.3; 1988: Table 6.2; 1993: Table 4.4; 1998: Table 4.2; 2003: Table 5.1]).

Most farms in Northeast Thailand have between 10 and 40 *rai* (1.60 and 6.40 ha.; 1 *rai* ＝0.16 ha.). This has not changed greatly in recent times, despite fragmentation of holdings (Fig. 8). In 2003, these medium size holdings represented about 60% of the farms and people in farm households (Table 11, line 1). They were about 66% in 1983 and in 1998. They accounted for 58% of the agricultural land in 1983 and 60% by 2003 (Table 11, line 2). (Within this 10–40 *rai* category, more detailed data are available for 1993 and 2003, which shows a slight increase in the percent of land in the 10–19 *rai* class, rising from 20% to 23%, but no change in the 20–39 *rai* class.)

Fragmentation has resulted in more noticeable changes above and below the medium sizes. Percent of holdings of 40＋ *rai* fell from 16% in 1983 to 10% in 2003 (Fig. 8). Agricultural land in this class fell from 37% in 1983 to 32% in 2003. However, for the very highest class, 140＋ *rai*, there has apparently been a recent small rise. In 1988 this class represented 4% of all agricultural land, falling to 3% in 1993 and 2% in 1998, but rising back to 4% in 2003. If this is an expansion of "agricultural entrepreneuring" [Rigg 2005] in the Northeast, it seems confined to a small percentage of the agricultural land (cattle ranches, vineyards and pine plantations being some highly visible examples). However, larger holding sizes are apparently also more likely to rent land (Table 11, line 3), which may be another indication of a movement in this direction.

For the very small holdings, agricultural land under 6 *rai* accounted for about 8% of holders and 1% of land in 1983 and 15% and 3% respectively by 2003. The very smallest

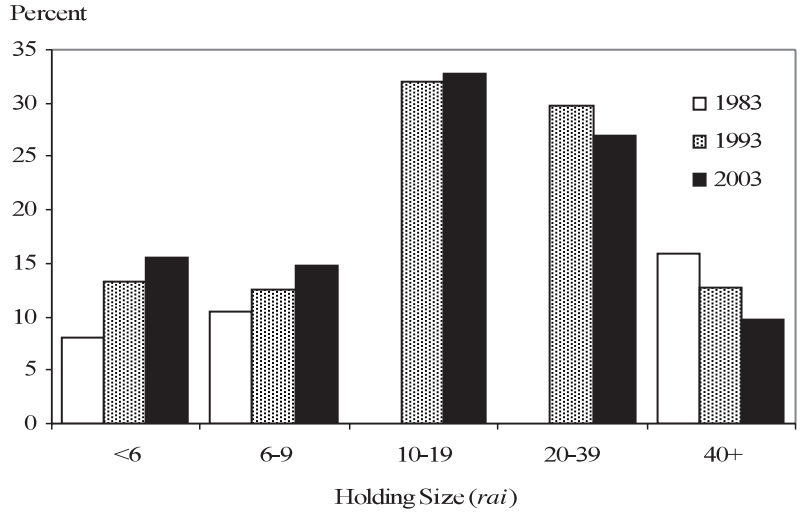

Fig. 8 Percent of Farms (Holdings) by Agricultural Land Holding Size Class in Northeast Thailand

Source: ACIS [1983: Table 1.1; 1993: Table 4.1; 2003: Table 1.1]

Note: In 1983, there were 66% of holders in class 10–39 *rai* (more detailed data not available).

category (< 2 *rai*) may have had the greatest change, but by 2003 accounted for only 2% of all the farms and farm population in the region and well less than 1% of the agricultural land.

Fragmentation of holdings has not resulted in any major increase in tenancy on small farms. In the Northeast, a large majority of holders own most or all of the land they work, and this has not changed greatly over the years. In 2003, 79% owned all of the land they worked, and only 8% worked only on land they did not own, and a third of those used that land free of charge [ACIS 2003: Table 4.1]. The smaller the holding, the *more* likely it was that holders would own all the land they worked (Table 11, line 3).

The vast majority of farm households in Northeast Thailand— 90% or more—have always grown rice, and still did by 2003, for all holding size classes except for those few holdings at the extremes (Table 11, line 4). At both extremes can be found commercial farmers of animals or crops other than rice, and among the smallest farmers there may be some who would like to grow rice but simply have insufficient land. However, in 2003, 13% of farms under 2 *rai* were able to grow rice (Table 11, line 4), a big increase from only 4% in 1993. In the 2–5 *rai* category, with 13% of total holdings, rice growers rose from 80% in 1993 to 87% in 2003. Apparently many small farms found it increasingly attractive to grow rice.[68)]

68) Villagers in one village in Khon Kaen confirmed smaller holdings achieved higher rice production per *rai*.

Small farm holders may have found rice more attractive because they could achieve better yields—not just better than before but also better than their neighbors (Table 11, line 5). They applied higher levels of chemical fertilizer (Table 11, line 7), and probably were able to manage small holdings more intensively in other ways. While very small rice farms could not produce the surplus needed for major increases in agricultural earnings, even the smallest category could meet most of their subsistence needs (Table 11, line 6; cf., footnote 31 above). Again, while off-farm earnings probably made this type of investment easier, there is no reason to think this was not an economically rational investment (to grow rice instead of having to buy it).

Throughout the Northeast, families on small farms have become differentially more dependent on off-farm work, but on a majority of Northeastern farms, holders (and most other household members) have worked mainly on-farm (holdings above 6 *rai*—Table 11, line 9) where they say they have also earned most of their income (for holdings of 2 *rai* or greater in Table 11, line 10).

In many data sets differentiated by holding size, obvious, expected patterns appear. For example, for households with income mainly from doing agricultural (wage) labor on other farms, the 2003 data exhibit a clear pattern decreasing with landholding class size: 9% for < 2 *rai*, 6% for 2–5 *rai* class, etc., down to 1% for 140+ *rai* [ACIS 2003: Table 15.4]. However, except for the very smallest holdings, the differences are not great, and the similarities meaningful. For example, there are at least *some* households earning most of their income from agricultural labor at all holding size levels, and at all levels they are only a small minority of households. This probably has more to do with the increasing need for agricultural labor in the vicinity, as mentioned above, and less to do with the holding sizes of the people who "help their neighbors out" in this manner. Likewise for off-farm employment (Table 11, lines 9–10), there is also enough similarity across land-holding size classes to make it clear that something other than landholding size must be more causative, for most Northeastern farm families. Perhaps some people just have better access to off-farm opportunities than others, due to personal skills, inclinations and connections [e.g., Fuller 1990].

Part-time off-farm work has been increasing across all holding classes, and converging. In 1993, 30% of holders were involved and the spread was 22% to 54% for the largest and smallest land-holding classes respectively [from ACIS 1993: Table 9.3]. By 2003, it was 45% and the spread was 37% to 59% (Table 11, line 9). Given that other farm family members are living at home but working non-farm or living elsewhere and sending remittances, a large majority of Northeastern farming households is now likely to be involved in mixed economic activities linking farm with off-farm and non-farm work.

The differential data discussed here are consistent with Rigg's [2005] contention that participation in non-farm employment in Southeast Asia has had the effect of delinking poverty from small land holding size. But in Northeast Thailand these improvements in agricultural technology have also worked for, rather than against, the rural poor, since

small farms have also been able to participate [cf., Rigg 2005: 182]. Agricultural improvements and off-farm employment have worked together here, helping to account for the often-noticed enduring resiliency of rural Isan villages [e.g., NESDB and World Bank 2005: 7].

Implications

Near the beginning of this report, we suggested positive feedback processes probably had taken place among a set of factors in the late 1980s and 1990s that would account for the persistence and well-being of rural communities and economic growth within the Northeast. In the first subsection here, we summarize particular factors and propose interrelationships. In the second subsection we then expand the perspective to set the changes in a generalized economic context. In a third subsection we take a different perspective to look at the changes in an historical context. In the last subsection we consider implications for the future.

Factors and Interrelationships

We start here with a short period-by-period summary of happenings, then consider interrelationships.

By the early 1980s, KDLM105 was already widely available, but had not yet undergone major expansion in most glutinous rice growing areas. Other technologies were also already available, including the particularly important two-wheel tractor. The markets, the all-weather roads, the extra-regional access, to both markets and temporary employment outside the region were also well developed by the early 1980s. Many Northeasterners were already working intermittently outside the region during this period (cf., Table 9, line 5 and note 9). Gross non-agricultural cash income was already half of total gross cash income in agricultural holding households in 1982 (Table 7A).[69)]

By the mid-1980s RD6 was widely available and being widely adopted. By 1989, RD6 was already 80% of the glutinous area planted, and area planted to KDML105 was about a third less than area planted to RD6 (data for Figs. 5A and 6A in Appendix Tables 5 and 6). Concurrent with the expansion of RD6 in the late 1980s, glutinous rice production and yields began to stabilize and improve (Fig. 5B). Area planted to non-glutinous rice had a very major increase in 1988–90, apparently because of expanded planting of KDML105. The late 1980s was also a period of increased remittances to farm families (Table 7A), and by far the biggest increases in agricultural investment. In particular, hired labor, fertilizer

69) Farm family income from remittances was smaller in the early 1980s (Table 7A, line 2.1), but at that time most people stayed at home on the farm most of the year, so most non-farm earnings were probably classified as off-farm income, rather than as remittances from people living elsewhere.

and equipment costs (Table 10A) and usages (Tables 10B–C) surged in this period. During this same period, gross agricultural cash income surged as did rice sales, but not net agricultural cash income (Tables 7A–B).

In the early 1990s non-glutinous planted area and production increased and area planted to glutinous rice began to decrease (Figs. 4A–5B). As discussed above, planting of KDML105 was expanded, after planting of RD6 had already leveled off (Fig. 6A). By 1994 area planted to KDML105 almost equaled area planted to RD6, before it later surged ahead. Remittances and agricultural investments continued to increase, but investments were apparently now paying off as net agricultural cash income underwent its biggest increase of all, averaging nearly +12% per year (in constant baht), during 1991–95 (Table 7B).[70)]

Along with the increased net agricultural cash income, the early 1990s was the same period when non-agricultural income of farm families doubled, non-agricultural expenditure of farm families expanded at +13% per year (all from Table 7A), the surge in village household possessions began (Fig. 1), and non-agricultural employment within the region rose sharply (Table 2). From our discussion of proxy data above, off-farm employment within the region *during the dry season* seems to have risen most in the years 1991–93, followed by a rise in off-farm employment within the region *during the growing season* in 1993–98 when labor-saving measures were being expanded (Tables 10B–C). But, as discussed above, seasonal employment *outside* the region seemed to have remained relatively steady over the years, as did the number of people in agriculture.

What follows is an hypothesized explanation of relationships in the above patterns. Although it contains a degree of conjecture, we offer it for its potential explanatory value and leave it to others to judge how convincing it is and to test the arguments with additional data and analysis.

In a systems explanation, key factors are seen in interrelationship and major changes come from positive feedback among factors [Maruyama 1963]. In Northeast Thailand, many of what turned out to be key factors were already in place by the early 1980s, and the above reconstruction suggests that the arrival of RD6, even though it was planted for *subsistence*, supplied the last "missing piece." Within the few years that followed, RD6 secured the glutinous rice consumption base for the majority of farm families in Northeast Thailand, and allowed them to expand the area planted to KDML105 as a cash crop. By the late 1980s it did this in two proximate ways: by raising and stabilizing production of glutinous rice, and by beginning to free some of the land that had been previously used or reserved for *other* glutinous rice varieties. With the highly compatible KDML105 already available, this allowed many farmers, probably for the first time, to make major

70) A growth rate of 12% is unusually high for net cash agricultural income, but that is because it is starting from a very low base, presumably because of the sudden start-up of rice sales. Agriculture inherently cannot sustain such a high growth rate [Mellor 1995a: 5–6].

cash investments in rice agriculture within the region. The congruent timing of the two rice varieties facilitated economies of scale, and labor freed from rice helped to sustain other cash crops as well. Area planted to KDML105 was expanded and by the early 1990s paid off in major increases in net agricultural cash income. The increased cash was used to purchase both agricultural inputs and non-agricultural possessions, stimulating the local economy and providing major increase in off-farm jobs in the dry season *within* the region. By the mid-1990s, the labor saving inputs that were being adopted, facilitated by the congruent timing of the two varieties, freed more labor within the growing season for off-farm employment, as well as for agricultural work on other farms, further increasing income, leading to increased spending and further growth of non-agricultural jobs, and so on.

The economic changes in Northeast Thailand during the late 1980s and 1990s undoubtedly were also affected by the income earned by Northeasterners working outside the region. But this does not necessarily mean that the industrial expansion going on in the GBMR and Eastern Seaboard at the same time was a major influence on the key changes noted in the late 1980s and early 1990s within the Northeast.

Remittances from outside the region could have contributed to economic growth within the region in two major ways: used directly for consumption or via agricultural investment. The biggest effects of spending of remittances for direct consumption probably came later, especially in the late 1990s (also see footnote 29 above). The number of households with most of their income from remittances was still very small in the late 1980s (Table 2, line 5) and the baht amounts were also much less than at later times (for most families). For farm households, remittances increased 61% in 1986–91 (averaging +12%/year), but less so in 1991–95 (+10%/year) and most of all in 1995–98 (+32%/year) (computed from Table 7A, line 2.1). This suggests that agricultural investments attracted remittances in the late 1980s and the biggest effect on direct consumption spending came much later, after the agricultural changes had already started, and even after the initial surge in consumer spending in the early 1990s suggested by Fig. 1. This suggests economically healthier villages encouraged joint investment, not that an otherwise moribund village economy was being propped up by remittances.

Undoubtedly off-farm income and remittances to farm families must have contributed to the agricultural investments noted above during the late 1980s and early 1990s. Remittances increased 61% between 1986 and 1991 and overall off-farm (non-agricultural) income increased 34% (calculated from Table 7A, lines 2.1 and 2). But, because of the way the data is collected, this larger surge in remittances, compared to the increase in overall off-farm income, could simply be because people stayed away more of the year as more work became available in the GBMR and Eastern Seaboard at the time, so the income was reported as remittances from others, rather than off-farm income from household members. By far the biggest increase in overall off-farm income came later, more than doubling (+135%) between 1991 and 1995 (Table 7A, line 2). This was after the by-far-

largest increases in agricultural investments had already been made in the late 1980s (Table 10A, discussed above). The farmers' off-farm income in 1991 was only marginally higher than in 1982, in constant baht (Table 7A, line 2). In the early 1980s, before the spread of RD6, this income was often used to offset subsistence rice harvest shortfalls. By the late 1980s, RD6 together with KDML105 created the opportunity to use off-farm income, mostly earned outside the region, for agricultural investment instead. Taken all together, this suggests it was probably this new opportunity, rather than increased off-farm income, that encouraged on-farm investment.

In any case, we can safely assume farmers would not have made these agricultural investments if they did not think it economically justifiable, and as the data show, that expectation was validated. Those with family farms, even small family farms, were able to continue farming, and earn more income from it, keeping the rural villages economically healthy and, largely because of that, the entire Northeast (further discussed below).

In a systems explanation of rapid, qualitative change, the key factors have to be in place and interact in a positive feedback manner, explaining the change. But we also point out that if RD6 was last to arrive, and so much started to happen after that, and credible proximate connectives have been proposed, and no other likely factor seems to have arrived to begin interacting at that time (the major increase in off-farm income of farm families coming later), then we therefore suspect the arrival of RD6 may have started (not "caused") a "rainfed revolution" in Northeast Thailand.[71] Certainly, even with KDML105 and all the other factors in place, we cannot see how the major changes documented in this report could have occurred without RD6. Rice production could not have undergone such a rapid increase, nor agricultural income increased so significantly, nor off-farm employment by farm families have increased so much within the growing season. And without the increased agricultural income within the agricultural households (a majority of households in the Northeast), then non-agricultural employment within the region could not have grown so quickly and so much. Indeed the reverse could have occurred if more and more people simply left the region for a better life elsewhere.

71）Maruyama [1963: 166] argued that the "initial conditions" for many types of positive feedback processes may actually be trivial, such as whatever initially caused the particular location of a city on a homogeneous plain, and only the "deviation-amplifying mutual positive feedback networks" could explain why the city grew. More recently, economists concerned with geographical factors have made similar points [e.g., Krugman 1993b: 131]. These points are not disputed here. But the arrival of RD6 was not trivial. It became one of the key factors within the positive feedback process. Its capabilities in this particular environment were unmatched by any other glutinous photoperiod-sensitive variety available at the time [cf., Rigg 1995]. This is also not to claim that environmental constraints are always the main constraints on resource practices.

Agricultural and Economic Development

To get a more general understanding of the processes by which farm and farm household changes connected to non-farm employment and other economic changes within the region, it is important first to see the Northeast for what it is—a major agricultural region. As we have seen above, even into the twenty-first century households practicing agriculture still represented a majority of Northeasterners, about two-thirds of the "village" population, and an even higher percent of the rural villages. For various reasons, the GBMR/Eastern Seaboard became Thailand's industrial region, where agriculture serves the cities, whereas in the Northeast, cities still largely serve a very extensive agricultural base [cf., Krugman 1993a: 13].[72] But agricultural development can play a complementary role to industrial development, especially in early stages, despite the inherently slower growth rates of agriculture compared to manufacturing, when agriculture is practiced by large populations (working for themselves on their own farms) [Mellor 1995a: 5–6; 1995b].[73]

Increased agricultural production and crop commercialization in the Northeast contributed directly to Thailand's economic growth, even though, with growing industrialization, agricultural production contributed a progressively smaller portion of GDP. This was primarily through grain and other basic crop production, but with growing incomes and changing diets, there is a growing role for higher-value meat and dairy products as cities and suburbs expand, and also within the villages themselves.

Agricultural development in the Northeast also supported economic development in the GBMR and Eastern Seaboard by helping to supply labor. The improvements in agricultural technology led to having to spend less time in agricultural activities while still realizing gains in productivity, freeing people to work more in other jobs in other places. The rural Northeast, with its very large population, contributed to the supply side of Thailand's economic growth not just through increased agricultural produce but also by its contribution to increased non-agricultural labor.

Increased agricultural productivity and commercialization also boosted industrial growth on the demand side through increased consumption (in addition to purchase of farm inputs). Even as early as the late 1980s, rural demand was beginning to "add somewhat to the boom in the industrial sector" [Siamwalla 1995: 164]. By 2004, the more

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72) Krugman cites McCarty for coining this relational dichotomy (McCarty, HH. 1940. *The Geographic Basis of American Life*. Westport, CT: Greenwood Press). There is much literature on the subject of spatial concentration(s) of industrialization within countries [e.g., Krugman 1999], including in Thailand, but it is beyond the scope of the current report.

73) We have chosen not to expand our discussion in this report into the literature debating various aspects of "virtuous cycles" between agricultural and non-agricultural economic growth, which would require a much more far-ranging discussion. In Northeast Thailand, the relationships we discuss seem fairly straightforward, and conform closely to Mellor's views except where noted.

than 4 million non-municipal households in Northeast Thailand spent 69% of their total household expenditure on manufactured goods, compared to 43% in 1986, when the total real expenditure was much less, and the percentage had consistently increased throughout intervening period (except for 1998, the year after the economic crisis).[74] There is no doubt that much of the urban growth within the region is linked directly and indirectly to increasing village prosperity, as urban businesses expanded their services into the villages, and village families and storekeepers commuted to shop in urban areas.

As discussed above, this rainfed type of agricultural revolution did not depend on large-scale irrigation schemes nor the very-high-yielding varieties of the Green Revolution. RD6 and KDML105 are only modestly high-yielding, and they do not require heavy chemical inputs, making them not only more suitable to small farms but also to an environment where chemical fertilizer might be washed away by flooding or leached from sandy soils in heavy rain. Most important, these varieties are highly photoperiod-sensitive and, like the native varieties from which they were derived, are adapted in the timing of their growth to the most reliable rainfall that is the climax of the Southwest Monsoon in September and October. It is this relationship (and its semi-aquatic nature) that makes rice a successful crop even in the Northeastern environment, an advantage perhaps misunderstood by those who have thought rice an unsuitable crop for this region. Actually, lowland rice is more productive than most other crops in this environment [Pendleton 1939: 43].[75]

It is also notable that development of rice as a commercial crop in the Northeast was accompanied and facilitated by the adoption of a higher-yielding *glutinous* variety for home consumption. The goal of increasing the yield for home consumption may not have

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74）Village household expenditure on manufactured products was calculated from SES 1986–2004 Statistical Table 2 and deliberately underestimated by excluding a wide range of expenditures indirectly involving purchase of manufactured goods (school fees, medical costs, transportation costs, etc.). The relatively minor ceremonial category (weddings, etc.) was included, but discounted by 50%.

75）While Northeastern rice production per hectare is relatively low, production per person is not as low, because of larger average holding size. For an early example of doubting the suitability and sustainability of rice cultivation on the poor, largely unirrigated soils of Northeast Thailand, see Long [1966: 356–357]. Lowland rice can be grown even on poor soils because of its "semi-aquatic nature" [Grist 1953: 11; Pendleton 1939: 43; 1943: 27]. In Northeast Thailand in earlier times, Pendleton observed that additional nutrients came from livestock droppings, run-off from adjacent forest (especially after burning the understory), from fallowed [upper] paddies where livestock graze, from litterfall from trees in paddies [also Vityakon 2001], and from run-off of nutrients from livestock manure [etc.] from the village area above the paddies [Pendleton 1943: 27, 30, 22; 1962: 72–74, bracketed comments added]. (Termite mounds might be another direct or indirect source [see Pendleton 1939: 43; 1942].) Wet season crops suffer from reduced sunlight during the monsoon but this is partly compensated for by photoperiod-sensitive crops that mature after the clouds lift [Farmer 1979: 309], and the Northeast gets a relatively great deal of sunlight [Pendleton 1962: 128], even during the peak monsoon period.

been characteristic of other areas in Asia where yields were higher to begin with. And because it involved two varieties—one for subsistence and the other for the market—farmer planning in Northeast Thailand was probably more difficult, so expected benefits would have had to be clear and compelling.

It should also be noted that while a good case can be made for technology-induced agricultural change, it would not be fully accurate to say it was government policy induced, as may have been more the case in some other countries [see Mellor 1995b: 311–312].[76] Both RD6 and KDML105 were government-developed varieties, and the government distributed the seeds and offered agricultural loans, etc. But it could be argued that the success of RD6 was almost in spite of government policy, since it took so long for the government to distribute it, and rice research in general was never heavily funded (some rice breeders say "far below adequacy").

Also perhaps unexpected is the persistent ownership of small holdings, seen as inhibiting consolidation to realize economies of scale [NESDB and World Bank 2005: 136, 141]. In areas where the terrain is very locally fragmented by land level and soil type, land-leveling to facilitate economies of scale may be impractical even if enough people were willing to sell or lease their holdings. But that is probably not the reason for the persistence of small farms. A better explanation is that, as shown above, agricultural earnings have been able to keep pace with non-farm earnings of people in agricultural households, and as shown above, all or nearly all holding sizes benefited from the changes in agricultural technology. As earlier, roughly 11 million people are still in agricultural households with 7 million of them working in agriculture, but increasingly part-time, coupling agricultural activities with non-farm work related to industrialization.

The retention of agricultural holdings by people who work mainly off-farm may indeed be partly due to concern for social security and this is apparently a widespread phenomenon in the developing world [Hart 1994: 67; Rigg 2001: 96, 138]. But many people in widely varying occupations and economic status throughout Thailand invest in or retain land for similar reasons, so this may not adequately explain the persistence and viability of the family farm.[77]

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76) There is another important difference between what has happened in Northeast Thailand and what seemingly occurred in some other Asian settings such as Taiwan. Despite the increasingly high-quality major road networks, transportation time and costs to other regions still limit diversification into higher-value agricultural activities, and there is little evidence of small local enterprises growing into major industrial contributors [cf., Mellor 1995b: 321–322]. This does not seem surprising in locations so distant from a country's major region of industrial and urban growth [e. g., Krugman 1999].

77) In any case, the coupling of seasonal farm and non-farm work should probably not be seen uniquely as "a defining feature of late twentieth century capitalism" [Hart 1996: 269]. The world's first industrial revolution in England exhibited a similar pattern lasting for many years, apparently until grain prices fell due to imports [Sokoloff and Dollar 1997].

We have argued above that the viability of the family farm was made possible by its increased earnings, especially increased earnings from sale of rice surplus.[78] If all the people who left the farm were still there, there might never have been a rice surplus in such a growing population. However, we have argued that it was primarily recent population growth that was siphoned off—the number of people in farm families, and the number of people being directly fed, has not undergone a large decrease. Instead, increased earnings from sale of rice surplus, even under still largely rainfed conditions, were primarily due to critical change in the varieties grown.[79] The superior yield potential justified increased initial investment in inputs, and the ensuing increase in net earnings justified the additional technological changes that increased production per labor and increasingly freed farmers for off-farm work.

Recently, however, rice prices have been rising and exports of KMDL105 have been increasing. If KDML105 and RD6 become more valuable crops, that could help the Isan family farm as much as the increased productivity has up to this point.

Adaptation in an Historical Perspective

Revolutionary economic change is still largely a black box—the causes still not fully apparent. What caused the first industrial revolution is still being hotly debated up to the present day. Modern employment benefits have yet to reach a very large portion of the world's population. By shining additional light on revolutionary economic change in

78）Most could sell rice, but even those very small farms who could not sell benefited if they did not have to buy rice, or had to buy less rice (farm size discussed above under "Differences by Size of Land Holdings").

79）The effect of seasonal absence contributing to more rice available for sale has not been addressed in this report [cf., Nakada 1995]. While labor is needed during rice growing, much less labor is needed at other times and people who leave the household for extended periods leave more rice behind for others to eat in their absence. Historically, this may have saved lives [see Fukui 1993: 145–146]. It may be that at some times in some places (e.g., with fewer nearby non-agricultural employment opportunities), seasonal migration has been so large as to be a major cause of rice surplus [see Nakada 1995; also Funahashi 1996; Fukui 1996]. But overall, the effect of increased production as discussed in this report is likely to be a larger cause. For example, in 2003 even if half the roughly 11 million farm people were away 10 out of 12 months, at 200 kg/person/year, that would be a savings of 0.9 million tons, less than 10% of the 10.2 million tons produced in that year (data for Fig. 4B in Appendix Table 4), much less than the roughly 60% production gain discussed in this report. It should also be noted that any increase in rice sales because of seasonal absence would not be reflected in overall household *income*. That is because, in government data, absent people are counted as either household members or not for the survey purpose. If they were not members, their contributions were via remittances as discussed in this report. If they were members, their income and expenses were already included. Whatever additional income the household earned from their absence came from their earnings. If they were not able to take rice with them, they probably had to pay more for their food than the farmgate value of home-produced food they left behind.

Northeast Thailand from a different perspective, we hope to get a better focused picture of what happened and why.

The sudden, major changes discussed in this report caught virtually every academic observer by surprise, including the authors, even though the particular type of rainfed rice-centered adaptation prevalent in Northeast Thailand in the 1970s and early 1980s was studied by many.[80] A principal reason for this may have been an insufficient historical perspective, a common difficulty in rural studies.

In retrospect, it may be that the particular type of rainfed rice-centered livelihood system characteristic of many places in Northeast Thailand in the 1970s and early 1980s was not just a rational way of dealing with the particular terrain, soils and rainfall of the region [cf., Grandstaff 1988], nor were the more radical changes in farming practices simply the result of changing needs and job opportunities of new roads and markets, etc. Rather, the situation just prior to the major changes was most probably the culmination of a long process of coping with population pressure.

Up until the middle of the twentieth century, because of abundance of land, Thai farmers could maintain a relatively high standard of living compared to other rice-growing societies [Falkus 1991]. There was no need to change the type of agricultural adaptation—change in production was quantitative, not qualitative [Falkus 1991: 66; Ingram 1971: 216]. Thereafter, with the rice land frontier closing, having expanded onto increasingly marginal land, and with higher population growth in the 1960s and 70s, output per person decreased. As a result, doing urban labor became more attractive, although that in itself was "an ingredient rather than a recipe for growth" [Falkus 1991: 63–64] (i.e., not discounting the importance of foreign direct investment, etc.). Within the Northeast, Falkus's argument is consistent with that of Fukui and colleagues who found that earthen bunds [barrages] existed in the early twentieth century and rainfed paddies on higher land may have come only later, under pressure of expanding population [Fukui and Naewchampa 1998; Fukui *et al*. 2000; Fukui and Hoshikawa 2003].[81]

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80) For description of the particular type of rainfed rice adaptation in Northeast Thailand around the 1970s and early 1980s, see Ng [1970: 32–33]; Demaine and Dixon [1972: 52ff]; Dixon [1978: 7]; Limpinuntana *et al*. [1982: 67, 103ff]; Rigg [1985]; Grandstaff and Grandstaff [1987: 56–58]; Grandstaff [1988]; Thomas [1988]; Fukui [1991: 527–528; 1993: 181, 291, 308–309, 389 note 19, 401 notes 13–14]; Rambo [1991]; and Vityakon *et al*. [2004]. Zimmerman [1999: 150] writing in 1931 may have been the first to mention varieties with different maturations matched to "level of land and the supply of water" in the Northeast.

81) See also Takaya and Tomosugi [1972], who describe an area in Buriram where paddies on lower, treeless valley bottoms were "established before 1930" whereas paddies with trees in them on valley slopes were "recently opened" when they surveyed the area in 1972. This is consistent with Janlekha [1968: 30, 41–42] in an area in Nakhon Ratchasima in the 1960s where land was not yet scarce and forest was still being cleared for paddies [cf., Falkus 1991: 64]. Zimmerman [1937: 387] asserted that "practically all agriculture [in "Northeastern Siam" c. 1930] is irrigated…" [also cited in Vityakon *et al*. 2004]. Certainly much of the Northeast was very sparsely settled until very recently but there is still doubt about the↗

Human needs and types of employment change with changing social contexts, rising incomes, living standards and technologies, etc. But subsistence systems, where people eat what they themselves raise (and hunt and gather), are ways of making a living shared by local groups that represent lifetimes of investment in learning, social organization, and accumulation and maintenance of resources, which are not readily abandoned [cf., Bennett 1971: 14–16; 1976: 245]. These investments are a major part of farmers' opportunity cost considerations, but not fully visible to outside analysts, making them susceptible to undervaluation.[82)] With population pressure, unless other very attractive and reliable options are readily available, people will attempt to elaborate their existing practices to get them to produce more, rather than make major, qualitative changes, even if marginal returns to labor decrease [cf., Brookfield 1984; 1996]. Theoretically, "the family farm, however small, can follow the domestic mode and increase its

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↘ specific cultivation practices in various places and periods. Boontawee [1980], in an autobiographical novel set in Yasothon around the time of his childhood in the 1930s (he was born in 1928), described rice shortages forcing people to undertake an oxcart trip to the Chi River in order to catch fish to exchange for rice, and implied this kind of trip was common. So irrigation if used was inadequate, and Miyagawa [1996: 570] says that in Don Daeng in Khon Kaen "old villagers" remembered that in their youth people had to take fish to other villages to exchange for rice because of flood damage. Pendleton was more qualified than Zimmerman to assess land use and probably more widely traveled in the region in the 1930s. He warned readers that Zimmerman and Andrews "failed adequately to interpret the observed land-use conditions and agricultural circumstances" [Pendleton 1943: 20 note 20; see also 1939: 43–44]. He also noticed the later expansion into uplands in Nakhon Ratchasima [1962: 149], but said rice agriculture throughout the whole region was primarily unirrigated [1962: 139, 148]. He observed that "not all the paddy land is planted every year; a considerable part is left fallow…" [Pendleton 1943: 27]. He noted the fallowed [upper] paddies which helped fertilize other paddies (footnote 75 above), and noted that trees in paddies were also widespread at that time [*ibid*.: 22, also 27]. In any case, it is logical that rice agriculture would still have become more elaborated and less productive per labor under greater population pressure by the 1970s.

82) In the old days, farmers feared that the penalty for guessing wrong in doing something else instead of planting rice would be starvation. Clearing land on the frontier was a way to keep an existing adaptation going in a new place, but many people, even now, would prefer to stay in their original village, where they already have valuable place-related investment and social relationships, if that were a viable alternative. And even today, choosing to abandon family rice-growing entirely is a very serious decision. There are "sunk costs and associated irreversibilities" [Coxhead and Plangpraphan 1998: 11–12] or filters that inhibit restarting later, for example, loss of technical knowledge, deterioration of infrastructure ("landesque capital") especially paddy floors and dykes which took many years to build, and as we have heard many times, "I've been away too long—I can no longer endure that level of physical labor" (or Subhadhira *et al*. [2004: 57]: "used to a Bangkok lifestyle"). Another example: Once the space under the houses (*tai thun*) was enclosed, raising water buffaloes would be much more difficult [Simaraks *et al*. 2003: 328; Funahashi 1996: 631]. Some villagers also mentioned people not wanting animal droppings on now-paved village roads and not wanting smells (and insects) from keeping big livestock so nearby (author fieldnotes).

inputs until the marginal product becomes zero" [Brookfield 1984: 33–34].[83] It has been claimed that lowland rice ("wet rice") agricultural systems are particularly manipulable to increase production per area, without environmental damage, although "ultimately self-defeating" when marginal returns to labor decline to the degree of "agricultural involution" when people become impoverished [Geertz 1963: 31–35, 80]. Fine-tuning a lowland rice system in this manner is best done through increasing control of water upon which rice yields are so particularly dependent. But even rainfed lowland rice systems tend to be "technically intricate" and subject to fine-tuning [Geertz 1963: 31–32], although presumably to a lesser degree than irrigated systems, before it becomes impossible for the same fields to feed ever-increasing population without major change in resource practices.

In retrospect, the state of the rainfed agricultural subsistence system in Northeast Thailand by the early 1980s may have reached a point where additional inputs produced unacceptably low marginal returns. As summarized by Fukui [1996: 683]: "the system of rice-growing was intricately adjusted to the intra-village variations in physical conditions: varieties, the cropping calendar, the planting density and others were selected according to the topographical, soil and hydrological variations."[84] This seems consistent with Geertz's insights about how a lowland rice system can be finely tuned to squeeze out at least some additional production, even under variable and uncertain rainfed conditions. Fitting other activities around rice (cassava, etc.) might not have required lower marginal return to labor, but increasing production within the rice system itself probably

83) Marginal return (marginal product) is the additional output (e.g., kgs of rice) that comes from adding a unit of a particular input (labor, land, fertilizer, etc.) while all other inputs remain unchanged. When marginal return to labor declines, people ought to become more interested to look for new technology, new land, or alternative forms of employment. If nothing else changes, at the theoretical point where marginal return to labor becomes zero, the local situation becomes hopeless—no amount of additional labor can get any additional product.

84) In matching varieties to micro-niches, the "rules" were straightforward. In Don Daeng in Khon Kaen, long, medium and short duration varieties were for lower, middle and upper paddies, respectively, but this was influenced by the yearly weather and land types within the holding [Fukui 1993: 179–181]. When these are taken into account, the actual planting patterns were highly logical. This is supported by data from the same era elsewhere in the Northeast as well. In unpublished analysis for a presentation at the NERAD Farm Systems Workshop held at NEROAC January 25–28, 1982, the first author of the current report and Mr. Nusit Chindarsi and colleagues analyzed data gathered by Mr. Nusit in 1981 in Nong Paen Village, Na Muang Subdistrict, Selaphum District, Roi Et Province. Of the 547 paddy plots in this village 25% appeared to be "illogical" in terms of the micro-niche rules. However, a simple set of other rules involving landholding size (small, medium, large) and composition of paddy plots within the holding (lower, middle, upper), could account for farmer choices of types of varieties planted (glutinous, non-glutinous; short, medium or long duration) on 513 (94%) of the paddy plots within the village. Key to the analysis was household priority on sufficient glutinous rice to meet subsistence needs.

did, as Geertz described. In Northeast Thailand, different varieties with different tolerances, growth and maturation times were planted in different places within the holding to suit different soil fertility, texture, moisture and rainfall conditions in each particular crop year. To maximize production in this manner required very detailed planning, stocking rice for years (for good years to offset bad ones), maintaining and trading different seed stocks, planting and harvesting different types of areas at different times, building and maintaining the type of "upper" paddies that could be used only once every few years, etc.[85] But a striking feature of the highly elaborated practices that characterized Northeastern rainfed lowland rice growing by the early 1980s was that they did not seem to be very effective [Fukui 1996: 683; also Kono 1991: 509, 516]. This suggests they may have been reaching a limit, with little additional production to be achieved from increasing inputs of any type available at the time (not just labor).

Brookfield [1984: 18] summarized Boserup [1965], by diagramming a process whereby incremental "innovations" in resource practices could "give the impression of constant returns to [labor] input" on a fixed amount of agricultural land.[86] Without violating the law of diminishing returns, a series of such innovations could accommodate increasing population by continuing to raise marginal output. In Northeast Thailand in the early 1980s, as Boserup noted was often the case, technological improvements had already become available (KDML105, two-wheel tractor, chemical fertilizer, pumps and farm pond technology, etc.). However, before the late 1980s they were evidently not being widely enough adopted (Tables 10B–C) to produce the kind of process Brookfield diagrammed. No dramatic increased returns to labor had yet occurred (Fig. 7C). As Rigg [1986] argued, this was probably due primarily to the environmental conditions under which primarily rainfed rice operated at the time. For most of the farmers of the Northeast, the Green Revolution had passed them by, and they fell into a Geertzian-type, involuted situation. In this type of situation, a technological breakthrough is needed and farmers are more likely to accept major change, even in the principal subsistence crop. With the arrival of

85) Apparently even shifting cultivation systems can be elaborated in this manner, planting and harvesting different species at different places and times, increasing weeding, etc. [Phengchanh 2007: 96, passim], or combined with small wet-rice paddies (e.g., Karen in North Thailand) and other innovations that can support increasing populations [Brookfield 1984: 24, 36–37; cf., Geertz 1963: 25ff]. It seems possible that tropical and subtropical agroecosystems in general, with their more plentiful rainfall and sunlight, allow a greater degree of agroecosystem elaboration than in temperate zones, like the natural ecosystems in these zones. On varying terrain and with some seasonality, the number of potential elaborations would logically be further increased. (Grist [1953: 8] noted that traditional rice was absent from equatorial zones because of insufficient seasonality.) In Northeast Thailand, even the rice paddies alone are a "multiculture of flora and fauna" [Heckman 1979: 204] and the main source of natural foods for most villagers [Somnasang *et al*. 1988].

86) Brookfield [1984: 18, Fig. 1] also neatly summarized Geertz's insights in the same diagram, with wet rice producing a greater marginal output before tailing down at a higher labor input, compared to swidden rice (but both consistent with Ricardian diminishing returns).

RD6, they were apparently offered such an opportunity, since not long after that they suddenly changed to the combined use of RD6 and KDML105, increasing use of chemical fertilizer and other inputs, no longer matching varieties against micro-niches, displacing a whole range of previous glutinous varieties.

Implications for the Future

Is the current adaptation, centered on RD6 and KDML105, sustainable? As rice researchers and farmers are well aware, it is dangerous to depend on only these two so closely related varieties over so large an area [Limpinuntana 2008]. Sooner or later pests or diseases may become adapted to exploiting these particular varieties, and crops losses could be disastrous. Even just one additional set of environmentally suited varieties allows for rotational use every two or three years to reduce that risk [Farmer 1979: 317]. This underscores the growing recognition of the need for priority development of monsoonal, primarily rainfed rice agriculture to feed Asia's growing populations [Hossain and Narciso 2004: 9–11; Trebuil and Hossain 2004: Chapter 4, passim; *Bangkok Post* 2008a; 2008b].[87] The need for the government to take the responsibility for the conservation of traditional varieties is another obvious implication of what has happened in Northeast Thailand.

The benefits of the Green Revolution have been primarily confined to well-controlled irrigated areas, where high-yielding photoperiod-insensitive rice varieties increase production not just because they raise yields under controlled conditions, but also because they can be planted several times a year, as long as enough water is available. But it may not be wise to try to pursue this strategy too widely, "dismantling naturally evolved mechanisms of adaptation" [Leakey 1986: 36]. Ambitious agricultural development plans have been proposed for the Northeast at least since the 1930s, but soils are unfavorable for widespread cultivation of most crops *except* for rice [Pendleton 1939: 43–44]. Photoperiod-sensitive, seasonal, primarily rainfed rice production has been overlooked for far too long, despite its enormous size and importance. Many people know that there is more rainfed than irrigated paddy land in Thailand, but fewer people realize that, despite the Green Revolution, the majority of not just rice land but also rice *production* not only probably long has been, but probably still is, under primarily rainfed conditions.[88] "Almost half of

87) This continuing need for variety improvement of rainfed rice must certainly include rainfed *glutinous* rice. It is consumed as the main staple by about half the population of Thailand (people in or from the North and the Northeast) and is increasingly being consumed by others as well as diets diversify throughout the world. It is also being increasingly used as an ingredient for many manufactured products by the world food industry.

88) According to data supplied by email from OAE (October 10, 2007), rainfed rice production in Thailand in 2006 was 12.92 million tons irrigated and 16.67 million tons non-irrigated. But the breakdown by season shows 1.41 million tons *non*-irrigated rice (on 0.35 million hectares) in the *dry* season, which could only occur if the rice was in fact irrigated (the yield of 4.0 tons/ha also suggests Green Revolution photoperiod-insensitive high-yielding varieties). ↗

area under rice cultivation in the world is rainfed" [Miyagawa 2003: 41]. Rainfed rice production is needed to help feed the growing global population.

There are also social changes likely to affect the future of rural Northeast Thailand. We have been warned that in rural Southeast Asia, the future is likely to "confound most academic attempts at prediction" [Rigg 2001: 157]. Nevertheless, there are some obvious potential forces that cannot be overlooked. There may be a social "time bomb" in waiting that virtually every recent informal interview pointed to, that can only get bigger as long as there is no catastrophic reversal in economic conditions. This is the exit of a probable majority of the next generation from agriculture (consistent with Rigg [2001: 56, 116]). Secondary school education is increasingly considered a necessity by all, and a full 12 years will probably soon be compulsory (9 years have been compulsory since 2002). According to villagers around the Northeast, many or most of these secondary school children do not work on their parents' farms, or want to, or even know how to, and time is getting short. In 1981 the average age of the head of a village household was 35 years, but in 2004 it was 55 [SES 1981: Table 10.4; 2004: Table 12.3].[89)]

Together with these impending social changes, increasing wages and the inherently slower growth rates of agriculture could make it impossible for small farm agricultural income to keep up with non-agricultural alternatives, as elsewhere in the world. Northeasterners are very aware of how people live in Bangkok (and Singapore and Taiwan, etc.) and aspire to that level of consumption and comfort. With other earning opportunities, most small farm families will find it increasingly difficult to grow a lower-value grain crop such as rice, leading to the consolidation of holdings and specialization of agricultural practices [e.g., Pingali 1997: 632–633]. Many holdings in the mini-watersheds probably cannot be leveled to facilitate economies of scale for rice, and most upper and lower paddies are no longer contiguous within a single holding. Some tree crops and field crops can be successfully grown on Northeastern soils and specializations might further develop within contours. In parts of Udonthani, Chaiyaphum and Khon Kaen, some upper paddy lands are being converted to rubber and eucalyptus or leveled and planted to sugarcane cultivated by machines with limited hired labor. Rice growing would logically increasingly concentrate on larger holdings in the

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↘ This is because "irrigated" rice in this data means only rice grown on land within a recognized irrigation system command area. If that production were re-assigned, irrigated would be 14.33 and non-irrigated 15.26 million tons. However, if that same amount of apparently irrigated dry-season land were also considered to be irrigated in the wet season as well, then irrigated would be 15.74 and non-irrigated 13.85 million tons. In any case, there would still be an enormous amount of mainly rainfed rice production in Thailand—certainly not marginal in any sense.

89) Another possible "time bomb" forcing sale of agricultural land might be household debt. In our judgment, and based on available data, this issue requires separate treatment and could not be assessed in the present report.

flatter areas near larger water sources, where major economies of scale are already being realized (e.g., from using large machines, including combine harvesters).[90] It has been observed that high-quality seasonal rice in the Northeast "still has much room for improving productivity" [Isvilanonda 2002: 235]. If further technological improvements can be found, productivity and returns to labor could continue to climb, extending the trends discussed in this report. As long as the Northeast can produce high quality rice like KDML105 and RD6, such varieties could remain promising regional specializations.[91] Assuming more and more glutinous rice is consumed in cities and outside the region (footnote 87 above), the price of RD6 should rise and RD6 should become a more commercial crop.

If the future leads to the end of part-time farming, reduced number of farmers, consolidation of holdings and greater production per capita, then the enormous number of "supported households" could be the first to disappear once the older generation is gone. Perhaps this will eventually result in rural village depopulation, but it remains to be seen how long that might take and what other developments might occur in the meantime. Even well-understood forces may be delayed by pre-existing investments and human ingenuity. American small towns beyond the urban fringe lasted for at least half a century longer than was expected [Hart 1995: 68–69]. Many people are clearly making major improvements in their houses and holdings in Isan rural villages, and improved facilities, communications and services have made many villages much more attractive places to live.[92] So perhaps Isan villages will have unexpected staying power as well. And if future economic change leads to more and more people working in non-farm jobs *not* in large factories or city centers, as motor vehicles allow flexible movement in geographically extended settlements [Glaeser and Kohlhase 2004], then perhaps those Isan villages that are not too remote but are becoming increasingly interconnected may have a bright future.[93]

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90) "There comes a stage in agriculture's development process where land has to be consolidated and farm size has to increase in order to take advantage of economies of scale" [Kay 2002: 1084].

91) Worldwide issues in the increasing privatization of grain seed production and patenting of plant genetic material are beyond the scope of the present report, but they may affect the welfare of billions of people, positively, negatively or both (e. g., see http://grain.org/briefings/?id＝35).

92) In addition to locally initiated improvements, there have been many recent reports concerning the expanding number of foreign men (mostly Europeans and Japanese) marrying women in Isan villages, building houses and setting up internet communications, etc. It is difficult to anticipate what longer-term effects this could have, but it is another indication that Northeastern villages have become attractive residential settings.

93) Perhaps the Northeast was never meant to sustain a large population [Pendleton 1939: 43–44], but that could change after enough investment (see "second nature" [Krugman 1993b]). In the United States, arid Nevada has had major population increases. It will presumably depend on many things in addition to the natural environment—Thailand's economic condi-↗

It might have all been very different without the agricultural breakthroughs that have been so instrumental in sustaining Isan villages up to this point. If the arguments, analyses and data in this report are substantially correct, the many changes in agriculture and living standards in Northeast Thailand in the late 1980s and 1990s might not have occurred were it not for the combined work of a small group of people in the Rice Department in the 1950s and 1960s. Without KDML105 there might never have been an RD6, and without RD6 there might never have been such an expansion of KDML105. Together, these two varieties rescued the people of rural Northeast Thailand, and helped power the Thai economy into the modern era.

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↘ tions (including wage rates), investment capabilities and goals, existing infrastructure and investments already made, range of technologies available, etc.

Acronyms Used in This Report

ACIS	NSO Agricultural Census or Intercensal Survey, Northeastern Region
AIT	Asian Institute of Technology
CDD	Department of Community Development, Village Profile (*ko cho cho 2 kho*) (unless other CDD source specified)
DIW	Department of Industrial Works
DOA	Department of Agriculture
DOPA	Department of Provincial Administration (formerly DOLA—Department of Local Administration)
GBMR	Greater Bangkok Metropolitan Region (or Extended Greater Bangkok Metropolitan Region)
HYV	high-yielding variety
IRRI	International Rice Research Institute
LFS	NSO Labor Force Survey
NERAD	Northeastern Rainfed Agricultural Development Project (USAID supported)
NEROAC	Northeastern Regional Office of Agriculture and Cooperatives
NESDB	National Economic and Social Development Board
NSO	National Statistical Office
OAE	Office of Agricultural Economics, *Agricultural Statistics of Thailand* (unless other OAE source specified)
OAEP	Office of Atoms for Peace (formerly Office of Atomic Energy for Peace)
PHC	NSO Population and Housing Census, Northeastern Region
SES	NSO Household Socio-Economic Survey, Northeastern Region
USAID	United States Agency for International Development

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Appendix

Table 1 Data for Fig. 1—Percent of Village Households in Northeast Thailand by Selected Durable Goods Owned

Durable Goods Owned	1981	1986	1990	1994	1998	2002	2004
Electric fan	n. d.	n. d.	54.5	79.8	90.6	92.9	94.5
Gas stove	0.2	0.9	4.2	16.1	40.6	48.2	54.3
Color television set	4.6	19.5	16.8	40.2	88.3	91.6	93.4
Refrigerator	1.6	4.1	10.2	25.9	51.7	62.9	71.8
Electric cooker	2.1	10.4	24.7	50.0	65.6	70.7	73.0
Motorcycle, motor scooter	6.8	13.4	20.7	36.4	57.7	63.8	69.0
Farm truck, other farm vehicle	n. d.	n. d.	2.8	8.0	19.6	22.3	19.3
Mini-truck, pick-up truck	0.4	2.3	2.5	2.8	7.4	7.7	9.6

Source: SES [1981–2004]. Table on "Percentage of Households Reporting Ownership of Some Selected Durable Goods." 1981 and 1986: Table 12.3; 1990 and 1994: Table 13.4; 1998: Table 14.4; 2002 and 2004: Table 14.3.

Note: The Village Profile data [CDD 2003; 2005] recorded 67% and 71% of village households owning motorcycle, 11% and 12% owing pick-up trucks in 2002 and 2004 respectively.

Table 2 Data for Fig. 2—Agricultural Land and Paddy Land in Northeast Thailand

	Agricultural Land ('000 hectare)	Paddy Land ('000 hectare)
1980	8,015	5,742
1981	8,273	5,789
1982	8,457	5,801
1983	8,475	5,852
1984	8,653	5,927
1985	8,858	5,953
1986	8,991	5,991
1987	9,048	5,971
1988	9,010	5,956
1989	9,044	5,981
1990	9,074	5,992
1991	9,235	6,076
1992	9,231	6,074
1993	9,219	6,048
1994	9,238	6,055
1995	9,257	6,065
1996	9,240	6,047
1997	9,220	6,031
1998	9,189	6,007
1999	9,271	6,039
2000	9,280	6,056
2001	9,280	6,069
2002	9,283	6,083
2003	9,263	6,067
2004	9,254	6,055
2005	9,240	5,996

Source: OAE. *Agricultural Statistics of Thailand Crop Years 1980/81–2007* [1980–2007] Table on "Land Utilization of Thailand by Region."

Note: Full text reports for crop years 1998/99–2007 currently available online at http: //www.oae.go.th/oae_website/

Table 3 Data for Fig. 3 ──Number of Farms, Average Farm Size and Paddy Area per Farm in Northeast Thailand

	Number of Farms ('000)	Average Size per Farm (hectares)	
		Farm	Paddy Land
1975	1,676	4.53	3.25
1976	1,705	4.58	3.25
1977	1,740	4.43	3.19
1978	1,755	4.50	3.24
1979	1,772	4.48	3.21
1980	1,786	4.48	3.21
1981	1,840	4.35	3.15
1982	1,945	4.38	2.98
1983	1,944	4.38	3.01
1984	1,976	4.34	3.00
1985	2,044	4.34	2.91
1986	2,081	4.32	2.88
1987	2,102	4.30	2.84
1988	2,116	4.26	2.81
1989	2,117	4.27	2.83
1990	2,131	4.26	2.81
1991	2,184	4.22	2.78
1992	2,220	4.16	2.74
1993	2,248	4.10	2.69
1994	2,261	4.08	2.68
1995	2,274	4.00	2.67
1996	2,324	3.98	2.60
1997	2,367	3.89	2.55
1998	2,420	3.79	2.48
1999	2,598	3.57	2.32
2000	2,610	3.55	2.32
2001	2,621	3.54	2.32
2002	2,636	3.52	2.31
2003	2,640	3.51	2.30
2004	2,695	3.43	2.25
2005	2,695	3.43	2.22

Source: OAE. *Agricultural Statistics of Thailand Crop Years 1978/79–2007* [1978–2007]. Data for 1975–2001 from table on "Land Utilization of Thailand by Region"; data for 2002–2005 from table on "Type of Farm Holding in Thailand by Region."

Note: Duplicate numbers are not a typographic error in the present report.

Table 4 Data for Figs. 4A–C──Rice Planted Area, Production and Yield for Area Planted in the Wet Season in Northeast Thailand

	Wet Season Rice		
	Planted Area ('000 hectares)	Production ('000 tons)	Yield (tons/hectare)
1980	4,516	5,748	1.27
1981	4,480	5,390	1.20
1982	4,257	4,969	1.17
1983	4,820	7,406	1.54
1984	4,571	6,969	1.52
1985	4,773	7,392	1.55
1986	4,601	6,384	1.39
1987	4,152	5,658	1.36
1988	4,670	6,600	1.41
1989	4,943	7,478	1.51
1990	5,062	7,745	1.53
1991	4,764	7,667	1.61
1992	5,073	8,027	1.58
1993	4,917	7,125	1.45
1994	4,966	8,010	1.61
1995	5,124	8,436	1.65
1996	5,070	7,978	1.57
1997	5,143	8,634	1.68
1998	5,027	8,073	1.61
1999	5,097	8,537	1.67
2000	5,295	9,139	1.73
2001	5,280	9,952	1.88
2002	5,186	9,459	1.82
2003	5,189	10,195	1.96
2004	5,272	10,006	1.90
2005	5,280	10,442	1.98
2006	5,234	10,293	1.97

Source: OAE. *Agricultural Statistics of Thailand Crop Years 1980/81–2007* [1980–2007]. Table on "Major Rice: Area, production, and yield by region."

Note: "1980" means crop year 1980/81, etc.

Table 5 Data for Figs. 5A–C——Rice Planted Area, Production and Yield for Area Planted in the Wet Season in Northeast Thailand by Type of Rice

	Planted Area ('000 hectares)			Production ('000 tons)			Yield per Planted Area (kg/ha)		
	Non-glutinous	Glutinous	Total	Non-glutinous	Glutinous	Total	Non-glutinous	Glutinous	Total
1984	1,824.0	2,746.8	4,570.8	2,901.0	4,070.5	6,971.6	1,590	1,482	1,525
1985	2,146.1	2,661.1	4,807.2	3,504.9	3,971.4	7,476.3	1,633	1,492	1,555
1986	2,048.4	2,552.3	4,600.7	2,958.9	3,421.8	6,380.8	1,445	1,341	1,387
1987	1,729.8	2,462.6	4,192.4	2,224.4	3,251.1	5,475.6	1,286	1,320	1,306
1988	1,986.8	2,682.8	4,669.6	2,908.2	3,690.7	6,598.8	1,464	1,376	1,413
1989	2,242.2	2,701.1	4,943.3	3,429.1	4,049.3	7,514.5	1,529	1,499	1,520
1990	2,383.2	2,679.1	5,062.3	3,645.7	4,099.1	7,744.7	1,530	1,530	1,530
1991	2,455.9	2,308.0	4,763.9	3,918.6	3,748.4	7,668.5	1,596	1,624	1,610
1992	2,474.1	2,599.1	5,073.2	3,877.1	4,150.3	8,027.4	1,567	1,597	1,582
1993	2,440.5	2,477.0	4,917.5	3,660.2	3,465.2	7,125.3	1,500	1,399	1,449
1994	2,527.4	2,439.1	4,966.5	4,135.2	3,875.4	8,010.7	1,636	1,589	1,613
1995	2,635.8	2,488.1	5,124.0	4,388.3	4,047.2	8,435.5	1,665	1,627	1,646
1996	2,618.2	2,452.0	5,070.2	4,049.7	3,928.3	7,978.0	1,547	1,602	1,574
1997	2,590.0	2,553.1	5,143.1	4,422.8	4,210.8	8,633.6	1,708	1,649	1,679
1998	2,653.0	2,374.2	5,027.2	4,216.3	3,863.1	8,079.4	1,589	1,627	1,607
1999	2,750.1	2,347.3	5,097.4	4,593.3	3,933.8	8,527.1	1,670	1,676	1,673
2000	2,877.7	2,416.8	5,294.5	5,080.1	4,058.6	9,138.7	1,765	1,679	1,726
2001	2,836.6	2,443.1	5,279.6	5,071.9	4,393.9	9,465.8	1,788	1,799	1,793
2002	2,772.5	2,413.2	5,185.8	4,976.8	4,116.7	9,093.5	1,795	1,706	1,754
2003	2,801.0	2,387.6	5,188.7	5,272.5	4,281.2	9,553.7	1,882	1,793	1,841
2004	2,888.0	2,384.3	5,272.3	5,612.2	4,393.2	10,005.4	1,943	1,843	1,898
2005	2,891.0	2,389.4	5,280.4	5,843.5	4,598.5	10,442.0	2,021	1,924	1,977
2006	2,845.6	2,388.2	5,233.8	5,717.8	4,575.2	10,293.0	2,009	1,916	1,967

Source: NSO. *Statistical Reports of Region, Northeast Region* [1992: Table 6.6; 1995: Table 2.5; 2000: Table 2.13]. Data for 1997–2006 from Center for Agricultural Information, OAE, via email from prcai@oae. go. th. Recent data (1995–2006) published by OAE in *Survey's Report of Major Rice* by crop year.

Note: "1984" means crop year 1984/85, etc.

Table 6 Data for Figs. 6A–C——Rice Planted Area, Production and Yield for Area Planted in the Wet Season in the Northeast by Rice Variety

	Planted Area ('000 Hectare)						Production ('000 tons)						Yield per Planted Area (kg/ha)					
	Native	RD6	RD15	KDML105	Others	Total	Native	RD6	RD15	KDML105	Others	Total	Native	RD6	RD15	KDML105	Others	Total
1989	951.9	2,151.8	113.9	1,402.3	323.4	4,943.3	1,466.8	3,207.7	152.5	2,110.5	641.0	7,578.5	1,541	1,491	1,340	1,505	1,982	1,533
1990	913.9	2,171.4	123.0	1,530.8	323.2	5,062.3	1,284.5	3,353.8	177.8	2,462.9	465.6	7,744.7	1,406	1,545	1,446	1,609	1,441	1,530
1991	722.1	1,921.2	266.4	1,514.7	339.5	4,763.9	1,183.5	3,113.0	421.4	2,373.3	575.7	7,667.0	1,639	1,620	1,582	1,567	1,696	1,609
1992	816.5	2,122.9	113.4	1,672.3	348.0	5,073.2	1,278.8	3,403.6	178.0	2,528.8	638.2	8,027.4	1,566	1,603	1,569	1,512	1,834	1,582
1993	632.8	1,991.5	180.7	1,777.6	334.8	4,917.5	961.5	2,833.7	279.7	2,535.5	514.9	7,125.3	1,519	1,423	1,548	1,426	1,538	1,449
1994	620.0	1,961.9	225.1	1,822.6	336.9	4,966.5	945.5	3,114.2	402.7	2,964.8	582.5	8,009.7	1,525	1,587	1,789	1,627	1,729	1,613
1995	579.9	2,054.9	235.8	1,875.2	378.2	5,124.0	949.3	3,270.9	417.7	3,119.9	677.8	8,435.5	1,637	1,592	1,711	1,664	1,792	1,646
1996	495.0	2,180.9	236.4	1,767.8	390.0	5,070.2	744.8	3,437.2	364.8	2,710.5	720.8	7,978.0	1,504	1,576	1,543	1,533	1,848	1,574
1997	582.1	2,137.4	204.3	2,025.0	194.4	5,143.1	908.2	3,535.0	405.8	3,432.3	352.4	8,633.6	1,560	1,654	1,986	1,695	1,813	1,679
1998	n. d. (no data collected by OAE in 1998)																	
1999	428.0	2,082.9	174.7	2,122.0	289.8	5,097.4	694.5	3,438.6	310.3	3,553.3	540.3	8,537.1	1,622	1,651	1,776	1,675	1,865	1,675
2000	437.8	2,087.9	307.2	2,131.0	330.6	5,294.5	733.8	3,512.6	555.5	3,736.3	600.6	9,138.7	1,676	1,682	1,808	1,753	1,817	1,726
2001	406.7	2,051.0	250.7	2,194.3	377.0	5,279.6	715.5	3,647.2	461.0	3,952.2	689.9	9,465.8	1,759	1,778	1,839	1,801	1,830	1,793
2002	339.0	2,062.6	237.3	2,214.0	332.8	5,185.8	582.2	3,514.2	420.3	3,949.5	627.3	9,093.5	1,717	1,704	1,771	1,784	1,885	1,754
2003	373.0	2,032.2	222.0	2,179.7	381.8	5,188.7	717.4	3,924.0	465.4	4,268.6	819.2	10,194.7	1,924	1,931	2,096	1,958	2,146	1,965
2004	378.7	2,056.6	181.6	2,321.2	334.1	5,272.3	689.0	3,884.3	351.8	4,417.4	662.9	10,005.4	1,820	1,889	1,937	1,903	1,984	1,898
2005	389.1	2,015.0	216.6	2,290.7	369.0	5,280.4	735.9	3,961.2	439.8	4,550.1	754.9	10,442.0	1,891	1,966	2,031	1,986	2,046	1,977

Source: 1989/90–2002/03 from Center for Agricultural Information, Office of Agricultural Economics via email transmission from prcai@oae.go.th; 2003–2005 from OAE, *The Survey's Report of Major Rice Crop Year 2003/04–2005/06* [2003–05: Table 6].
Note: "1989" means crop year 1989/90, etc.

Table 7 Data for Figs. 7A–C——Labor Employed in Agriculture and Its Percent of All Employed Labor in the Wet Season, Rice Planted Area and Production per Labor Employed in Agriculture in the Wet Season in Northeast Thailand

	Employed in Agriculture ('000 persons)	Employed in Agriculture as Percent of All Employed	Rice Planted Area per Labor Employed in Agriculture (ha/person)	Rice Production per Labor Employed in Agriculture (kg/person)
1981	7,962	89	0.56	667
1982	7,708	85	0.55	645
1983	8,120	87	0.59	912
1984	8,226	87	0.56	848
1985	7,966	87	0.60	938
1986	8,333	87	0.55	766
1987	8,208	85	0.51	667
1988	9,031	88	0.52	731
1989	9,859	86	0.50	762
1990	9,575	82	0.53	809
1991	9,087	84	0.52	844
1992	9,877	80	0.51	813
1993	9,071	77	0.54	785
1994	8,823	74	0.56	908
1995	8,411	71	0.61	1,003
1996	7,773	75	0.65	1,026
1997	8,531	74	0.60	1,012
1998	8,017	68	0.63	1,008
1999	7,028	71	0.73	1,213
2000	7,657	65	0.68	1,194
2001	7,036	65	0.75	1,345
2002	7,385	66	0.70	1,228
2003	7,457	62	0.71	1,367
2004	7,235	63	0.73	1,383
2005	7,444	62	0.71	1,398

Source: OAE. *Agricultural Statistics of Thailand Crop Years 1981/82–2007* [1981–2007]. Table on "Major Rice: Area, production and yield by region." And LFS, *Report of the Labor Force Survey* [1981–2001; 2002–06]. Table on "Employed Persons by Level of Educational Attainment, Industry, Sex and Area, Northeastern Region" (1981–99 August Round, 2000–05 July-September Round)]

Notes: "1981" means crop year 1981/82, etc. "Employed in agriculture" is only for the August round of the Labor Force Survey (in the middle of the wet season for that crop year). Number of "employed in agriculture" in 1989 and 1992 are probably overestimated (see Table 9, note 9) but this may be less true for rice labor (a large but unknown part of overall agricultural labor) since these two years in Figs. 7B and particularly 7C show no major departures from trend.

Table 8A Cash Income of Agricultural Holder Households by Source (in current baht)

	1982	1986	1991	1995	1998	2004
1. Agricultural income	12,093	12,374	21,532	35,258	44,620	51,626
(as % of total cash inc)	(50%)	(56%)	(56%)	(43%)	(47%)	(49%)
1. 1. Rice sales	2,372	2,350	4,972	9,541	13,687	n. d.
(as % of all ag inc)	(20%)	(19%)	(23%)	(27%)	(31%)	
1. 2. Other crop sales	6,381	5,786	7,987	10,890	11,300	n. d.
(as % of all ag inc)	(53%)	(47%)	(38%)	(31%)	(25%)	
1. 3. Livestock sales	2,609	2,762	3,601	8,098	8,848	9,669
(as % of all ag inc)	(22%)	(22%)	(17%)	(23%)	(20%)	(19%)
1. 4. Other own ag	132	122	2,466	2,662	4,979	3,119
(as % of all ag inc)	(1%)	(1%)	(11%)	(8%)	(11%)	(6%)
1. 5. Ag off own farm	599	1,354	2,505	4,067	5,806	8,503
(as % of all ag inc)	(5%)	(11%)	(12%)	(12%)	(13%)	(16%)
2. Non-agriculture	11,930	9,892	16,642	46,824	51,056	54,776
(as % of total cash inc)	(50%)	(44%)	(44%)	(57%)	(53%)	(51%)
2. 1. Remittance	854	1,017	2,057	3,410	8,131	8,506
(% of non-ag)	(7%)	(10%)	(12%)	(7%)	(16%)	(16%)
Total cash income	24,023	22,266	38,174	82,082	95,676	106,402
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

Sources: OAE. *Agricultural Statistics of Thailand Crop Years 1986/87–1998/99* [1986–98]. 1986/1987: Tables 127–132; 1989/90: Tables 149–153; 1992/93: Tables 150–154; 1997/98: Tables 150–154; 1998/99: 144–148; 2004 from OAE, *Report of Agricultural Household and Labor Socio-economic Study, Crop Year 2004/05*, Appendix Tables 37–38 [2005: 100–103].

Notes: "1982" means "crop year 1982/83," etc. Minor inconsistencies due to rounding error.

Table 8B Average Cash Expenditure of Farm Holding Households on Agricultural Inputs (in current baht)

	1982	1986	1991	1995	1998	2004
1. Hired labor (incl food, etc.)	113	967	4,879	8,171	9,134	11,219
1. 1. (as % of total ag inputs)	(2%)	(22%)	(38%)	(40%)	(37%)	(38%)
2. Fertilizer	677	877	2,044	3,207	4,203	5,250
2. 1. (as % of total ag inputs)	(12%)	(20%)	(16%)	(16%)	(17%)	(18%)
3. Pesticides	42	117	181	246	340	354
3. 1. (as % of total ag inputs)	(1%)	(3%)	(1%)	(1%)	(1%)	(1%)
4. Equipment	n. d.	640	1,827	2,178	2,364	3,051
4. 1. (as % of total ag inputs)		(15%)	(14%)	(11%)	(10%)	(10%)
5. Land purchase	n. d.	369	807	883	1,593	1,616
5. 1. (as % of total ag inputs)		(8%)	(6%)	(4%)	(6%)	(5%)
6. Animal stock, feed, medicine	1,087	634	1,415	1,958	2,557	3,115
6. 1. (as % of total ag inputs)	(19%)	(15%)	(11%)	(10%)	(10%)	(11%)
7. Interest payment	259	95	723	743	1,281	1,807
7. 1. (as % of total ag inputs)	(5%)	(2%)	(6%)	(4%)	(5%)	(6%)
8. All others (approximate)	n. d.	657	1,123	2,940	3,059	3,112
8. 1. (as % of total ag inputs)		(15%)	(9%)	(14%)	(12%)	(11%)
Total agricultural inputs	5,748	4,356	12,999	20,326	24,531	29,534
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

Sources: OAE. *Agricultural Statistics of Thailand Crop Years 1978/79–97/98* [1978–97]. Computed from 1986/87: Table 133; 1989/90: Table 154; 1992/93: Tables 155–158; 1997/98: Tables 155–158; 1998/99: Tables 149–152. For 2004: OAE, *Report of Agricultural Household and Labor Socio-economic Study, Crop Year 2004/05*, Appendix Tables 27–36 [2005: 90–99].

Notes: Line 4 includes purchase, rental, maintenance and fuel. Purchase alone was 254 baht in 1986, 1,061 baht in 1991 and 1,401 baht in 1995. In this table, "1982" means "crop year 1982/83," etc. Minor inconsistencies due to rounding error.

Table 8C Average Non-Farm Cash Expenditure of Farm Holding Households (in current baht)

	1982	1986	1991	1995	1998	2004
1. Food and beverages	4,912	3,529	8,071	9,981	11,267	16,038
1. 1. Rice	n. d.	688	827	555	807	650
2. Clothing	1,498	1,128	1,513	2,546	2,057	2,245
3. Housing (incl rental value)	2,544	3,309	4,679	6,553	7,689	10,441
4. Transportation and energy	1,726	1,491	3,223	10,079	8,577	16,442
5. All others (approximate)	5,360	4,674	6,189	14,382	16,914	16,174
Total	16,040	14,130	23,675	43,540	46,504	61,340

Sources: OAE. *Agricultural Statistics of Thailand Crop Years 1978/79–97/98* [1978–97]. Computed from 1986/87: Table 132; 1989/90: Table 157; 1992/93: Table 158; 1997/98: Table 158; 1998/99: Table 152. For 2004: OAE, *Report of Agricultural Household and Labor Socio-economic Study, Crop Year 2004/05*, Appendix Table 38 [2005: 102–103].

Notes: "1982" means crop year 1982/83, etc. Minor inconsistencies due to rounding error. In Appendix Table 8C here and Table 7C in the main text: Business/farm expenses generally not included (expenses on agricultural inputs are in Table 10A). "Food and beverages" includes alcohol. "Transportation and energy"＝non-farm vehicle purchase and maintenance; bus fare, etc.; electricity, water and "fuel" (of which vehicle fuel is likely to be a sizeable portion). Fuel category missing from 1992/93 data, but was probably small compared to later years. Vehicle category missing from 1986/87 data, which undoubtedly lowers percentage shown for that year. Electricity and piped water not yet available in many villages in 1982 probably raised "transportation and energy" costs at that time. Expenditure on vehicle purchase and maintenance was included in "transportation" after 1991. In line 4, "communication" was added to the "transportation" category in 2004, and the increased expenditure probably reflects increased use of mobile phones. Reduction in medical care expenditure due to the government's "30–baht health program" probably reflected in reduction in "all others" in 2004. The sizeable "all others" category is necessary mostly because of changing definitions in many other categories over the years (details not shown).

Table 9 Current and Constant Farmgate Price of KDML105 and Glutinous Rice in Northeast Thailand

	Current Farmgate Paddy Price (Baht per *kwian*)		1998 Constant Farmgate Paddy Price (Baht per *kwian*)		Annual Growth Rate of Constant Farmgate Price	
	KDML	RD6	KDML	RD6	KDML	RD6
1984	2,970	2,299	5,490	4,250	n. a.	n. a.
1985	2,910	1,911	4,330	3,500	−2.92	−17.64
1986	2,778	2,146	5,010	3,870	−6.00	10.58
1987	2,690	2,512	4,765	4,450	−4.88	14.98
1988	3,523	3,442	6,007	5,869	26.05	31.88
1989	4,540	3,394	7,510	5,615	25.03	−4.33
1990	4,086	3,048	6,475	4,830	−13.78	−13.97
1991	3,859	3,174	5,781	4,755	−10.72	−1.56
1992	3,994	3,720	5,610	5,225	−2.97	9.88
1993	4,366	3,493	5,977	4,782	6.55	−8.48
1994	4,699	3,536	6,203	4,668	3.79	−2.38
1995	4,236	3,707	5,256	4,599	−15.28	−1.47
1996	5,245	4,584	6,131	5,358	16.66	16.50
1997	7,447	6,302	8,064	6,824	31.53	27.36
1998	8,275	7,562	8,271	7,558	2.57	10.76
1999	6,781	4,963	6,778	4,961	−18.05	−34.37
2000	7,123	4,445	7,025	4,384	3.64	−11.63
2001	5,848	5,034	5,700	4,906	−18.86	11.93
2002	5,360	4,951	5,174	4,779	−9.23	−2.6
2003	7,054	5,610	6,661	5,297	28.75	10.85
2004	8,651	6,157	7,911	5,631	18.77	6.29
2005	7,766	5,903	6,789	5,160	−14.19	−8.35
2006	8,022	7,227	7,176	6,465	5.70	25.28

Source: Farmgate price via email: prcai@oae.go.th, from Center for Agricultural Information, OAE, received October 10, 2007. Consumer price index from Ministry of Commerce, accessed April 2008, at
http: //www.indexpr.moc.go.th/price_present/SelectProvinceIndexG_ 45 _En_M.asp

Notes: 1 *kwian* = 1,000 kilograms. Farmgate price for glutinous rice provided by OAE is listed simply as "long grain glutinous rice." However, since production of RD6 by late 1980s already accounted for more than 80% of all glutinous rice produced in the Northeast (OAE various years) and continued to increase to 92% in 2003 and remained almost 90% through 2006, it is thus safe to treat the farmgate price for the long grain glutinous rice as the farmgate price for RD6. Consumer price index for the Northeast Region was used to convert current farmgate price into 1998 constant price.