Human Ecology, Vol. 20, No. 2, 1992

Agricultural Intensification in a Philippine Frontier Community: Impact on Labor Efficiency and Farm Diversity

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There continues to be much debate in anthropology concerning the mechanism by which agricultural intensification takes place and its impact on labor efficiency, farm diversity, and quality of diet. A major reason for this lack of consensus is the paucity of data from case studies that focus on specific agricultural systems at the point of transition from extensive to intensive methods of cultivation. Research in a frontier community in the Philippines, where farmers are making the shift from swidden cultivation to small-scale irrigated rice production, indicates that intensification does not necessarily result in lower efficiency or a decline in dietary standards. Rather, farmers faced with growing population pressure and an unproductive short fallow swidden system have been motivated to adopt irrigation because it increases the efficiency of their labor while maintaining a reliable and diverse farming system.

KEY WORDS: intensification; shifting cultivation; irrigation; labor efficiency; Philippines.

INTRODUCTION

Many farmers in the frontier community of Napsaan, located on the west coast of Palawan Island in the Philippines, are beginning the transition from shifting cultivation to a more intensive system of irrigated rice production. According to Boserup's (1965) widely cited theory of agricultural intensification, the adoption of irrigation should enable Napsaan farmers to support a larger population by increasing the amount of rice they can produce on each hectare of land. This growth in carrying capacity will be accomplished, however, at the cost of a reduction in efficiency that results from the need to adopt more labor-intensive methods of cultivation in or-

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0300-7839/92/0600-0203$06.50/0

der to maintain soil fertility and productivity at adequate levels (Boserup 1965, p. 39). Because of these costs, Boserup's theory predicts that farmers will resist intensification until they are compelled to make the transition by growing population pressure and land scarcity.

Though many anthropologists continue to accept Boserup's basic thesis, her theory has stimulated much debate and has been qualified or challenged on many occasions. Some researchers argue that population pressure is only one of several factors that may stimulate the adoption of more labor-intensive farm techniques. Environmental advantage (Padoch, 1985), market incentives (e.g., Eder, 1977; Anderson, 1989; Stone *et al.*, 1990), and political centralization (Hakansson, 1989) have all been proposed as alternative explanations for the intensification process. Others, rejecting Boserup, argue that the adoption of intensive cultivation ultimately leads to economic progress and increased labor efficiency (see Bronson, 1972; Barlett, 1976, 1982; Simon, 1983; and Harris, 1988 for a discussion of the debate on labor efficiency and agricultural intensification).

Cohen (1989), in his influential analysis of the impact of agriculture on health and nutrition, proposes an argument that parallels Boserup's claim that intensification leads to a decline in standard of living. He suggests that as a population shifts its subsistence focus from hunting and gathering to extensive agriculture, and from there to intensive farming techniques, the reliability and quality of the food supply typically decline (1989, pp. 55-69). In this view he challenges a long standing assumption that "advances" in agricultural technology have led to a steady improvement in food security and health.

In this paper, I argue that much of the debate and disagreement concerning the process and impact of agricultural intensification is the result of a lack of appropriate data. Typically, conclusions about relative labor efficiency have been drawn by comparing *different* agricultural systems, often widely separated by time, geographic distance, or localized environmental variation (Bronson, 1972, pp. 191-199). Such comparisons must be treated with caution since they ignore potentially important differences in the social and physical environment that may influence agricultural efficiency. Likewise, archeological investigations of the impact of subsistence change on health and diet diversity (Cohen, 1989), while providing many valuable insights, often rely on data from populations widely separated in time (Netting, 1985, p. 9).

To better understand the process and impact of agricultural intensification we need more information on specific farming systems *at the point of transition* from extensive to more intensive farming techniques (cf. Barlett, 1976, pp. 127-128; Cohen, 1989, p. 57). Napsaan, a frontier community first settled in the mid 1950s and now experiencing rapid population growth, provides the basis for such an analysis. Based on data collected in Napsaan during 1980–81, I argue that the interpretation of agricultural intensification developed by Boserup and Cohen, while accurately describing long-term processes, overlooks the positive short-term benefits that intensification may provide. These benefits help us to better understand the actual mechanism by which intensification occurs and explain why some Napsaan farmers have enthusiastically begun to adopt a more labor-intensive system of production. Specifically, I contend that the adoption of irrigation by swidden farmers in Napsaan has resulted in an *improved* standard of living — irrigation has resulted in higher labor efficiency while maintaining a diverse and reliable farming system.

THE RESEARCH AREA

The long and narrow island of Palawan (11,700 km^2), located just to the northeast of Borneo, is the fifth largest island in the Philippine archipelago. Historically, geographic isolation and mountainous terrain, the presence of endemic malaria, and the threat of slave raiding by Muslim "pirates" from the Sultanate of Sulu to the south, left Palawan outside the mainstream of Philippine political and economic development during most of the colonial period. Since the 1930s, however, with the influx of thousands of lowland Filipino settlers from overpopulated islands in the central Philippines, Palawan has entered a period of rapid population growth, environmental modification, and economic development. In 1975 the population of Palawan Province, including many small outlying islands, was estimated to be 300,000 persons with a population density of about 20 people/km^2 (NEDA, 1980). By 1990, estimates of the population residing on the main island of Palawan had increased dramatically to about 500,000. Despite these changes, Palawan remains the least developed of the major Philippine islands and is seen by many as the nation's last frontier. The island is still heavily forested, especially in its mountainous interior where logging companies, migrant lowland Filipino settlers, and indigenous peoples compete for its remaining resources (Conelly, 1985; Lopez, 1987; Eder, 1990).

My research on Palawan was conducted over an 18-month period in 1980–1981 on the central west coast of the island. In the Napsaan area, a group of Tagbanua — indigenous swidden cultivators and hunter–gatherers who have migrated from the east coast of the island — live intermingled with a large population of lowland Christian settlers, most of whom have arrived from the Visayan Islands in the central Philippines. Both groups began settling in Napsaan in the mid 1950s when the area was still largely primary forest. By 1980, farmers had cleared the forest from a strip of land parallel to the coast up to 3 km inland. Much of the community consists of hilly land used for the production of rice, root crops, maize, and vegetables in swiddens. Small orchards of bananas and tree crops such as cashew are also cultivated. In low-lying areas, small, irrigated rice fields have recently been developed, and a number of coconut orchards line the coast. Though agricultural production in Napsaan is primarily for subsistence, the marketing of local products such as cashew, bananas, and maize has become more important in recent years.

In addition to these farming activities Napsaan settlers also have access to a productive inter-tidal zone. A variety of marine resources from the ocean are also exploited. In the still forested mountain slopes above the community, some Tagbanua continue to hunt animals, especially wild pig, and to collect a variety of forest products for the market, including rattan (primarily *Calamus caesius*) and Manila copal, a resin produced by the tree *Agathis dammara* (Conelly, 1983, 1985).

POPULATION PRESSURE AND INTENSIFICATION OF SWIDDEN AGRICULTURE

During the 1950s and 1960s, all of the settlers produced their rice, the mainstay of the Philippine diet, in long-fallow swidden fields cleared from both primary forest and mature secondary forest regrowth. Population densities were low and forest land was freely available to new settlers as they migrated into the community. By the 1970s, however, the availability of land for swidden farming began to decline at an alarming rate. Early in the decade a logging road was constructed connecting Napsaan with the provincial capital of Puerto Princesa, located about 40 km away on the east coast of the island. Without the barrier of the difficult 2-day walk through the forest, a new wave of settlers arrived in Napsaan after 1972. By 1980, there were about 350 people in the community living in 65 households with a population density of roughly 75 persons/km^2.

Land scarcity began to be a concern by the early 1970s, but the rapidly growing population was initially accommodated by expansion of the community farther upstream along the Napsaan River where many newly arrived settlers claimed uncleared forest land. By the mid 1970s, however, local forestry officials started to effectively enforce Philippine legislation prohibiting the clearing of swiddens on forest land by "squatters" who were seen as illegally destroying government land.[2]

[2]Though some illegal forest swiddens were still cultivated on the west coast of Palawan in

With this development, as predicted by Boserup, acute land pressure began to be felt and fallow periods decreased rapidly as farmers were forced to rotate their fields within the boundaries of land they had already cleared. By 1980 typical fallow periods in Napsaan swiddens had declined from more than 10 years to only 2–4 years. As a result, rice yields plummeted and Napsaan settlers began to emphasize alternative means of producing food and securing a living. Some Tagbanua began to intensify their collection of forest products for sale on the market (Conelly, 1985, 1989), while other settlers started to focus more attention on ocean fishing, the production of tree crops such as cashews for the market, permanent rainfed plow agriculture, or migrant wage employment. Many farmers responded to the scarcity of land by choosing to intensify their farm production through the adoption of irrigated rice cultivation. This paper explores the impact of the latter decision on labor efficiency and farm diversity.

SHORT-FALLOW SWIDDEN PRODUCTION

In 1981, considered a poor year because of a 3-week drought just before the harvest, gross rice yields in Napsaan swiddens averaged only 556 kg/ha. The previous year, which enjoyed adequate and well-distributed rain throughout the growing season, farmers reported gross yields averaging 836 kg/ha. The 2-year average of just under 700 kg/ha is only 50% to 33% of the yields potentially achieved under conditions of long-fallow cultivation (Conklin, 1957; Schlegel, 1983) and is one of the lowest yields recorded for any swidden system in Southeast Asia (Conelly, 1983).[3]

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the early 1980s because of less than complete enforcement of the law, these were relatively rare because of the fear of government penalties. Twice during my stay in Napsaan two large groups of farmers in neighboring communities were arrested and imprisoned in Puerto Princesa City for clearing illegal swiddens in the forest. Events such as these have convinced most Napsaan farmers to refrain from cultivating forest land.

[3]Data on swidden and irrigated rice yields are based on farmers' reports of the number of *cavan* of rice they harvested. A *cavan* is equal to 44 kg of unhusked rice. As all households keep careful track of the amount of rice seed they plant and the number of *cavan* they harvest, I believe these data are quite accurate. Of course most swidden systems in Southeast Asia, though dominated by rice, may also produce significant quantities of other cultigens such as root crops, maize, and vegetables. Thus, their total productivity in terms of calories produced per hectare may be different than the figures discussed in the text. I use rice as the measure of productivity because (1) in most swidden systems in the region rice is clearly the dominant crop, (2) it is much more difficult to develop accurate data on the yields of other cultigens, especially root crops (I was unable to collect sufficient data for an accurate estimate), and (3) there are almost no reliable sources of data on the yields of non-rice crops in Southeast Asia that could be used for comparison.

Boserup predicts that swidden farmers faced with population pressure and declining yields will *increase* their labor inputs in an attempt to maintain yields at previous levels (1965, pp. 30-31). This, however, does not seem to be the strategy employed by Napsaan settlers who average only 825 hours of labor/ha in their short-fallow swidden production system. Compared to forest fallow swiddening, which requires in the range of 1000–2500 hr of labor/ha (Conelly, 1983), this level of labor expenditure is quite low.

These low labor inputs can be explained by a description of the short-fallow swidden cycle. Clearing the vegetation usually requires relatively little effort when bush and low weeds or grasses are being removed rather than large forest trees (as was the case in the past). Likewise, burning the cleared vegetation is less time consuming and planting is easier on the uncluttered surface of fields cleared from short-fallow vegetation than in the long-fallow fields strewn with the remains of large trees. Since poor burns fail to eliminate the seeds of competing wild vegetation, the major task in short-fallow swidden production becomes weeding. Napsaan farmers report that they need to complete two tedious weedings of the field during the growing season to achieve the best possible yields.

Guarding the maturing crops from animal pests, reported to be a time consuming activity among some forest fallow cultivators such as the Hanunoo (Conklin, 1957), is not a significant task today in Napsaan. Many fields are now located at a distance from forest boundaries and are less prone to animal predation than in the past. Even fields cleared close to the forest edge, where monkeys and wild pig remain a hazard, are rarely guarded with any diligence, though a few farmers employ "pig bombs" to kill marauding wild pigs. Despite the lack of crop protection practices, farmers reported no significant losses to animal pests during 1980–81.

Finally, the labor required for the harvesting, threshing, winnowing, drying, and storage of the rice, though it varies from year to year, also declines with short-fallow production simply because yields are significantly lower than with long-fallow cultivation. Table I summarizes the labor requirements of Napsaan short-fallow swidden rice production. The data exclude any work carried out solely on non-rice crops (such as planting sweet potatoes).[4]

In terms of efficiency, the returns to labor in Napsaan swiddens averaged 0.81 kg of rice/hr over the 2-year period. In 1980, a year with good

[4]Data on the labor costs per hectare for each task in the swidden and irrigation cycle in Table I were calculated as follows: the total area covered by a group of workers as they carried out a task was calculated using a tape measure at the end of the day. This area measurement was then divided by the total number of person-hours of labor invested. The average hr/ha was then estimated, based on 5–15 such measurements of each task.

Table I. Estimated Labor Expenditures for Short-Fallow Swidden and Rainy Season Irrigated Rice Production in Napsaan, 1981

Swidden labor[a]	Avg Hrs/Ha	Irrigation labor[a]	Avg Hr/Ha
Field preparation	150	Field preparation	310
Slashing vegetation	140	Clear canals	10
Burning vegetation	10	Harrow/plow	300
Planting	145	Planting	410
		Seedbed	10
		Transplanting	400
Field maintenance	390	Field maintenance	10
Weeding no. 1	135	Water management	10
Weeding no. 2	245		
Guarding	10		
Harvesting	140	Harvesting	320
Field harvest	105	Field harvest	250
Carry/thresh/dry	35	Carry/thresh/dry	70
Total	825		1050

[a]See Footnote 3 for details of labor data methodology. Walking time to fields was not calculated, but typically it is less than 5 minutes because of the dispersed settlement pattern in which most houses are located adjacent to the family's fields.

rainfall, returns were 0.93 kg/hr. In the poor rainfall year of 1981, returns fell to only 0.67 kg/hr (Table II). Though reliable data are difficult to find, these figures for Napsaan rice swiddens are much lower than the very high efficiency believed possible in long-fallow production, with estimates as high as 2.25 kg of rice/hr (Bronson, 1972 cited in Cohen, 1989, p. 171).

ADOPTION OF IRRIGATED RICE PRODUCTION

With the decline of swidden yields, some households in Napsaan have responded by developing permanent irrigated rice fields. After a slow expansion in the early 1970s, when only a few farmers had small *basakan* (irrigated fields), the number of irrigated rice fields grew rapidly in the second half of the decade, reaching a total of 13 households (20% of all households) by 1980. Five of the *basakan* were operated by Tagbanua families, the remainder by Visayans who had migrated from the central Philippines, where irrigated rice production is widespread.

Reflecting their recent development, all of the irrigated rice fields in Napsaan are relatively small and technologically unsophisticated. During 1980–81, the largest area planted to wet rice was 1.03 ha. The average field size in the rainy season was only .64 ha. In the dry season, when portions of some *basakan* cannot be irrigated because of lack of water, the

Table II. Estimated Inputs, Yields, Efficiency, and Cash Returns for Napsaan Swidden vs. Irrigated Rice Production, 1980–1981

	Swidden			Irrigation		
	1980 (n = 21)	1981 (n = 35)	Avg	Dry (n = 6)	Rainy (n = 6)	Avg
Field size (ha)	1.17	1.08	1.12	.56	.64	.60
Labor inputs[a] (hr/ha)	897	826	862	1274	1050	1162
Gross yield (kg/ha)	836	556	696	1809	1080	1445
Gross labor Efficiency (kg/hr)	.93	.67	.81	1.42	1.03	1.24
Net yield[b] (kg/ha)	736	489	613	1263	818	1040
Gross cash returns[c] (Pesos/ha)	—	—	605	—	—	1256
Cash costs[d] (Pesos/ha)	—	—	90	—	—	290
Net cash returns (Pesos/ha)	—	—	515	—	—	966
Net cash labor efficiency (Pesos/hr)	—	—	.60	—	—	.83

[a]Labor inputs are total of household labor combined with non-household exchange, share, and wage labor. Measured only for 1981 swidden and 1981 rainy irrigated seasons. Labor for 1980 swidden and 1980–81 dry season irrigation are estimates based on increased harvest and post-harvest labor required to process larger yields in these two seasons (see Table I and Footnote 3 for methodology).
[b]Net yield is gross yield minus the proportion of harvest paid to non-household workers, primarily for share labor (see Footnote 2 for yield methodology).
[c]Gross cash value is farm gate sale price of the gross yield calculated at local sale price of 50 Pesos per cavan of threshed rice (57.5 kg). U.S. $1.00 = 8 Pesos.
[d]Cash costs are for wage labor hired plus costs of chemical fertilizer and pesticides for irrigation.

average field size fell to .56 ha. This compares to an average swidden size in Napsaan of just over one hectare per-household (Table II).[5]

All of the fields are irrigated by short, hand-excavated canals connected either to small nearby streams or to ponds that were developed by constructing simple earthen dams. Although small hand-operated tractors are fairly common on more prosperous farms located on the east coast of

[5]The average size of swidden fields reported in the text and Table II was determined by carefully measuring a sample of 15 fields and noting the amount of rice seed planted (in *ganta,* equal to 1.7 kg), a figure that each household carefully measures. Based on these data, the size of fields not physically measured was estimated by collecting data on the number of *ganta* planted in each field. The size of all irrigated fields was directly calculated using a tape measure.

Palawan, mechanization has yet to reach Napsaan. All land preparation is carried out by human labor and the use of water buffalo. Farmers continue to rely for the most part on locally made tools, though some own a metal shovel, plow, or harrow purchased in the city. Napsaan *basakan* farmers have begun to plant improved "green revolution" varieties of rice, but typically they use early strains that have since been superseded elsewhere in the Philippines by more productive and pest resistant varieties. The use of chemical fertilizers and pesticides is still limited.[6]

After the water delivery canals have been cleaned of debris and the field prepared for planting by plowing and harrowing, the 3- to 4-week-old rice seedlings are transplanted into the field from nearby seedbeds. During the rainy season (late May to December) field preparation and transplanting are usually accomplished between June and early August, after the swidden rice fields have been planted. After the rice is transplanted, relatively little labor is normally required in the *basakan* because the constant supply of water controls most weed growth. The main tasks are to patch occasional breaks in the bunds at the edge of the fields and repair any damage caused by heavy rains. The irrigated rice harvest normally takes place from mid-November to early December. The rice is then hauled from the field, threshed to remove the grain from the stalk, winnowed to separate the chaff from the grain, dried in the sun, and placed in bags for storage. Table I summarizes the total labor costs of *basakan* rice production during the 1981 rainy season, which averaged 1050 hr/ha (see Footnote 3 for methodology).

At the conclusion of the rainy season harvest, most farmers immediately prepare the *basakan* for a second dry season crop. This second crop is ideally planted between mid-December and early January. If planted on time, the second rice crop benefits from another month or so of rain before the dry season starts in earnest in late January or early February. The sequence and timing of dry season labor tasks is basically the same as described for the rainy season.

Based on limited comparative data from Southeast Asia, the labor input of just over 1000 hr/ha for irrigated rice in Napsaan falls within the mid-range of labor requirements for non-mechanized, transplanted wet rice production involving the use of the plow for land preparation. Moerman

[6]The simple technology employed in Napsaan *basakan* and the paucity of chemical inputs indicates that the stimulus of external factors such as government development programs and the technology of the "green revolution" have been relatively unimportant for understanding the process of agricultural intensification. Likewise, despite the road connection to Puerto Princesa City in the early 1970s, market incentives also do not appear to be important for explaining the adoption of irrigated rice. In 1981, while commodities such as cashew and bananas were increasingly produced for the market, rice was very rarely sold by Napsaan farmers.

(1968, p. 206) calculated an expenditure of only 99 days of labor per ha in northern Thailand, while Gourou reported as many as 200 days labor in a similar irrigated system in the Red River delta of Vietnam (1940, cited in Moerman 1968, p. 206). Ruthenberg, citing two case studies from Thailand and Sri Lanka, reports a labor cost of between 825 and 1998 hr/ha for comparable irrigation systems (1976, p. 190).

Rice yields in Napsaan irrigated fields ranged from an average of 1080 kg/ha in the 1981 rainy season to more than 1800 kg/ha in the 1980 dry season. Thus, irrigated rice production is roughly twice as productive as short-fallow rice cultivation in Napsaan.

ADVANTAGES OF IRRIGATED RICE PRODUCTION

Efficiency

The experience of Napsaan farmers as they make the transition from swidden to irrigated rice production helps to clarify the mechanism by which agricultural intensification takes place as well as its impact on the quality of life. My data indicate that, contrary to Boserup, irrigation is not only more productive but also more efficient than short-fallow swidden cultivation. Gross *basakan* yields are double those typically achieved by swidden rice production, averaging 1445 kg/ha. While the labor efficiency of swidden rice in Napsaan averaged only .81 kg of rice/hr of labor in 1980 and 1981, irrigation during the same period produced returns of 1.24 kg/hr (Table II).

Labor, of course, is not the only input that must be considered in evaluating the costs and productivity of irrigated rice farming in Napsaan. More so than for swidden cultivation, irrigated rice generally requires a cash investment in the hiring of non-household laborers and, in some cases, the purchase of small quantities of chemical fertilizer and pesticide. Laborers who help in land preparation and transplanting are sometimes paid in cash, but they may also be remunerated with a share of the crop after the harvest is complete.

Even considering the greater cash costs of irrigation, *basakan* rice production remains significantly more efficient than short-fallow swidden cultivation in Napsaan. The average cash costs of irrigated production (290 Pesos/ha) are more than three times the costs of swidden cultivation (90 Pesos/ha). Nonetheless, efficiency calculated in terms of cash returns to labor (the "net cash labor efficiency" in Table II, or the cash returns if the crop was sold, after deducting production costs, divided by the total labor inputs) remains almost 40% higher.

I believe irrigation is the more efficient production system for two reasons. First, as indicated earlier, short-fallow swidden cultivation in the Napsaan environment has led to precariously low yields, well below the production levels of long-fallow cultivation. By comparison, the transition to irrigation permits significant increases in yield. Second, the image of irrigation as a technique that requires endless hours of labor, as popularized in Geertz's (1963) description of the "involuted" production system of Java and argued by Boserup (1965, pp. 39-40), may be misleading. *Small-scale* irrigation (the type of system appropriately compared to short-fallow swiddening) can produce good yields with relatively low labor requirements. As a result, from the vantage point of farmers calculating costs and benefits *at the point of transition,* irrigation provides a clearly more efficient and attractive option (cf. Bronson, 1972; Barlett, 1976, 1982).

Reliability and Farm Diversity

Efficiency is not the only factor that motivates Napsaan farmers to adopt irrigation. Irrigation also provides increased reliability compared to swidden farming and maintains a high level of farm diversity as well. One reason that irrigation is more reliable than swidden rice production is that the constant supply of water in irrigated fields provides protection against the effects of drought and controls most weed species. This reduces the year-to-year fluctuations in yield characteristic of rainfed swidden cultivation (Ruthenberg, 1976, p. 171). Swidden rice fields generally can tolerate no more than 20 days without rain before suffering serious damage (Moormann and Breemen, 1978, p. 33) while irrigated fields, in contrast, can remain productive even during prolonged periods without precipitation.

Furthermore, as Napsaan farmers are keenly aware, irrigation has the added advantage of permitting the production of two rather than only one crop of rice each year. While swidden production of rice is largely confined to the single long rainy season (a few farmers attempt to cultivate small dry season swiddens of maize and root crops), irrigated rice can be produced with confidence during the dry season. This increases the reliability of the household supply of grain, reducing or eliminating altogether the shortages of rice that plague many Napsaan farmers who rely solely on swiddens for their subsistence.[7]

[7]While this is true for irrigated farming in general, it should be noted that in Napsaan the simple design of the water delivery system sometimes results in crop losses in irrigated fields during extended periods of drought when portions of some fields dry up entirely. Nonetheless, the damage inflicted on the rice crop by the August 1981 drought appeared to be much less serious in irrigated fields than in rainfed upland fields.

With an average swidden size of 1.1 ha and yields of only 700 kg of rice/ha in 1980–81, the typical Napsaan swidden produces enough rice to feed a family for only about six months after the harvest. At this point, swidden households must buy rice or, if they have inadequate income, borrow it from better-off farmers. In the "hunger" months before the August–September harvest season, women in poor swidden households often spend hours each week visiting relatives and neighbors attempting to borrow rice to feed their families. A common form of loan is the *timpuan* in which the borrower promises to repay the lender with a portion of the next harvest. Typically, a loan of one sack of rice is repaid with two sacks at harvest time, an interest rate of 100% over a period of 2–6 months.

Reflecting their more secure production system, members of households with irrigation rarely need to borrow or purchase rice. Moreover, irrigation farmers are unlikely to lose a portion of their harvest to debt repayment. I have no record of any rice harvested from an irrigated field being used to repay a *timpuan* debt. Likewise, in a sample of seven irrigated households only one (14%) lost any of its harvest from supplemental swidden fields in 1981 to debt repayment. In contrast, of 26 households depending solely on shifting cultivation for rice production, 11 (42%) reported forfeiting a portion of their swidden harvests to fulfill *timpuan* obligations. These debt payments accounted for 12% of their total harvest.

In addition to its greater reliability, irrigation in Napsaan has also led to greater, not less, farm diversity. Cohen argues that the move from swidden production with extensive intercropping to intensive permanent cultivation, often focusing on a single crop such as irrigated rice, typically results in a loss of diversity and a greater risk of crop failure (1989, pp. 55-67). While the risks of low diversity he describes may indeed be real for long established, intensive irrigation systems in very populous areas of Southeast Asia, I found the opposite to be the case with the small-scale irrigation system adopted by Napsaan farmers.

Farmers using irrigation maintain diversity by concentrating rice production in a small area of the farm, freeing the remainder of the holding for a variety of other uses, including tree crop production and continued shifting cultivation. Typical farm size is now between 3–7 ha in the community. For many farmers tree crops such as coconut, banana, and cashew, sources of both food and cash, compete with swidden production for the limited land area. With reliance on swidden rice, farmers must leave much of their land fallow as part of the 2–4 year field rotation.

The competing demands of tree orchards and shifting cultivation were apparent during 1981. At least a half dozen swiddens in the community were cleared in still immature orchards of coconut, banana, and cashew because no other suitable land was available to the household. Though tree crops, especially coconut, can sometimes survive swidden fires that do not burn too intensely, at best the fires seriously delay the maturation of the orchards. In other cases, tree crops are simply lost and must be replanted, provided suitable land can be found.

Tree orchards are more compatible with a land-use pattern involving irrigated rice farming. Irrigation focuses the production of rice on low-lying soils, where farmers say fruit trees do not do well anyway. This leaves upland areas free for the production of tree crops. In addition, because irrigated farming is more productive in terms of yield-per-hectare than shifting cultivation, and because it does not require a fallow rotation, less land is needed for rice production and more can be devoted to tree crops. For these reasons, even if their total land holdings are the same size, households with irrigated fields have more land available for tree crop farming than farmers who rely solely on shifting cultivation for the production of rice.

Irrigation in Napsaan also maintains diversity because it is not an exclusive method of rice production. All irrigated households also cultivate swiddens — though typically these are smaller in size than in the past. This permits the production of additional rice during the rainy season as well as secondary swidden crops such as sweet potato, cassava, and vegetables that are important for the maintenance of a balanced diet. Figure 1 shows the complex and diversified land use of one typical irrigated rice farm household in Napsaan.

The timing of irrigation labor is generally compatible with the swidden labor cycle so that farmers are able to maintain both cropping systems simultaneously without serious scheduling conflicts. While there is some overlap in the timing of labor requirements in the two systems, the periods of *peak* labor demand do not coincide. Land preparation and the transplanting of the rainy season irrigated rice occur after the period of intense labor in early May when swidden fields are planted. The heavy labor demand of the swidden rice harvest occurs from late August to early October when little labor is required to maintain the maturing rice in the irrigated fields. The harvest of the rainy season irrigated crop and the planting of the dry *basakan* take place in November through January, when little swidden labor is required. The harvest of the dry season irrigated fields is normally completed in April before it is time to begin planting the next year's rice swidden.

WHO ADOPTS IRRIGATION?

The adoption of irrigation in Napsaan has been gradual and not all families have participated in the transition. Barlett's study of the intensifi-

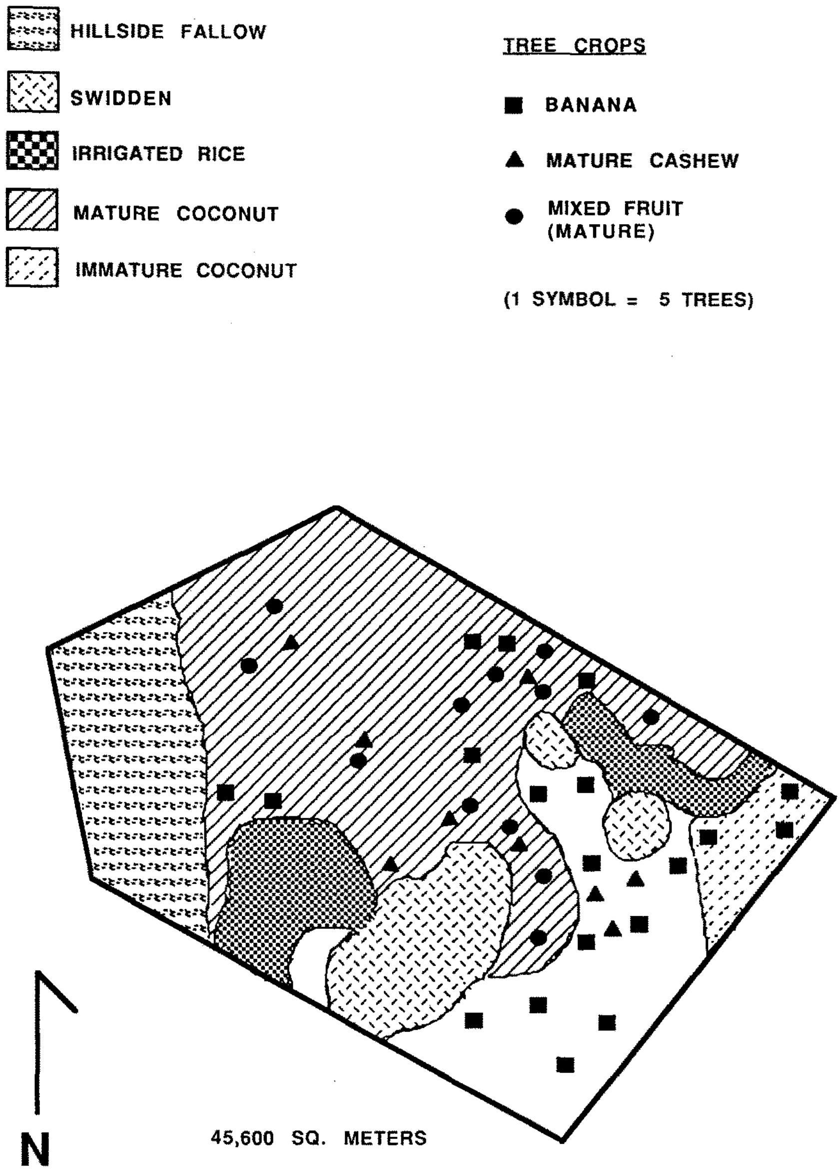

Fig. 1. Land use pattern integrating irrigated rice, shifting cultivation, and tree crops.

cation of agriculture in Paso, Costa Rica (1976, 1982) makes the astute observation that the pressure on land resources exerted by growing population density may not be felt equally within the community because of differences in size of land holding. Rather, she argues, households with small parcels will be the first to experience land scarcity in the form of reduced yields of maize and beans in their overworked and infertile swidden fields. Larger "well-to-do" farmers, in contrast, are able to maintain a sufficient fallow period as well as high levels of productivity and labor efficiency in their swidden system.

As a result of these differences, only households with small land holdings in Paso have been motivated to intensify production by the adoption of permanent terraced fields in which maize and beans are grown in combination with tobacco. For these farmers, as in Napsaan, intensification results in an increase in labor efficiency. Large landowners in Paso, on the other hand, have for the most part not adopted the intensive terraced agriculture because for them it would result in a decline in the efficiency of their labor.

Can we expect this pattern of early innovation by farmers with the smallest land holdings to be a key for understanding the mechanism of agricultural intensification in general? The experience of Napsaan settlers suggests that this is not necessarily the case. In Napsaan, though there is not yet dramatic inequality in the size of land holdings, it has been primarily the households with *larger* farms (about 5 ha or more) that have made the transition to irrigated rice cultivation.

One reason for this pattern of intensification in Napsaan is that historically the larger farm households have removed a considerable portion of their land from the swidden rotation by planting tree crops such as coconut along the coastline and cashew and bananas farther inland. As a result, like small farmers, these large farm holders also often find themselves with insufficient land for swidden rice production, and suffer as well from short-fallow periods and low yields. Thus, like the households with little land, they also feel the incentive to intensify rice production.

If all households are experiencing similar difficulties with their short-fallow swidden system, why has the adoption of irrigation been undertaken primarily by large farmers in Napsaan? The reason appears to be a factor not emphasized by Barlett in her study of Paso — the establishment costs of developing permanent agriculture. Since irrigation requires access to a water buffalo and control over sufficient labor to transform swidden land into the completely cleared, flat, and bunded fields needed for permanent rice cultivation, these costs are significant.

It is possible to work an irrigated field with a borrowed or rented water buffalo, but this can be risky if the animal is not available when it is really needed. Purchasing a mature water buffalo is very expensive, costing over P2000 ($250). In fact, most households that own a plow animal did not buy it as an adult. Rather, they typically purchase a much less expensive young buffalo and wait for it to mature. In some cases they obtain an animal by agreeing to take on the expense and labor of feeding and maintaining a neighbor's buffalo for a year or two in return for the right to one of its future offspring. These alternate methods of obtaining livestock greatly reduce the cost of acquiring a water buffalo for irrigated rice production.[8]

A second difficulty in establishing an irrigated rice field is the time and expense required to clear and level the land, establish the irrigation system, build canals, and construct the berms surrounding each individual portion of the larger field. One young farmer, who kept a written record of the work put into his field, reported spending approximately 400 hours to open up his first *basakan* of only .05 ha in 1981. Except for hiring a neighbor who did the initial plowing of the new field with his buffalo, the field owner and his unmarried adult siblings performed all the necessary work.

Though this newly established *basakan* was exceptionally productive, the high labor costs of establishing the field reduced the gross labor efficiency in the first year of production to only .60 kg of rice/hr. This is less than half the average efficiency for established *basakan* and lower than the typical return of about .81 kg/hr for swidden rice cultivation. Thus, the greater efficiency made possible by the transition to irrigated farming cannot be achieved in the first few years while a field is being developed. The farmer must be able to defer gaining the full benefits of irrigation until the *basakan* is completely established. The intensity of labor required to initially develop an irrigated field helps to explain why many families who own irrigable land have not yet been able to establish a *basakan*.

Because of these establishment costs, unlike in the case of Paso studied by Barlett, irrigation has been adopted first in Napsaan primarily by larger farmers with a greater ability to take on the costs of a water buffalo and command the necessary labor. A socioeconomic survey that measured the quality and size of houses, ownership of household items such as lanterns and radios, and possession of productive equipment (Conelly, 1983),

[8]Boserup also argues that the labor expenditures and cost of fodder to maintain plow animals should be included in calculations of efficiency for permanent agriculture such as irrigation. This is certainly true in many highly intensive systems with severe land scarcity. In Napsaan, however, the maintenance of water buffalo is not a major cost because considerable fallow land and fodder are still freely available. The animals are normally simply tethered near the home either to graze on the scrub vegetation or wallow in ponds or mud holes. The labor requirements for this system of livestock management are not onerous and much of the work such as tethering can be carried out by children. Data from a year-long time allocation survey indicate that adults in households with irrigation spend an average of less than 10 minutes per day caring for animals (Conelly, 1983). Thus, I argue that at the early stages of transition to small-scale irrigation, animal maintenance costs do not significantly alter the overall efficiency of the system.

indicates that all *basakan* households are in either the upper (54%) or middle (46%) income categories. In most cases, *basakan* are also owned by more mature households in which grown children are able to contribute a significant amount of the labor needed to open up and maintain the irrigated fields.

Security of land tenure is another factor that may influence the adoption of irrigated farming. When the settlers first arrived in Napsaan they were viewed by the government as illegal "squatters" and thus had no legal title to the parcel of land they were farming. In the 1960s, however, many households in the community began to petition the government for titles of ownership based on the planting of "permanent" tree crops such as coconut and cashew. By 1981, only seven of the thirteen households with irrigation had successfully obtained a title and were recorded as taxpayers by the Land Assessor's Office in Puerto Princesa City. All of the remaining *basakan* households were still in the process of applying for title to their land. Thus, secure title does not appear to have been a prerequisite for developing a *basakan*. Rather, the opening up of an irrigated field could be viewed as a strategy, like planting permanent tree crops, for eventually securing a legal title to the land and increasing security of tenure.

DISCUSSION AND CONCLUSION

What then does the experience of agricultural intensification by Napsaan farmers say about Boserup's model? I believe that *in the long run,* if we compare forest fallow swiddens to permanent irrigated agriculture there is strong evidence to support Boserup's claim that labor efficiency declines. This long-term view, however, does not help us understand the actual mechanism by which more intensive technology is adopted; nor does it properly characterize the relationship *at the point of transition* between short-fallow swidden production and the early stages of small-scale irrigation (the point at which farmers actually make the calculation concerning the costs and benefits of intensification). From this vantage point, irrigation provides an option that improves, rather than lowers, the efficiency of their labor.

Based on data in Table II, Fig. 2 summarizes the argument. Beginning from a presumed high level of efficiency for long-fallow swidden cultivation, Boserup posits a steady decline in returns to labor as the farming system moves to short-fallow and then to permanent techniques of cultivation. By contrast, the Napsaan data indicate that land scarcity leads initially to a precipitous decline in yields and efficiency with the forced adoption of short-fallow swidden production. As new irrigated fields are opened, farmers suffer a further temporary decline in returns to labor because of the high establishment costs of irrigation. After these establishment costs are absorbed in the first few years, however, *basakan* farmers enjoy clearly improved efficiency compared to short-fallow swidden production. This helps explain their willingness to adopt irrigation despite its increased labor demands. Nonetheless, the efficiency of irrigated production remains lower than that of traditional *long-fallow* swidden production.[9]

A similar argument can be made concerning changes in crop diversity and quality of diet as farmers move from long-fallow through short-fallow to irrigated production. As argued by Cohen, the initial high diversity and productivity of long-fallow swidden production combined with continued exploitation of wild resources would typically result in a highly diverse and reliable diet. With short-fallow production, as in the case of Napsaan, yields

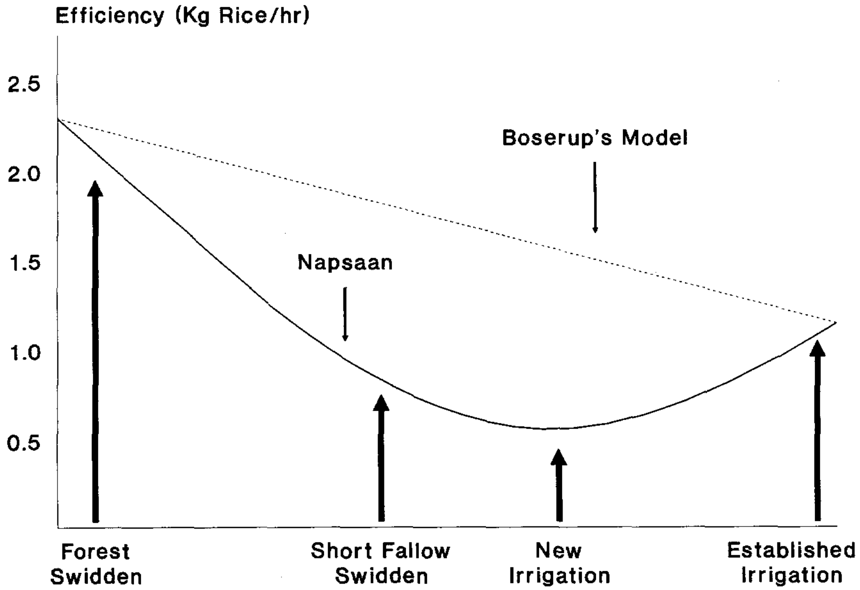

Fig. 2. Boserup's model of changes in labor efficiency compared to the transition from swidden agriculture to irrigation in Napsaan.

[9]I intentionally separate establishment costs in the first years from a discussion of the efficiency of irrigation once the fields are established. It would be possible to average or amortize the establishment costs of irrigation into the overall efficiency of the system over a 10- to 20-year period. This, however, would not accurately reflect the experience of farmers who must typically absorb the added labor costs of establishment in the first few years of production. Therefore Fig. 2, I believe, represents a realistic view of actual changes in labor efficiency, with an initial decline in the first few years because of the establishment costs followed by a significant increase once the *basakan* is fully developed.

decline while at the same time diversity may be lost because most land must be held in reserve as fallow for future production. In addition, the availability of wild food resources is reduced because of population increase in the region. With short-fallow production, swiddening as a viable subsistence system has collapsed and food scarcity and a decline in the diversity and quality of diet can be expected.

At this point of collapse in the farming system, however, I argue that irrigation, at least in the near term, reverses the trend and provides increased reliability and crop diversity. Irrigation permits the production of a dependable second rice crop each year and improves the security of cultivation by providing an artificial source of water to maintain soil fertility and protect against drought. At the same time, because irrigation concentrates production of the staple rice crop in a small field and eliminates the need to maintain large areas of fallow, it permits a more diverse use of the farm parcel. Irrigation farmers in Napsaan are able to cultivate supplemental swiddens and develop large tree orchards on their non-irrigated land (once needed as part of the fallow rotation). This diverse land use pattern provides the family with both a source of cash income and a balanced, high quality diet.[10]

Initially then, the adoption of small-scale irrigation in Napsaan has been a rational decision for farmers and has led to an improved standard of living, whether measured in terms of labor efficiency or farm diversity. This case study suggests that we need to see agricultural intensification as being more complex than an inevitable process of decline in the quality of life. It also indicates the importance of observing the process of intensification as it occurs in particular farming systems rather than developing models that compare agricultural systems that may be widely separated in time and space.

There is also the risk, however, of focusing analysis too narrowly and failing to see the long-term processes that Boserup and Cohen are ultimately attempting to explain. Based on the experience of irrigated production systems elsewhere in Southeast Asia, it is reasonable to expect that eventually the adoption of irrigation in Napsaan could lead to the negative consequences that they predict. As population densities continue to increase in the community, the growth of irrigation at the expense of other,

[10]These claims about the maintenance of adequate nutrition despite intensification are supported by limited data collected on diet intake and anthropometric measurements of children in Napsaan. Records of household food consumption by a representative sample of households over a nine month period indicate that families with *basakan* enjoy better than average diets by community standards. Likewise, anthropometric measurements show that preschool age children in irrigated households are less likely to suffer from malnutrition than children from households that rely solely on swiddening for their food production (Conelly, 1983).

currently complementary, land uses could indeed lead to a loss of diversity in the diet. In addition, increased reliance on monocropping of rice often results in growing insect pest problems (Litsinger and Moody, 1976; Marten, 1986) that require greater dependence on costly pesticides. Likewise, as irrigated fields are used over long periods of time, fertility typically declines, requiring increased labor expenditures and the cost of chemical fertilizers to maintain yields. When these additional long-term costs that accompany intensive irrigation are calculated, the future efficiency of Napsaan irrigation may fall from its current levels.

In the near-term calculation of farmers concerned with the capacity of the land to support their families, however, irrigation appears to promise a better future. It is from their perspective that we can come to a more complete understanding of the mechanism by which agricultural intensification takes place and its impact on the quality of life.

ACKNOWLEDGMENTS

I am especially grateful to Luis Dulce, Tingting Fulgarines, Galon Gansing, Venancio Israel, and Rudy Sublemente, for their assistance in my research on swidden farming and irrigation in Napsaan. I also want to thank Miriam Chaiken, Steve Sanderson, and the several anonymous reviewers who made many helpful suggestions for improving this paper. The research was partially funded by the Institute for Intercultural Study and the University of California, Santa Barbara.

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