PN-ABP-176
82535

FEBRUARY 1993
WORKING PAPER 34

Constraints on Rice Production in Madagascar:
The Farmer's Perspective

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CORNELL FOOD AND NUTRITION POLICY PROGRAM

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Paul Dorosh

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CFNPP is funded by several donors including the Agency for International Development, the World Bank, UNICEF, the Pew Memorial Trust, the Rockefeller and Ford Foundations, The Carnegie Corporation, The Thrasher Research Fund, and individual country governments.

Preparation of this document was financed by the U.S. Agency for International Development under USAID Cooperative Agreement AFR-000-A-0-8045-00.

© 1993 Cornell Food and Nutrition Policy Program ISBN 1-56401-134-8

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ABBREVIATIONS

AIRD	—	Associates for International Resources and Development
CPI	—	Consumer Price Index
FAO	—	Food and Agriculture Organization
FMG	—	Malagasy Franc
IMF	—	International Monetary Fund
MPARA	—	Ministere de la Production Agricole et de la Reforme Agraire
OSIPD	—	Office Statistique et Informatique pour la Programmation du Developpement

1. INTRODUCTION: RICE IN THE MALAGASY ECONOMY

Rice plays a central role in the economy of Madagascar. Paddy is a major part of farming systems throughout the country. Over half of total cultivated area is devoted to paddy (MPARA 1988), and rice production accounted for 38 percent of total agricultural production in value terms in 1984 (Dorosh, Bernier, and Sarris 1990). Moreover, rice is the major staple. Together, domestic production and rice imports supplied 54 percent of calorie intake in the early eighties (FAO 1984).

Madagascar's rice sector stagnated during the late 1970s and reached a crisis point in the early 1980s as official procurement declined and imports rose substantially. A number of major policy reforms involving market liberalization and higher producer prices were undertaken after 1982, but on average, rice production in Madagascar has increased more slowly than the population since 1985 with important consequences for overall economic growth and household welfare. Why has there not been a more significant increase in rice production? To what extent are marketing problems still important? What other constraints to increased rice production are perceived by farmers? In attempting to shed light on these issues, a survey of rice farmers in Madagascar was conducted in September and October 1990, the results of which are presented in this paper.

THE ROLE OF PADDY IN MALAGASY AGRICULTURE

Although rice is a major staple throughout the country, the role of paddy varies according to agroecological zone. On the High Plateau in the center of the island, cultivation of irrigated paddy is a defining feature of most farming systems, with paddy generating an estimated 44.2 percent of agricultural income and 14.1 percent of total income of small farmers (those cultivating less than 1.5 hectares) in 1984 (Dorosh et al. 1991). Cassava, maize, vegetables, and livestock are also important parts of these farming systems. Along the East Coast of Madagascar, where export crops account for 33 percent of the value of agricultural production, paddy is a secondary source of revenue (25.7 percent of agricultural income and 10.3 percent of total revenues). In the generally drier western and southern regions of the country, livestock and crops such as cotton and cassava are major sources of revenue. Here, paddy accounts for only 11.9 percent of total revenues of small farmers.

Nationally, paddy yields average only 2.25 tons per hectare. Chemical fertilizer use is low and only about 2 or 3 percent of the country's cultivated paddy area is sown with improved varieties. Although many farmers know something of the existence of improved varieties, extension services and distribution networks are extremely limited in scope (AIRD 1991; Fujisaka unpublished).

The 1990 Cornell survey focused on economic incentives, production trends, and farmer perceptions; it did not cover many agronomic issues which are undeniably important in understanding rice production in Madagascar. More detailed exploration of agronomic constraints remains crucial, especially considering the importance of regional differences in production practices. The information in the survey is thus meant to complement other research on farmer practices and technical constraints, and we hope that the analysis will provide hypotheses for further testing.

RICE SECTOR POLICIES AND PERFORMANCE, 1960 TO 1981

Rice production in Madagascar increased steadily during the 1960s at an average annual growth rate of 5.3 percent (AIRD 1984). Much of this growth was due to increased yields achieved through increased application of chemical fertilizers. Yields grew 31 percent from 1.57 to 2.05 tons per hectare between 1960 and 1968. Fertilizer use increased from 1,000 tons in 1956 to 13,000 tons in 1973 (AIRD 1984).

In accordance with the generally laissez-faire outlook of the post independence regime,[1] Madagascar initially did not have an explicit rice policy. Marketing was left to the private sector and prices were market determined. Only after a rice crisis in 1965 did the government set policies of low producer and consumer prices to protect low-income consumers.

The 1970s were marked by much heavier government involvement in all aspects of the Malagasy economy. After a period of political instability from 1972 to 1975, a new regime, headed by Didier Ratsiraka, consolidated its position and committed the government to following and intensifying the socialist path embarked upon by his predecessor. In broad macroeconomic terms, the government nationalized many industries and established parastatals responsible for marketing and trading. Moreover, the government sought a more egalitarian distribution of income and pursued interventionist welfare policies.

A state monopoly over the distribution of rice was established so as to regulate producer and consumer prices and to avert price fluctuation-induced rice crises such as the one that occurred in 1965. The government subsidized consumer prices so as to keep them low and to improve the welfare of consumers. Over time, increases in official prices of rice failed to keep pace with overall price inflation in the economy. Producer prices declined by 33 percent in real terms between 1976 and 1982, while real consumer prices fell by 29 percent (Table 1).

---

[1] Madagascar maintained close commercial and financial ties with France by remaining in the Franc zone and by permitting French (and other expatriate) commercial interests to play a large role in industry and commerce. French-controlled firms accounted for 65 percent of the sales of the largest firms. French settlers owned large estates and were important producers of the major export crops (Dorosh, Bernier, and Sarris 1990). See Pryor (1990), for a thorough examination of the economic history of Madagascar.

Table 1 – Madagascar: Rice Production, Availability, and Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Area[a]	Yield	Paddy Production[a]	Exports[b]	Imports[b,h]	Change in Stocks[b]	Total Availability[b]	Production per Capita[b]	Availability per Capita[b,c]	Imports/ Availability	Real Consumer Price[d,e]	Real Producer Price[f,g]
	(000 ha)	(tons/ha)	(000 mt)					Kgs/year		Percentage	1980=100	
1970	935	1.99	1,865	68	20	0	996	155.0	147.8	2.0	146.1	80.2
1971	943	1.99	1,873	36	61	0	1,074	152.0	155.7	5.7	138.3	80.2
1972	1,008	1.67	1,687	26	49	0	968	133.7	137.0	5.1	131.2	76.0
1973	1,055	1.64	1,730	6	96	0	1,059	133.9	146.3	9.1	138.1	71.6
1974	1,134	1.63	1,844	7	129	5	1,150	139.2	155.0	11.2	184.6	97.8
1975	1,078	1.83	1,972	5	64	-5	1,168	145.2	153.6	5.5	178.9	108.5
1976	1,064	1.92	2,043	4	72	5	1,207	146.7	154.8	6.0	170.4	120.5
1977	1,175	1.76	2,067	2	95	4	1,247	144.6	155.8	7.6	141.8	116.9
1978	1,133	1.70	1,922	1	153	-2	1,230	131.0	149.7	12.4	131.2	109.7
1979	1,158	1.77	2,045	1	156	-7	1,307	135.7	154.9	11.9	115.0	104.4
1980	1,178	1.79	2,109	1	177	2	1,355	136.2	156.3	13.1	100.0	100.0
1981	1,186	1.70	2,012	0	193	6	1,314	126.4	147.4	14.7	96.7	83.7
1982	1,188	1.66	1,970	0	351	58	1,396	120.3	152.3	25.1	121.7	81.1
1983	1,189	1.81	2,147	0	179	54	1,327	127.6	140.8	13.5	175.6	81.6
1984	1,163	1.82	2,112	0	111	-90	1,384	122.1	142.8	8.0	231.6	82.5
1985	1,180	1.84	2,179	0	106	-30	1,356	122.5	136.1	7.8	291.4	85.2
1986	1,187	2.06	2,230	0	162	28	1,383	121.8	134.9	11.7	344.4	159.1
1987	1,213	2.09	2,296	0	94	9	1,371	122.0	130.0	6.9	212.9	120.4
1988	1,189	1.88	2,235	0	90	-24	1,366	115.3	125.8	6.6	346.1	83.8
1989	1,221	1.91	2,332	0	112	15	1,403	116.9	125.6	8.0	198.9	102.4
1990			2,420	0	44	-23	1,422	118.3	124.1	3.1	198.9	110.0

Sources:

[a] 1970-85 (Shuttleworth 1989); 1985-89 (IMF 1988, 1991; MPARA 1989; World Bank 1990).
[b] Rice equivalent equal to 0.67 kilograms of milled rice per kilogram of paddy times loss rate of 16 percent. (Loss rate from Hirsch 1986).
[c] 1970-85 (Hirsch 1986); 1986/87 (IMF 1988, 1991; World Bank 1990).
[d] Consumer price, calendar year basis, deflated by traditional basket CPI; 1970-82 data are official consumer prices 1983-90 data are free market consumer prices.
[e] AIRD (1984); Dorosh, Bernier, and Sarris (1990).
[f] Producer price deflated by traditional CPI; 1970-1982 data are official producer prices for the crop year (for example the crop year t/t+1 is shown as t+1); 1983-89 data are free market producer prices, annual average.
[g] 1970-1974 (AIRD 1984; Dorosh, Bernier, and Sarris 1990).
[h] 1990 figure is net imports.

The low real producer prices diminished incentives for production and for sales to the official distribution network. Between 1970 and 1980, domestic production of rice increased by 13 percent because of a 26 percent increase in the area of land under cultivation, despite a downward trend in yields. Per capita production of rice fell from a high of 155 kilograms in 1970 to 120.3 kilograms in 1980. Sales in the official market (about half of total sales) fell from about 10-12 percent of domestic production during the 1975-1980 period to only 6 percent of domestic production by 1981 (Dorosh, Bernier, and Sarris 1990).

The reduction in official procurement, combined with increasing urban demand for subsidized rice, resulted in a gap in domestic rice availability. Initially, this gap was met by increasing rice imports. Imports of rice rose from 64 thousand tons in 1975 to 351 thousand tons in 1982, or in terms of the shares of imports in total availability, from 5.5 percent to 25 percent of total availability.

REFORMS, 1982 TO 1988

In the early 1980s rapidly increasing rice imports, adverse movements in the terms of trade, and a large government investment program financed largely by foreign borrowing and domestic credit led to serious macroeconomic imbalances and a balance of payments crisis. The Malagasy government began implementing IMF-sponsored stabilization policies in 1981, quickly reducing the government budget deficit, the trade deficit, and monetary growth through sharp reductions in aggregate demand (cutbacks in government spending and imports). Beginning in 1984, structural adjustment policies, including market liberalization, privatization, exchange rate devaluation, and trade liberalization, were implemented in the hopes of removing perceived constraints on aggregate supply.

Reforms in the rice sector were a major part of the overall reform program. In general, the major objectives of the reforms in the rice sector were to increase domestic rice production and to reduce the fiscal and foreign exchange drains entailed by consumer subsidies and massive rice imports. To accomplish these goals, a number of measures were implemented. The nominal official producer price was increased by 28 percent in 1982/83, private trade in rice was legalized in 1983, and, in conjunction with the IMF standby agreements, limits were imposed on rice imports. In 1985, the maximum official producer price was redefined as the floor price, and producer prices were increased.

On the consumption side, the official distribution price was raised by 87 percent in 1982, and by a further 31 percent between 1982 and 1985. Private market consumer prices rose by 71 percent between 1983 and 1985. The major reason for the rise in consumer prices was the decline in per capita availability resulting from reduced rice imports. Availability fell from 152.9 kilograms per capita per year to 136.7 in 1985.

Rice production increased substantially in the first few years after the market reforms. Production increased by 10.6 percent between 1982 (a year of poor harvests partly due to unfavorable weather) and 1985. Between 1985 and

1990, however, the trend in production was somewhat disappointing. The average annual growth rate was only 2.67 percent and per capita production fell from a 1985 level of 122.5 kilograms per capita to 115.3 in 1988 before recovering somewhat in 1989 and 1990 to 116.9 and 118.3 kilograms per capita, respectively. Since reforms on rice policy also reduced imports, per capita availability of rice has also fallen and in 1990 was at the lowest level since independence (124.1 kilograms per capita).

PLAN OF THE PAPER

This paper presents the results of a survey of rice farmers in Madagascar conducted by the Cornell Food and Nutrition Policy Program (CFNPP) in collaboration with a local consulting firm, the Office Statistique et Informatique pour le Programmation du Developpement (OSIPD). The survey, designed to explore the reasons for the low supply response of rice farmers to the changes in economic environment of the 1980s, focuses on production trends, farmers' perceptions of constraints on production, incomes, and expenditures.

Section 2 describes the sampling frame and the questionnaire used in the survey. Descriptive statistics on household characteristics and rice production, consumption, and processing are found in Section 3. Section 4 contains a statistical analysis of constraints on production, fertilizer use, and rice consumption. General observations and conclusions are presented in the final section.

2. THE CORNELL SURVEY: DESIGN AND IMPLEMENTATION

With the series of policy reforms and disappointing rice supply response in mind, the CFNPP, in collaboration with OSIPD, conducted a survey of rice farmers in order to understand the constraints on rice production from the standpoint of the farmers themselves.

The survey sought to elucidate the structure of rice-producing farms in Madagascar, and to provide an insight into the determinants of paddy production. The questionnaire addressed general characteristics of the household, production, and sales of rice and other crops, rice milling, incomes and their sources, input and credit use, other costs of production, crop marketing, and constraints on production and marketing.

Of additional interest was an estimation of the incidence of deficits in rice balances among farmers by collecting data on rice consumption. This issue was of concern since price increases would be likely to adversely affect rice-deficit farmers.

SAMPLE SELECTION

The sample consisted of 825 rice-producing households from four geographical regions (North, East, Central, and South). These regions include four different agroecological zones as defined in the 1984 National Agricultural Census (Littoral West, East Coast, High Plateau, and South/South West). Within each region, at least two *fivondranana* (districts) were selected — one with an average farm size that was above the regional average, and one with an average farm size below the regional average. Four *fivondranana* were selected from the Central region due to the importance of this region in production for Madagascar as a whole (Table 2).

The four agroecological zones included in the survey account for over 77 percent of total area devoted to traditional paddy cultivation, or about 826,103 hectares, and 72 percent of total area, including large modern farms (Table 3). The census reports that there are about 973,000 farmers cultivating paddy on an average of .801 hectares per farm. Irrigated paddy is cultivated on 612,314 hectares in these four zones, or 78.6 percent of total paddy area (traditional and modern farms).

Ten *fivondranana* were originally selected, Fenerive Est and Brickaville on the East Coast, Ankazoabo Sud and Bekily in the South/South West, Miandrivazo and Ambato Boeni in the Littoral West, and Befandriana Nord, Ambatodrazaka,

Table 2 - Madagascar: Survey Sample

Fivondronana (District)	Faritany (Province)	Survey Region	Agroecological Zone
Befandriana-Nord	Majahanga	North	High Plateau
Ambato-Boeni	Majahanga	North	Littoral West
Fenerive Est	Toamasina	East	East Coast
Brickaville	Toamasina	East	East Coast
Ambatondrazaka	Toamasina	Center	High Plateau
Mianarivo	Antananarivo	Center	High Plateau
Ambositra/Ambovombe	Fiananrantsoa	Center	High Plateau
Miandrivazo	Toliary	Center	Littoral West
Bekily	Toliary	South	South/Southwest
Ankazoabo Sud	Toliary	South	South/Southwest

Table 3 – Madagascar: Characteristics of Survey Zones and Fivondranana: Census Data

Fivondranana	Survey No. of Villages	Survey No. of Households	Census Rice Area (Ha/farm)	Census Total Area (Ha/farm)	Census Rice Production (Kg/ha)	Census No. of Households	Census Rice Farms
Region 1: Nord	5	110	1.27	n/a	2,145	n/a	134,415
Befandriana-Nord	3	68	1.21	1.51	2,186	18,350	18,263
Ambato-Boeni	2	42	1.48	1.74	2,016	13,737	12,103
Region 2: Est	11	206	0.36	n/a	2,634	n/a	347,300
Fenerive Est	8	165	0.47	1.07	1,810	28,046	22,421
Brickaville	3	41	0.80	1.41	1,524	19,703	18,071
Region 3: Centre	26	383	0.81	n/a	2,816	n/a	434,185
Ambatondrazaka	2	30	1.88	2.52	2,265	18,142	18,178
Mianarivo	10	176	0.91	1.52	2,817	14,481	13,773
Ambositra/Ambovombe	10	129	0.55	0.72	2,155	30,411	30,030
Miandrivazo	4	48	0.78	1.01	2,407	11,099	10,990
Region 4: Sud	9	126	1.04	n/a	2,202	n/a	169,748
Bekily	5	73	0.55	0.94	2,210	15,680	11,026
Ankazoabo Sud	4	53	0.70	0.92	2,492	6,252	5,780

Fivondranana	Census Rice Area		Census Total Area	Census Rice Production	MPARA Rice Production	MPARA Rice Area	Altitude Meters*	Rainfall Millimeters*
	Total	Percent of Total						
Region 1: Nord	171,217	83.8	204,325	367,322	269,840	150,100	0-300	2,000
Befandriana-Nord	22,032	79.6	27,663	48,170	32,610	19,115		
Ambato-Boeni	17,921	75.1	23,872	36,135	21,080	10,280		
Region 2: Est	24,753	65.9	191,819	328,630	545,775	318,565	0-1,200	1,500-
Fenerive Est	10,539	35.2	29,943	19,078	22,245	13,790		2,000
Brickaville	14,393	51.8	27,792	21,940	18,975	11,820		
Region 3: Centre	353,840	72.5	488,047	996,443	758,765	371,635	1,200-	1,500
Ambatondrazaka	34,097	74.7	45,656	77,235	209,775	86,180	1,400	
Mianarivo	12,523	56.7	22,078	35,275	42,260	19,475		
Ambositra/Ambovombe	1,700	63.4	26,797	36,630	25,525	10,725		
Miandrivazo	8,557	76.2	11,230	20,595	22,315	11,870		
Region 4: Sud	176,293	65.6	268,646	388,214	68,475	47,385	0-500	500
Bekily	6,087	41.1	14,795	13,450	3,180	3,090		
Ankazoabo Sud	4,025	70.3	5,728	10,030	6,025	4,305		

* Altitude and rainfall represent the average levels for the RNA agroecological zone that corresponds to the survey zone. The numbers of the Northern region are than of the RNA zone "Littoral West" (see Table 2).

Source: Dorosh, Bernier, and Sarris (1990).

Miarinarivo, and Ambositra[2] on the High Plateau. Ambatondrazaka was selected because it is in the important rice-producing region around Lac Aloatra.

According to the 1985 agricultural census, the ten *fivondranana* in the sample included 145,215 hectares of cultivated paddy by traditional farmers, 13.6 of the total area devoted to rice production in Madagascar. The *fivondranana* of Ambatondrazaka has 32,279 hectares devoted to paddy cultivation by traditional farmers (34,079 hectares by all farmers). Ankazoabo, Bekily, and Miandrivazo, on average, had fewer than 10,000 hectares devoted to traditional paddy. The other *fivondranana* had paddy areas that ranged from 10,000 to 20,000 hectares.

Traditional paddy area as a percentage of total cultivated area ranged from lows of 35.2 and 41.1 percent in Fenerive Est and Bekily, respectively, to 79.6 percent in Befandriana-Nord. Most of the cultivated land in Fenerive-Est is devoted to export crops such as cloves and coffee.

Traditional farm paddy yields vary between and within regions. Yields are lowest in the Eastern zone sample *fivondranana*, although the zone average is much higher. The highest yields are on the Plateau, especially in Mianarivo and Miandrivazo.

The Ministry of Agriculture Annuaire des Statistiques Agricoles reported a 1985 national paddy production level of 2,131,100 tons. The eleven *fivondranana* in the sample produced 403,990 tons of paddy in 1985, about 19 percent of the aggregate figure (*fokontany*).

The actual sample villages (*fokontany*) and households were selected as follows. A global sampling rate of 1 per 1600 was employed: a sampling rate of 1 per 200 was used to select 51 villages within the ten sample *fivondranana* and a rate of 1/8 was used to select individual households within each village (see Appendix 1 for a list of sample villages.)

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[2] Since the 1984 census, Ambositra *fivondronana*, has been divided into two *fivondronana*, Ambositra Proper and Ambovombe Centre (or Manandriana). As a result, the survey actually encompasses eleven *fivondronana*.

3. RICE PRODUCTION IN MADAGASCAR: DESCRIPTIVE STATISTICS

Major characteristics of the farm households in each of the four survey regions are given in Table 4. Average landholding for the sample as a whole is 1.92 hectares per household, of which 1.18 is allocated to paddy cultivation. Slightly over one-half of the farmers in the sample (53 percent) are small farmers (owning 1.5 hectares or less).

Rice production represents 66.7 percent of reported total income. Most households both sell and buy paddy (or rice). Average household production of paddy is 1,589 kilograms, and average paddy sales equal 303 kilograms (19.1 percent of production). Net sales for the entire sample are only 45 kilograms per household (2.8 percent of production).

There are important regional differences in household characteristics. Average household size is considerably larger in the Central region (6.1 persons per household) than in the other regions (4.5 to 4.9 persons per households). In general, these households are very much involved in the marketing of paddy/rice. Although households in the central region purchase the most rice (212 kilograms per household), they are still net sellers of rice on average. Per capita rice consumption is lowest in the Central region (150 kilograms per capita).

Farm sizes are smallest in the North, where average farm size is only 1.11 hectares, of which only 0.22 hectares is not planted with paddy (compared with a sample average of 0.74 hectares of landholdings not planted with paddy). Given the greater percentage of landholdings devoted to paddy cultivation, it is not surprising that rice accounts for a larger share of total income and that total income is lower in the North than in the other regions.

The East is a rice-deficit region despite the highest average paddy cultivation area per household (1.33 hectares). Much of the paddy is cultivated on upland soils. Low yields resulted in an average production of 1,209 kilograms in 1990, 76 percent of average paddy production for the entire sample. Farmers in the Eastern region sell less of their paddy than do farmers in other regions (representing 8 percent of total production, compared to a sample average of 19.1 percent). Net purchases of rice are equal to about 5 percent of rice consumption of the farmers sampled. Rice production as a share of total income is only 56 percent, reflecting the importance of other crops, including export crops on the East Coast.

Farmers in the Southern region have relatively high net sales of 166 kilograms of rice per farm in 1990 and the highest family incomes of the sample (680,109 FMG). With a small average household size (4.5), per capita income is over 40 percent higher than the all survey average of 106,981 FMG per person,

Table 4 – Madagascar: Characteristics of Zones

	Zone				
	North (1)	East (2)	Central (3)	South (4)	Total (National)
Number of households	110	206	383	126	825
Average household size (persons)	4.6	4.9	6.1	4.5	5.3
Small farms (percent)*	81.0	38.0	58.0	42.0	53.0
Average family income (FMG)	420,448	543,991	594,398	680,109	571,709
Per capita income (FMG)	91,801	111,702	97,442	152,491	106,981
Average land holding (ares)	111	223	200	186	192
Average paddy cultivation area (ares)	89	133	115	130	118
Average paddy production (kgs)	1,529	1,209	1,679	1,991	1,589
Average paddy sales (kgs)	425	97	368	334	303
Average paddy sales (FMG)	101,691	25,612	87,011	80,431	72,632
Average paddy sales price (FMG/kg)	239	253	237	241	240
Per capita rice consumption (kgs)	211	170	150	139	166
Average rice purchases (kgs)	177	103	212	57	157
Average net sales of rice (kgs)	107	-38	34	166	45
Rice self-sufficiency ratio (percent)	81.7	95.4	76.9	93.3	82.4
Rice production/total income (percent)	87.0	56.2	66.9	70.5	66.7

* Number of farmers with 1.5 hectares or less as a percentage of all farmers surveyed in the region.

Source: Cornell Madagascar Rice Survey (1990).

two-thirds higher than per capita income in the North. Here it is important to emphasize that the survey sample is only for rice farmers in the Southern region and is not indicative of household incomes for farmers without access to irrigated land.

Table 5 shows the characteristics of large and small farms. The average area of small farms is just over 1 hectare while that of large farms is 3.5 hectares. This figure includes area not under cultivation; cultivated area accounts for 79 percent of total landholdings for small farmers and 81 percent for large farmers. Upland (*tanety*) and other nonirrigated land accounts for most of the difference in cultivated area between small and large farmers. While irrigated area for large farmers is 2.3 times that for small farmers, the ratio of upland (*tanety*) area cultivated for large farmers is 4.3 times as great as for small farmers. Large farmers cultivate 6.3 times as much other nonirrigated land as do small farmers.

PRODUCTION COSTS AND REVENUES

Table 6 calculates 1990 gross and net revenues from paddy per hectare by farm size.

Purchased inputs, rents, and wage payments are incurred primarily in the production of irrigated paddy. Large farmers spend about more on chemical inputs than do small farmers in the production of irrigated paddy, but less, per hectare, than the amount spent by small farmers on either hired labor or land rental.

On a per-farm basis, income from paddy production accounts for over 75 percent of total net revenues from cultivation: 71 percent for small farmers and 79 percent for large farmers.

About 27 percent of all farmers used chemical inputs and spent an average of 21,387 FMG per farm in 1990 (Table 7). Chemical input use was highest in Ambatondrazaka (Lac Alaotra), Miarinarivo and Ambositra, all on the Plateau in the Central Region.[3] Fertilizer applied to seed gardens was the main chemical input used. Most of the farmers who reported using fertilizer on paddy used less than 5 kilograms of fertilizer (Table 8).[4]

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[3] Place (1991) reports that only 24.5 percent of all farmers in a sample in the Central Highlands use N-P-K on their irrigated rice, applying about 109 kilograms per hectare.

[4] In the same survey mentioned above in Place (1991), almost 50 percent of farmers use N-P-K fertilizer on their rice nurseries, applying, on average, 273 kilograms per hectare. Place concludes that "while farmers are unwilling to invest in the large quantities of fertilizer necessary to cover their rice fields, they nonetheless spend the necessary resources to promote rice seedling development" (p. 33).

Table 5 – Madagascar: Characteristics of Survey Farms, by Land Size

	Holding Area Less than or Equal to 1.5 Hectares	Holding Area Greater than 1.5 Hectares	Total
Number of households	442	383	825
Average household size	4.95	5.80	5.34
Landholding (hectares)	1.08	3.48	2.19
Irrigated	0.50	1.12	0.79
Tanety (upland)	0.37	1.57	0.93
Other	0.21	0.78	0.47
Cultivated area (hectares)	0.85	2.82	1.76
Irrigated	0.48	1.09	0.76
Tanety (upland)	0.27	1.16	0.69
Other	0.09	0.57	0.31

Source: Cornell Madagascar Rice Survey (1990).

Table 6 – Madagascar: Paddy Production, Costs, and Net Revenues, by Farm Size

	Value of Production	Value of Chemical Inputs	Land Rental	Hired Labor	Net Revenue
	1,000 FMG				
Irrigated paddy					
Small (less than/equal to 1.5 hectares)	386.5	14.8	15.9	44.0	311.8
Large (greater than 1.5 hectares)	305.3	20.6	6.9	31.8	245.9
Sample average	348.7	17.5	11.7	38.3	281.2
Nonirrigated paddy					
Small (less than/equal to 1.5 hectares)	50.6	2.6	0.6	5.1	42.3
Large (greater than 1.5 hectares)	120.8	3.3	12.1	9.6	95.8
Sample average	83.2	2.9	5.9	7.2	67.1
Total					
Small (less than/equal to 1.5 hectares)	337.3	13.0	13.7	38.3	272.4
Large (greater than 1.5 hectares)	252.6	15.7	8.4	25.5	203.1
Sample average	283.8	13.9	10.3	30.7	228.8

Source: Cornell Madagascar Rice Survey (1990).

Table 7 — Madagascar: Input use, by Survey Region

	Number of Households			Number That Use Chemical Inputs			Average Expenditures on Chemical Inputs (FMG)			Average Expenditures on Chemical Inputs - Other Crops			Average Expenditures on Chemical Inputs - Paddy		
	Small	Large	Combined	Small	Large	Combined	Small	Large	Combined	Small	Large	Combined	Small	Large	Combined
Fivondronana															
Defandriana-Nord	67	1	68	0	0	0	0	0	0	0	0	0	0	0	0
Ambato Boeni	22	20	42	0	0	0	0	200	95	0	0	0	0	200	95
Fanerive-Est	63	102	165	0	1	1	0	222	137	0	0	0	0	222	137
Brickaville	15	26	41	0	0	0	0	0	0	0	0	0	0	0	0
Ambatondrazaka	16	14	30	6	9	15	7,906	20,100	13,597	125	6,825	3,252	7,781	13,275	10,345
Miarinarivo	85	91	176	55	61	116	30,127	132,776	83,201	3,022	8,595	5,904	27,105	124,181	77,298
Ambositra	74	29	103	55	18	73	15,953	37,898	22,132	7,470	22,065	11,579	8,483	15,833	10,552
Ambovombe Centre	15	11	26	12	6	18	9,799	12,727	11,033	1,066	0	615	8,733	12,727	10,423
Miandrivazo	32	16	48	0	0	0	0	0	0	0	0	0	0	0	0
Bekily	20	53	73	0	0	0	0	0	0	0	0	0	0	0	0
Ankazoabo Sud	33	20	53	0	0	0	0	0	0	0	0	0	0	0	0
Total	442	383	825	128	95	223	9,084	35,587	21,387	1,873	3,963	2,843	7,211	31,624	18,545

Source: Cornell Madagascar Rice Survey (1990).

Table 8 – Madagascar: Chemical Fertilizer Application, by Farm Size and by Amount

	Total Number	Do Not Use	< 5 Kilograms per Are	> 5 Kilograms per Are
Farm size				
Small	442	403	38	1
Large	383	355	28	0
Total	825	758	66	1

Source: Cornell Madagascar Rice Survey (1990).

Table 9 presents data on the use of credit by farmers. Very few farmers use credit (6.2 percent), and roughly the same number of small and large farmers have any debts. Small farmers borrow primarily from family members to finance family needs. Large farmers borrow primarily from banks and family members to finance the purchase of agricultural inputs.

Table 10 presents estimates of small and large farm total and per capita revenues. Per capita income of small farmers was 83.945 FMG in 1990, or $45, while that of large farmers was 129,644 FMG, or $69. The sample average of 106,977 ($57) is only 51.6 percent of the inflation adjusted estimate of per capita income in the 1984 Social Accounting Matrix (Dorosh, Bernier, and Randrianarivony 1991). The survey estimates probably understate farmer income since implicit income from other food crops, especially fruits and vegetables, is under-reported in the survey.

Small farmers depend less on crop income, their share of total income being 65 percent, compared to 75.8 percent for large farmers. Small farmers rely much more on sales of nonagricultural products (such as artisanal goods, eggs, hides, and wood/charcoal) than do large farmers. Such sales account for 16.9 percent of small farmer total income, compared to only 6 percent for large farmers. Salaries are important sources of income for small and large farm households, accounting for 14.3 and 12.7 percent of total household income, respectively. These patterns are consistent with the results from a Cornell University/USAID survey of export crop farmers (see Dorosh, Bernier, and Rakotondrasanjy 1991).

MARKETING ISSUES

Table 11 presents data by survey village on access to markets, sales of rice, and average sales price. The average distance to the urban market is about 21 kilometers, and varies from 0 to 76.8 kilometers. The average distance to the rural market is only 5.8 kilometers. There are 1.3 collectors per village. Many villages report no collectors, meaning that the farmers have to go directly to the markets if they want to sell their rice. A few *fokontany* had from eight to ten collectors, due largely to their being on main roads. Sales of paddy were highest in Beteva *fokontany* in Miandrivazo (Mahajanga *faritany* on the Bongolava Plateau), at 521,000 FMG per farmer, over seven times the average of all villages (72,632 FMG per farmer).

The average paddy price was 240 FMGs per kilo. For the sample as a whole, the Central region, which includes parts of Antananarivo, Fianarantsoa, and Eastern Mahajanga *faritany*, had the largest share of total paddy sales (55.6 percent). This is due in part to the large number of the survey households in the Central region as well as to a number of *fokontany* with high average sales. The Eastern zone, in Toamasina *faritany*, had the lowest share of total sales (8.8 percent).

Table 12 indicates that very few farmers pay any transport costs. Most farmers sell their rice to collectors at the farm gate, or they carry their own produce to the nearest market.

Table 9 — Madagascar: Credit Use, by Farm Size

Size	Number of Households	Use of Credit: Use of Credit			Use of Credit: Do Not Use Credit		Reason for Borrowings: Agricultural Inputs			Reason for Borrowings: Family Needs			Reason for Borrowings: Others		
		Number	(%)	(FMG)[a]	Number	(%)	Number	(%)[b]	Amount in FMG	Number	(%)[b]	Amount in FMG	Number	(%)[b]	Amount in FMG
Small	442	22	5.0	64,830	420	95.0	8	26.7	87,500	15	50.0	11,361	7	23.3	89,413
Large	383	29	7.6	135,612	354	92.4	18	56.3	176,667	10	31.3	81,571	4	12.5	45,438
Total (average)	825	51	6.2	105,078	774	93.8	26	41.9	149,231	25	40.3	42,078	11	17.7	73,250

Size	Number of Households	Source: Merchant lender			Source: Family Member			Source: Bank			Source: Money lender			Source: Other		
		Number	(%)	Amount in FMG	Number	(%)	Amount in FMG	Number	(%)	Amount in FMG	Number	(%)	Amount in FMG	Number	(%)	Amount in FMG
Small	442	1	3.3	1,500	15	50.0	20,250	7	23.3	135,188	3	10.0	28,667	4	13.3	25,000
Large	383	3	9.4	120,250	8	25.0	103,714	15	46.9	173,000	5	15.6	71,250	1	3.1	15,000
Total (average)	825	4	6.5	80,667	23	37.1	56,766	22	35.5	159,848	8	12.9	55,281	5	8.1	22,500

[a] Average debt for households that borrow.
[b] Percent of borrowing by size category for each region.

Source: Cornell Madagascar Rice Survey (1990).

Table 10 – Madagascar: Total Revenues, by Farm Size

Source	Total Income (FMG)		
	Small	Large	Average
Crops			
Net value of Production	270,327	570,040	409,451
Paddy	192,186	448,186	311,016
Other	78,141	121,854	98,435
Value of sales			
Nonagricultural products	70,319	45,416	58,758
Salaries (12 months)	59,500	95,165	76,057
Other sources	15,213	41,523	27,443
Rents	385	896	623
Gifts/grants	984	437	730
Pensions	2,738	3,512	3,097
Other	5,475	29,110	16,463
Transfers	5,631	7,568	6,530
Total	415,359	752,143	571,709
Average household size	4.9	5.8	5.3
Per capita revenue	83,945	129,644	106,977
Per capita revenue (US at 1,880 FMG/$)	45	69	57

Source: Cornell Madagascar Rice Survey (1990).

Table 11 — Madagascar: Overview of Survey Fokontany

Fivondranana Firaisana Fokontany		Number of Households	Distance to Urban market (kms)	Distance to Weekly market (kms)	Number of Collectors	Average Rice Sales (FMG)	Average Price Received (FMG/kg)
Zone 1: North		110	37.1	6.5	0.1	101,691	225
Befandriana-Nord							
101	201	20	34.0	3.0	0.0	11,875	167
102	202	29	32.1	3.0	0.1	16,955	171
103	203	19	50.0	10.0	0.0	26,251	176
Ambato-Boeni							
104	204	18	12.2	0.0	0.0	96,389	293
105	205	24	54.3	16.3	0.5	34,2625	256
Zone 2: East		206	33.6	10.1	0.7	25,612	253
Fenerive Est							
106	206	7	69.0	5.9	0.0	500	175
107	207	28	49.0	18.6	0.0	40,982	225
107	208	27	12.0	21.0	0.1	18,843	250
108	209	15	25.3	10.0	0.0	56,156	283
108	210	29	10.0	6.0	0.1	19,621	250
109	211	15	9.0	9.0	0.0	52,833	262
110	212	23	58.0	10.6	0.0	20,109	250
111	213	21	40.0	11.0	0.2	23,810	250
Brickaville							
112	214	8	45.0	0.0	7.0	0	n/
113	215	19	76.8	0.0	2.0	7,895	300
114	216	14	1.0	1.0	0.0	21,429	300
Zone 3: Central		383	12.5	3.5	2.3	87,012	237
Ambatondrazaka							
115	217	18	15.0	4.0	2.0	257,357	248
116	218	12	51.0	6.1	3.0	127,542	201
Miarinarivo							
117	219	20	20.2	0.0	4.6	105,375	212
118	220	22	10.9	10.4	1.7	93,179	239
118	221	18	18.8	10.6	0.7	56,111	250
119	222	16	4.6	1.2	1.3	87,109	250
119	223	10	9.0	0.0	0.6	42,750	250
119	224	18	2.0	0.2	1.0	29,069	250
120	225	14	6.9	6.9	8.9	214,464	230
121	226	18	6.8	6.6	1.1	27,485	230
121	227	19	12.0	0.0	2.7	220,026	252
122	228	21					250
Ambositra			5.0	0.0	2.4	59,524	n/
123	229	15	10.0	3.0	0.0	0	200
124	230	15	22.0	5.0	0.2	6,667	n/
124	231	15	17.0	0.0	0.0	0	445
125	232	15	19.0	4.1	0.0	40,698	310
125	233	9	22.0	7.0	0.0	8,267	180
126	234	10	7.0	7.0	5.4	18,000	180
126	235	13	8.0	6.0	6.0	74,769	n/
127	236	11	5.0	5.0	0.0	0	180
Ambovombe Centre							178
128	237	16	0.9	0.1	9.4	34,313	240
128	238	10	0.0	0.2	10.0	28,193	240
Miandrivazo							260
129	239	13	6.5	1.6	0.0	40,615	240
129	240	9	6.6	0.7	0.0	31,600	
130	241	13	14.1	0.0	0.0	521,807	
130	242	13	30.0	6.0	0.8	37,606	
Zone 4: South		126	11.7	5.2	0.1	80,431	250
Bekily							
131	243	18	21.9	7.7	0.0	53,667	230
132	244	14	7.6	0.0	0.0	105,964	230
133	245	15	15.4	0.0	0.0	52,900	230
134	246	16	9.7	9.9	0.4	121,767	228
135	247	10	5.9	0.0	0.0	92,230	230
Ankazoabo Sud							
136	248	8	6.0	7.4	0.0	85,000	400
137	249	6	5.0	0.0	0.3	83,333	400
138	250	20	8.6	0.6	0.1	76,825	329
138	251	19	15.0	15.0	0.0	68,640	167
Average		825	20.9	5.8	1.3	72,632	240

Source: Cornell Madagascar Rice Survey (1990). See Appendix 2 for list of Firaisana and Fokontany.

Table 12 – Madagascar: Transport of Rice to Market, by Farm Size

	Distance (Kilometers)	Unit Cost (FMG/kg/km)	Cultivators Who Pay Any Transport Fees	
			Number	(Percent)
Small farmers				
Motor vehicle	7.6	6.33	5	1
Canoe	–	–	–	–
Cart	11.3	4.12	8	2
Handcarried	15.0	3.73	3	1
Other	–	–	–	–
Large farmers				
Motor vehicle	9.7	6.77	3	1
Canoe	–	–	–	–
Cart	10.9	3.51	20	5
Handcarried	7.0	3.35	1	0
Other	–	–	–	–
Combined				
Motor vehicle	8.4	6.49	8	1
Canoe	–	–	–	–
Cart	11.0	3.69	28	3
Handcarried	13.0	3.64	4	1
Other	–	–	–	–

Source: Cornell Madagascar Rice Survey (1990).

Table 13 provides details of the rice marketing situation: the average number of collectors, the perceptions of the farmers of the prices that they received, and why they sold if they believed that they did not receive a good price. One objective of the survey was to try to ascertain if the liberalization of rice marketing had resulted in an increase in the number of collectors operating in the main producing regions. The total number of collectors encountered by farmers in their own villages hardly changed between 1987 and 1990. In the *fivondranana* of Brickaville, the number of collectors actually declined from four to two.

Only 351 (43 percent) of farmers sold any rice. Of these, 248 (71 percent) believed that they received a good price. The remaining 103 farmers indicated that they did not receive a good price. When these farmers were asked why they sold to a trader who did not offer a good price, 34 percent said that all the collectors offered the same price. More common though was the answer, "other reason." Unfortunately, the survey data do not provide more information on this issue.

Table 14 provides a breakdown on the milling of paddy. Small farmers mill most of their paddy at the farm level. Large farmers, while doing most of their own milling, sell a larger share of their paddy production in an unmilled state.

Table 15 presents information on household rice milling. Farmers sell about 6 percent of the bran; and they either throw away, burn and use as fertilizer, or use in the household (for mattress or pillow stuffing) about 55 percent. The remaining 39 percent is fed to livestock.

The table also shows that most rice milling is done by women and children, on average, with .26 person hours spent by children per batch, and .89 person hours for women per batch. In total, 1.2 person hours are spent milling 6.8 kilos of paddy, at a rate of 5.7 kilos per hour. Large farms expend 1.3 person hours on an 8 kilo batch, at a rate of 6.4 kilos per hour.

Table 16 provides estimates of off-farm milling costs of paddy by hand millers and by formal sector rice mills. In general, very little paddy is milled off-farm. Hand millers charge 40.7 FMG per kilogram or 16.6 percent of the 1990 producer price. Formal sector mills charge 22 FMG per kilogram of paddy, or 9 percent of the producer price. Hand millers keep on average 24 percent of the bran. The remaining 76 percent is kept by the household and is used primarily for animal feed.

RICE CONSUMPTION

Table 17 presents data on the availability and uses of rice within the household by survey zone and farm size category for 1990. The paddy production and sales figures were converted into rice equivalents using a factor of 2/3. The ensuing production and sales numbers did not balance with the consumption and purchases numbers. The losses and stock change column was created as a residual so that rice availability and uses would balance.

Table 13 – Madagascar: Marketing of Rice, by Region

Region	Number of Collectors		Number of Respondents Who Feel They Received a Good Price		Reason for Having Sold Despite Low Price Received							
					1		2		3		4	
	1990	1987	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
1 Befandriana-Nord	0.0	0.0	26	57.8	1	5.3	0	0.0	3	15.8	15	78.9
2 Ambato Boeni	0.3	0.1	21	67.7	4	40.0	1	10.0	0	0.0	5	50.0
3 Fenerive-Est	0.1	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0
4 Brickaville	2.3	4.3	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0
5 Ambatondrazaka	2.2	2.2	2	8.3	0	0.0	21	95.5	0	0.0	1	4.5
6 Miarinarivo	2.5	1.9	71	79.8	4	22.2	9	50.0	0	0.0	5	27.8
7 Ambositra	1.3	1.1	8	80.0	0	0.0	0	0.0	0	0.0	2	100.0
8 Ambovombe Centre	9.6	9.6	22	88.0	0	0.0	2	66.7	0	0.0	1	33.3
9 Miandrivazo	0.2	0.2	28	84.8	0	0.0	1	20.0	0	0.0	4	80.0
10 Bekily	0.1	0.1	66	97.1	0	0.0	0	0.0	0	0.0	2	100.0
11 Ankazoabo Sud	0.1	0.1	4	16.7	1	5.0	0	0.0	0	0.0	19	95.0
Total	1.3	1.2	248	70.7	10	9.7	35	34.0	3	2.9	55	53.4

Source: Cornell Madagascar Rice Survey (1990).

Key:
1. Only one collector in the village.
2. All the collectors offer the same price.
3. Collector had lent farmer money.
4. Other reason.

Table 14 - Madagascar: Milling of Paddy

Size	Production (Kilograms)	Production Sold in an Unmilled State		Quantity of Paddy Milled		
		(Kilograms)	(Percent)	Outside of household (Kilograms)	By the household (Kilograms)	Other (Kilograms)
Small	994	114	11.4	22	743	-
Large	2,222	478	21.5	83	1,428	-
Total	1,564	283	18.1	50	1,061	-

Source: Cornell Madagascar Rice Survey (1990).

Table 15 – Madagascar: Milling of Paddy in the Household

	Farm Size		
	Small	Large	Average
Quantity milled (kilograms)	743	1,428	1,061
Use of bran (percent)	100.0	100.0	100.0
Sold	4.6	7.3	5.8
Livestock feed	38.4	40.5	39.4
Other	57.0	52.2	54.8
Quantity of bran Sold (kilograms)	8.1	12.0	9.9
Value of bran sold (FMG)	501.5	752.1	617.8
Average amount milled at a time (kilograms)	5.8	8.1	6.8
Number of people working per batch			
Men	0.21	0.26	0.24
Women	1.01	1.10	1.05
Children (under 15 years old)	0.54	0.77	0.64
Number of hours per person per batch			
Men	0.19	0.19	0.19
Women	0.89	0.80	0.85
Children (under 15 years old)	0.39	0.43	0.41
Person hours worked per batch			
Men	0.04	0.05	0.04
Women	0.90	0.88	0.89
Children (under 15 years old)	0.21	0.33	0.26
Total person hours per batch	1.15	1.26	1.20
Output	5.8	8.1	6.8
Output per person hour	5.04	6.43	5.67

Source: Cornell Madagascar Rice Survey (1990).

Table 16 — Madagascar: Cost of Off-farm Paddy Milling

Method	Paddy		Bran							
					Recipient		Use of Bran (100%)			
	Average Amount	Average Milling Cost	Average Amount	Average Value	Household	Miller	Sold	Animal Feed	Other	Average Cost of Transportation to Mill
	(Kgs/household)	(FMG/menage)	(Kilogram)	(FMG)	(Percent)					(FMG/kg/km)
Handmilled	15	610	5	122	76	24	5	94	1	-
Formal sector milling	35	771	12	300		100	-	-	-	1.82

Source: Cornell Madagascar Rice Survey (1990).

Table 17 — Madagascar: Rice Consumption, by Zone and by Farm Size Category

Zone/ Farm Size	(1) Consumption of Rice Per Year (kgs/ household)	(2) Quantity Purchased Per Year (kgs)	(2) %	(3) Quantity Own Produced per Year (kgs)	(3) %	(4) Production (Equivalence in Rice) (kgs)	(5) Sales (Equivalence in Rice) (kgs)	(6) Losses and Implicit Changes in Stocks (kgs)	(7) Losses and Implicit Changes in Stocks (% of (4))	(8) Net Sales (kgs)	(9) Net Sales/ Consumption (%)	(10) Total Number of Households	(11) Number of Deficit Households (No.)	(11) Number of Deficit Households (%)
North														
Small	912.5	196.5	21.5	716.0	78.5	720.1	75.7	-71.5	-9.9	-120.8	-13.2	89	40	44.9
Large	1,199.3	92.1	7.7	1,107.1	92.3	2,287.3	1165.1	15.1	0.7	1,073.0	89.5	21	4	19.0
Combined	967.2	176.6	18.3	790.6	81.7	1019.3	283.7	-55.0	-5.4	107.1	11.1	110	44	40.0
East														
Small	684.6	103.3	15.1	581.3	84.9	532.1	10.1	-59.3	-11.1	-93.2	-13.6	78	41	52.6
Large	913.4	102.7	11.2	813.0	89.0	972.8	97.7	62.1	6.4	-5.0	-0.5	128	53	41.4
Combined	826.7	102.9	12.4	725.3	87.7	805.9	64.5	16.1	2.0	-38.4	-4.6	206	94	45.6
Central														
Small	745.1	227.0	30.5	518.1	69.5	709.0	98.5	92.4	13.0	-128.5	-17.2	222	141	63.5
Large	1,151.6	191.2	16.6	960.4	83.4	1,684.7	448.1	276.2	16.4	256.9	22.3	161	68	42.2
Combined	916.0	211.9	23.1	704.4	76.9	1,119.1	245.1	169.6	15.2	33.2	3.6	383	209	54.6
South														
Small	671.4	121.7	18.1	549.7	81.9	751.2	124.0	77.5	10.3	2.3	0.3	53	17	32.1
Large	969.9	9.5	1.0	960.5	99.0	1,745.3	294.1	490.8	28.1	284.7	29.3	73	1	1.4
Combined	844.3	56.7	6.7	787.7	93.3	1,327.2	222.5	317.0	23.9	165.9	19.6	126	18	14.3
Total														
Small	759.3	186.4	24.5	573.2	75.5	685.1	81.4	30.5	4.5	-105.0	-13.8	442	239	54.1
Large	1,039.9	121.5	11.7	919.2	88.4	1,491.3	341.0	231.2	15.5	219.4	21.1	383	126	32.9
Combined	889.6	156.3	17.6	733.8	82.5	1,059.4	201.9	123.7	11.7	45.6	5.1	825	365	44.2

Note: Production and sales figures converted from paddy to rice at 2/3 conversion rate.

Source: Cornell Madagascar Rice Survey (1990).

Small farmers on average were less self-sufficient than large farmers, purchasing 24.5 percent of their total consumption, compared to only 11.7 percent for large farmers. Small farmers were on average net purchasers of rice, having an average deficit of 105 kilograms, or 13.8 percent of total consumption. Over half the sample of small farmers had rice deficits. Large farmers were large net sellers of rice, with sales that were about 21 percent of their total consumption. About 33 percent of large farmers had rice deficits. The entire sample of large and small farmers had positive net sales, although 44 percent had rice deficits.

A disaggregation of the sample by survey zone yields some interesting observations. The most striking result is the contrast between the Eastern and the Central zones. Average sales in the East are considerably lower than the all survey average, and all farmers are on average net buyers of rice. The farmers in the Central zone, which encompasses the Plateau and Lac Aloatra, are less self-sufficient, and, on average, are small net sellers of rice. Almost 64 percent of small farmers on the Plateau are in deficit, having to purchase over 128 kilograms of rice per household in 1990, over 17 percent of their total consumption. Large farmers are net sellers of rice, selling on average 260 kilograms of rice, 22.3 percent of their consumption. About 42 percent of large farmers on the Plateau have deficits in rice.

Large farmers in the Northern and Southern zones also stand out. They also are large net sellers of rice: Northern large farmers sell almost as much rice as they consume. Only 19 percent of northern large farmers had deficits. Large farmers in the southern zone did not have net sales that were as large (29.3 percent of consumption); however they were almost all net sellers of rice. Only 1.4 percent of large farmers had a rice deficit.

RICE DEMAND PARAMETERS

Ordinary least squares regressions were run on value and quantity of rice consumed per adult equivalent (AE) and are presented in Table 18. Consumption was regressed on regional dummy variables, the log of income per adult equivalent (with a squared term), and the log of paddy price.

Examination of the data revealed that many households had consumption figures that were too high in relation to reported income. Ranking households by income, it was discovered that the first decile had consumption of rice in value terms that was 121 percent of reported household income (Table 19). The regression results presented here are based on a subsample with the first decile dropped from the regression analysis.

The regression yielded significant coefficients for income, price, and a number of regional dummy variables. Income elasticities were calculated and range from .226 to .238, lower than the estimates presented in AIRD (1984), (approximately 0.41). These latter estimates were based on expenditures rather

Table 18 – Madagascar: Determinants of Rice Consumption

Dependent Variable:	Equation 1 Log Value of Rice Consumption per Adult Equivalent	Equation 2 Log Value of Rice Consumption per Adult Equivalent	Equation 3 Log Quantity of Rice Consumption per Adult Equivalent	Equation 4 Log Quantity of Rice Consumption per Adult Equivalent
Independent variables:				
Constant	2.646 (0.959)	8.089 33.883*	-3.158 (-1.241)*	4.460 12.177*
Log income per adult equivalent	1.177 (2.479)*	0.238 (11.424)*	1.531 (3.546)*	0.226 (11.918)*
Log income per adult equivalent squared	-0.040 (-1.982)*	– –	-0.056 (-3.026)*	– –
Log average price	– –	– –	-0.256 (-4.314)*	-0.268 -4.503*
Regional dummy:				
Ambatoboeni	0.519 (6.660)*	0.517 (6.618)*	0.193 (2.555)*	0.194 2.564*
Ambatondrazaka	0.014 (0.165)	0.023 (0.266)	-0.191 (-2.423)*	-0.176 (-2.221)*
Ambositra	-0.101 (-1.576)*	-0.110 (-1.719)*	-0.360 (-5.836)*	-0.368 -5.943*
Ambovombe	-0.346 (-3.846)*	-0.336 (-3.732)*	-0.388 (-4.753)*	-0.373 -4.556*
Ankazoabe	-0.064 (-0.836)	-0.073 (-0.957)	-0.341 (-4.693)*	-0.349 -4.784*
Bekily	0.194 (2.826)*	0.210 (3.075)*	-0.066 (-1.002)	-0.039 -0.601
Brickaville	0.353 (4.509)*	0.352 (4.490)*	-0.065 (-0.825)	-0.059 -0.747
Fenerive Est	0.053 (0.905)	0.062 (1.057)	-0.239 (-4.096)*	-0.222 -3.800*
Mianarivo	-0.003 (-0.058)	0.001 (0.022)	-0.257 (-4.544)*	-0.247 -4.342
Miandrivazo	-0.049 (-0.650)	-0.041 (-0.534)	-0.292 (-4.086)*	-0.276 -3.851*

Memorandum item:

AIRD (1984) estimate	Equation 1 Log Value of Rice Consumption per Adult Equivalent	Equation 2 Log Value of Rice Consumption per Adult Equivalent	Equation 3 Log Value of Rice Consumption per Adult Equivalent	Equation 4 Log Quantity of Rice Consumption per Adult Equivalent
Expenditure elasticity			0.412	0.419
Price elasticity			-0.333	-0.352
Mean values				
Dependent variable	10.9	10.9	5.4	5.4
Log income	11.5	11.5	11.5	11.5
Log income squared	133.8	–	133.8	–
Log price	–	–	5.5	5.5
Income elasticity	0.244	0.238	0.235	0.226
Price elasticity	–	–	-0.256	-0.268
Adjusted R^2	0.316	0.313	0.312	0.305
F-test	29.3*	31.5*	26.7*	27.8*
Number of observations	738	738	738	738

* Significant at 90 percent level.

Table 19 - Madagascar: Rice Consumption and Income, by Income Decile

Decile	Consumption		Households	
	Income	Rice	Share	Number
	FMGs		Percent	
1	122,669	148,387	121.0	87
2	210,771	161,769	76.8	82
3	270,712	157,381	58.1	82
4	324,449	168,218	51.8	82
5	393,377	225,298	57.3	82
6	477,521	223,250	46.8	82
7	579,490	221,794	38.3	82
8	726,794	275,810	37.9	82
9	943,114	294,197	31.2	82
10	1,695,570	285,528	16.8	82
Average	571,709	215,734	37.7	825

than incomes and may thus overstate the elasticities.[5] The coefficients on the squared income terms indicate that the income elasticity falls as income increases.

The estimated price elasticities for rice demand are -.256 and -.268 for equation 3 and 4, respectively. These estimates are lower than those reported in AIRD (1984), shown at the bottom of Table 18.

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[5] The Cornell survey made no attempt to obtain complete expenditure data, so no comparable calculation of expenditures is presented here.

4. DETERMINANTS OF SUPPLY RESPONSE

In this chapter, survey data is used to shed light on the determinants of supply response. First, the sample is broken down according to whether the farm household produced more, a constant amount, or less rice during the three year period 1987/88 to 1989/90. Next, survey data on farmers' perceived constraints is analyzed for subsamples of large and small farmers and according to the farmers' historical production trends. Finally, the role of fertilizers in supply response is explored through regression analysis of yield responsiveness to fertilizer and determinants of fertilizer use.

TRENDS IN PRODUCTION AND SALES

Table 20 presents data on price production and sales for the 1987/88 to 1989/90 growing seasons.[6] A number of households that did not have production data for all three years were dropped from the sample. This table is based on 702 households that had data for 1988, 1989, and 1990.

Total area under both irrigated and nonirrigated paddy cultivation rose by less than 1 percent during the three years. Irrigated paddy production increased about 4 percent during the period, while nonirrigated paddy production fell 13.1 percent. Total production increased slightly, although production per hectare fell.

Sales prices increased by 4.7 percent between 1987/88 and 1989/90, although sales quantity declined 4.2 percent. Underlying the aggregate trend in sales is an 18.1 percent increase in sales of irrigated rice and a 53.2 percent decline in sales of nonirrigated rice.

Table 21 presents the evolution of paddy production and yields by zone and farm size category. Yields and production trends follow roughly the same pattern for all regions except for the East Coast. Irrigated paddy yields for small farmers on the East Coast were only 12.3 kilograms per are in 1989/90 compared with 16.0-17.3 kilograms per are for the other regions. The difference is even more pronounced for large farmers (9.9 kilograms per are versus 14.0-17.2 kilograms per are). Production of irrigated paddy on the East Coast declined by 15.5 percent for small farmers (7.9 percent for large farmers) in contrast to generally rising trends elsewhere.

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[6] The questionnaire asked for data for a five year period but data for the early years was generally of poor quality and is not used in this analysis.

Table 20 – Madagascar: Evolution of Paddy Cultivated Area, Production and Sales

	1987/88	1988/89	1989/90
Per household			
Irrigated paddy			
Area (ares)	87	88	88
Production (kgs)	1,264	1,296	1,314
Yield (kg/are)	14.5	14.7	14.9
Average price (FMG/kg)	235	247	247
Sales (FMG)	55,323	60,271	65,327
Nonirrigated paddy			
Area (ares)	28	29	29
Production (kgs)	360	369	313
Yield (kg/are)	12.7	12.7	10.8
Average price (FMG/kg)	243	242	244
Sales (FMG)	25,111	21,771	11,764
Total			
Area (ares)	116	117	117
Production (kgs)	1,623	1,665	1,627
Yield (kg/are)	14.1	14.2	13.9
Average price (FMG/kg)	236	246	247
Sales (FMG)	80,434	82,042	77,092

Source: Cornell Madagascar Rice Survey (1990).

Table 21 — Evolution of Paddy Production and Yields by Zone and Farm Size

	1987/88		1988/89		1989/90	
	Small	Large	Small	Large	Small	Large
Irrigated Paddy						
North						
Area (ares)	62.6	185.0	61.8	192.2	61.9	206.1
Production (kgs)	1,049.0	3,122.2	977.0	3,161.1	1,071.7	3,544.4
Yield (kgs/are)	16.8	16.9	15.8	16.4	17.3	17.2
East Coast						
Area (ares)	53.5	91.8	53.5	91.7	45.7	89.4
Production (kgs)	668.1	956.1	658.0	957.5	564.3	881.2
Yield (kgs/are)	12.5	10.4	12.3	10.4	12.3	9.9
Plateau						
Area (ares)	55.8	163.5	56.8	165.7	55.8	165.0
Production (kgs)	994.2	2,194.4	1,009.7	2,312.7	950.0	2,302.8
Yield (kgs/are)	17.8	13.4	17.8	14.0	17.0	14.0
South						
Area (ares)	52.4	51.7	51.6	55.9	54.9	66.5
Production (kgs)	827.6	971.8	879.5	1,034.5	875.6	1,085.9
Yield (kgs/are)	15.8	18.8	17.0	18.5	16.0	16.3
Nonirrigated Paddy						
North						
Area (ares)	1.0	0.0	1.1	0.0	0.0	0.0
Production (kgs)	12.9	0.0	11.1	0.0	0.4	0.0
Yield (kgs/are)	12.5		10.4		8.8	
East Coast						
Area (ares)	25.8	74.5	25.8	75.9	6.9	53.1
Production (kgs)	200.8	536.4	190.7	555.9	54.0	384.2
Yield (kgs/are)	7.8	7.2	7.4	7.3	7.8	7.2
Plateau						
Area (ares)	2.6	14.7	2.7	14.8	0.2	2.5
Production (kgs)	36.5	180.8	35.4	180.9	2.0	27.1
Yield (kgs/are)	13.8	12.3	13.2	12.2	11.4	10.9
South						
Area (ares)	19.3	100.1	20.0	103.2	20.0	103.6
Production (kgs)	380.8	1,896.6	390.0	1,967.9	290.3	1,533.0
Yield (kgs/are)	19.7	19.0	19.5	19.1	14.5	14.8
Total						
North						
Area (ares)	63.6	185.0	62.8	192.2	61.9	206.1
Production (kgs)	1,061.9	3,122.2	988.1	3,161.1	1,072.1	3,544.4
Yield (kgs/are)	16.7	16.9	15.7	16.4	17.3	17.2
East Coast						
Area (ares)	79.2	166.3	79.2	167.6	52.7	142.5
Production (kgs)	869.0	1,492.5	848.6	1,513.4	618.2	1265.4
Yield (kgs/are)	11.0	9.0	10.7	9.0	11.7	8.9
Plateau						
Area (ares)	58.4	178.2	59.5	180.5	56.0	167.5
Production (kgs)	1,030.7	2,375.1	1,045.1	2,493.6	952.0	2,330.0
Yield (kgs/are)	17.7	13.3	17.6	13.8	17.0	13.9
South						
Area (ares)	71.7	151.7	71.6	159.1	74.8	170.1
Production (kgs)	1,208.4	2,868.4	1,269.5	3,002.4	1,165.9	2,618.9
Yield (kgs/are)	16.8	18.9	17.7	18.9	15.6	15.4

Table 22 presents average paddy production figures by farm size and growth category. The households used in Table 20 were divided into six categories according to whether or not production increased, declined, or remained the same each year during the 1987/88 to 1989/90 seasons, or whether there was a net increase, decline, or no change during the period.

Eighty-two percent of farmers reported either a net decline or no net change in production. The average net production increase of .2 percent is insignificant, and suggests a general stagnation. Farmers that reported a net increase in production experienced a 64.6 percent increase between 1988 and 1990. Those with falling production levels saw a decline of 25.9 percent.

Production of paddy is quite variable as indicated by the relatively high percentage of cases (260 of 702) that did not have year-to-year movements in the same direction.

FARMERS' PERCEIVED CONSTRAINTS ON PRODUCTION[7]

Table 23 presents the responses on the principal constraints on increased paddy production by survey zone and by farm size category. The general pattern is that a lack of land, a lack of inputs, and a lack of money to buy them, as well as other factors (especially bad weather) are the most important constraints. A slightly larger percentage of small farmers cited lack of land, while proportionately more large farmers cited lack of inputs. Only 27 percent of the entire sample cited high labor costs. Very few farmers cited relative profitability of other crops or an inability to sell as major constraints on increased paddy production.

REGIONAL DIFFERENCES

Breaking the sample down by survey zone provides greater insight into the regional variations in the sample. Lack of arable land is the most-commonly cited constraint in all regions except the South, where it was cited by only 41.5 percent of small farmers and 31.5 percent of large farmers. Shortage of land was most often mentioned by farmers in the East (71.4 percent). Lack of inputs is perceived as a major constraint by more than half the farmers only in the Center (70.0 percent) and South (62.7 percent). In the South, however, this constraint is felt more by large farmers (75.3 percent) than small farmers (45.3 percent).

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[7] The following three sections represent constraints on paddy production as perceived by farmers. As pointed out by an anonymous reviewer, these results should be interpreted with caution since constraints may vary by season. Moreover, some farmers may tailor their responses in hopes of eliciting assistance from government programs. Nevertheless, the authors believe the farmers' responses provide much useful information that can complement (but not substitute for) further farming systems analyses.

Table 22 – Madagascar: Average Paddy Production, by Farm Size and by Growth Category

	Small		Large		Total		Number of cases		
	1988	1990	1988	1990	1988	1990	Small	Large	Total
	(Kilograms)								
Net increase	876	1,304	1,933	3,355	1,350	2,222	69 (19.2)	56 (16.4)	125 (17.8)
No net change	933	933	2,003	2,003	1,452	1,452	198 (55.0)	187 (54.7)	385 (54.8)
Net decline	1,350	930	2,891	2,209	2,145	1,589	93 (25.8)	99 (28.9)	192 (27.4)
Average net	1,030	1,003	2,248	2,284	1,623	1,627	360	342	702
Increased both years	680	1,237	2,095	4,682	1,405	3,002	20 (8.9)	21 (9.6)	41 (9.3)
No change both years	915	915	2,016	2,016	1,453	1,453	185 (82.6)	177 (81.2)	362 (81.9)
Declined both years	1,576	915	2,653	1,727	2,128	1,332	19 (8.5)	20 (9.2)	39 (8.8)
Number of cases (net change)							360	342	702
Number of cases (consecutive)							224	218	442
Number of cases without consecutive movement							136	124	260

Source: Cornell Madagascar Rice Survey (1990).

Note: Net change is the difference between 1990 production and 1988 production. "Both years" signifies movement in the same direction for two consecutive years; 123 of the 825 cases had a zero value for one or more years and were dropped.

Table 23 – Madagascar: Constraints on Increased Paddy Production

Response	Small		Large		Total	
	Number	Percent	Number	Percent	Number	Percent
North	89		21		110	
1 Lack of family labor	16	18.0	7	33.3	23	20.9
2 High cost of labor	25	28.1	10	47.6	35	31.8
3 Lack of arable land	57	64.0	14	66.7	71	64.5
4 Lack of inputs	23	25.8	5	23.8	28	25.5
5 Lack of means to buy inputs	21	23.6	3	14.3	24	21.8
6 Other crops more profitable	10	11.2	9	42.9	19	17.3
7 Could not sell harvested quantity	7	7.9	2	9.5	9	8.2
8 Other	53	59.6	18	85.7	71	64.5
East	78		128		206	
1 Lack of family labor	22	28.2	29	22.7	51	24.8
2 High cost of labor	33	42.3	51	39.8	84	40.8
3 Lack of arable land	57	73.1	90	70.3	147	71.4
4 Lack of inputs	35	44.9	45	35.2	80	38.8
5 Lack of means to buy inputs	31	39.7	37	28.9	68	33.0
6 Other crops more profitable	8	10.3	11	8.6	19	9.2
7 Could not sell harvested quantity	9	11.5	8	6.3	17	8.3
8 Other	28	35.9	38	29.7	66	32.0
Center (Plateau)	222		161		383	
1 Lack of family labor	46	20.7	42	26.1	88	23.0
2 High cost of labor	36	16.2	35	21.7	71	18.5
3 Lack of arable land	134	60.4	77	47.8	211	55.1
4 Lack of inputs	160	72.1	108	67.1	268	70.0
5 Lack of means to buy inputs	135	60.8	86	53.4	221	57.7
6 Other crops more profitable	57	25.7	42	26.1	99	25.8
7 Could not sell harvested quantity	6	2.7	4	2.5	10	2.6
8 Other	107	48.2	71	44.1	178	46.5
South	53		73		126	
1 Lack of family labor	11	20.8	4	5.5	15	11.9
2 High cost of labor	21	39.6	17	23.3	38	30.2
3 Lack of arable land	22	41.5	23	31.5	45	35.7
4 Lack of inputs	24	45.3	55	75.3	79	62.7
5 Lack of means to buy inputs	22	41.5	40	54.8	62	49.2
6 Other crops more profitable	3	5.7	2	2.7	5	4.0
7 Could not sell harvested quantity	25	47.2	14	19.2	39	31.0
8 Other	31	58.5	22	30.1	53	42.1
Total	442		383		825	
1 Lack of family labor	95	21.5	82	21.4	177	21.5
2 High cost of labor	115	26.0	113	29.5	228	27.6
3 Lack of arable land	270	61.1	204	53.3	474	57.5
4 Lack of inputs	242	54.8	213	55.6	455	55.2
5 Lack of means to buy inputs	209	47.3	166	43.3	375	45.5
6 Other crops more profitable	78	17.6	64	16.7	142	17.2
7 Could not sell harvested quantity	47	10.6	28	7.3	75	9.1
8 Other	219	49.5	149	38.9	368	44.6

Source: Cornell Madagascar Rice Survey (1990).

In the North, only one-quarter of the farmers consider lack of inputs to be a major constraint.

High labor costs were cited much less often by farmers on the densely populated Center (Plateau) region than in other areas (18.5 percent compared with 40.8 percent in the East region). Other crops were considered more profitable by a large percentage of farmers only among large farmers in the North (42.9 percent), and small and large farmers on the Plateau (25.7 and 26.1 percent, respectively). Marketing constraints appear to be important only in South where 47.2 percent of small farmers stated that they were not able to sell their harvested quantity.

FARMER RESPONSE BY SIZE AND PRODUCTION TREND

Tables 24 through 27 provide cross-tabulations of households in the various size and growth categories introduced in Table 22 with the constraints on increased production discussed in Table 23. The sample includes only the 702 households with production figures for the three years. A similar exercise was also conducted on a subsample that excluded all nonirrigated paddy production, since non-irrigated production has fallen primarily due to poor weather. The results are presented in Appendix Tables 2a-2d.

Table 24 shows few differences between the responses of large and small farmers. Over 50 percent of all farmers cite a lack of arable land and a lack of inputs as the primary constraints. Table 25 shows the frequencies of the various constraints by growth category. All of the Chi-squares are significant save for the first type of constraint. Fifty percent or more of all farmers cited lack of arable land. The high cost of labor is also important, and is higher for "increasing" farmers (48 percent) than for "declining" or "stagnant" farmers. More increasing farmers could not sell their harvests than could the other farmers. The profitability of other crops was a less significant constraint on increased paddy production for increasing farmers than it was for the farmers in the other categories.

Declining farmers saw a lack of inputs and of the means to buy them, and other weather related factors as the main obstacles. High labor costs are less constraining for declining farmers than for the other categories of farmers.

Tables 26 and 27 present constraints by growth category for small and large farmers. Small farmers all cite a lack of arable land as the main constraint; however, the Chi-square coefficient is not statistically significant. A lack of inputs is cited by all three growth category groups, with those experiencing no change reporting this obstacle most frequently. Relative to the other groups, increasing farmers saw inputs as less of a problem. Lack of means to buy inputs was also frequently cited, although the Chi-square is not significant. Very few small farmers were unable to sell all of their crops, but increasing farmers had a little more difficulty finding buyers than did nonincreasing ones. Farmers whose production did not change said that the relatively greater profitability

Table 24 – Madagascar: Responses, by Size Category

	Percent with Response "Important"		
	Small	Large	Chi-Squared
Number of cases	360	342	
Lack of family labor	18.6	20.2	0.18
High cost of labor	24.4	28.7	1.39
Lack of arable land	61.4	53.2	4.46*
Lack of inputs	54.4	57.9	0.71
Lack of means to buy inputs	46.9	45.3	0.13
Other crops more profitable	17.2	16.7	0.01
Could not sell harvested quantity	10.0	6.7	2.04
Other	49.7	39.2	7.46*

* Significant at 95 percent level.

Source: Cornell Madagascar Rice Survey (1990).

Table 25 – Madagascar: Responses, by Growth Category

	Percent with Response			
	Increasing	Declining	No change	Chi-Squared
Number of cases	125	192	385	
Lack of family labor	18.4	17.7	20.5	0.0
High cost of labor	48.0	20.8	22.3	25.9*
Lack of arable land	56.8	50.0	61.3	1.4
Lack of inputs	39.2	59.4	60.0	12.3*
Lack of means to buy inputs	36.8	52.6	46.0	7.6*
Other crops more profitable	11.2	12.5	21.0	0.1
Could not sell harvested quantity	20.0	8.9	4.4	8.2*
Other	55.2	43.2	41.8	4.3*

Notes: Chi-square tests exclude "no change" cases.

* Significant at 95 percent level.

Source: Cornell Madagascar Rice Survey (1990).

Table 26 – Madagascar: Responses, by Growth Category, Small Farms

	Percent with Response "Important"			
	Small Increasing	Small Declining	Small No Change	Chi-Squared
Number of cases	69	93	198	
Lack of family labor	14.5	19.4	19.7	0.65
High cost of labor	37.7	29.0	17.7	1.35
Lack of arable land	53.6	59.1	65.2	0.49
Lack of inputs	42.0	46.2	62.6	0.28
Lack of means to buy inputs	43.5	52.7	45.5	1.34
Other crops more profitable	8.7	12.9	22.2	0.71
Could not sell harvested quantity	15.9	14.0	6.1	0.12
Other	55.1	54.8	45.5	0.00

Note: Chi-square tests exclude "no change" cases.

Source: Cornell Madagascar Rice Survey (1990).

Table 27 – Madagascar: Responses, by Growth Category, Large Farms

	Percent with Response "Important"			
	Large Increasing	Large Declining	Large No Change	Chi-Squared
Number of cases	56	99	187	
Lack of family labor	23.2	16.2	21.4	1.17
High cost of labor	60.7	13.1	27.3	38.30*
Lack of arable land	60.7	41.4	57.2	5.33*
Lack of inputs	35.7	71.7	57.2	19.13*
Lack of means to buy inputs	28.6	52.5	46.5	8.33*
Other crops more profitable	14.3	12.1	19.8	0.15
Could not sell harvested quantity	25.0	4.0	2.7	15.31*
Other	55.4	32.3	38.0	7.87*

Note: Chi-square tests exclude "no change" cases.

* Significant at 95 percent level.

Source: Cornell Madagascar Rice Survey (1990).

of other crops was a constraint in 22 percent of the cases, compared to 8.3 and 12.4 percent for increasing and declining farmers, respectively.

There are significant differences between those large farmers whose production increased and those whose production decreased. Large increasing farmers view the high cost of labor, a lack of arable land, and other factors as major constraints, and give relatively less importance (in terms of all constraints within the growth category and relative to the importance given by other growth categories) to a lack of inputs, or the means to buy them. Relatively more increasing farmers experienced an inability to sell their harvest. Farmers with declining production saw a lack of inputs and the means to buy inputs as major constraints, but saw a lack of arable land and the high cost of labor as relatively unimportant constraints. Farmers with unchanged production had responses that fell in between those of increasing and declining farmers. The most frequently cited constraints were lack of inputs and a lack of arable land.

FERTILIZER RESPONSE IN PADDY PRODUCTION

We undertook a preliminary investigation on the relationship between rice yields on irrigated land and fertilizer use. Paddy yields per are were regressed on organic and chemical fertilizer use per are, squared fertilizer use variables and an interaction term of organic fertilizer use times chemical fertilizer use. Dummy variables for all but one *fivondranana* were added to the equation to account for regional factors and other fixed effects that may influence yields. The inclusion of the dummy regional variables was found to be statistically significant for all regressions using an F-test. Regional differences thus are an important factor in determining yields. In addition to regressions using the entire sample, the regressions were also run for subsamples of small farmers and large farmers.

Regressions 1 through 3 in Table 28 include only levels of use of chemical and organic fertilizer as explanatory variables (apart from the constant and regional dummy variables). Marginal (and average) yield response per unit of chemical fertilizer is 3.59 for large farms, 7.00 for small farms, and 6.25 for all farms together. The marginal (and average) yield response for organic fertilizer on all farms is 0.032 kilograms of paddy per kilogram of organic fertilizer.

Regressions 4 through 6 include squared terms and an interaction term (chemical fertilizer use times organic fertilizer use). Among the fertilizer variables, only the interaction term is significant for small farmers (Equation 5). Measured at their mean level of organic fertilizer use (2,286 kilograms per hectare), the marginal yield response for small farmers who use chemical fertilizer is 5.41 kilograms of paddy per kilogram of organic fertilizer. For large farmers, only the squared term for mineral fertilizer is significantly different from zero. At the mean level of chemical fertilizer use for large farmers who use chemical fertilizer (62.4 kilograms per hectare), the marginal yield response is 3.27. For the sample as a whole, among the fertilizer

Table 28 – Madagascar: Regression Results – Paddy Yields and Fertilizer Use on Large Farms

Model 1: Sample Limited to Farms that Use Organic Fertilizer

Step 1: Regression of RICEYLD on QORGF_HA and QMINF_HA

Dependent variable: Paddy yields per are (Y)
Independent variables: Organic fertilizer per are (QORGF_HA); Chemical fertilizer per are (QMINF_HA)

Variable	Coefficient (t-stat)	Significance Level	Average	Elasticity at the Mean
QORGF_HA	0.041	99.0%	40.08	0.10
	(2.519)			
QMINF_HA	2.492	98.6%	0.25	0.11
	(2.615)			
Constant	14.981			
	(15.735)			
Average yield	17.19			
No. of observations	89			
R-square	0.121			
F-test	5.97			
Significance	99.6%			

Step 2: Addition of regional dummy variables

QORGF_HA	0.023	91.9%	40.08	0.05
	(1.408)			
QMINF_HA	1.660	83.7%	0.25	0.08
	(1.764)			
AMBOVOMB	-3.484	78.0%		
	(-1.234)			
AMBATOND	-7.216	98.7%		
	(-2.526)			
AMBOSITR	-5.334	99.5%		
	(-2.866)			
Constant	17.534			
	(14.951)			
Average yield	17.19			
No. of observations	89			
R-square	0.234			
F-test	5.13			
Significance	100.0%			
F- Change due to step two:			4.135	
Significance level			99.1%	

Table 28 (continued)

Model 2 – Sample Limited to Large Farms that Use Chemical Fertilizer

Step 1: Regression of RICEYLD on QORGF_HA and QMINF_HA

Dependent variable: Paddy yields per are (Y)
Independent variables: Organic fertilizer per are (QORGF HA); Chemical fertilizer per are (QMINF HA)

Variable	Coefficient (t-stat)	Significance Level	Average	Elasticity at the Mean
QORGF_HA	0.104	89.9%	17.17	0.11
	(1.074)			
QMINF_HA	2.783	70.8%	0.78	0.13
	(1.700)			
Constant	13.018			
	(5.245)			
Ave. Yield	16.27			
Num. Obs.	29			
R Square	0.161			
F-test	2.60			
Signif.	90.7%			
Step 2: Addition of regional dummy variables				
QORGF_HA	0.119	82.0%	17.17	0.13
	(.988)			
QMINF_HA	2.998	66.7%	0.78	0.14
	(1.382)			
Constant	12.227			
	(14.951)			
FENERIVE	-2.920	19.9%		
	(-.255)			
AMBATOND	5.304	52.4%		
	(.724)			
AMBOSITR	-0.719	9.6%		
	(-.122)			
Ave. Yield	16.27			
Num. Obs.	29			
R Square	0.199			
F-test	1.20			
Signif.	65.9%			
F- Change due to step two:			0.38	
Significance level			23.2%	

variables only the interaction term is significantly different from zero. At the mean level of organic fertilizer use (1,992 kilograms per hectare), the marginal yield response for farmers who use fertilizer is 3.09.

Using the average prices of paddy and chemical fertilizer obtained in the survey of 240 and 457 FMG per kilo, respectively, the value of the marginal product of rice per FMG of fertilizer used ranges from 1.6 to 2.8 FMG, based on the results of regressions 4 through 6. The implication is that, for farmers who currently use fertilizer, fertilizer use is profitable at the margin. The incentives for fertilizer use are not large compared with other countries, as will be discussed in the concluding chapter.

DETERMINANTS OF FERTILIZER USE

Regressions were also run in an attempt to understand the determinants of fertilizer use. Probit regressions were run first to ascertain what factors affected the decision to use fertilizer. Tobit regressions were then run to find the correlation between fertilizer use per are, for those that use fertilizer, and the various independent variables.

Tables 29 and 30 present the regression results from the Probit and Tobit models for chemical and organic fertilizer use, respectively. In the Probit models, the dependent variable is a dummy variable for whether or not the farmer uses chemical (organic) fertilizer. The independent variables are the proportion of farmers in the *fivondranana* using chemical (organic) fertilizers,[8] the number of cattle owned,[9] irrigated rice area, and dummy variables for highest level of education — primary, secondary, or tertiary — attained by the head of the household.

The results in Table 29 show that chemical fertilizer use is highly correlated with the proportion of farmers within the region that use chemical fertilizer, suggesting the importance of local variations in agro-climatic and microlevel factors, such as the quality of water control in an irrigated perimeter and possibly the participation of a region in a government fertilizer promotion program. (Recall that fertilizer use is limited to four regions on the Plateau, Table 7.) The Probit regressions also show that, ceteris paribus, farmers with a primary education are more likely to use chemical fertilizers, although the coefficient is significantly different from zero only at the 85 percent confidence level. Plot size is also correlated with fertilizer use.

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[8] This variable is calculated for each farmer as the ratio of the number of farmers using fertilizer to the total number of farmers in the *fivondranana*, excluding the farmer himself.

[9] The number of cattle owned indicates wealth. Current period income per capita is not used since it is endogenous, being determined in part by fertilizer use.

Table 29 – Madagascar: Probit and Tobit Models of Determinants of Chemical (Inorganic) Fertilizer Use

Probit Models	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6	Equation 7	Equation 8
Dependent Variable:	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy
Independent variables:								
Constant	-2.330 (-12.314)*	-2.372 (-12.372)*	-2.320 (-12.272)*	-2.251 (-13.140)*	-2.581 (-9.516)*	-2.488 (-9.748)*	-2.625 (-9.679)*	-2.586 (-9.558)*
Proportion of farmers in region using fertilizer	5.475 (9.685)*	5.539 (9.712)*	5.461 (9.678)*	5.356 (9.791)*	5.396 (9.476)*	5.275 (9.570)*	5.474 (9.511)*	5.409 (9.481)*
Household head education level (how measured?)	0.071 (0.553)	0.051 (0.389)	0.080 (0.621)	0.078 (0.606)	– –	– –	– –	– –
Number of cattle	0.012 (0.770)	0.008 (0.481)	0.014 (0.951)	– –	0.017 (1.116)	– –	0.010 (0.627)	0.015 (0.936)
Total plot area (units)	– –	0.000 (1.583)	– –	– –	– –	– –	0.000 (1.582)	– –
Irrigated rice area	0.000 (0.677)	– –	– –	– –	– –	– –	– –	0.000 (0.608)
Primary education dummy	– –	– –	– –	– –	0.428 (1.614)	0.412 (1.550)	0.393 (1.471)	0.416 (1.563)*
Secondary education dummy	– –	– –	– –	– –	-0.190 (-0.941)	-0.175 (-0.879)	-0.221 (-1.087)	-0.195 (-0.964)
Tertiary education dummy	– –	– –	– –	– –	0.544 (0.777)	0.508 (0.724)	0.574 (.812)	0.541 (0.770)
Chi-squared	123.9*	125.8*	123.5*	122.7*	126.9*	125.8*	129.7*	127.3*

Table 29 (continued)

Tobit Models	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6	Equation 7	Equation 8
Dependent Variable:	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre	FMG Value of Fertilizer Used Per Acre
Independent variables:								
Constant	-2,013.210 (-7.651)[a]	-2,042.590 (-7.618)[a]	-2,009.590 (-7.688)[a]	-1,924.410 (-7.688)[a]	-2,222.500 (-6.907)[a]	-2,110.980 (-6.907)[a]	-2,251.590 -6.969[a]	-2,224.140 (-6.969)[a]
Proportion of farmers in region using fertilizer	3,919.470 (6.324)[a]	3,964.100 (6.316)[a]	3,913.430 (6.334)[a]	3,786.290 (6.268)[a]	3,823.940 (6.226)[a]	3,689.660 (6.147)[a]	3,872.910 6.208[a]	3,827.520 (6.216)[a]
Household head education level	95.858 (0.884)	83.944 (0.766)	97.915 (0.910)	94.196 (0.864)	– –	– –	– –	– –
Number of cattle	21.651 (1.769)[a]	19.444 (1.560)[a]	22.075 (1.848)[a]	– –	24.757 (2.027)[a]	– –	22.111 (1.735)[a]	24.482 (1.953)[a]
Total plot area	– –	0.208 (0.847)	– –	– –	– –	– –	0.201 (0.825)	– –
Irrigated rice area	0.056 (0.165)	– –	– –	– –	– –	– –	– –	0.033 (0.100)
Primary education dummy	– –	– –	– –	– –	396.987 (1.797)[a]	368.088 (1.647)[a]	380.793 (1.712)[a]	395.198 (1.782)[a]
Secondary education dummy	– –	– –	– –	– –	-117.797 (-0.695)	-97.356 (-0.574)	-133.064 (-0.775)	-118.817 (-0.700)
Tertiary education dummy	– –	– –	– –	– –	316.465 (0.521)	267.805 (0.433)	328.523 (0.537)	315.900 (0.520)
Regression standard error	885.35 (9.992)[a]	888.269 (9.976)[a]	884.733 (10.003)[a]	897.278 (9.980)[a]	880.620 (10.012)[a]	894.876 (9.985)[a]	884.164 (9.984)[a]	881.010 (10.001)[a]
Adjusted R^2	0.010	0.010	0.010	0.006	0.009	0.004	0.009	0.009

[a] Significant at 90 percent level.

Notes: t-statistics in parentheses. In the total sample of 823 households, 210 heads of household had no education; 493 attended only primary school; 117 attended up to secondary; 5 heads of household had some tertiary education.

Table 30 – Madagascar: Probit and Tobit Models of Determinants of Organic Fertilizer Use

Probit Models	Equation 1	Equation 2	Equation 3	Equation 4
Dependent Variable:	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy	Fertilizer Use Dummy
Independent variables:				
Constant	-2.124 (-11.444)*	-1.969 (-11.579)*	-2.120 (-11.331)*	-2.124 (-11.442)*
Proportion of farmers in region using fertilizer	6.455 (14.035)*	6.311 (13.966)*	6.455 (14.031)*	6.454 (14.032)*
Number of cattle	0.026 (2.441)*	– –	0.027 (2.387)*	0.026 (2.340)*
Total plot area	– –	– –	0.00 (-0.171)	– –
Irrigated rice area	– –	– –	– –	0.00 (0.053)
Primary education dummy	0.810 (4.418)*	0.759 (4.193)*	0.812 (4.417)*	0.809 (4.396)*
Secondary education dummy	-0.055 (-0.361)*	-0.060 (-0.398)*	-0.052 (-0.343)*	-0.055 (-0.362)*
Tertiary education dummy	1.119 (1.901)*	1.113 (1.895)*	1.115 (1.894)*	1.119 (1.901)*
Chi-squared	309.0	303.4	309.0	309.0

Tobit Models	Equation 1	Equation 2	Equation 3	Equation 4
Dependent Variable:	Quantity of Organic Fertilizer Used Per Acre	Quantity of Organic Fertilizer Used Per Acre	Quantity of Organic Fertilizer Used Per Acre	Quantity of Organic Fertilizer Used Per Acre
Independent variables:				
Constant	-143.473 (-9.846)*	-135.379 (-9.894)*	-140.615 (-9.637)*	-142.920 (-9.809)*
Proportion of farmers in region using fertilizer	314.380 (10.044)*	307.933 (9.967)*	311.356 (10.003)*	313.609 (10.042)*
Number of cattle	1.519 (2.102)*	– –	1.825 (2.440)*	1.693 (2.263)*
Total plot area	– –	– –	-0.022 (-1.383)	– –
Irrigated rice area	– –	– –	– –	-0.017 (-0.836)
Primary education dummy	60.700 (4.850)*	57.779 (4.686)*	61.307 (4.944)*	61.062 (4.904)*
Secondary education dummy	-4.028 (-0.424)	-3.947 (-0.416)*	-3.111 (-0.329)	-4.020 (-0.424)
Tertiary education dummy	49.542 (1.448)	49.076 (1.432)*	48.185 (1.417)	119.597 (1.463)
Regression standard error	72.373 (18.616)*	72.558 (18.604)*	71.943 (18.602)*	72.198 (18.607)*
Adjusted R^2	0.064	0.063	0.072	0.067

* Significant at 90 percent level.

The Tobit regressions show that the regional variable is again significant in determining how much fertilizer is used. The number of cattle possessed by the household (a measure of wealth) and attainment of primary education are also significant explanatory variables, while secondary and tertiary educational attainment contribute little to explaining the quantity of fertilizer used.[10] Irrigated paddy area and total plot area are not significant. Unfortunately, the R-squared values are very small, about one percent of the variation in fertilizer use per are is "explained" by the independent variables.

The Probit and Tobit regressions for organic fertilizer produce better results (Table 3C). Almost all the independent variables have statistically significant coefficients, with the exception of irrigated paddy area, plot size, and secondary and tertiary education. The probability of organic fertilizer use increases for every head of cattle owned. Surprisingly, those farmers who have some tertiary education are more likely to use organic fertilizer on their paddy fields. The explanatory power of the Tobit regression, as measured by the adjusted R-squared value, is still low (only 0.06).

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[10] Place (1991) finds that chemical fertilizer use in the Central Highlands is positively correlated to the age of the household head and to total household wealth.

5. CONCLUSION

Given the important role of rice in rural production and consumption in Madagascar, the serious macroeconomic and sectoral crises and the subsequent reforms of rice policies had important consequences for the rural population, especially for poor farmers. The primary objective of the rice policy reforms, apart from reducing government subsidies and rice imports, was to boost domestic rice production.

Rice marketing was liberalized in December 1986, but aggregate rice production has not increased substantially: only 8 percent between 1986 and 1990. Population during that same period increased by almost 11 percent, resulting in a decline in per capita production. As imports have themselves fallen since 1986, per capita availability has declined by about 8 percent. The disappointing supply response suggests that other important constraints remain which were not fully addressed by the rice policy reforms.

Farmers' own assessments of their constraints on rice production varied by farm size and growth category (positive or negative three-year trend in production). Large farmers with positive production trends are constrained by high labor costs and a lack of arable land. One quarter of these farmers also reported inability to sell their output as an important constraint, implying that marketing problems remain despite the liberalization. Large farmers with declining production trends cite a lack of inputs and of the means to buy inputs as the most important constraints.

No significant differences were found in the responses of small farmers across growth category. Lack of arable land was consistently cited as the main constraint among all small farmers. Lack of inputs and of the means to buy inputs are also important constraints for only about half of small farmers. The other half of the small farmers did not consider lack of inputs or the means to purchase them as major constraints, yet fertilizer use among small farmers is very low and is limited to the high plateau region of the country (only 7 percent of small farmers used more than 5 kilograms of chemical fertilizer per hectare on their rice paddies.)

Technical recommended doses of fertilizer on paddy are 300 kilograms per hectare of N-P-K (11-22-16) and 66 kilograms of urea (Price Waterhouse n.d.). Nationally, fertilizer use on paddy in 1987 was only 2 percent of the recommended dose of fertilizer (about 7.3 kilograms per hectare). The present survey finds a similar gap between recommended and actual fertilizer use (reported fertilizer use was only 6.0 kilograms per hectare.)

One reason for the lack of demand for fertilizer by small farmers may be low productivity of fertilizer given the available rice varieties, water control,

soil types, and other agronomic factors. A positive yield response to fertilizer use on irrigated land was found for small farmers in the sample, but only when combined with organic fertilizer. These results are consistent with agronomic considerations that without organic material, chemical fertilizer use can lead to soil compaction and other problems[11] (Fujisaka unpublished; Place 1991). Regression analysis of yields on irrigated land for large farmers that do use fertilizer indicates a positive response to fertilizer use: 3.3 to 3.6 kilograms of additional paddy yield per kilogram of fertilizer. This fertilizer response is about 30 percent less than the fertilizer response in the Ministry of Agriculture cost-budgets (4.78 kilogram increase in paddy yield per kilogram of fertilizer when fertilizer use is increased from 0 to 366 kilograms per hectare).[12] The mean level of fertilizer use among large farmers in the sample who use fertilizer is only 73 kilograms per hectare.[13]

At 1990 prices, the ratio of marginal revenue to marginal cost for fertilizer applied to paddy on irrigated land in the Madagascar sample is 1.8 (Table 31). By comparison, the marginal benefit—cost ratio in southern Asia in the mid-1980s, when fertilizer use or paddy was much higher,[14] was about 9.2. The relative price of fertilizer to paddy was only a secondary factor underlying the difference in incentives. Subsidizing fertilizer and so increasing the paddy/fertilizer price ratio to 1.15 as in southern Asia in the mid-1980s, would raise the marginal benefit-cost ratio to only 3.8. The change in relative prices would still leave Madagascar's cost-benefit ratio at only 41 percent of the average for southern Asia.

The gap between yield responsiveness to fertilizer in southern Asia and in Madagascar is more important. In southern Asia, the yield response of improved rice varieties is about 8.0 kilograms of paddy per kilogram of fertilizer (urea). Even with the higher yield response in the Ministry of Agriculture cost budgets (4.78 kilograms of paddy per kilogram of fertilizer), the marginal benefit-cost ratio at the 1990 paddy/fertilizer price ratio is only 2.56. At the same price ratio, but with the South Asia yield response, the marginal benefit-cost ratio jumps to 4.29.

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[11] Fujisaka (unpublished) reports that farmers claim that chemical fertilizer use makes the top soils shallower and harder, and less fertile. Place (1991) indicates that most farmers who use chemical fertilizers also use organic fertilizer. Farmers who use chemical fertilizer during the off-season on cash crops use organic fertilizer during the rainy season to restore soil fertility.

[12] 300 kilograms per hectare of N-P-K (11-22-16) and 66 kilograms per hectare of urea (Price Waterhouse n.d.).

[13] The mean level of fertilizer use is calculated for a subsample of 27 farmers using fertilizer.

[14] Fertilizer application per hectare in Indonesia is about 127 kilograms. See Bumb (1990).

Table 31 – Madagascar: Costs and Benefits of Fertilizer Use

	(1) 1990 Survey	(2) Low Price Fertilizer	(3) High Yields	(4) Southern Asia Yields	(5) Southern Asia Yields, Price
Price ratio (paddy/fertilizer)	0.54	1.15[a]	0.54	0.54	1.15[a]
Change in yield (kgs paddy/ kg fertilizer)	3.30[b]	3.30	4.78[c]	8.00[d]	8.00
Benefit/cost ratio (FMG paddy/FMG[e] fertilizer)	1.77	3.78	2.56	4.29	9.17
Benefit/cost ratio (as percentage of Southern Asia)	19.3	41.3	27.9	46.8	100.0

[a] Price ratio is average for seven Asian countries 1985/86 (paddy/urea) from Bumb (1990), p. 147.

[b] Approximate marginal yield increase from regression results, Table 24.

[c] Change in yield calculated from Ministry of Agriculture data reported in Price Waterhouse, Table 2.31b.

[d] Approximate value from synthesized response curves in Barker, Herdt, Rose (1985), p. 83.

[e] Benefit/cost ratio is equal to price ratio times the change in yield ratio.

The low yield responses and weak economic incentives for fertilizer use outlined above help explain why half of the small farmers do not consider lack of purchased inputs to be a major constraint. Lack of information about current fertilizer practices may be especially important in areas other than the high plateau as well. The lack of reported fertilizer use in many regions could well be due to a lack of demand arising from the ineffectiveness of fertilizer in these ecologies. Higher risks associated with fertilizer inputs (and improved seeds) and poor extension systems are also factors limiting improvements in yields (AIRD 1991).

The relatively infrequent use of credit reported in the survey might otherwise suggest that credit constraints were important in limiting fertilizer use. Yet when small farmers do borrow, the funds are used to finance immediate consumption, rather than to purchase modern inputs. High cost of credit could discourage borrowing except for emergency consumption needs. However, Place (1991) notes that farmers on the Plateau are able to obtain the resources to use fertilizer on potatoes and other off-season crops.[15]

In the wake of the price and trade liberalization undertaken in the mid-1980s, rice marketing problems do not seem to be the most important constraints on Madagascar's rice production. Some rice marketing problems remain, particularly for a number of farmers who reported increasing production and for small farmers in the South, but more direct constraints on rice production now seem paramount.

Land constraints are still the most important constraint countrywide, especially for small farmers on the East Coast and Plateau, making yield-augmenting technology critical for increased production. Unfortunately, the evidence suggests that the yield-responsiveness to increased fertilizer use on irrigated land is still somewhat low for many farmers. Off the Plateau, many small farmers do not consider the lack of inputs a major constraint on production even though their input use is very low. More effort in research and extension is needed to develop and disseminate new technologies suited for various rice ecologies. Other problems such as inadequate water control may require investments in the rehabilitation of small irrigated perimeters before higher input technology is profitable. Marketing reforms have been an important first step in increasing rice production in Madagascar; the remaining agronomic constraints cannot be ignored if the country is to maintain or increase per capita rice production in the coming decades.

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[15] He concludes that farmers are not willing to make large expenditures on inputs for crops, such as rice, that do not themselves provide cash revenues.

APPENDIX 1

SAMPLE FIVONDRONANA, FIRAISANA, AND FOKONTANY

Zone 1 (North)

Befandriana - Nord
- Ambodimotso Sud (101)
  - Tsifohana (201)
- Maromalona (102)
  - Maroamalona (202)
- Tsarahenonenana (103)
  - Beriana (203)

Ambato-Boeni
- Ankijabe (104)
  - Morarano (204)
- Madirovalo (105)
  - Akeliroy (205)

Zone 2: East

Fenerive-Est
- Antsiatsiaka (106)
  - Ambodiraotra (206)
- Vohilengo (107)
  - Soberak (207)
  - Vohi[illegible] (208)
- Mahambo (108)
  - Tanambao Antanam (209)
  - Antsikafoka (210)
- Ambodimanga II (109)
  - Ambinan'lazafo (211)
- Saranambana (110)
  - Ambodilaitra (212)
- Tsaratampona (111)
  - Ambohimanarivo (213)

Brickaville
- Fanasana (112)
  - Fanasana (214)
- Ranomafana (113)
  - Antongombato (215)
- Vohibinany (Brickaville) (114)
  - Ambodiampahy (216)

Zone 3: Central (Plateau)

Ambatondrazaka
- Manakambahiny Ouest (115)
  - Andilanomby (217)
- Imerimandroso (116)
  - Antanifotsy (218)

Miarinarivo
- Ambatomanjaka (117)
  - Bedasy (219)
- Soamahamanina (118)
  - Antairoka (220)
  - Mandrosoa (221)
- Analavory (119)
  - Mandrevo (222)
  - Ambohijafy (223)
  - Ankorondrano (224)

Zone 3 (Central Plateau) (continued)

- Mandiavato (120)
  - Ambohimanga (225)
- Miarinarivo II (121)
  - Amboniriana (226)
  - Ampasamanatongrota (227)
- Anosibe Ifanja (122)
  - Ambaiboho (228)

Ambositra
- Ivory Miaramiasa (123)
  - Ambohimahatsiahy (229)
- Andina Firaisana (124)
  - Ampasina Mandritsa (230)
  - Manirisoaniraryiny (231)
- Ivato (125)
  - Ambohipanlainana (232)
  - Ankaramainty (233)
- Tsarasaotra (126)
  - Andrainarivo (234)
  - Maneva (235)
- Ambositra II (127)
  - Tsimitono (236)

Ambovombe Centre
- Ambovombe Centre (128)
  - Vohimanombo (237)
  - Alarobia Andalandranobe (238)

Miandrivazo
- Ankavandra (129)
  - Morafeno (239)
  - Antsakoazato (240)
- Manandaza (130)
  - Beteva (241)
  - Antsapandrano (242)

Zone 4: South

Bekily
- Tanandava (131)
  - Ambararata Toby (243)
- Manakopy (132)
  - Befangitsy (244)
- Ambatosola (133)
  - Temagnalo (245)

Bekily
- Beraketa (134)
  - Mahazoarivo (246)
- Ambahita (145)
  - Ambatomainty Haut (247)

Ankazoabo Sud
- Tandrano (136)
  - Ankeriky (248)
- Andranomafana (137)
  - Maintirano (249)
- Berenty (138)
  - Ankilivalobe (250)
  - Tsinjorano (251)

APPENDIX 2

CROSS-TABULATIONS OF CONSTRAINTS AND SIZE AND GROWTH CATEGORIES — IRRIGATED PADDY PRODUCERS ONLY

Text Tables 23 through 26 were replicated based on a sample that included farmers producing only irrigated paddy. There were 517 observations, 315 of which were small farmers. Over half of the sample (307) reported no change in production, and 60 percent of those were small farmers.

As Appendix Tables 2.1 through 2.4 show the results are essentially the same. Table 2.4 is the exception in that the Chi-square results are no longer significant for lack of arable land and lack of means to buy inputs.

Appendix Table 2.1 — Responses, by Size Category

	Percent with Response "Important"		
	Small	Large	Chi-Squared
Number of cases	315	202	
Lack of family labor	19.0	22.8	0.83
High cost of labor	24.1	29.2	1.39
Lack of arable land	61.6	51.0	5.23[a]
Lack of inputs	52.7	54.5	0.09
Lack of means to buy inputs	45.4	41.1	0.76
Other crops more profitable	18.1	23.3	1.74
Could not sell harvested quantity	11.1	9.4	0.22
Other	49.2	49.5	0.00

Appendix Table 2.2 — Responses, by Growth Category

	Percent with Response "Important"			
	Increasing	Declining	No Change	Chi-Squared
Number of cases	107	103	307	
Lack of family labor	15.9	26.2	20.8	1.1
High cost of labor	46.7	26.2	18.9	11.3[a]
Lack of arable land	54.2	54.4	59.6	0.2
Lack of inputs	35.5	49.5	60.9	2.1
Lack of means to buy inputs	37.4	45.6	45.3	0.4
Other crops more profitable	10.3	15.5	25.1	0.5
Could not sell harvested quantity	23.4	15.5	4.2	2.3
Other	57.0	57.3	44.0	0.2

[a] Significant at 95 percent level.

[b] Significant at 90 percent level.

Appendix Table 2.3 — Responses, by Growth Category, Small Farms

	Percent with Response "Important"			
	Small Increasing	Small Declining	Small No Change	Chi-Squared
Number of cases	64	68	183	
Lack of family labor	12.5	23.5	19.7	2.00
High cost of labor	35.9	30.9	17.5	0.19
Lack of arable land	54.7	58.8	65.0	0.09
Lack of inputs	40.6	38.2	62.3	0.01
Lack of means to buy inputs	46.9	45.6	44.8	0.00
Other crops more profitable	6.3	13.2	24.0	1.11
Could not sell harvested quantity	17.2	19.1	6.0	0.00
Other	53.1	60.3	43.7	0.43

Appendix Table 2.4 — Responses, by Growth Category, Large Farms

	Percent with Response "Important"			
	Large Increasing	Large Declining	Large No Change	Chi-Squared
Number of Cases	39	39	124	
Lack of family labor	23.1	23.1	22.6	0.00
High cost of labor	66.7	15.4	21.8	21.01[a]
Lack of arable land	59.0	41.0	51.6	1.84
Lack of inputs	30.8	64.1	58.9	7.40[a]
Lack of means to buy inputs	25.6	41.0	46.0	1.44
Other crops more profitable	17.9	17.9	26.6	0.00
Could not sell harvested quantity	35.9	7.7	1.6	7.52[a]
Other	69.2	46.2	44.4	3.36[b]

Note: Chi-square tests exclude "no change" cases.

[a] Significant at 95 percent level.
[b] Significant at 90 percent level.

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