AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION
   A. PRIMARY: ECONOMICS
   B. SECONDARY: AGRICULTURAL ECONOMICS

2. TITLE AND SUBTITLE
   ANALYSIS OF ARROZ (RICE) PRODUCTION IN NICARAGUA A DETAILED STUDY OF COSTS AND RETURNS

3. AUTHOR(S)
   ROBERT M. FINLEY

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
FEBRUARY 1974	26 PAGES	ARC NU-338.17318-F513

7. REFERENCE ORGANIZATION NAME AND ADDRESS
   UNIVERSITY OF MISSOURI
   DEPT. OF AGRICULTURAL ECONOMICS
   COLUMBIA, MISSOURI 65201

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

In this analysis 60 arroz farms have been studied. Initial emphasis was to give an overall perspective of the data for the average farm in the sample. This budget is set forth in Table 2. Next the analysis of the costs and returns were made by:

Size: 7 groupings
Region: 5 groupings
Ecology: 2 groupings
Technology: 3 groupings

In addition to the above, special attention is given to physical labor information. These data are presented in Table 7.

Statistical tests of Analysis of Variance were made and summarized in the Appendix. Gross Income, Yield, Total Labor, and Total Cost were analyzed as to differences in Size, Region, Ecology, and Technology. Generally, statically significant differences were found in all strata--except for Ecology (note however that only 2 levels of Ecology were present). Coefficients of Variation (COV), F values and significance levels are set forth in Appendix Table 1.

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAB-009	
12. DESCRIPTORS: SIZE, REGION, ECOLOGY, TECHNOLOGY, GROSS INCOME, YIELD, TOTAL LABOR, TOTAL COST	13. PROJECT NUMBER: 524-11-110-073
	14. CONTRACT NUMBER: AID/CM/LA-C-73-21
	15. TYPE OF DOCUMENT: SECTOR ANALYSIS

AID 590-1 (4-74)

ANALYSIS OF ARROZ PRODUCTION IN NICARAGUA:
A DETAILED STUDY OF COSTS AND RETURNS

Presented to

Vice-Minister Mayo Vega

and

United States Agency for International Development/Nicaragua

by

Dr. Robert M. Finley

Professor of Agricultural Economics

University of Missouri-Columbia

Columbia, Missouri

February 1974

CONTENTS

TABLES

INTRODUCTION

The following discussion supplements the previous report "Input-Output Analysis for Crops and Livestock in Nicaragua". There were 60 Arroz farms in the sample. (See Table 1.) Seven size categories; all regions but one; two ecology levels; and three technological levels were included.

Over three-fourths (46) of the farms were in size groups 1 to 9.9 mz. Four farms averaged less than one manzana and 10 farms were in excess of 9.9 mz. In fact, the last two size categories contain only one farm in each and should be considered as case farms rather than sample farms.

The Pacific regions predominate with about 77% (46 farms) being located in those regions. Region PC has the most farms (23) while PS is next with 19. There were no sample farms in IC.

A vast majority of the sample is in Ecology Level B--54 farms or 90%. No farms were in level M and only 6 are in the optimal, P.

Arroz farms were evenly distributed with respect to technology levels. Levels 01 and 02 each had 23 farms; and 03 had 14 farms.

Table 1

ARROZ--SAMPLE DESCRIPTION

Arroz--Size

Size	Number of Farms	Percent of Samples
1 (<1 mz)	4	6.7
2 (1 - 4.9 mz)	36	60.0
3 (5 - 9.9 mz)	10	16.6
4 (10-19.9 mz)	3	5.0
5 (20-57 mz)	5	8.3
6 (80 mz)	1	1.7
7 (120 mz)	1	1.7

Arroz--Region

Region	Number of Farms	Percent of Samples
IN	7	11.6
IS	7	11.6
PC	23	38.3
PN	4	6.7
PS	19	31.7

Arroz--Ecology

Ecology Level	Number of Farms	Percent of Samples
B	54	90.0
P	6	10.0

Arroz--Technology

Technological Level	Number of Farms	Percent of Samples
01	23	38.3
02	23	38.3
03	14	23.3

PRODUCTION COSTS: ARROZ--AN OVERALL VIEW

Table 2 presents data for the average rice farm in the sample. The considerations and stratifications for the other variables (size, region, ecology, technology) follow this overview.

On a per manzana basis, Total Costs averaged C$833 of which 17.7% or C$147 were classed as Fixed Costs. Land charges took the major share of Fixed Costs--C$121 or 14.6% of all costs. Depreciation and fixed labor together accounted for slightly over 3% of total costs.

Over 82% of Total Costs were of a variable nature. The variable labor accounted for almost 44% of Total Cost. Animal and machine power costs combined to make up 13% of all costs while almost 20% was associated with seed and chemicals.

Gross Income per mz was approximately C$1278--the result of an average yield of about 34 qq/mz and a price per qq of approximately C$38. Cost per qq was slightly less than C$25 and Return on Investment and Working Capital averaged about 53 to 65 respectively. Net Benefit averaged C$445 per mz.

With the preceding as background, the various classifications--size, region, ecology and technology levels are presented.

Table 2

ARROZ--AVERAGE PRODUCTION COSTS*

Total Cost C$	833.15	
Fixed Cost C$	147.09	(17.7)
Depreciation	21.24	(2.5)
Land	121.66	(14.6)
Labor	4.18	(.5)
Variable Cost C$	686.06	(82.3)
Labor	363.42	(43.6)
Animal Units	46.86	(5.6)
Mechanical Units	62.51	(7.5)
Seed	65.22	(7.8)
Chemicals	97.80	(11.7)
Ener-Rep.	3.38	(.4)
Interest	28.34	(3.4)
Other	18.50	(2.3)
Gross Income C$	1278.27	
Net Cash Income	683.09	
Net Farm Income	592.21	
Net Benefit C$	445.12	
Return to Investment	53.42	
Return to Working Capital	64.88	
Yield/mz	33.83	
Price	37.79	
Cost/qq C$	24.63	

*Data in parentheses refer to percentage of Total Cost.

ARROZ--PRODUCTION COSTS BY SIZE

The following table (Table 3) presents basic data for all rice farms by size groupings.*

Total Costs, in general, varied directly with size with C$667 in Size 1 to C$1579 and $1493 for the two largest farms.

Fixed Cost increased absolutely (from C$75 in Size 1 to over C$400 in Sizes 6 and 7) and relatively (11% to 27% of all costs) as size increased. And of course while Variable Costs increased with size (C$592 to over C$1000), as a percent of Total Cost the trend was down (from 89% in Size 1 to 73% in the two large sizes).

For Sizes 1,2 and 3 labor as a variable input constituted 50% or more of all costs but in the largest farms labor was only 13% of costs.

Animal unit cost ranged from 4% to 8% of all costs in the first four size categories but this type of power was not used on the three largest sizes. On the other hand, machine units were unimportant in the first two sizes but increased from C$62 (6% of all costs) in Size 3 to C$345 (23%) in Size 7.

Seed costs were an important entity in all sizes ranging from a low of C$58 (Size 3) to a high of C$140 (Size 7). Dramatic increases in the use of chemicals accompanied increases in size. Use increased from C$34 in Size 1(5%) to C$318 in Size 7

---

* Size groupings were:
1 . . . less than 1 mz
2 . . . 1 - 4.9 mz
3 . . . 5 - 9.9 mz
4 . . . 10 - 19.9 mz
5 . . . 20 - 57 mz
6 . . . 80 mz
7 . . . 120 mz

(21% of all costs).

Interest as input showed great stability when viewed as a percentage of Total Cost--2 to 4%. Other costs were relatively unimportant, never exceeding 3% of total costs and were non-existent in the two largest sizes.

The range in Gross Income was wide--from C$928 in those farms with less than one manzana to almost triple that (C$2604) in Size 7.

With the notable exception of Size 6 the trend in Gross Income was directly correlated with size. In general (with the exception of Sizes 5 and 6) Net Cash Income, Net Farm Income, and Net Benefit increased with size.

Rates Earned on Investment and Working Capital were very favorable (with the exception of Size 6) ranging from 39 and 44 in Size 1 to 85 and 104 in Size 4.

Yields ranged from a low in Size 1 to a high Size 4 (22 qq/mz to 53 qq/mz).

Prices received per qq also showed great fluctuation ranging from a high of over C$62 in Size 7 to a low of C$26 in Size 6. However, when the extremes are left out the range was much smaller C$34 (Size 5) to C$43 (Size 1).

Costs per qq varied from a low of about C$22 in Size 4 to over C$39 in Size 6.

The basic reason for the poor showing of Size 6 was two-fold: 1) higher than average costs (particularly in labor) and 2) much below average prices received, C$26 versus C$38 (ave.).

The smallest size was able to stay competitive primarily on the basis of receiving prices which were 13% above average thus offsetting a relatively low crop yield.

Table 3

ARROZ--PRODUCTION COSTS BY SIZE*

	Sizes						
	1	2	3	4	5	6	7
Total Cost C$	666.88	716.19	954.71	1142.24	1098.51	1579.14	1492.77
Fixed Cost C$	75.00(11)	120.16(17)	159.50(17)	204.33(18)	233.80(21)	422.00(27)	400.40(27)
Depreciation	0 --	4.33 (1)	6.50 (1)	40.33 (4)	83.40 (7)	215.00(14)	300.40(20)
Land	75.00(11)	115.83(16)	153.00(16)	150.00(13)	130.00(12)	100.00 (6)	100.00 (7)
Labor	0 --	0 --	0 --	14.00 (1)	20.40 (2)	107.00 (7)	0 --
Variable Cost C$	591.88(89)	596.03(83)	795.21(83)	937.91(82)	864.71(79)	1157.14(73)	1092.37(73)
Labor	440.00(66)	361.50(50)	477.18(50)	270.33(24)	170.98(15)	401.90(26)	191.57(13)
Animal Units	22.00 (4)	55.13 (8)	59.87 (6)	46.66 (4)	0 --	0 --	0 --
Mechanical Units	0 --	13.33 (2)	61.50 (6)	186.06(16)	282.72(26)	339.00(22)	345.32(23)
Seed	60.25 (9)	56.53 (8)	57.89 (6)	94.00 (8)	107.00(10)	100.00 (6)	140.00(10)
Chemicals	34.00 (5)	61.17 (9)	93.37(10)	261.00(23)	250.80(23)	251.00(16)	318.00(21)
Ener-Rep.	0 --	1.33 --	0 --	11.66 (1)	9.46 (1)	11.00 --	61.91 (4)
Interest	20.63 (3)	24.05 (3)	36.59 (4)	38.51 (3)	36.14 (3)	54.24 (3)	35.57 (2)
Other	15.00 (2)	22.95 (3)	9.80 (1)	29.66 (3)	7.40 (1)	0 --	0 --
Gross Income C$	928.19	1110.63	1481.58	2115.51	1639.00	1040.00	2603.75
Net Cash Income	494.80	605.51	731.10	1306.66	879.88	-99.14	1856.70
Net Farm Income	336.30	514.60	686.37	1177.59	774.28	-117.14	1511.38
Net Benefit C$	261.30	394.43	526.87	973.26	540.48	-539.14	1110.98
Return to Investment	39.18	55.07	55.18	85.20	49.20	-34.14	74.42
Return to Working Capital	44.14	66.17	66.25	103.76	62.50	-46.59	101.70
Yield/mz	21.65	30.27	37.15	52.62	48.60	40.00	41.66
Price	42.87	36.69	39.88	40.20	33.72	26.00	62.50
Cost/qq C$	30.80	23.66	25.70	21.70	22.60	39.48	35.84

*Data in parentheses refer to percentage of Total Cost.

ARROZ -- PRODUCTION COSTS BY REGION

Table 4 sets forth budgets by region. All regions but IC were represented. Total Costs ranged from a low of C$671 in IS to over C$1000 in PN.

Fixed Costs varied from a high of C$196 in PN to a low of only C$90 in IS. In all regions, land was the most significant Fixed Cost and only in regions IN and PN was labor even a minor Fixed Cost.

Variable Costs ranged from C$581 in IS to over C$831 in PN. In all areas, labor was the major Variable Cost. The range was from over C$400 in IS and PS to C$277 in IN. In relative terms, the range was 60% of all costs in IS to 34% in IN.

Animal power was significant only in the Pacific regions, where it uniformly represented about 7% of Total Cost.

Machine costs were most significant in IN where they averaged over C$128 (15% of costs) and least important in PS--C$38 or 5% of Total Cost. Seed averaged about 8% of Total Cost ranging from C$81 in IN (10%) to C$52 in PS (7%).

Expenditures for chemicals exhibited a wide range--from C$197 (20% of all costs) in PN to only C$43 in PS (6% of all costs).

Again as is the usual situation, the relative proportion of interest as a part of Total Cost was slight--3 to 4%.

The classification "Other Costs" was not important except in regions PC and PN where it was C$34 (4%) and C$53 (5%) respectively.

Gross Income exhibited a range--rrom C$820 in IS to more than C$1674 in PN. Net Cash Income, Net Farm Income and Net Benefit showed similar ranges with the high region consistently, PN and the low region consistently, IS.

The major reason for IS's poor showing was due to low yields--only about 66% of average, slightly below average prices (98% of average) and relatively high labor costs.

Region PN's high ranking was due basically to high yields* (about 9% above average) and excellent prices (almost 20% above average).

On Rate on Investment and Working Capital, area PN was exceeded only by PS. Region IS had the lowest Returns on Investment and Working Capital.

---

*Note that the yield in PS were even higher, however. Also the yield in IN was approximately that of PN.

Table 4

ARROZ--PRODUCTION COSTS BY REGION*

	Regions				
	IN(7)	IS(7)	PC(23)	PN(4)	PS(19)
Total Cost C$	817.11	670.70	899.20	1027.31	778.07
Fixed Cost C$	194.14(24)	90.05(13)	138.52(15)	196.00(19)	150.84(19)
Depreciation	73.42 (9)	42.91 (6)	6.17 (1)	35.50 (3)	9.26 (1)
Land	92.85(12)	47.14 (7)	131.73(14)	150.00(15)	141.57(18)
Labor	27.85 (3)	0 --	0 --	10.50 (1)	0 --
Variable Cost C$	622.97(76)	580.65(87)	760.68(85)	831.31(81)	627.22(81)
Labor	276.58(34)	400.73(60)	358.86(40)	301.62(29)	400.20(51)
Animal Units	11.42 (1)	0 --	58.82 (7)	75.00 (7)	56.77 (7)
Mechanical Units	128.42(15)	49.33 (8)	62.76 (7)	83.30 (8)	38.42 (5)
Seed	81.42(10)	54.28 (8)	71.91 (8)	78.50 (8)	52.38 (7)
Chemicals	94.42(12)	45.42 (7)	142.26(16)	197.00(20)	43.38 (6)
Ener-Rep.	6.65 (1)	8.84 (1)	.50 --	8.75 (1)	2.52 --
Interest	24.01 (3)	22.02 (3)	31.32 (3)	34.14 (3)	27.42 (4)
Other	0 --	0 --	34.21 (4)	53.00 (5)	5.86 (1)
Gross Income C$	1215.71	820.04	1314.70	1674.13	1342.17
Net Cash Income	711.31	357.58	656.79	957.12	766.07
Net Farm Income	592.74	239.39	554.02	842.82	751.48
Net Benefit C$	398.59	149.34	415.50	646.82	564.64
Return to Investment	48.78	22.26	46.20	62.96	72.56
Return to Working Capital	63.98	25.71	54.62	77.80	90.02
Yield/mz	36.85	22.20	32.14	36.96	38.40
Price	32.99	36.93	40.91	45.30	34.95
Cost/qq C$	22.17	30.21	27.98	27.80	20.26

*Data in patentheses refer to percentage of Total Cost.

ARROZ--PRODUCTION COSTS BY ECOLOGY LEVEL

The following table (Table 5) gives a breakdown of per manzana costs and returns structured from the Ecology Level Only levels B and P were represented. Total Costs, Total Fixed Costs, and Total Variable Costs varied directly with ecological level as did yields. Costs per qq were relatively uniform (C$23 - C$25/qq) and returns are distorted somewhat by large variations in prices received, per qq, at the farm level.

Total Costs per manzana were, C$825, and C$909 for the B and P farms respectively; of these C$141.04 (17% of total) at the B level, and C$201.50 (22% of total) at the P level, were Fixed Costs. Although land opportunity charges were highest at the B level, (C$125.92: 15% of total) no other large fixed charges accrued to this category (however C$14.08 was charged for depreciation expenses). In the highest ecological level, P, 9% of total costs was charged for depreciation expense and for land opportunity charges C$32.50 (4% of total) were spent for fixed labor. These three items accounted for 22% of total growing costs for farms at this level.

Variable Costs made up the largest portion of total charges and expressed as a percent of total, an inverse relationship with ecological level is shown. For B level farms C$683.79 (83% of total) and C$706.44 (78% of total) for P farms were charged for this same item. For B farms C$368.13 (45% of total) were spent for variable labor and for P farms C$321.01 (35% of total) were expended for the same item.

For B farms C$51.00 (6% of total) were expended for animal use and only about 1% of Total Costs was charged for this item at the highest ecological level. Farms in ecology P, on the other hand, spent about C$150.00 (17% of total) for machine use.

Seed expense was C$64 for B farms and that charge increased to C$79 for P level farms. Expenditures for chemical use were C$110.16 for P level farms and the expense was nearly as great for B level farms (C$96.42). Interest charges were a uniform 3% for all farms.

All income figures are distorted by prices received by farmers for their product. Assuming that there is no great difference in the product (rice) at the various levels, a uniform price will greatly influence returns. For B farms C$1289 was the Gross Income figure and the P level farms grossed C$1183. For all income figures, B level farms had the highest returns.

Returns to Investment were 56% and 20%, for the B and P level farms. Returns to Working Capital were 68% and 26%--inversely related to ecological level.

In terms of yield, only a 6 qq/mz separated the B and P levels. Costs/qq were relatively close at C$24.85 and C$22.89.

The major difference between the two levels was the C$9.00 additional price per qq received by farms in the B ecology level. For the farms in level P, yields were superior and costs of production per qq were almost C$2 lower--however these two factors were more than offset by the significantly lower price received.

Table 5

ARROZ--PRODUCTION COSTS BY ECOLOGY LEVEL*

	B	P
Total Cost C$	824.84	907.94
Fixed Cost C$	141.04(17)	201.50(22)
Depreciation	14.08 (2)	85.66 (9)
Land	125.92(15)	83.33 (9)
Labor	1.03 --	32.50 (4)
Variable Cost C$	683.79(83)	706.44(78)
Labor	368.13(45)	321.01(35)
Animal Units	50.95 (6)	10.00 (1)
Mechanical Units	52.81 (6)	149.83(17)
Seed	63.67 (8)	79.16 (9)
Chemicals	96.42(12)	110.16(12)
Ener-Rep.	2.90 --	7.76 (1)
Interest	28.32 (3)	28.49 (3)
Other	20.56 (3)	0 --
Gross Income C$	1288.82	1183.33
Net Cash Income	694.01	584.88
Net Farm Income	605.03	476.88
Net Benefits C$	463.98	275.38
Returns to Investment	56.25	30.33
Returns to Working Capital	67.85	38.98
Yield/mz (qq)	33.19	39.66
Price/qq	38.83	29.84
Cost/qq C$	24.85	22.89

*Data in parentheses refer to percentage of Total Cost.

ARROZ--PRODUCTION COSTS BY TECHNOLOGY LEVEL

The following table (Table 6) gives a breakdown per manzana of costs and returns, structured from a lower technological level, 01, to the highest, 03. Total Cost, Total Fixed Cost and Total Variable Cost items varied directly with technological as did Gross Income, Net Cash Income, Net Farm Income, and Net Benefits. Returns to Investment for all rice farms were 47% or more and Returns to Working Capital were also large, ranging from 55% (for category 02) to 76% (for 03).

Total Costs were C$581 for farms in the lowest technological level (01). Farms in the 02 category averaged almost C$879 for total charges and 03 farms incurred over C$1194 of Total Costs. Fixed Costs varied directly with technological level with 01 farms having the smallest absolute amount of C$99.58 (17% of total), 02 farms the next smallest, C$137.45 (16% of total), and the 03 category averaging the highest amount of C$243.67 (20% of total).

Depreciation was less than a 1% charge for all farms except those classified 03. At the highest level, C$80.17 (7% of total) were incurred reflecting an intensive use of mechanical units.* Land charges varied directly with technological level also and C$97.50 (17% of total), C$130.90 (15% of total), and C$148.57 (12% of total) were incurred for opportunity charges for the 01, 02, and 03 levels respectively. Fixed labor was

---

*Note under Variable Costs the sharp increase in both the relative (0% to 19%) and absolute (C$0 to C$231) in charges for mechanical power.

not significant for 01 and 02 farms but did amount to C$15 (1% of total) for the 03 category.

Variable Costs also varied directly with technological level and C$481 (83% of total) were charged to 01 farms, C$741 (84% of total) charged to 02 farms, and C$951 (80% of total) for all farms in the 03 category. Labor was the largest single charge in all three categories but was the lowest for 03 farms, (C$314 or 26% of total), partially due to a large use of fixed labor and machinery. Farms in the 01 category charged C$367 (63% of total) to variable labor expenses and 02 farms C$391 (45% of total). Animal unit use was highest for the 02 category contributing about 9% of all costs (C$75) to this item. Farms classified 01 charged C$38 (7% of total) for animal use while for 03 less than 2% of Total Cost was for this item.

Machine use was totally absent (no charges) for 01 farms and only 2% of Total Costs (C$24) was charged for this item at the 02 level. Farms in the highest technological level incurred about C$231 (19% of total) to machine use, which explains lower labor and higher depreciation charges. Seed costs for all categories were about 8% of total but in absolute terms ranged from C$46 (01 level) to C$104 (03 farms). Chemical use varied greatly. At the 01 level C$4.58 (less than 1% of total), at the 02 level C$119.53 (14% of total), and at the 03 level C$223.44 (19% of total) were charged for the use of fertilizer, pesticides, and insecticides.* Interest charges were a uniform 3% of Total Costs for all farms and all other costs amount to 4% or less.

---

*Note that the chemical and machine items account for about 38% of Total Costs for 03 farms.

Table 6

ARROZ--PRODUCTION COSTS BY TECHNOLOGY LEVEL*

	01	02	03
Total Cost C$	580.83	878.50	1194.43
Fixed Cost C$	99.58(17)	137.45(16)	243.67(20)
Depreciation	2.08 --	4.63 (1)	80.17 (7)
Land	97.50(17)	130.90(15)	148.57(12)
Labor	0 --	1.90 --	14.92 (1)
Variable Cost C$	481.24(83)	741.04(84)	950.75(80)
Labor	366.75(63)	391.14(45)	314.15(26)
Animal Units	38.37 (7)	74.81 (9)	17.47 (2)
Mechanical Units	0 --	23.72 (2)	230.65(19)
Seed	45.78 (8)	61.53 (7)	104.32 (9)
Chemicals	4.58 (1)	119.53(14)	223.44(19)
Ener-Rep.	0 --	0 --	14.51 (1)
Interest	19.22 (3)	30.74 (3)	40.18 (3)
Other	6.52 (1)	39.54 (4)	6.00 (1)
Gross Income C$	897.33	1287.32	1917.10
Net Cash Income	493.50	641.66	1073.22
Net Farm Income	416.08	546.27	966.35
Net Benefits C$	316.50	408.81	722.67
Returns to Investment	54.49	46.53	60.50
Returns to Working Capital	65.76	55.16	76.10
Yield/mz (qq)	26.70	31.08	50.38
Price/qq	33.61	41.42	38.05
Cost/qq C$	21.75	28.27	23.71

*Data in parentheses refer to percentage of Total Cost.

All income figures directly correlated with technological level. Gross Incomes were C$897.33, C$1287.32, and C$1917.10 for the 01, 02, and 03 categories respectively. Net Farm Income was over twice as large for 03 farms over 01 ones and Net Benefit figures were likewise. Yields were 50.38 qq/mz for 03 farms, 31.08 qq/mz for 02 farms and 26.70 qq/mz for farms at the 01 level. Although cost/qq was somewhat lower for 01 farms, the large difference in yields made farming at the 03 level the most profitable.

LABOR REQUIREMENTS
(Table 7)

Size

Labor requirements varied from a high 97.5 days in smallest size to about 14 days in the largest size. Since there was only one farm each in the two largest sizes discussion will center on the first five sizes. The decline was steady and consistent as farm size increases. Finally for Size 5 (20-57 mz) labor per mz was only about 21% that of the smallest size. Only in Sizes 4 and 5 was the fixed labor component important and even in these cases it amounted only to about 7 to 9% of the total labor requirement.

Region

Regional differences were important. The range was from a low 48.2 days in PN to a high of 82.6 days in PC. Fixed labor was important only in IN where it accounted for 6.3% of total labor.

Some machine substitution for labor may be apparent. For example, one of the low labor areas, IN spent 15% of all costs in machine units while one of the high labor areas PS spent only 5% for machine units.

Ecology

As Ecology levels changed from B to P labor days per mz decreased by 22.4 days. Furthermore, fixed labor increased from almost none (.2) to an important factor (4.0). Note that machine unit expenses increased from 6% of Total Costs in level B to 17% in level P. At the same time yields increased from 33 qq/mz to almost 40 qq/mz which further increased labor productivity.

Technology

Labor days increased from technological level 1 to 2 but decreased from level 2 to 3. Some differences in the proportion of variable to fixed labor are observed with fixed labor being most significant in 03.

Animal and machine power increased as technology increased--from C$38 in 01 to C$248 in 03. Hence if viewed over the entire range, some substitution of animal and machine power for labor occurred. Certainly if labor productivity per unit of product (qq) is a criterion then a definite relation is viewed as yield almost doubled from 01 to 03.

Table 7

LABOR REQUIREMENTS PER MZ FOR ARROZ
BY REGION, SIZE, ECOLOGY,
TECHNOLOGICAL LEVEL

	Days of Labor/Mz		
Size	Total	Fixed	Variable
1	97.5	0	97.5
2	80.0	0	80.0
3	72.1	0	72.1
4	36.5	2.4	34.1
5	20.9	1.8	19.1
6	57.1	18.0	39.1
7	13.9	0	13.9
Region			
IN	53.8	3.4	50.4
IS	58.2	0	58.2
PC	82.6	.1	82.5
PN	48.2	1.8	46.4
PS	73.7	0	73.7
Ecology Level			
B	73.5	.2	73.3
P	51.1	4.0	47.1
Technological Level			
1	70.0	0	70.0
2	91.9	.3	91.5
3	41.2	1.9	39.3
Average for all farms	71.3	.6	70.7

SUMMARY

In this analysis 60 arroz farms have been studied. Initial emphasis was to give an overall perspective of the data for the average farm in the sample. This budget is set forth in Table 2. Next the analysis of the costs and returns were made by:

Size: 7 groupings
Region: 5 groupings
Ecology: 2 groupings
Technology: 3 groupings

In addition to the above, special attention is given to physical labor information. These data are presented in Table 7.

Statistical tests of Analysis of Variance were made and summarized in the Appendix. Gross Income, Yield, Total Labor, and Total Cost were analyzed as to differences in Size, Region, Ecology, and Technology. Generally, statically significant differences were found in all strata--except for Ecology (note however that only 2 levels of Ecology were present). Coefficients of Variation (COV), F values and significance levels are set forth in Appendix Table 1.

* * *

In the main, the Tables (2, 3, 4, 5, 6 and 7) and the accompanying discussion thereto form a summary not duplicated here. Table 8 does present a brief summary of the study findings. In general, higher costs but also higher returns went with increases in size. Likewise, yields increased with size (even though Size 4 and 5 had the highest yields). Prices showed no such consistent pattern with the high and the low

prices received by the two highest sizes.

Regional differences occurred with IS receiving lowest returns (primarily due to very low yields) and areas PN and PS having best returns. Of interest is the fact that IN would have had much more favorable profits if not for a very low price received.

With only two Ecology levels represented and most farms in level B, generalizations are limited. A major difference however was that the farms in P were considerably more mechanized as compared to B. Yields were significantly higher in level P but this favorable item was more than offset by significantly lower prices received in level P.

Total Costs, Fixed Costs and Variable Costs increased with technological level. Yields responded to the increased inputs and as a result yields in 03 were almost twice that of 01. Prices received were somewhat higher in 02 but the lowest level, 01, had very low prices. The effects of increased technology were most apparent when the lowest level, 01, and highest level, 03, are compared. While some favorable returns are noted when 01 and 02 are compared, they are not as dramatic as might be postulated.

Table 8

ARROZ--HIGHEST AND LOWEST COSTS AND RETURNS BY SIZE, REGION, ECOLOGY AND TECHNOLOGY LEVELS

	Size	Region	Ecology*	Technology
Highest Total Cost	6	PN	P	03
Highest Fixed Cost	6	PN	P	03
Highest Variable Cost	6	PN	P	03
Highest Gross Income	7	PN	B	03
Highest Net Benefit	7	PN	B	03
Highest Return on Capital	4	PS	B	03
Highest Yield	4	PS	P	03
Highest Prices	7	PN	B	02
Highest Cost per qq	6	IS	B	02
Lowest Total Cost	1	IS	B	01
Lowest Fixed Cost	1	IS	B	01
Lowest Variable Cost	1	IS	B	01
Lowest Gross Income	1	IS	P	01
Lowest Net Benefit	6	IS	P	01
Lowest Return on Capital	6	IS	P	02
Lowest Yield	1	IS	B	01
Lowest Prices	6	IN	P	01
Lowest Cost per qq	4	PS	P	01

*Level M was not represented.

Appendix Table 1

ANALYSIS OF VARIANCE FOR GROSS INCOME, CROP YIELD, TOTAL LABOR AND TOTAL COST--COEFFICIENTS OF VARIATION, F VALUES AND LEVELS OF SIGNIFICANCE

		Coefficient of Variation	F Value	Prob. > F
Gross Income:	Size	48.6%	2.80	.0191
	Region	52.4%	1.24	.3026
	Ecology	53.2%	.13	.7206
	Technology	46.6%	14.79	.0001
Crop Yield:	Size	38.8%	3.30	.0077
	Region	41.8%	1.89	.1248
	Ecology	43.0%	1.07	.3065
	Technology	34.5%	20.34	.0001
Total Labor:	Size	43.9%	4.32	.0016
	Region	49.6%	1.71	.1607
	Ecology	50.3%	2.11	.1476
	Technology	43.6%	11.40	.0002
Total Cost:	Size	34.5%	4.30	.0016
	Region	42.1%	1.00	.4142
	Ecology	43.4%	.30	.5933
	Technology	31.29%	25.01	.0001