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9. ABSTRACT

This study has considered 94 sorgo farms. First emphasis was to give an overview of the sample and of the costs and returns on an "average" sorgo farm. (See Table 1 and Table 2.) Comparisons of input-output data were then made by:

Size .... 6 groupings
Region .... 6 groupings
Ecology .... 3 groupings
Technology .... 3 groupings

Special consideration was given to physical labor requirements per mz. These data are set forth in Table 7 and are viewed in the context of size, region, ecology and technology. Parameters were tested by Analysis of Variance and the results are summarized in the Appendix. With respect to the various groupings, the following parameters were tested to ascertain significant differences:

1. Gross Income
2. Yield
3. Total Labor
4. Total Costs

Coefficients of Variation (COV), F values and levels of statistical significance are presented. Of the 16 parameters tested, 11 were statistically significant at the 5% or less level of probability.

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ANALYSIS OF SORGO 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

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INTRODUCTION

The following report supplements the previous report, "Input-Output Analysis for Crops and Livestock in Nicaragua". Sorgo represented a fairly large sample in the survey with 94 farms. Every size level, region, ecology level, and technological level were represented. In Table 1 it is noted that the great majority of the farms (86%) were in size groups 2, 3, and 4 (1-9.9 mz). Only one farm was less than 1 mz and only 12 greater than 9.9 mz.

Region PN accounted for over 38% of the sample while IC, IS, and PC were also important. Only a few farms were in regions IN and PS.

Over three-fifths of the farms (58) were in ecology level B; however, a good proportion, almost 30%, were in the highest ecological level. Only 8 farms, 8.5%, were in the lowest ecology level.

Technology level 01 accounted for over half of the farms while almost 40% were in 02. The highest technological level, 03, had about 10% of the sample represented.

Table 1

SORGO--SAMPLE DESCRIPTION

Sorgo--Size

Size	Number of Farms	Percent of Sample
1 (<1 mz)	1	1.1
2 (1 - 2.9 mz)	39	41.5
3 (3 - 4.9 mz)	20	21.3
4 (5 - 9.9 mz)	22	23.4
5 (10-15 mz)	9	9.6
6 (20-57 mz)	3	3.2

Sorgo--Region

Region	Number of Farms	Percent of Sample
IC	18	19.1
IN	3	3.2
IS	18	19.2
PC	15	16.0
PN	36	38.3
PS	4	4.3

Sorgo--Ecology

Ecology Level	Number of Farms	Percent of Sample
M	8	8.5
B	58	61.7
P	28	29.8

Sorgo--Technology

Technology Level	Number of Farms	Percent of Sample
01	49	52.1
02	36	38.3
03	9	9.6

PRODUCTION COSTS: SORGO--AN OVERALL VIEW

In order to provide a basis for comparison for all sorgo farms, Table 2 is presented. In this context the average farm is represented without reference to any stratification as to region, size, technology or ecology. For the average sorgo farm Total Costs were approximately C$469 of which C$104 (22.2% of Total Costs) were Fixed Costs and C$365 (77.8%) were Variable Costs. Of the Fixed Costs land was the most important, accounting for most of the Fixed Costs and almost 19% of Total Costs. As Fixed Costs, depreciation and labor amounted to a little over 3% of all costs combined. Labor was the most important cost item included in Variable Costs--42% of the Total Costs. The next most important entities in Variable Costs were animal and machine units. These inputs were 9.1% each of Total Costs. Chemicals were important--C$36.63, 7.8% of Total Costs. Seed, interest and the classification "other" costs averaged around 3% each of Total Costs.

Gross Income was approximately C$460 per mz. Gross Income, of course, is derived on the basis of yield/mz multiplied by the price received. The yield was about 20 qq/mz and the price/qq averaged about C$23. Net Cash Income, Net Farm Income, and Net Benefit figures are given with Net Benefit amounting to -C$8.73. Returns to Investment and Returns to Working Capital averaged around -C$2. The cost of producing a qq was about C$23.50; hence, the Gross Income did not quite cover all costs. Note, however, that Net Cash Income and Net Farm Income were both positive while a slight negative figure accrued to Net Benefits.

Table 2

SORGO--AVERAGE PRODUCTION COSTS*

Total Cost C$	468.50	
Fixed Cost C$	103.80	(22.2)
Depreciation	7.49	(1.6)
Land	88.43	(18.9)
Labor	7.87	(1.7)
Variable Cost C$	364.70	(77.8)
Labor	196.87	(42.0)
Animal Units	42.47	(9.1)
Mechanical Units	42.45	(9.1)
Seed	13.32	(2.8)
Chemicals	36.63	(7.8)
Ener-Rep.	2.63	(.6)
Interest	13.81	(2.9)
Other	16.49	(3.5)
Gross Income C$	459.77	
Net Cash Income	169.56	
Net Farm Income	95.06	
Net Benefits C$	-8.73	
Returns to Investment	-1.86	
Returns to Working Capital	-2.39	
Yield/mz (qq)	19.94	
Price/qq	23.06	
Cost/qq C$	23.50	

*Data in parentheses refer to percentage of Total Cost.

SORGO--PRODUCTION COSTS BY SIZE

Table 3 gives information for all sorgo farms according to size grouping.* For the first five size groupings, Total Cost exhibited a very narrow range--from a low of C$421 (Size 3) to C$489 (Size 4). However, the largest size had a Total Cost C$712. The lowest absolute and relative amount of Fixed Costs were associated with the small size group where only C$50 or 11% of all costs were Fixed Costs. In all cases the land charge was the predominant Fixed Cost with depreciation and labor assuming for the most part minor roles. (In Size 5 11% of all costs were associated with depreciation and fixed labor, however.) Except for the largest size the range in Variable Costs was not great. The range for the first five sizes was from C$318 in Size 3 to C$427 in Size 1. However, in a relative sense, the range for Variable Costs was 89% of Total Costs in Size 1 to 73% of all costs in Size 5. With the exception of Size 6, labor was the largest input and varied from 47% of all costs in Size 3 to only 12% thereof in the largest size, Size 6. Animal units as an input followed a rather consistent pattern of decreasing absolutely and relatively with farm size. The range was from C$107 for this input (22% of total costs) in Size 1 to 0 in Size 6. The pattern is reversed

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*Size groupings were:

1 ... less than 1 mz	4 ... 5 - 9.9 mz
2 ... 1 - 2.9 mz	5 ...10 - 15 mz
3 ... 3 - 4.9 mz	6 ...20 - 57 mz

(One farm was eliminated as non-representative. This was farm #149 in PC comprised of 130 mz; ecology level P; technological level 03.)

Table 3

SORGO--PRODUCTION COSTS BY SIZE GROUPING*

	1	2	3	4	5	6
Total Cost C$	477.38	458.24	42[illegible].18	489.39	484.85	712.20
Fixed Cost C$	50.00(11)	95.28(21)	10[illegible].55(25)	108.72(22)	129.38(27)	121.32(17)
Depreciation	0 --	1.10 --	6.80 (2)	7.09 (1)	31.16 (6)	29.66 (4)
Land	50.00(11)	90.38(20)	88.90(21)	91.36(19)	75.00(16)	91.66(13)
Labor	0 --	3.79 (1)	7.85 (2)	10.27 (2)	23.22 (5)	0 --
Variable Cost C$	427.38(89)	362.96(79)	317.63(75)	380.66(78)	355.46(73)	590.87(83)
Labor	183.00(38)	211.93(46)	197.70(47)	205.92(42)	145.45(30)	87.98(12)
Animal Units	107.00(22)	42.66 (9)	36.57 (9)	50.99(10)	42.10 (9)	0 --
Mechanical Units	0 --	31.66 (7)	23.85 (5)	26.60 (5)	83.20(17)	314.80(44)
Seed	22.40 (5)	8.99 (2)	10.35 (3)	15.54 (3)	23.55 (5)	39.33 (6)
Chemicals	53.30(11)	35.94 (8)	26.07 (5)	41.52 (8)	26.58 (5)	104.66(15)
Ener-Rep.	0 --	1.30 --	.75 --	4.43 (1)	1.91 --	22.43 (3)
Interest	11.68 (2)	13.60 (3)	11.23 (3)	15.36 (3)	14.76 (3)	20.32 (3)
Other	50.00(11)	16.84 (4)	11.08 (3)	20.76 (6)	17.88 (4)	1.33 --
Gross Income C$	432.90	461.79	400.52	492.67	379.21	837.73
Net Cash Income	187.52	179.09	164.57	169.94	69.01	410.99
Net Farm Income	5.52	98.83	82.89	112.00	23.74	246.86
Net Benefits C$	-44.48	3.54	-20.65	3.28	-105.64	125.53
Returns to Investment	-9.31	.77	-4.90	.67	-21.78	17.62
Returns to Working Capital	-10.40	.97	-6.50	.86	-29.71	21.24
Yield/mz (qq)	13.00	19.66	18.86	20.16	18.10	36.81
Price/qq	33.30	23.49	21.24	24.44	20.95	22.75
Cost/qq C$	36.72	23.31	22.[illegible]	24.28	26.79	19.35

*Data in parentheses refer to percentage of Total Cost.

for machine units with smallest size having 0 charge to Size 6 where C$315 or 44% of all inputs were spent on machine units. Seed and chemicals accounted for 8-16% of Total Costs for the first five sizes but for the largest size the expenditures for these items sharply increased both absolutely and in percentage--C$144 or 21% of Total Costs. Another input of some importance is interest. As usual, this input showed much stability with a very narrow range when viewed as a percentage of Total Cost. The range was from a low of 2% in Size 1 to a consistent 3% for the other sizes. The input "other" was important in several sizes ranging from a nominal amount spent in Size 6 to C$50 or 11% of all costs in Size 1.

The range in Gross Income was not great for the first five sizes--C$379 in Size 5 to C$493 in Size 4. However, the largest farm size, Size 6, had almost C$838 in Gross Income. The reason for the remarkable stability in Gross Income could be traced directly to the very little variance in both yields and prices for Sizes 2 through 5. Size 1 had a low yield (13 qq/mz) but compensated by having a price which was over C$10 above average. In Size 6 the high Gross Income was not due to high prices--in fact, the prices were slightly below average--but was related to yields which were about 85% above the average. All sizes showed positive -- Net Cash Income and Net Farm Income, however, only Sizes 2, 4 and 6 showed positive Net Benefits. Sizes 1, 3 and 5 had a Net Benefit figure varying from -C$21 to almost -C$106 and, of course, Returns to Investment and Working Capital in these cases were

negative. A common feature with those sizes having negative Net Benefits was below average yields in every case. Another method of viewing efficiency is cost of producing a hundredweight (qq) of sorgo. The cost of producing a hundredweight of sorgo ranged from about C$19 in Size 6 to almost C$37 in Size 1; the average was about C$23.50.

SORGO--PRODUCTION COSTS BY REGION

As set forth in Table 4, Total Costs showed a high range from a low of C$360 in IS to a high of C$617 in PC. Fixed Costs as a percentage of Total Costs varied from 29% in IS to only 14% in regions PC and PS. In all regions land was the major Fixed Cost. (However, note in IN that fixed labor accounted for 9% of Total Costs.)

Variable Costs likewise showed a wide range of C$219 in IS to over C$526 in PC. As a percentage of Total Costs, Variable Costs ranged from a low of 71% in IS to a high of 86% in both PC and PS. In all regions labor was the dominant Variable Cost. The range was from IS where labor was 58% of Total Costs to regions IC and IN where 36% of all costs were associated with this input. Animal units represented only a nominal cost in region IS--C$7.58 (2%) to region PS where over C$66 (16%) were expended for this item. Machine units were again least important both in an absolute and relative sense in region IS (C$15, 5% of all costs) to a high of C$74 in PS. Seed as an expenditure showed wide variance: less than C$4 or 1% of Total Cost in IS to over 6 times that in IN where seed costs were over C$23 (5%). Chemicals as an expenditure also showed an extremely wide variance from a 0 expenditure in IS to almost C$61 in PC. Interest, as usual, showed high stability--around 3%--when viewed as a percentage of Total Costs. The item "other costs" was significant in several regions especially in IC and IN where it averaged 5% of Total Costs.

Table 4

SORGO--PRODUCTION COSTS BY REGION*

	IC	IN	IS	PC	PN	PS
Total Cost C$	412.77	488.65	306.22	616.76	517.33	439.04
Fixed Cost C$	100.94(24)	102.66(21)	87.50(29)	90.33(14)	123.98(24)	59.75(14)
Depreciation	11.33 (3)	0 --	12.22 (4)	2.00 --	6.84 (1)	1.00 --
Land	75.44(18)	60.00(12)	75.27(25)	88.33(14)	107.22(21)	58.75(14)
Labor	14.16 (3)	42.66 (9)	0 --	0 --	9.91 (2)	0 --
Variable Cost C$	311.83(76)	385.98(79)	218.72(71)	526.42(86)	393.35(76)	379.29(86)
Labor	149.12(36)	179.13(36)	176.76(58)	293.34(48)	190.77(37)	208.75(48)
Animal Units	35.88 (9)	45.46 (9)	7.58 (2)	34.60 (6)	63.59(12)	66.25(16)
Mechanical Units	47.92(11)	60.00(12)	14.93 (5)	71.73(11)	36.30 (7)	74.00(17)
Seed	19.69 (5)	23.46 (5)	3.71 (1)	19.53 (3)	12.30 (2)	6.19 (2)
Chemicals	24.63 (6)	23.76 (5)	0 --	60.66(10)	55.30(11)	7.00 (2)
Ener-Rep.	2.91 (1)	17.18 (4)	0 --	.98 --	3.58 (1)	0 --
Interest	12.45 (3)	14.30 (3)	7.46 (2)	22.36 (4)	14.03 (3)	14.10 (3)
Other	19.19 (5)	22.66 (5)	8.28 (3)	23.20 (4)	17.49 (3)	3.00 (1)
Gross Income C$	431.69	698.50	319.17	750.34	407.02	424.83
Net Cash Income	170.10	398.01	162.34	280.59	112.16	128.53
Net Farm Income	119.86	312.51	100.45	223.91	13.66	45.53
Net Benefits C$	18.92	209.85	12.95	133.58	-110.31	-14.21
Returns to Investment	4.58	42.94	4.22	21.65	-21.32	-3.23
Returns to Working Capital	6.06	54.36	5.92	25.37	-28.04	-3.74
Yield/mz (qq)	23.05	21.00	13.19	30.31	17.03	22.78
Price/qq	18.72	33.26	24.20	24.76	23.90	18.65
Cost/qq C$	17.91	23.27	23.22	20.35	30.38	19.27

*Data in parentheses refer to percentage of Total Cost.

Gross Income varied from less than C$320 in IS to more than double that figure in the high region, PC (C$750). All regions except PN and PS showed positive figures in Net Cash Income, Net Farm Income and Net Benefit. The highest Net Benefit was in IN, C$210 and the lowest was in PN, -C$110. The range in Returns to Investment and Working Capital were 43% and 54% in IN to -21% and -28% in PN. Yields also showed a high range from only 13 qq/mz in IS to over 30 qq/mz in PC. The yields are directly related to expenditures for seed and chemicals. For example, in IS only C$3.71 or 1% of all costs were spent for these two items whereas in PC over C$80 or 13% of all costs were spent for seed and chemicals. Prices received also showed wide variance. The range was from a low of C$18.65 in PS to C$33.26 in IN. With the exception of PN, the cost for producing a hundredweight of sorgo showed only moderate range from about C$18 in IC to a little over C$23 in IN and IS. (However, in region PN the cost/qq was C$30.38.)

SORGO--PRODUCTION COSTS BY ECOLOGY LEVEL

The following table (Table 5, Sorgo--Production Costs by Ecology Level) gives a breakdown of per manzana costs and returns, structured from the lowest ecological level, M, to the highest, P. Total Costs, Total Fixed Costs, and Total Variable Costs directly correlated with ecological level as did Gross Income, Net Cash Income and Net Farm Income. Increasing yields from ecological levels M to B were not great enough to offset increased costs and an inverse relationship was noted for Returns to Investment and Working Capital with B compared to M. However, with the highest level, P, yields were 25% above average and prices were C$2/qq higher than average and the net result was a positive Net Benefit and Returns on Investment and Working Capital of 8.5 and 10.4.

Total costs for the categories were C$269, C$445, and C$575, for the M, B, and P categories respectively. Fixed Costs were C$61 (23% of total), C$108 (22% of total), and C$107 (19% of total) for the same order of these levels. Depreciation on machinery and fixed labor together amounted to 4% or less of total charges for farms at all ecological levels. Land opportunity charges were equal to total fixed costs at the M level (C$61, or 23% of total). This same item amounted to C$87 (20% of total) for B farms and C$99 (18% of total) for P farms. (Note that as the absolute value of opportunity charge increases its relative significance declines from level to level.)

Table 5

SORGO--PRODUCTION COSTS BY ECOLOGY LEVEL*

	M	B	P
Total Cost C$	268.79	444.88	574.49
Fixed Cost C$	60.62(23)	108.12(24)	107.17(19)
Depreciation	0 --	11.04 (2)	2.28 --
Land	60.62(23)	87.20(20)	98.92(18)
Labor	0 --	9.87	5.96 (1)
Variable Cost C$	208.16(77)	336.75(76)	467.31(81)
Labor	146.91(54)	181.28(40)	243.44(42)
Animal Units	24.05 (8)	38.91 (9)	55.10(10)
Mechanical Units	8.75 (3)	40.86 (9)	55.35(10)
Seed	6.61 (2)	11.62 (3)	18.75 (3)
Chemicals	6.70 (2)	32.48 (7)	55.50(10)
Ener-Rep.	0 --	3.14 (1)	2.35 --
Interest	8.02 (3)	12.23 (3)	18.75 (3)
Other	13.12 (5)	16.21 (4)	18.04 (3)
Gross Income C$	262.39	408.03	623.33
Net Cash Income	93.92	151.94	229.33
Net Farm Income	54.22	71.27	156.01
Net Benefit C$	-6.40	-36.85	48.83
Return to Investment	-2.30	-8.28	8.49
Return to Working Capital	-3.07	-10.94	10.44
Yield/mz	11.52	18.70	24.90
Price	22.78	21.82	25.03
Cost/qq C$	23.33	23.79	23.07

*Data in parentheses refer to percentage of Total Cost.

Variable costs entailed 76% of more of Total Costs for all farms. Here labor was the largest cost amounting to C$147 (54% of total), C$181 (40% of total), and C$243 (42% of total) for the M, B, and P farms respectively. Animal unit charges increased from level to level but remained about 9% of Total Costs for all farms. Mechanical units were over 6 times larger for P farms than M farms but still amounted to only 10% of costs at the highest level. Seed costs were 3% or less for all farms and interest charges were about 3% across the board. Chemical expenditures were about C$7 (2% of total) for M farms, C$32 (7% of total) for B farms, and C$56 (10% of total) for P farms. Hence, the charge for this item increases almost five-fold from the M to B level and almost doubles from the B and P levels. The "other" costs category amounted to 5% or less of all costs for all farms.

Gross Income was C$262, C$409, and C$623 moving from the lowest to the highest ecological level.

Returns to Investment decreased from -2.3% at the M level to -8.3% for B level farms but increased to 8.5% for the highest ecology level. The Returns to Working Capital showed similar results. Despite the fact that yields are 62% higher from the M to the B level, costs/qq increased slightly.

SORGO--PRODUCTION COSTS BY TECHNOLOGY LEVEL

The following table (Table 6, Sorgo--Production Costs by Technology Level) gives a breakdown of per manzana costs and returns, structured from lowest technological level 01 to the highest 03, for sorgo farms. Total Costs, Total Fixed Costs, and Total Variable Costs varied directly with technological level as did Gross Income. Yields also increased significantly and directly but these increased yields were not large enough to decrease cost/qq and this item also increased moving up the technological levels.

Total Costs for sorgo farms were C$314, C$578, and C$873 for the 01, 02 and 03 levels respectively. In the same technological order, Fixed Costs amounted to C$74 (23% of total), C$129 (22% of total) and C$169 (19% of total). Depreciation as a cost was not high--averaging only 2% of all costs in levels 02 and 03. Fixed labor was somewhat significant in level 03 where it was about C$45 or 5% of Total Cost.

The largest fixed charge for the technological levels was land opportunity costs. Twenty-three percent of total costs (C$273) was charged for this item at the 01 level and C$105 (18% of total) for 02 farms while at the 03 level a larger absolute amount (C$109) but smaller relative charge (12%) for land costs was incurred.

Variable Cost items accounted for 77% and 78% of total charges for 01 and 02 farms and 81% of the charges for 03 farms. Of these items, labor was the largest cost for all

Table 6

SORGO--PRODUCTION COSTS BY TECHNOLOGY LEVEL*

	01	02	03
Total Cost C$	313.87	577.90	872.83
Fixed Cost C$	73.63(23)	128.68(22)	168.55(19)
Depreciation	1.02 --	14.59 (2)	14.33 (2)
Land	72.61(23)	104.72(18)	109.49(12)
Labor	0 --	9.36 (2)	44.77 (5)
Variable Cost C$	240.24(77)	449.22(78)	704.27(81)
Labor	168.69(53)	214.71(37)	278.93(32)
Animal Units	36.98(12)	55.44(10)	20.44 (2)
Mechanical Units	2.85 (1)	66.64(12)	161.24(19)
Seed	4.04 (1)	17.94 (3)	45.44 (5)
Chemicals	8.16 (3)	52.00 (9)	130.16(15)
Ener-Rep.	0 --	5.06 (1)	7.31 (1)
Interest	8.14 (3)	17.20 (3)	31.17 (4)
Other	11.35 (4)	20.22 (3)	29.55 (3)
Gross Income C$	315.26	581.61	759.13
Net Cash Income	144.17	220.38	104.51
Net Farm Income	75.02	132.39	54.85
Net Benefit C$	1.39	3.71	-113.69
Return to Investment	0.44	0.64	-13.02
Return to Working Capital	0.57	0.82	-16.14
Yield/mz	14.02	24.45	34.10
Price	22.49	23.79	22.26
Cost/qq C$	22.39	23.64	25.60

*Data in parentheses refer to percentage of Total Cost.

three categories amounting to C$169 (53% of total) for 01 farms, C$215 (37% of total) for 02 farms, C$279 (32% of total) for 03 farms.

Animal units amounted to C$37 (12% of total), C$55 (10% of total), and C$20 (2% of total) for the 01, 02, and 03 levels respectively.

Mechanical units amounted to less than 1% of total charge for 01 farms but accounted for about C$67 (12% of total for farms in the 02 category and C$161 (19% of total) for 03 farms.*

Farms at the 03 level spent (C$45) over 11 times for seed compared to 01 farms and 2½ times as much as 02 farms (C$18). Chemical use followed the same pattern. Farms at the 03 level spent (C$130, 15% of total) over 16 times as much for this item as did 01 farmers (C$8, 3% of total) and 2½ times that of 02 farms (C$52.00 or 9% of total). Remember, however, that although these inputs increased yields significantly, returns do not justify this intensification. All other costs for energy, repairs, interest, and other expenses amounted to 8% or less of total costs for all farms.

Net Cash Income was C$144 for 01 farms, C$20 for 02 farms and C$104 for farms at the 03 level. Net Farm Income was

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*Here it is interesting to note the intensive nature of farming at the highest technological level. Labor charges (fixed and variable) were about 37% of Total Costs. Another 21% was for animal and machine units. With this type of ratio between physical inputs and capital inputs it is unlikely that this type farming will be a profitable one.

positive for all levels and highest at C$132 for 02 farms. Net Benefits received from this crop was only C$1.39 and C$3.71 for the 01, 02 and negative (-C$114) for 03 farms.

Returns to Investment were highest for 02 farms (.64) and next highest for 01 farms (.44). The 03 category was losing money at the rate of -13%. Although yields increased almost 2½ times moving from the 01 to the 03 level, Total Costs almost tripled leaving costs/qq to steadily increase. In fact, in order to sustain the added costs, yields in 03 would have had to equal 39.2 qq rather than the actual 34.1 qq.

LABOR REQUIREMENTS

Table 7 sets forth total, fixed and variable labor requirements for the size groupings, regions, ecology levels, and technological levels.

Size

The labor requirements per mz varied from a high of 50.3 days in the smallest size to 13.4 days in the largest size. Hence, labor requirements per mz were reduced 37 days moving from the smallest to the largest size. Labor requirements for the largest size were less than 27% that of the smallest size. The decline in labor requirements was consistent and steady as size increased. Fixed labor was of no importance in the largest and smallest size groups and of only little importance in any of the other size groups except perhaps Size 5 where it was 10% of the total labor.

Region

Regional differences were great. The low labor region was IC with 28.2 days. The high region was PS with 52.3 days per mz--hence, over a 24 day spread is evident from the high to the low region. Only in region IN was fixed labor of any consequence--in that region fixed days for over 13% of the total labor was in the fixed category.

Ecology

As ecology level changed from M to B to P, labor days increased from 37.6 to 38.6 to 43.6--an increase of 6 days per mz.

Table 7

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

	Days of Labor/Mz		
Size	Total	Fixed	Variable
1	50.3	0	50.3
2	46.8	.4	46.4
3	40.8	.6	40.2
4	37.9	.8	37.1
5	21.7	2.0	19.7
6	13.4	0	13.4
Region			
IC	28.2	.7	27.5
IN	43.3	6.0	37.3
IS	29.3	0	29.3
PC	42.6	0	42.6
PN	48.6	.9	47.7
PS	52.3	0	52.3
Ecology Level			
M	37.6	0	37.6
B	38.6	0	37.6
P	43.6	.6	43.0
Technological Level			
01	38.6	0	38.6
02	41.4	1.0	40.4
03	42.0	3.0	39.0
Average for all farms	40.0	.7	39.3

The more intensive agriculture in B and P as compared to M accounted for some of the increased labor. Yields increased over 7 qq from level M to B and more than doubled when yields of the highest level, P, are compared to those in the lowest level, M. Fixed Labor was of very little consequence when the stratification is by ecology level. In fact, only the highest level, P, showed any fixed labor and even here it amounted only to .6 days per mz or a little over 1% of the total labor days.

Technology

A very slight difference in labor days is evident as technological level changes. In total days the spread was only 3.4 days from the lowest to the highest technological level. The spread was even less when variable days were considered. Here the spread was only from 38.6 days to 40.4--a difference of less than two days. Fixed labor was non-existent in technological level 01 and of minor importance in 02 but this factor assumed some importance in 03 where it accounted for about 7% of all labor.

One of the reasons for technological level 03's rather poor showing was the fact that too much labor was probably used in comparison with other power. For example, level 01 spent about C$40 for animal and machine units; 02, C$122 for these items; and 03 expended almost C$184 for animal and machine units. Hence, more labor and more mechanization were used on the 03 level farms and as a consequence obviated the good yields experienced in 03 versus the two lower levels.

SUMMARY

This study has considered 94 sorgo farms. First emphasis was to give an overview of the sample and of the costs and returns on an "average" sorgo farm. (See Table 1 and Table 2.) Comparisons of input-output data were then made by:

Size	.... 6 groupings
Region	.... 6 groupings
Ecology	.... 3 groupings
Technology	.... 3 groupings

Special consideration was given to physical labor requirements per mz. These data are set forth in Table 7 and are viewed in the context of size, region, ecology and technology. Parameters were tested by Analysis of Variance and the results are summarized in the Appendix. With respect to the various groupings, the following parameters were tested to ascertain significant differences:

1. Gross Income
2. Yield
3. Total Labor
4. Total Costs

Coefficients of Variation (COV), F values and levels of statistical significance are presented. Of the 16 parameters tested, 11 were statistically significant at the 5% or less level of probability.

* * * *

The Tables 1 through 7 and the accompanying discussions thereof form the basic summary. However, Table 8 provides a briefing of the findings. The highest cost and highest income were associated with the highest size, Size 6. (However,

Table 8

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

	Size	Region	Ecology	Technology
Highest Total Cost	6	PC	P	03
Highest Fixed Cost	5	PN	B	03
Highest Variable Cost	6	PC	P	03
Highest Gross Income	6	PC	P	03
Highest Net Benefit	6	IN	P	02
Highest Return on Investment	6	IN	P	02
Highest Yield	6	PC	P	03
Highest Prices	1	IN	P	02
Highest cost per qq	1	PN	B	03
Lowest Total Cost	3	IS	M	01
Lowest Fixed Cost	1	PS	M	01
Lowest Variable Cost	3	IS	M	01
Lowest Gross Income	5	IS	M	01
Lowest Net Benefit	5	PN	B	03
Lowest Return on Investment	5	PN	B	03
Lowest Yield	1	IS	M	01
Lowest Prices	5	IC	B	03
Lowest cost per qq	6	IC	P	01

it should be noted that the next to the largest size, Size 5, had the lowest Net Benefit and Returns to Investment and Returns to Working Capital.) Highest prices, however, were received in the lowest size group while the lowest prices were in Size 5. Animal units as a source of power decreased with size and the reverse was true with machine units (e.g. costs for machine units increased from 0 in Size 1 to 44% of Total Costs in the largest size). In general, the costs for seed and chemicals increased with size.

Wide regional differences were noted. Total Costs ranged from C$306 in IS to more than double that figure, C$617, in PC. Land was the major fixed cost in all areas, however, in regions IC and IN a significant portion of the Total Costs were associated with Fixed Labor. Of the Variable Costs, labor showed a wide absolute and relative range and in every region was the dominant item in Total Costs. Animal and machine units varied from less than C$23 (7% of all costs) in IS to over C$140 (33% of all costs) in PS. Expenditures for seed also showed wide variance with only 1% of all costs for these items in IS to 13% in PC and PN. Yields ranged from a low of about 13 qq in IS to over 30 qq in PC. Prices likewise showed wide variation with a range of C$18.65 in PS to C$33.26 in IN.

All major costs varied directly with ecological level. Increasing costs occurred with changes in the ecological level but increased yields in the highest level, P, (as well as an above average price) raised the returns to this crop.

Furthermore, the lowest cost/qq was also in the high ecological level.

Higher costs and higher Gross Income accompanied changes in technological level. However, the highest Net Benefit occurred in the moddle technological level, 02. Although yields showed good increases as technological level increased, Total Cost increased proportionately more and hence offset this favorable aspect of technological advance.

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	69.7	1.13	.3495
	Region	64.4	4.36	.0017
	Ecology	66.14	6.57	.0025
	Technology	61.5	14.8	.0001
Crop Yield:	Size	66.6	1.16	.3368
	Region	60.1	4.11	.0024
	Ecology	62.7	4.31	.0160
	Technology	55.9	17.10	.0001
Total Labor:	Size	43.5	4.72	.0010
	Region	42.8	5.45	.0004
	Ecology	47.8	.72	.5045
	Technology	48.0	.28	.7586
Total Cost:	Size	54.8	.73	.6073
	Region	51.3	3.29	.0091
	Ecology	51.8	5.65	.0052
	Technology	38.5	47.31	.0001