PN AAM 219

A RAND NOTE

CHILDREN AND WOMEN IN TRADITIONAL AND CASH CROP AGRICULTURE: A PRELIMINARY CROSS-SECTION STUDY OF ECONOMIC DEVELOPMENT IN GUATEMALA

John P. Stein

July 1982

N-1547-AID

Prepared for The Agency for International Development

Rand
SANTA MONICA, CA 90406

This research was supported by the Agency for International Development under Contract No. AID/OTR-G-1822.

Published by The Rand Corporation

A RAND NOTE

CHILDREN AND WOMEN IN TRADITIONAL AND CASH CROP AGRICULTURE: A PRELIMINARY CROSS-SECTION STUDY OF ECONOMIC DEVELOPMENT IN GUATEMALA

John P. Stein

July 1982

N-1547-AID

Prepared for The Agency for International Development

Rand
SANTA MONICA, CA. 90406

PREFACE

The data for this study were collected under grants from the Rockefeller Foundation to The Rand Corporation and to the Institute for Nutrition in Central America and Panama. The research and writing were supported by Contract No. AID-otr-C-1432 between the U.S. Agency for International Development and The Rand Corporation. Publication was funded by Grant No. AID/otr-1822 from AID to Rand. The latter grant supports The Family in Economic Development Center at Rand.

This Note is the second of two publications by the author concerning the roles of women and children in labor markets and agricultural production in rural Guatemala. The first publication is John P. Stein, _Labor Markets in Rural Guatemala: A Cross-Section Study of Economic Development and Incentives To Reduce Family Size_, The Rand Corporation, P-6111-1, April 1979.

The author is grateful to William P. Butz and Dennis DeTray for their helpful comments on an earlier draft, and to Cathy Kasala for her extensive research assistance.

SUMMARY

This is the second of two publications concerning the economic activities of a sample of rural Guatemalan families in 1974, and how their activities relate to economic development and population growth. This note focuses on agricultural production, emphasizing the role of children and women. The previous Note examined labor markets.

The data describe the economic activities of roughly 1000 families in four rural villages and another 1000 families in a larger, more modern community about 30 mintues' bus ride from Guatemala City. In the four villages, subsistence agriculture, largely with hand labor, is the major economic activity. Corn, beans and feed corn are the traditional subsistence crops; tomatoes and chiles are the principal cash crops. The more modern community is primarily non-agricultural although it has some farming, of generally the same scale (size of farm) and crops as in the villages.

While corn, beans and feed corn, the traditional subsistence crops, employ predominantly the heavy labor of adult men, tomatoes and chiles, the principal cash crops, use relatively more of the light labor contributed by women and children, usually for weeding and harvesting. Also, with cash crops, women and children can work side by side such that a mother's job participation complements childrearing. Thus, children are especially valuable in a society growing cash crops and cash crop agriculture is an inducement to large family size.

Insofar as economic development shifts production from traditional to cash crops, incentives arise that increase population growth. It

appears that the net effect of development on population growth may be a complex resultant of various incentives, some acting to promote and some to retard population growth. Because, in the present case, the shift from agricultural and non-agricultural work involves far more people than the shift from traditional to cash crops, the net incentive is for economic development to reduce population growth.

Another difference between traditional and cash crops appears in the efficiency with which farmers use production inputs. The marginal product of family labor is significantly below market usages in traditional but not in cash crops. Acknowledging that the analysis does not account for risk, this result points to what appears to be disguised unemployment in traditional, but not in cash-crop, agriculture.

Purchased inputs appear underutilized in every instance, but more so in traditional than cash crops and more so in the villages than the modern community. Risk could account for this result, or it might be attributable to a general tendency for peasants to implicitly value purchased inputs closer to their market prices the closer is production integrated with the cash economy, i.e., production is more efficient in cash than traditional crops and in the more modern community than in the villages.

This Note also suggests that both children and women may be more productive in family agriculture relative to adult men than previously estimated by other researchers. Consequently, the economic value of children appears higher. The optimistic conclusion is that development away from agriculture reduces the incentive to large family size by a greater margin than previously believed, and this acts to retard population growth.

CONTENTS

I. INTRODUCTION

This is the second of two publications concerning the economic activities of a sample of rural Guatemalan families in 1974, and how their activities relate to economic development and population growth. This Note focuses on agricultural production, emphasizing the role of children and women. The previous paper examined labor markets.[1]

The data describe the economic activities of roughly 1000 families in four rural villages and another 1000 families in a larger, more modern community about 30 minutes' bus ride from Guatemala City.[2] In the four villages, subsistence agriculture, largely with hand labor, is the major economic activity. Corn, beans and feed corn are the traditional subsistence crops; tomatoes and chiles are the principal cash crops. The more modern community is primarily non-agricultural, although it has some farming, of generally the same scale (size of farm) and crops as in the villages.[3] This Note analyzes and compares

[1] John P. Stein, Labor Markets in Rural Guatemala: A Cross-Section Study of Economic Development and Incentives to Reduce Family Size, The Rand Corporation, P-6111-1, April 1979.

[2] These data are part of a larger data set collected by Rand and the Institute for Nutrition in Central America and Panama (INCAP). See Henry L. Corona, Codebook and User's Manual: INCAP-Rand Guatemala Survey, The Rand Corporation, P-6181, November 1977. Also, John P. Stein and Cathy Kasala, Income, Wealth and Agricultural Production in 1974: A Guide for Researchers to the Use of Questionnaire R-10 from the Rand-Rockefeller Guatemala Project, The Rand Corporation, P-6292, October 1978. These communities were selected for study on the basis of an analysis of about 150 communities originally considered. Only mestizo rather than Indian communities were examined so as to have a sample as representative as possible of rural conditions throughout Latin America.

[3] There are one or two lettuce farms outside the more modern community. These are owned by persons in Guatemala City and employ people from the entire region. The farmers that we will be examining in the more modern community are the small-scale peasant farmers.

production practices in the village and the more modern community, distinguishing between traditional and cash crops. I am especially interested in the use and value of children and women in agriculture and how these influence population growth.

The previous paper found evidence supporting the hypothesis that incentives to reduce family size arise naturally during the development process.[4] Two well-recognized patterns were confirmed: children have a larger production role in the rural agricultural economy than they do in the urban, non-agricultural economy; job opportunities for women are relatively more abundant in the non-agricultural sector. The present Note focuses on the effects of economic development on the use of family labor in agriculture and how these factors influence the incentive to reduce family size.

II. DAYS WORKED BY CHILDREN AND WOMEN IN TRADITIONAL AND CASH CROPS

The total number and pattern of persons working in family agriculture differ from crop to crop. In both the villages and the more modern community, children contribute a greater share of the family's labor in the production of cash crops than traditional crops, suggesting that cash crops employ the light labor of children in relatively greater proportion than do traditional crops, regardless of the development stage of the community. Thus, the development from traditional to cash crop agriculture within a given community creates work for children and, therefore, acts, ceteris paribus, as an inducement to expand family

[4] The development process is dynamic and time-dependent. Although this Note uses cross-section data, one can, with care, make inferences about development using cross-section data. Ronald G. Ridker (ed.), Population and Development, John Hopkins University Press, Baltimore, 1976, is a good introduction to the general literature.

size, contrary to the overall conclusion of my previous paper referred to above. However, this one aspect of development, the shift from traditional to cash crops within the agricultura. sector, accompanies the more fundamental shift out of both types of agriculture and into non-agricultural sectors. Development from an agricultural to a non-agricultural economy reduces the opportunities for child labor and is only partly offset by development within agriculture from traditional to cash crops. Nonetheless, this finding points to the possibly conflicting effects of specific aspects of economic development on incentives to reduce population growth.

Table 1 shows work by children in traditional and cash crops. Days worked by children are expressed as a share of the family's total work contribution to demonstrate the relatively greater proportion of child labor to total labor input in cash crops as compared with traditional crops. Young children up through age 12 contribute more than twice as great a share of the family's work in cash crops as in traditional crops. Older children up to age 20 contribute roughly similar shares of the work for both types of crops. The rest of the work is done by adults, mainly men.

Older children work less relative to other family members in the more modern community than in the villages, for both types of crops, while younger children contribute roughly the same shares in both places. Apparently, older children in the more modern community attend school or work in non-agricultural jobs instead of working in the fields. In the rural environment education costs more and its benefits are lower than in the more modern community. There are no high schools in the villages and rural children would have to commute, so a high

Table 1

CHILDREN WORKING IN AGRICULTURE

(Share of Total Family Work
Contributed by Children)

	Four Villages				More Modern Community			
Age	Traditional Crops		Cash Crops		Traditional Crops		Cash Crops	
3	.001		--		--		--	
4	--		--		--		--	
5	.001		.004		--		--	
6	.001		.004		--		--	
7	.005		.008		--		--	
8	.007	.059	.021	.159	--	.064	--	.144
9	.010		.012		--		.029	
10	.007		.033		.011		.029	
11	.011		.042		.032		.057	
12	.016		.033		.021		.029	
13	.037		.046		--		--	
14	.042		.012		.032		.086	
15	.027		.025		.053		--	
16	.030	.242	.021	.217	--	.117	--	.173
17	.022		.029		.011		.029	
18	.041		.046		--		.029	
19	.019		.017		--		--	
20	.024		.021		.021		.029	
Over 20		.699		.626		.819		.683
Total		1.000		1.000		1.000		1.000

school education costs more, absolutely, in the villages compared with the more modern community. The wage benefits to a high school education are greater in the more modern community than the villages, as shown in my previous paper, where the elasticities of daily wages with respect to additional years of schooling (evaluated at the means) were estimated to be 2.2 for females in the modern community, 1.33 for females in the villages, 1.16 for males in the modern community, and 0.91 for males in the villages. Thus, cost is lower and economic return to schooling is greater in the more modern community than in the villages, and, therefore, older children go to school more.

The role of women in agriculture is partially indicated in Table 2, which describes women's agricultural work in the villages. In both traditional and cash crops, women represent a small share of all people working, but the share is larger in cash crops. Most women work just a few days, usually at the harvest. This pattern corroborates the above hypothesis that cash crops employ light labor (children and women) in relatively greater proportion than do traditional crops.[5]

III. PRODUCTION OF AGRICULTURAL CROPS

Cobb-Douglas Production functions were estimated separately for each of five basic crops (corn, beans, feed corn, tomatoes, chiles) and for all these crops aggregated together in value terms.[6] The

---

[5] Many loose ends in this Note had to be left untied. Thus, it was impossible to show women's work in the more modern community or to derive other tables showing women's work. A useful and simple extension of the above analysis would be to examine the proportion of total work days by man, woman and child devoted to light labor activities (e.g., weeding and harvesting) and heavy labor activities (e.g., soil preparation) for each crop. The data are readily available.

[6] Other more minor crops were ignored. Not enough families grew any one crop to make estimation worthwhile.

Table 2

MOTHERS WORKING IN AGRICULTURE

(Number of Mothers Working Indicated Number of Days in Traditional and Cash Crops in the Villages Only)

	Mothers		All Persons	
Number of Days	Traditional	Cash	Traditional	Cash
1 - 6	3	13	345	32
7 - 12	3	12	212	32
13 - 24	4	3	218	38
25 - 50	2	1	245	75
51 - 100	1		357	90
101 - 200			262	37
201 - 300			32	7
301 - 500			8	3
501 - 1000			1	5
> 1000				2

following regression model was used in all cases:

$$(1) \qquad Q = aL^{b_1} H^{b_2} V^{b_3} A^{b_4}$$

Q is output, L is land, H is labor, V is variable inputs and A is animals and durables.

In the crop production functions, output is measured in physical terms and the unit of observation is production on a single parcel of land planted to a single crop in a single season. For example, there are two separate production observations for a given family in each of the following cases: a family growing a single crop on two land parcels; two crops on the same parcel; a single crop in two seasons on the same parcel.[7] In the aggregate-output-value production functions, the unit of observation is a family's total production of all crops on all parcels. The appendix to this Note defines the variable used in estimating the production functions. The data have the following features not commonly found in surveys of peasant agriculture: each family member's labor input, in days or "tasks" (roughly equivalent to a day's work by an adult man--see Appendix), was recorded separately for each crop, parcel and season. Then, the total labor input for a given crop, parcel and season was taken as the sum of the days and tasks worked by all persons, including employees and any unpaid friends and relatives, where, to adjust for differences in productivity, the work of women and children is weighted by average wage rates by age and sex in local agricultural day labor.[8] Thus, the labor input variable is measured in equivalent adult man-days. The land input (area planted) was adjusted on a parcel-by-parcel basis for soil quality and type of irrigation (see Appendix). Purchased inputs, including improved seed, unimproved seed carried over from a previous season, fertilizers, insecticides, herbicides and fungicides, are measured in value terms. The value of the stock of work animals and agricultural durables owned by a farmer was used as a proxy for the services of such assets.

---

[7] Having data on a parcel-by-parcel basis yields more production observations from the sample than would be possible were the data available only for all parcels aggregated together. For example, 800 observations were obtained from the 562 families growing corn in the villages during the first season. Also, farmers seemed best able to recall their work input on a parcel-by-parcel basis.

[8] Several weighting schemes were tested. Relative wage rates in local agricultural work was the most satisfactory. (See Stein, *Labor Markets*.)

However, most farmers in the villages owned no work animals and no agricultural durables other than hand plows and water hoses. The condition of the agricultural durables was taken into account when valuing these assets.

Rainfall, April to July 1974, the relevant period for most production functions estimated here, was slightly above average, so the supply of water was adequate and need not be included as a separate input variable. However, for the second planting season, August through November (applicable only to corn and beans in the villages), rainfall was substantially below average, and in a few cases farmers were unable to harvest any production. As a result, estimated production functions covering the second season may not be representative.

General Behavior of the Production Functions

The aggregate-output-value production functions are presented in Table 3. Table 4 presents the crop production functions. All variables are in natural logs.

The estimated production coefficients for all input variables in the aggregate production functions were significantly positive at the 97 percent confidence level with the single exception of animals and durables in the villages. In the crop production functions, most variables were again highly significant, with some exceptions. Land appears as an insignificant determinant of bean production in the villages. Variable inputs appear as an insignificant determinant of bean production in the more modern community. Also highly insignificant were land, animals and durables, and variable inputs for chiles in the villages, a case with a relatively small number of observations.[9]

[9] Animal and durable stock is negatively related to production of feed corn, contrary to what would be expected were there a direct

Table 3

AGGREGATE OUTPUT VALUE PRODUCTION FUNCTIONS
(Standard Errors in Parentheses)

	Four Villages				More Modern Community		
	Season 1			Both Seasons			
		With Literacy	With Experience			With Literacy	With Experience
Labor	.564[a] (.0437)	.567[a] (.0437)	.588[a] (.0440)	.568[a] (.0472)	.507[a] (.129)	.487[a] (.128)	.506[a] (.129)
Land	.171[a] (.0433)	.170[a] (.0432)	.177[a] (.0430)	.0963[a] (.0410)	.300[a] (.104)	.349[a] (.105)	.312[a] (.105)
Animals and Durables	.00963 (.0152)	.00947 (.0151)	.0160 (.0152)	.00467 (.0196)	.0684[a] (.0293)	.0681[a] (.0290)	.0683[a] (.0294)
Variable Inputs	.254[a] (.0227)	.248[a] (.0228)	.239[a] (.0229)	.299[a] (.0246)	.212[a] (.0640)	.197[a] (.0641)	.211[a] (.0643)
Constant	1.01	.976	1.08	.987	.474	.199	.529
Partial Literacy		.0136 (.0677)				-.00382 (.263)	
Full Literacy		.0977 (.0518)				.296 (.218)	
Experience			-.00525[a] (.00165)				-.00171 (.00401)
Returns to Scale	.999	.994	1.020	.968	1.096	1.101	1.097
n	555	555	555	568	122	122	122
R^2	.764	.765	.768	.743	.805	.812	.806
F	444	298	363	407	121	82.6	96.0
RSS	163.5	162.4	160.5	181.0	48.85	47.18	48.77

[a]Coefficient estimate is significantly different from zero at the 97 percent significance level.

Table 4

CROP PRODUCTION FUNCTIONS: CORN

(Standard Errors in Parentheses)

	Four Villages				More Modern Community		
	Season 1			Season 2			
		With Literacy	With Experience			With Literacy	With Experience
Labor	.397[a]	.397[a]	.412[a]	.340[a]	.244	.213	.234
	(.0424)	(.0423)	(.0432)	(.0891)	(.123)	(.122)	(.123)
Land	.290[a]	.290[a]	.284[a]	.290[a]	.603[a]	.655[a]	.606[a]
	(.0354)	(.0354)	(.0355)	(.0772)	(.166)	(.166)	(.155)
Animals and Durables	.0203	.0205	.0236	-.00632	.0578	.0550	.0591
	(.0154)	(.0154)	(.0155)	(.0310)	(.0277)	(.0272)	(.0275)
Variable Inputs	.231[a]	.229[a]	.226[a]	.155[a]	.104[a]	.0833	.102[a]
	(.0281)	(.0283)	(.0282)	(.0616)	(.0447)	(.0444)	(.0444)
Constant	-.459	-.476	-.413	-1.29	-1.21	-1.58	.943
Partial Literacy		.0521				.0934	
		(.0611)				(.240)	
Full Literacy		.0241				.416	
		(.0462)				(.206)	
Experience			-.00249				-.00629
			(.00150)				(.00368)
Returns to Scale	.938	.937	.946	.779	1.009	1.006	1.001
n	800	800	800	450	123	123	123
R^2	.610	.611	.612	.263	.688	.706	.696
F	311	207	250	39.7	65.0	46.5	53.4
RSS	269.30	269.03	268.36	391.31	44.9	42.3	43.8

[a]Coefficient estimate is significantly different from zero at the 97 percent significance level.

Table 4 (cont)

CROP PRODUCTION FUNCTIONS: BEANS

(Standard Errors in Parentheses)

	Four Villages: Season 1	Four Villages: Season 1 With Literacy	Four Villages: Season 1 With Experience	Four Villages: Season 2	More Modern Community	More Modern Community With Literacy	More Modern Community With Experience
Labor	.306[a] (.112)	.306[a] (.112)	.320[a] (.111)	.335[a] (.0979)	.375[a] (.174)	.349[a] (.174)	.396[a] (.179)
Land	.0956 (.0932)	.107 (.0955)	.106 (.0931)	.0344 (.0712)	.395 (.214)	.442[a] (.214)	.399 (.214)
Animals and Durables	.145[a] (.0501)	.139[a] (.0508)	.156[a] (.0505)	-.0173 (.0333)	.0884 (.0476)	.0870 (.0473)	.0880 (.0478)
Variable Inputs	.370[a] (.0688)	.369[a] (.0692)	.353[a] (.0694)	.519[a] (.0559)	.0976 (.109)	.0670 (.110)	.0969 (.109)
Constant	-1.60	-1.66	-1.40	-1.47	-2.24	-2.76	-2.07
Literacy		.00443 (.208)				.280 (.480)	
$(\text{Literacy})^2$		.127 (.151)				.586 (.385)	
Experience			-.00705 (.00477)				-.00442 (.00607)
Returns to Scale	.917	.921	.935	.871	.956	.945	.980
n	165	165	165	255	96	96	96
R^2	.456	.458	.463	.526	.463	.483	.446
F	33.5	22.3	27.4	69.2	19.6	13.9	15.7
RSS	116.8	116.3	115.3	130.1	72.64	69.95	72.22

[a] Coefficient estimate is significantly different from zero at the 97 percent significance level.

Table 4 (cont)

CROP PRODUCTION FUNCTIONS: FEED CORN AND CHILES
(Standard Errors in Parentheses)

	FEED CORN			CHILES		
		Four Villages			Four Villages	
		With Literacy	With Experience		With Literacy	With Experience
Labor	.342[a]	.335[a]	.375[a]	.717[a]	.702[a]	.715[a]
	(.140)	(.139)	(.137)	(.166)	(.171)	(.168)
Land	.354[a]	.349[a]	.322[a]	-.0322	-.0173	-.0237
	(.156)	(.155)	(1.53)	(.161)	(.165)	(.164)
Animals and Durables	-.0812	-.0671	-.0427	-.0510	-.0391	-.0533
	(.0538)	(.0539)	(.0546)	(.0737)	(.0770)	(.0746)
Variable Inputs	.196[a]	.199[a]	.196[a]	.184	.225	.169
	(.0776)	(.0782)	(.0757)	(.144)	(.155)	(.148)
Constant	-.0647	-.0230	.237	.235	.288	.444
Partial Literacy		-.244			-.0998	
		(.159)			(.319)	
Full Literacy		.0761			-.235	
		(.137)			(.288)	
Experience			-.1016[a]			-.00452
			(-.00412)			(.00903)
Returns to Scale	.811	.816	.850	.818	.871	.807
n	117	117	117	43	43	43
R^2	.491	.508	.520	.704	.709	.706
F	27.0	18.9	24.0	22.6	14.7	17.8
RSS	45.3	43.8	42.7	19.37	19.02	19.24

[a]Coefficient estimate is significantly different from zero at the 97 percent significance level.

Table 4 (cont)

CROP PRODUCTION FUNCTIONS: TOMATOES
(Standard Errors in Parentheses)

	Four Villages			More Modern Community		
		With Literacy	With Experience		With Literacy	With Experience
Labor	.545[a] (.175)	.544[a] (.178)	.579[a] (.175)	.647[a] (.236)	.703 (.252)	.672[a] (.246)
Land	.271 (.138)	.268 (.140)	.260 (.137)	.106 (.176)	.163 (.202)	.0721 (.195)
Animals and Durables	.104 (.0591)	.102 (.0597)	.112 (.0590)	.073 (.0643)	.0503 (.0696)	.0768 (.0657)
Variable Inputs	.122 (.0781)	.122 (.0787)	.106 (.0784)	.389[a] (1.62)	.360 (.181)	.397[a] (1.65)
Constant	.0509	.0597	.275	-.698	-.453	-.871
Partial Literacy		.182 (.254)			-.668 (.656)	
Full Literacy		-.0154 (.160)			-.567 (.649)	
Experience			-.00840 (.00580)			.00349 (.00811)
Returns to Scale	1.042	1.036	1.057	1.215	1.276	1.218
n	94	94	94	36	36	36
R^2	.507	.510	.518	.747	.756	.759
F	22.9	15.1	18.9	22.9	15.0	17.9
RSS	45.59	45.27	44.53	13.27	12.81	13.19

[a]Coefficient estimate is significantly different from zero at the 97 percent significance level.

The R^2 coefficients ranged between 0.74 and 0.81 for the aggregate production functions and 0.46 to 0.76 for the crop production functions, values somewhat larger than typically obtained for such studies. Returns to scale varied between 0.97 and 1.13 for the aggregate production functions and between 0.78 and 1.28 for the crop production functions, in no case significantly different from unity.

Marginal Value Products in Agriculture

In my previous paper I reported that agricultural day laborers earned an average wage of Q.83 per day in the villages and Q1.23 per day in the more modern community. One would expect the estimated marginal value products for a day's labor to differ insignificantly from these values, assuming efficient resource allocation and assuming, for the moment, no risk in agricultural production. Variable inputs are measured in value terms, so one would expect an estimated marginal value product insignificantly different from unity. Land is measured by its annual rental value. One would expect a marginal value product below unity because land is sometimes used for more than one season such that only a portion of the annual rental value would correspond to a given harvest quantity. Land parcels were used an average of 1.7 seasons in the villages and 1.1 seasons in the modern community, so we expect estimated marginal value products of about Q.58 in the villages and Q.90 in the more modern community. The expected marginal value product of the animals and durables stock is difficult to gauge because data on the feeding and upkeep of animals were not examined. In contrast with the

dependence of feed corn production on the stock of animals eating this corn, but the effect is insignificant.

above expected coefficient marginal value products, estimates derived from the production functions are given in Table 5. The estimated marginal value products of animals and durables refers to gross return.

Risk probably differs from crop to crop and village to village depending on, among other factors, the elasticity of output with respect to rainfall. Additionally, risk might be greater for the traditional subsistence crops than cash crops, if peasants have a safety-first risk attitude toward subsistence crops. I have not been able to examine the importance of risk, and the following discussion assumes risk neutrality. Under the weaker assumption that farmers are risk averse, but that, in any given production function, all inputs are proportionally less productive when rainfall is below normal (a reasonable assumption since no input substitutes for water), expected marginal value products would be proportionally higher in that production function than the a priori estimates given in the paragraph above.

From Table 5, the estimates of labor's marginal products at the aggregate level are significantly below local wages in both the villages and the more modern community. If it were not for the omitted risk factor, this finding would suggest disguised unemployment in family agriculture. Labor's marginal product is significantly lower in traditional than cash crops, in both the villages and the modern community. Labor's marginal products in corn, feed corn and beans are never within a significant range of the local wage rates, while in tomatoes and chiles, labor's marginal products in all cases differ insignificantly from local wages. The apparent overutilization of labor (disguised unemployment) occurs in traditional crops but not in cash

Table 5

MARGINAL VALUE PRODUCTS (Q) IN AGRICULTURE FROM COBB-DOUGLAS PRODUCTION FUNCTIONS[a]
(Standard errors in parentheses)

	Labor	Variable Inputs	Land	Animals & Durables
Villages				
Aggregate	.547[b]	6.40[b]	.391[b]	.172
	(.045)	(.589)	(.101)	(.258)
Corn Season 1	.359[b]	8.25[b]	.592[b]	.219
	(.041)	(1.00)	(.071)	(.165)
Season 2	.135[b]	1.07[b]	.152[b]	-.020
	(.035)	(.691)	(.040)	(.104)
Feed Corn	.248[b]	29.0[b]	.815[b]	-.529
	(.102)	(11.3)	(.373)	(.357)
Beans	.220[b]	2.84[b]	.146	.632[b]
	(.078)	(.530)	(.136)	(.226)
Chile	1.47[b]	2.14	-.547	-1.76
	(.347)	(1.66)	(2.92)	(2.60)
Tomatoes	.762[b]	.547	2.34[b]	1.05
	(.254)	(.355)	(1.21)	(.619)
More Modern Community				
Aggregate	.673[b]	2.14[b]	.561[b]	.508[b]
	(.170)	(.653)	(.188)	(.218)
Corn	.185	1.66[b]	.766[b]	.315[b]
	(.140)	(.745)	(.193)	(.152)
Beans	.442[b]	.611	.412[b]	.364[b]
	(.198)	(.672)	(.216)	(.194)
Tomatoes	1.37[b]	2.77[b]	.0873	.267
	(.514)	(1.13)	(1.43)	(.244)

[a]Marginal value products are estimated at arithmetic mean input values. Literacy and experience variables have been omitted. All marginal value products are expressed in quetzales.

[b]t-value significant at 97 percent confidence level.

crops. Labor's marginal products are higher in the more modern community than in the villages, as expected, although insignificantly so.

Purchased inputs in most cases appear significantly underutilized, in both cash and traditional crops, in the villages and the more modern community. But marginal value product is three times greater in the villages than the more modern community, suggesting that underutilization is more of a problem in the villages. Underutilization is more of a problem in traditional crops than cash crops. A safety-first risk attitude would explain these findings, assuming villagers and subsistence farmers are living closer to the margin of existence than people in the more modern community and cash crop farmers, and are less able to afford risking the investment in purchased inputs. Thus, in general, purchased inputs appear more efficiently used the more closely is production tied to the modern cash economy, i.e., the more modern community vis-a-vis the villages and cash crops vis-a-vis traditional crops.

Land use for corn and feed corn appears insignificantly different from efficient levels in both the villages and the more modern community. Land appears underutilized for beans in both places, which may be attributed to the practice of interplanting. When beans are interplanted with corn they use more land per bean plant than when they are planted on their own, and interplanting is common.[10] Land

[10] In crop production functions, we count land, labor and variable inputs separately for each crop even though some inputs may be doing double duty (see Appendix). In the aggregate production functions, we counted such inputs only once. Data are available on interplanting on each land parcel, and the practice can be examined in more detail in subsequent research.

marginal productivities in cash crops appeared insignificantly different from efficient levels, but also insignificantly different from zero.

The estimated marginal value product of the stock of animals and durables is, in many cases, insignificant.[11] The insignificance can be attributed in part to the inadequacy of this variable as a proxy for the services of the animals and durables, and in part to the scarcity of work animals and agricultural durables among farmers, especially in the rural villages.

In an initial attempt to investigate the value of education in agricultural production, the productivity of the father's literacy and experience were tested with dummy variables, but no estimates of marginal products could be derived.[12]

---

[11] Inclusion or exclusion of the asset variable has a negligible effect on the other coefficients. The principal effect of deleting assets was to raise slightly the overall F statistic and the estimated returns to scale. The asset variable was left in the equations because it appears significant at the aggregate level in the more modern community.

[12] In the aggregate production functions, only in the four villages did being fully literate have a positive effect on output at the 95 percent confidence level (one tailed test). In the crop production functions, literacy was an insignificant determinant of output in all but a few cases (see Tables 3 and 4). No consistent pattern emerged.

Experience (age minus five years) appears to have a significant negative effect on output in the aggregate production function for the villages. Perhaps older farmers are less likely to adopt new production methods or perhaps these farmers are less vigorous. Under the first explanation, the overall level of productivity can be expected to rise as the younger generation of adopters replaces the older generation of nonadopters. Further research in this area would likely be fruitful.

Years of schooling was examined as a test variable, but the average educational level in the villages was very low and literacy levels gave a more even dispersion in the sample. In the villages, 62 percent of the male heads of households (principal farmers) had zero years of schooling and the average schooling level was only 1.1 years. Literacy was more evenly distributed with 47 percent tested as being unable to read and write, 15 percent being able to read and write with difficulty and 39 percent being fully able to read and write. Average schooling and literacy levels were substantially higher in the more modern community, but most peasant farming occurs in the villages.

Marginal Productivities of Labor by Age and Sex

The sample population was partitioned into various age and sex groups with approximately equal number of observations in each group. To estimate marginal products for each age-sex group of family labor within the context of the agricultural production functions, the following equation was estimated simultaneously with Equation (1):

$$(2) \qquad H = \sum_{i=1}^{5} w_i h_i$$

where h_i is the number of days worked by persons of age-sex group i and the w_i are relative marginal productivities normalized around adult males, for whom $w_i \equiv 1.0$. This non-linear model was chosen, instead of a linear model with the work of each age-sex group included as a separate Cobb-Douglas input because work by different persons is thought to be strictly substitutable within the labor input variable, after

---

Other structural forms could be tested in any subsequent investigation of literacy, schooling, experience and other human capital attributes using these data. In the above analysis, these variables were incorporated multiplicatively under the assumption they improved the farmer's overall efficiency in allocating and combining all resources, rather than his efficiency in using any particular resource. When data collection was originally conceived, it was intended that one branch of analysis would focus on the productivity of various types of human capital in agriculture. A number of physiological and psychological variables (e.g., height, weight, intelligence score) describing various family members are available for testing.

allowing for differences in relative productivities. Further, the linear Cobb-Douglas model collapses when any age-sex group shows zero days worked, a situation that occurs frequently.

The w_i were estimated simultaneously with a and b_1 to b_4 of Equation (1) using non-linear least squares regression and the results are shown in Table 6 as "least squares estimates." Unfortunately, the estimates are unreasonable.[13]

For comparison, Table 6 also shows two sets of estimates of labor marginal products derived from agricultural wage data. The first, labeled "Guatemala," is derived from the local agricultural labor market in these communities as estimated in my previous paper; the second is based on Mueller's consensus estimates based on a survey of previous research in peasant societies.[14]

---

[13] Estimation was by means of a quadratic hill climbing algorithm. See S. M. Goldfeld and R. E. Quandt, Nonlinear Methods in Econometrics, North Holland, 1972, p. 59. Given additional resources, it would be possible to test alternative production models, ways of incorporating relative labor marginal products and groupings of persons by age-sex categories.

[14] Eva Mueller, "The Economic Value of Children in Peasant Agriculture," in Ronald Ridker (ed.), op. cit. Mueller refers to the "normal" relationship found in many rural wage studies as far back as before the Second World War that women's daily wages are about two-thirds those of men, children's about one-half (Mueller, p. 116). She then incorporates more recent evidence and concludes the following profile of productivity relative to adult men:

Age	Males	Females
0 - 9	--	--
10 - 14	.60	.60
15 - 19	1.00	.75
20 - 54	1.00	.75
55 - 64	.75	.56
65 & over	.50	.38

Estimates for the age-sex groups used in the present paper were interpolated from Mueller's estimates.

Table 6

RELATIVE LABOR MARGINAL PRODUCTS
(Standard errors in parentheses)

	Least Squares Estimates		Wage Estimates	
Age and Sex Category	Villages	Modern Community	Guatemala	Mueller
Males & Females ≤ 12 years old	.64 (.027)	.36 (.10)	.62 (.15)	.52
Males & Females 13 - 15 years old	7.47 (.11)	.00 (.77)	.81 (.26)	.76
Males 16 - 19 years old	.85 (.19)	.00 (.22)	1.03 (.10)	1.00
Females ≥ 16 years old	.00 (.40)	1.61 (.34)	.88 (2.2)	.75
Males ≥ 20 years old	1.00	1.00	1.00	1.00

Comparing the Guatemala wage estimates with Mueller's, women and children appear more productive relative to adult men with the Guatemala estimates. I tested and compared all the alternative estimates of marginal productivities in Table 6 within the context of the agricultural production functions using Equations (1) and (2). The estimates based on Guatemalan wages consistently (in all aggregate and crop equations except one) yielded higher F statistics and lower residual sums of squares than Mueller's estimates, although, of course, neither fit was as good as that with the least squares estimates. I conclude that women and children in agriculture are probably more productive relative to adult men in the Guatemalan sample than Mueller finds in her survey.[15]

If these results are correct, children contribute relatively more to family income than previously estimated, increasing the benefit-to-cost ratio of children relative to previous calculations. At the same time, the productivity of women in agriculture, an activity generally more complementary to childrearing than is market work, appears higher than previously estimated. This also increases the benefit/cost ratio of having children. In sum, the incentive to have large families in peasant agricultural societies appears higher in the

---

[15] An attempt was made to derive estimates of relative labor marginal productivities from data on days worked in each of several specific agricultural production activities: preparing the soil, weeding, bending over corn stalks, and harvesting. Each activity was examined as a separate production process, and relative marginal labor products were estimated in each case, with separate estimates for each crop. On average, the estimates for the various age-sex groups were more uniform than Mueller's although they differed widely from activity to activity and crop to crop. The analysis was not pursued far enough to identify statistically significant differences between estimates for heavy versus light labor tasks, as originally hoped.

present case than would have been calculated using previous estimates. Economic development away from agriculture reduces what now appears to be a stronger inducement to large family size than previously estimated. The optimistic implication is that development away from agriculture has a stronger effect in reducing the incentive to population growth than previously believed.

IV. CONCLUSION

This paper reaches some provocative conclusions, while corroborating the fundamental hypothesis, supported in my previous paper, that economic development creates incentives to reduce population growth.

An important distinction is drawn between traditional and cash crops. According to preliminary analysis of the data, while corn, beans and feed corn, the traditional subsistence crops, employ predominantly the heavy labor of adult men, tomatoes and chiles, the principal cash crops, use relatively more of the light labor contributed by women and children, usually for weeding and harvesting. Also, with cash crops, women and children can work side by side such that a mother's job participation complements childrearing. Thus, children are especially valuable in a society growing cash crops and cash crop agriculture is an inducement to large family size.

Insofar as economic development shifts production from traditional to cash crops, incentives arise that exacerbate population growth, contrary to the initial hypothesis. It appears that the net effect of development on population growth may be a complex resultant of various incentives, some acting to promote and some to retard population growth. Because, in the present case, the shift from agricultural to non-agricultural work involves far more people than the shift from traditional to cash crops, the net incentive is for economic development to reduce population growth.

Another difference between traditional and cash crops appears in the efficiency with which farmers use production inputs. The marginal product of family labor is significantly below market usages in traditional but not in cash crops. Acknowledging that the analysis does not account for risk, this result points to what appears to be disguised unemployment in traditional, but not in cash-crop, agriculture.

Purchased inputs appear underutilized in every instance, but more so in traditional than cash crops and more so in the villages than the modern community. Risk could account for this result, or it might be attributable to a general tendency for peasants to implicitly value purchased inputs closer to their market prices the closer is production integrated with the cash economy, i.e., production is more efficient in cash than traditional crops and in the more modern community than in the villages.

This paper also suggests that both children and women may be more productive in family agriculture relative to adult men than previously estimated by other researchers. Consequently, the economic value of children appears higher. The optimistic conclusion is that development away from agriculture reduces the incentive to large family size by a greater margin than previously believed, and this acts to retard population growth.

APPENDIX: AN EXPLANATION OF THE VARIABLES

In gathering this data set, care was taken to collect data useful in making adjustments for the quality of land and labor inputs. Farmers were asked the dimensions of each of their land parcels separately. Interviewers asked whether each land parcel was flat valley land (where topsoil is most abundant and irrigation is often available), sloped mountain land (also irrigable, but generally with less topsoil), or high mountain land (usually less productive, more inaccessible and not irrigable). Also asked was what irrigation facilities were available on each land parcel (none, access to a government irrigation project, river water, a private well). Land parcels were divided into three classes: irrigable land (almost always flat lowlands), high mountain lands (always without irrigation) and everything else (non-irrigable lowlands and low mountain slopes). Three specially selected informants in each community, surveyed to obtain certain data relevant to the entire community, usually price data, were asked to estimate typical rental values for each of the three types of land in their community.[16] The informants' responses were averaged to obtain estimates of relative productivities for the three qualities of land. The land input in the production functions is expressed in terms of its annual rental value.

Within a given land parcel, the area planted to each crop was known separately. Sometimes corn and beans were interplanted, in which case the full land area planted to both crops was counted in each crop production function separately, since the two crops are closely

[16] Nearly half the parcels in each community were rented, so the rental market was well established and was assumed to be our most accurate way of estimating relative soil productivities. Rental data as reported by farmers have not yet been analyzed.

complementary. In the aggregate production functions, however, the land area interplanted with corn and beans was only counted once.

Each person's work was recorded separately for each season, parcel and crop. The work by women and children was translated into an equivalent number of "adult man-days," using relative wages in local agricultural work, by age and sex, as estimates of relative productivities. Work that was performed jointly for two crops (such as preparation of the soil for interplanted corn and beans) was only counted once when estimating the aggregate production functions, but was fully counted for each crop in estimating the crop production functions.

All purchased seed, fertilizers, insecticides, herbicides, and fungicides are included in variable inputs. This production variable also includes unpurchased seed held over from a previous crop, in which case the seed was valued at local prices. Variable inputs are measured in value terms and any differences in quality among inputs are assumed to be reflected in price.

Work animals (oxen, bulls, cows, horses, burros, mules) and agricultural durables (wood plows, metal plows, sprayers, water pumps, carts, storage drums, silos) were valued at the market prices for these assets. Agricultural durables were valued differently, according to whether they were reported as being in "good" or "bad" condition. The value of the farmer's total stock of animals and durables was used as a proxy for the services of these assets in the relevant production function, for both aggregate and crop production functions.

Crop production is measured in physical terms for the crop production functions and in value terms for the aggregate production functions.

BIBLIOGRAPHY

Corona, Henry L., Codebook and User's Manual: INCAP-Rand Guatemala Survey, The Rand Corporation, P-6181, November 1977.

Goldfeld, S. M., and R. E. Quandt, Nonlinear Methods in Econometrics, North Holland Publishing Company, Amsterdam, 1972, p. 59.

Mueller, Eva, "The Economic Value of Children in Peasant Agriculture," in Population and Development, Ronald G. Ridker (ed.), John Hopkins University Press, Baltimore, 1976.

Ridker, Ronald G. (ed.), Population and Development, John Hopkins University Press, Baltimore, 1976.

Stein, John P., Labor Markets in Rural Guatemala: A Cross-Section Study of Economic Development and Incentives to Reduce Family Size, The Rand Corporation, P-6111-1, April 1979.

Stein, John P., and Cathy Kasala, Income, Wealth and Agriculture Production in 1974: A Guide for Researchers to the Use of Questionnaire R-10 from the Rand-Rockefeller Guatemala Project. The Rand Corporation, P-6292, October 1978.