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THE IMPACT OF MALARIA ON ECONOMIC DEVELOPMENT

Summary:

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Dr. Gladys N. Conly, Economist
Department of Malaria Eradication
Pan American Health Organization

The study of which this is a summary was carried out in eastern Paraguay in a colonization area devoted to semi-subsistence farming. The areas of study were located in the Department of Alto Paraná, in a region hit during the first part of the period of data collection by a severe epidemic of malaria, primarily P. falciparum. Sixty-nine farm families are included in this report. They were all neighbors, living on their farms within an area not more than 10 kms from one end to the other, so that the soil, weather, marketing conditions and so on were identical for all of them.

Data collection began early in the malaria season of 1968, while the eradication campaign was still in preparatory phase, and it continued for 22 months. An epidemic affected that whole region of Paraguay in early 1969 and built up in intensity in the study area until finally, in February 1969, the 7th month of the study, emergency spraying was carried out. Radical-cure treatment was administered by the project personnel to all confirmed cases and a satisfactorily malaria-free condition was achieved in the study households during the second agricultural year studied.

An index was calculated for each individual farm household of illness due to malaria or suspected to be due to malaria. The economic importance of the sick person was taken into account as well as the number of days the person was reported to have been incapacitated. Some degree of debility in the following weeks was also postulated, over a longer or shorter period depending upon the kind of malaria and

how ill the person had been.

Data on health and on all economic activity were collected every two weeks for 22 months from each farm by a resident data-collector and were recorded in detail on special forms.

After the data-collection period had ended, the farms were divided into three groups according to the seriousness of the malaria they had suffered during the first year. An index of 100 meant that the household was completely healthy (with respect to malaria) and equalled full capacity to work. Those farms wich had not more than a 5% reduction of their index of potential capacity to work were classed as healthy, or Group 1; those with a reduction of between 5% and 15% during the first, malarious year were classed as moderately-affected, or Group 2; and those with a reduction of more than 15% were classed as Group 3, with much malaria. (See Figure 1).

The principle method used for measuring the effect malaria had on the economic activity of the farm families is based on the assumption that productivity in the second year, when there was almost no malaria in any of the groups, was representative of their normal performance. The difference between the first and the second year arising from factors other than malaria, mainly, no doubt, the weather, were gauged by using Group 1 which had suffered very little from the disease in either year as an indicator. The level of production during the first, malarious year in Groups 2 and 3 if they had not had malaria was estimated by applying this relationship between the years to the second-year level of the respective group. Then the actual performance of the group during the malarious year was expressed as a percentage of this level which could have been expected had there been no malaria.

The groups of farms were not large and there were differences among them in some important respects. The characteristics in the three groups are shown in Table 1. It can be seen that the 12 farms of Group 3, which suffered heavily from malaria, had been the shortest time on their farms--an average of 2 years and 4 months--but had the largest cleared area--4.06 ha; they were relatively more prosperous with a better supply of tools than Group 1 and more draft animals than either of the other groups. The 16 farms of Group 2, which suffered moderately from malaria, had been resident longer than either of the other groups with an average of 4 years and 5 months. Their farms were also large for the zone, with 3.74 ha cleared. They were the best supplied with tools, but had few draft animals. Group 1 farms were the smallest and poorest, on the average, and the families had been resident for an average period of 3 years and 9 months. All the farms had ample uncleared land which could be brought under crops if they put in the work of clearing it of jungle.

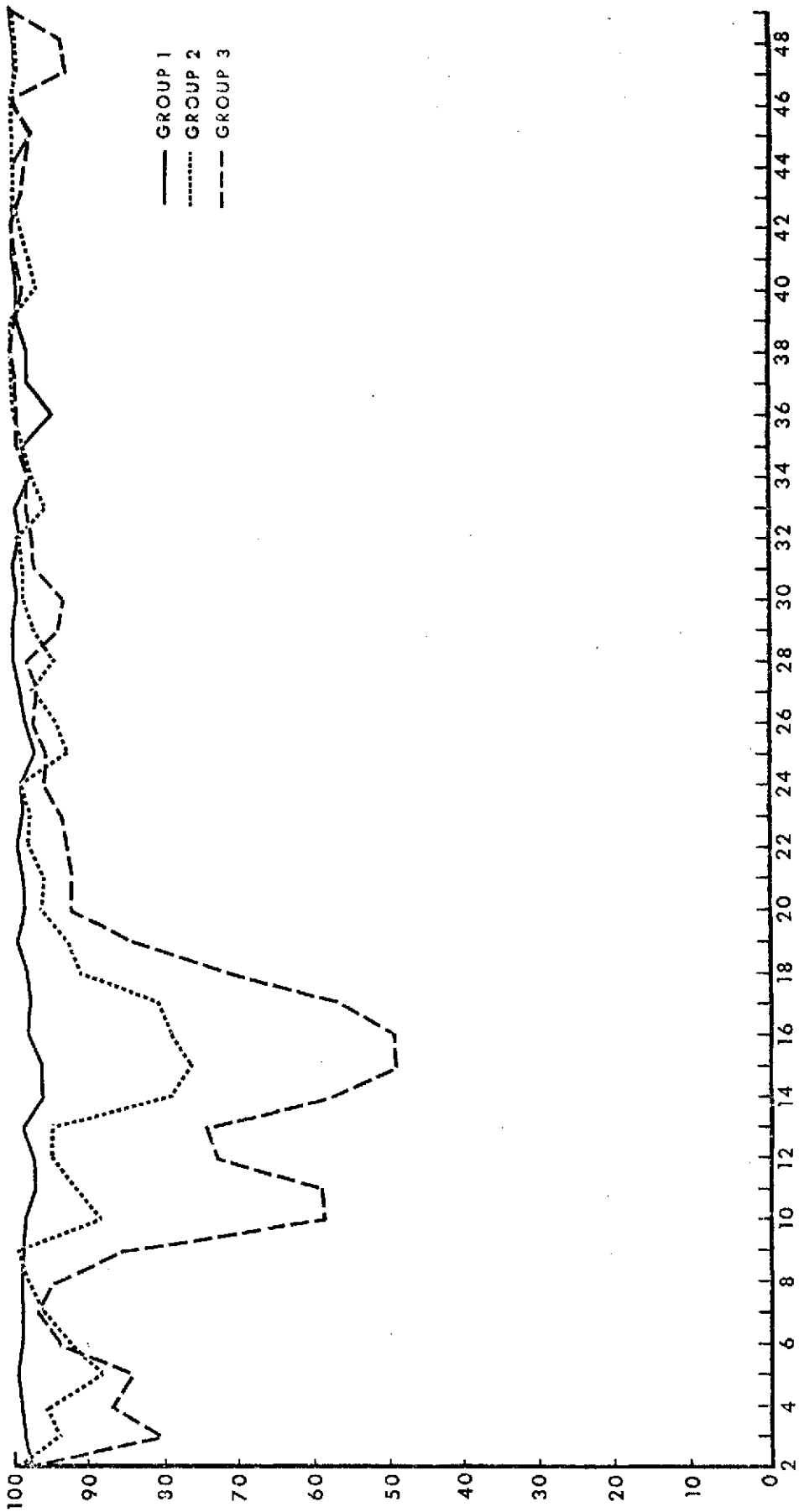

Fig. 1. Anticipated effect of malaria on economic potential in three groups of families, by two-week interval.

TABLE 1

INITIAL CHARACTERISTICS OF THE FARMS, BY MALARIA GROUP

	No. of farms	Average years of residence on farm	Initial cleared hectares	Hectares cultivated as of day 69			Average no. of persons per farm, days 29-257	Index of tools owned	No. of draft animals per farm
				Total	Use (%)	Cash (%)			
Little malaria in first year	41	3 yrs 9 mos	2.93	1.72	46.3	53.7	6.15	100	0.56
Moderate malaria in first year	16	4 yrs 5 mos	3.74	2.46	39.6	60.4	8.38	123	0.31
Much malaria in first year	12	2 yrs 4 mos	4.06	2.78	49.7	50.3	7.55	112	1.00

There were also differences among the groups in family size and composition. During the first part of the study period, the average size of household was 6.15 persons in Group 1, 8.38 in Group 2, and 7.55 in Group 3, but the number of farm workers (men and boys) was 1.99, 2.55 and 1.77 respectively. Group 3 thus had the largest area and the fewest farm workers; Group 2 had a large area but many resident farm workers; and Group 1 had the smallest area and an intermediate number of workers.

During the following year there were changes in this situation which were important to the interpretation of the results of the study. The area in general witnessed an exodus of farm workers; overall there was a reduction of about 11%. Group 1 (which had had almost no malaria) lost 11% of their workers, but Group 2 lost 19% of theirs. Group 3 lost only 3%.

Although the families studied do other kinds of work as well, the activities which have been analyzed and which are reported on here are only those related directly to their own farming. Investigations were made concerning the work the farmers did--how much work, how it was distributed over the year, how efficient it was, and who did it; concerning the harvests they got, crop by crop, in respect to quantity and quality; and of the yields that the farmers were able to obtain, both in terms of how much harvest they got her day of work that they had put in on the crop and in terms of how much harvest they got per hectare of land planted. These questions were investigated for each of the three groups of farms, and the results compared to see if the presence of malaria had made any difference. The results in the principal areas of interest are summarized in Table 2.

Group 3, which suffered most heavily from malaria, naturally showed the strongest effects in most areas. The first signs that malaria was interfering with their usual farming patterns appeared during the first months, which were early spring months when the land-clearing activities of the winter were being finished up and the spring planting was under way. Land clearing is customary on these new farms which are still expanding and where newly-cleared land is substituted for cropped land every four or five years. It was below its expected level in Group 3 and even this reduced amount was still being worked on when farms in the other groups had finished their current year's deforestation and, in Group 1, had even started on a few fields for use not in the current year, but the following one.

Not only deforestation, but the work of clearing away the remains of last year's crops or the weeks and second-growth on land left fallow for a time was greatly diminished. The farmers apparently put all their effort into finishing up their deforestation, and did

TABLE 2

SUMMARY OF MAIN POINTS DISCUSSED

HYPOTHESES CONCERNING THE IMPACT OF MALARIA

Group 2, moderate-malaria group: During the first, malarious year illness reduced the work the labor force could do. Work was devoted preferentially to completing the clearing of new land and to the main cash crops and reasonably good harvests were obtained from these; other crops were neglected. Non-essential tasks were neglected and left for the following year. Manioc was to some degree substituted for other foods.

In the second year the emigration from the area of men from these farms and the death of one head of family caused a continuing shortage of labor; the backlog of work could not be made up and the cumulative effect of inadequate work reduced harvests.

Group 3, much-malaria group: During the first, malarious year illness strongly affected the work the labor force could do and its efficiency. Work essential to the most important cash crops was carried out by persons inefficient because of illness or because they were family members who did not ordinarily do such work, total days of work therefore being higher than normal in cash crops and lower than normal in less important crops and overall. Deforestation was below normal, work on land clearing and other non-essential tasks being neglected and left for the following year. Manioc was substituted for other foods to such a degree that acreage was depleted.

In the second year no emigration from these farms occurred because there were few loosely attached men and the cash position improved, allowing them to return to a higher level of use of hired labor and resulting in good second-year harvests.

CONSISTENCY OF THE FINDINGS WITH THE HYPOTHESES

Subject and indicator		Calculation method[a] (all results transformed to percentage difference from Group 1)	Group 2 Moderate-malaria		Group 3 Much-malaria	
			Consistent with hypothesis		Consistent with hypothesis	
			Yes	No	Yes	No
FACTORS RELATING TO THE PERFORMANCE OF WORK						
Expansion	% of land-clearing days spent on deforestation high in relation to % added to available land	% in Gr X / % in Gr 1 (in % days on deforest. / in % added to land)	82 / 0		57 / -30	
Clearing fallow	days/ha low	(days/ha Gr X) / (days/ha Gr 1)	-51		-38	
Farm work per ha	family days low	Method I	-1.4		-3.8	
	hired labor days low	Method I	-37.3		-28.9	
	total days low	Method I	-4.0		-6.5	
per farm	total days low	Method I	-2.1		-14.0	
Farm work in 2nd yr	family days/farm higher	Method I	-0.7		12.9	
	family days/ha higher	Method I	1.4		3.9	
Tobacco	plantings lost	Method I for days planting/ha high	27.7		86.0	
	care neglected	Method I for days care/ha low	-40.1		-2.0	
	harvesting affected	Graphic comparison of timing	yes		yes	
	harvest days/kg high	Method I		-5.0	33.0	
	work/ha high	Method I	6.1		39.4	
	extra workers high	Method II	yes		yes	
Cotton	plantings lost	Method I for days planting/ha high		-17.4	54.3	
	care neglected	Method I for days care/ha low	-0.6			14.3
	harvesting affected	Graphic comparison of timing	yes		yes	
	harvest days/kg high	Method I	9.4		28.3	
	work/ha high	Method I		-0.6		-1.9
	extra workers high	Method II	yes		yes	
Corn	planting hurriedly done	Method I for planting days/ha low	-47.5		-21.4	
	care neglected	Method I for days care/ha low	-1.8		-2.4	
	harvesting affected	Graphic comparison of timing	yes		yes	
	kg corn/harvest day low	(Gr X/Gr 1)	-2.0		-14.6	
	work/ha low	(Gr X/Gr 1) for days adjusted to equal harvests	-10.1			9.0
		Method I days not adj'd: comp. period	-3.4		-7.5	
		whole year	-2.4		-7.5	
	extra workers high	Method II	yes		yes	

Subject and indicator		Calculation method[a] (all results transformed to percentage difference from Group 1)	Group 2 Moderate-malaria		Group 3 Much-malaria	
			Consistent with hypothesis		Consistent with hypothesis	
			Yes	No	Yes	No
Manioc	work/ha low	Method I	-12.7		-18.5	
	care neglected	Method I for days care/ha low	-23.2		-11.7	
Other crops	work/ha low	Method III	-7.7		-35.0	
	work/farm low	Method I	-5.2		-9.8	
Work delays	for illness	(delays/farm Gr X)/(delays/farm Gr 1)	12 times as many		5 times as many	
	for weather	" "	1.4 times as many		5 times as many	
	all reasons	" "	3.5 times as many		5 times as many	
Extra workers	high in planting	Method II	yes			no
	high in crop care	Method II	yes		yes	
	high in harvesting	Method II	yes		yes	
FACTORS RELATING TO RESULTS ACHIEVED						
Expansion	adds to initially available land low	$\frac{\text{actual additions}}{\text{additions at Gr 1 rate}}$	-91.3		-41.4	
Total crops	% of total ha planted low	Based on reduction in % after 69th day relative to Group 1	-7.7		-7.4	
Tobacco	yield/100 days low	Method I		26.4	-20.0	
	yield/ha low	Method I		35.9		13.0
Cotton	yield/100 days low	Method I		6.2	-42.5	
	yield/ha low	Method I		5.6	-43.6	
Corn	yield/100 days low	Method I: to day 318	-8.6		-12.9	
		entire crop year		9.6	-8.1	
	yield/ha low	Method I: to day 318	-25.5		-22.4	
		entire crop year	-9.8		-18.1	
Manioc	quantity harvested high	Method I	11.0		15.3	
	reserve ha depleted	(Gr X/Gr 1) for planting days per additional ha high		-0.6	27.0	
Other crops	yield/100 days low	Method III	-37.5		-27.0	
	yield/ha low	Method III	-31.9		-70.4	
	ha in 2nd year not increased	Method III	-2.7		-23.5	
Losses	% ha damaged - tobacco	Method III		-22.0	16.1	
	- cotton	Method III		-11.5		-12.2
	- corn	Method III		-10.2	6.4	
	- manioc	Method III		-2.4	7.4	
	- 8 other	Method III		-10.1	12.2	
	combined % with fixed acreages	(% in Gr X, yr 1) - $\left(\frac{\%\text{ in Gr 1, yr 1}}{\%\text{ in Gr 1, yr 2}} \times (\%\text{ in Gr X, yr 2})\right)$		-0.9	14.0	
Combined yield	yield/100 days low	Method I	21.5		-17.3	
	" excl. manioc	Method I	19.3		-28.8	
	yield/ha low	Method I	13.5		-28.2	
	" excl. manioc	Method I	15.1		-36.5	
Total harvests	all crops, low	Method I	23.2		-21.5	
	" " excl. beans, low	Method I	21.8		-21.7	
	" " excl. beans & manioc low	Method I	23.2		-26.8	
Crop quality	tobacco, rel. price low	(Gr X yr 1/Gr 1 yr 1)	-2.2		-2.4	
	cotton, rel. price low	"		6.2		1.8
	corn, rel. price low	"	-2.3		-3.5	
Bargaining position	tobacco, av. price low	"		1.3		7.6
	cotton, av. price low	"		12.5		3.0
	corn, av. price low	"		0.6	-18.7	

[a]Calculation Methods:

I The relationship between the first and second years' performance in Group 1 is taken as the normal effect of weather and other factors operating in the area apart from malaria. The expected figure for Group X in the first year is calculated using this relationship applied to the Group X level in the second, nonmalarious year and the actual first year value is expressed as a percentage of this expected level:

$$\left[1 - \left[\frac{\text{1st-year value in Group X}}{\frac{\text{1st-year value in Group 1}}{\text{2nd-year value in Group 1}} \times (\text{2nd-year value in Group X})}\right]\right] \times 100$$

II The percentage of total days of work performed by boys from 10 to 12 years of age (one day of work being counted equal to 1/2 adult day) is expressed as a relative to the percentage of boy-days in the total of man- and boy-days, these totals being based on the family composition patterns described in Chapter V:

$$\frac{\text{days worked by boys at task}}{\text{total days worked at task}} \Big/ \frac{\text{number of available boy days}}{\text{total available man- + boy-days}}$$

Results of foregoing calculations for tobacco, cotton, and corn crops:

		First Year				Second Year			
		Tobacco	Cotton	Corn	Combined crops	Tobacco	Cotton	Corn	Combined crops
Planting:	Group 1	.17	.22	.11	.16	.98	.00	.19	.08
	Group 2	.57	1.65	.92	.94	1.69	.41	.37	.82
	Group 3	.47	.17	.07	.29	.55	.00	.23	.34
Crop care:	Group 1	.25	.06	.11	.16	.38	.01	.20	.23
	Group 2	.57	.14	.58	.47	.65	.72	.23	.47
	Group 3	.48	.64	.08	.40	.32	.87	.15	.37
Harvesting:	Group 1	.59	.39	.48	.53	.58	.01	.41	.59
	Group 2	1.15	2.44	2.14	1.65	.85	.79	1.31	.97
	Group 3	1.56	.80	.69	1.17	.96	.33	.97	.85
All operations:	Group 1	.45	.21	.28		.58	.01	.41	
	Group 2	.95	1.61	1.28		.87	.70	.64	
	Group 3	1.11	.65	.38		.77	.51	.50	

III The percentage change from the first to the second year in Group 1 is taken as normal and the difference between this and the percentage change in the malaria affected Group X is calculated:

$$\left(\frac{\text{2nd-year value in Group X}}{\text{1st-year value in Group X}} \times 100\right) - \left(\frac{\text{2nd-year value in Group 1}}{\text{1st-year value in Group 1}} \times 100\right)$$

only the minimum work on clearing and preparing land which was already usable, though perhaps barely so.

When the time spent at farm work is considered as a whole, over the period from day 28 to day 224 of the data-collection period, which included the most severe part of the malaria season, it can be seen that the days of work done per hectare of land ready for farming was 7% below normal in this group. Not only was the work done by family members low, but the use of hired labor was very much reduced, probably because cash for paying hired help was scarce and also because hired laborers and family members usually work together, so that if the family couldn't work the use of hired labor would in some instances also be reduced. There were, however, aome examples of unusually high employment of day laborers during the malarious year, as, for example, in the harvesting of corn.

The principal crops were studied individually. The most important is tobacco, which is also Paraguay's principal agricultural export. Corn and cotton rank next in importance on the study farms, followed by manioc which forms the staple item of the diet. Tobacco, cotton and a goodly portion of the corn crop are raised for sale, and manioc, corn, beans and a variety of crops of lesser importance are grown mainly for the use of the household.

The data show that when malaria reduced their ability to work, the farmers concentrated their efforts on their cash crops. In Group 3, almost frantic efforts were made to save the tobacco crop. The whole family was pressed into service, especially during the harvest season when tobacco demands a great deal of care attention for picking, stringing, sorting and drying the leaves. In terms of numbers of days of work, much more work was done per hectare of tobacco by Group 3 than by the other farmers, but the figures on kilograms of tobacco harvested per day of harvesting work show clearly that the efficiency of this labor was very low. Over the whole first year's crop, these farmers managed to get an acceptable tobacco harvest per hectare of tobacco despite their illness, but in terms of yield for days of work put in their performance was poor.

In cotton, days of work appear to be at a normal level, but here too the efficiency was far below normal so that the work actually performed was inadequate to the need and the harvest was reduced so greatlu that the yield per hectare was 43% below its expected level.

Corn is a crop which allows the farmer great leeway in performing his work; planting is relatively easy, harvesting may be delayed for long periods while the ears dry on the stalk. Poor care during the growing season--lack of weeding, neglect of insect pests--will reduce

the yield but the demands made on the farmer are not so urgent as those of tobacco or cotton. But even in this crop, Group 3 farmers suffered a heavy loss. The growing crop was given inadequate care and when the epidemic grew severe it was completely abandoned. Harvesting was delayed and finally completed long after the other farmers had finished, and then it was finished with an unusual reliance on hired help. The total crop per hectare was 18% smaller than it should have been.

Manioc is a root crop which forms the basis of the rural Paraguayan' diet. It is generally left two years in the ground, but it can be harvested from about 6 months after planting to a number of years later. Most farmers have enough manioc growing so that there is always some in reserve. During the study year when malaria was rampant in the area, the Group 3 farmers used up a good deal more of their manioc than they normally would have done. Their harvests of this crop were 15% above their usual level and that this was not planned but a form of forced drawing-down of capital is shown by the fact that in the following year, when they were free of the disease, they worked hard to replace the used-up acreages.

Most of the remaining crops raised were grown in such small amounts that they could not be analyzed separately. When eight such crops, including sweet potatoes, sugarcane, onions, garlic, bitter orange, bananas, peanuts and soybeans were aggregated, however, it can be seen that these crops were even more neglected than corn and manioc, and the yields were 70% below normal. The priorities of the various crops were quite plainly: first, cash crops; next, corn; then manioc; and last, the minor crops that afforded variety to their diet or were perennials.

From study of the prices that the farmers received for those crops sold, it is possible to determine something about the quality of the product. The group 3 farms' harvests were apparently about 3.5% below average in quality compared with Group 1, in tobacco and corn; and while they had a level of quality 1% above Group 1 in cotton, they were still 5% below Group 2.

The timing of sales of produce tell us something about the bargaining position of the farmers. Prices tend to rise toward the end of the selling season, when the bulk of the harvest has already been sold. Group 3 farmers were clearly in the habit of taking this into account and waiting for higher prices before selling, as can be seen in the following year. In tobacco, they managed even in the malarious year to hold on to enough of their crop so that their selling price averaged over their entire sales was 8% above that received

by Group 1 despite the lower quality of their tobacco. In cotton they were somewhat less successful. In corn they failed completely, evidently selling off whatever they could in order to get some cash, and the result was that they compounded their 18% loss in kilos of corn harvested by losing 19% of the value of the corn they sold.

In summary, in this hard-hit group the farmers and their whole families worked many long hours whenever they were able to, but despite these strenuous efforts they couldn't do as much work as usual, couldn't clear as much land as planned, planted less acreage of crops than they would have done, and the crops they did plant, leaving aside manioc which they were using up at a rapid rate, yielded 36% less than they normally would have obtained from them. These farmers customarily used a quite high percentage of hired hands to help them in farming their larger-than-average acreages, but the malaria epidemic cut down their ability to hire help. Paraguay boasts a wide-spread system of mutual assistance among the rural population but this also broke down, since illness prevented these farmers from reciprocating for any work they might have received from their neighbors. They had one advantage: although they were unable to hire much help, they were not burdened with the cost of supporting these same laborers is they also fell ill. To this extent, the cost of illness could be shifted onto others, who had to bear their own expenses as well as finding the market for their services reduced.

The farmers of Group 2 were considerably less hard-hit by malaria but they nevertheless experienced enough illness to show its effects. These were also prosperous farmers with large farms, but in this group farming was to much greater degree carried out using family labor; it will be remembered that there were considerably more workers per farm than in either of the other groups (28% more than in Group 1). There were also more dependents and the ratio of inhabitants to workers was 6% higher than in Group 1.

Deforestation was adversely affected on these farms, too. It so happened that the malaria season caught them with more land in process of being cleared than the Group 3 farmers had had, and they made every effort to complete this work, but also no additional deforestation was initiated after the study began although on the healthy families' farms nearly 4% of new land was started during these weeks. The clearing away of weeds and detritus was reduced to a bare minimum, leaving much work undone which would make the followinf year's operations more difficult. Planting activity fell below normal once malaria became a common occurrence, and the total crops planted were apparently 8% below what would have been planted had the disease not affected them.

The care of the growing crops coincided in time with the recurrent waves and gradual worsening of the malaria epidemic. The work of this kind which was done by Group 2 farmers was below the normal amount in tobacco and manioc and somewhat low in corn, but in cotton they seem to have maintained a good level.

Harvesting of tobacco and cotton fell right in the worst part of the malaria season and for corn and minor crops also much harvesting coincided with this period. Efficiency, as measured by kilos of produce gathered per day of work, fell off in cotton and to some extent in corn, but not, evidently, in tobacco. In this group the family members who would not customarily have worked to any extent in farm work pitched in to help with the cotton harvest and also with the corn harvest, and less so for tobacco.

The yields which were obtained on Group 2 farms were not particularly low during the malarious crop year. In the important cash crops, tobacco and cotton, their yields exceeded those of the Group 1 farms and they were only slightly lower than theirs in the remaining crops. Apparently their single-minded attention to the maximization of their current harvests (at the expense of proper farming practices for long-term output) served the purpose and permitted them to bring in acceptably large returns, if these are compared directly with those produced on the farms of Group 1 during the same year.

When the second, malaria-free year is taken as the standard of normalcy for judging the performance of the various groups, however, a serious difficulty arises in the analysis. As already mentioned, between the first and second years there was a very considerable difference in the number of farm workers on the Grojp 2 farms--an exodus from the area occurred and in terms of equivalent adult male workers, Group 2 lost 19% of its workers, or 8% more than did the farms of Group 1.

In addition, the head of the family on one of the 16 farms of Group 2 died of malaria during the first year. His place was taken by a grown, resident son and a 14-year-old son was called home from school, so that no alteration occurred in the statistics of workers because of this death, but it would be unrealistic not to expect a difference in performance.

Both Group 2 farmers and Group 3 farmers had let much work go undone during the malarious year. In the following year, when there was almost no malaria to hinder them, the Group 3 farmers were able to resume their usual pattern, which meant doing more themselves and hiring considerably more labor than they had been able to afford during the epidemic. They caught up reasonably well with the work

left from the previous year and their achievements in terms of harvests and yields were greatly improved.

In Group 2, however, things went otherwise. These families also increased the amount of work they did per person, but there were so many fewer persons to work that compared with Group 1 (which had not suffered from malaria in either year) the total work per farm was just slightly lower rather than catching up. In terms of work per hectare available there was some slight improvement, but even with this the work they could do, which had been inadequate from a long-run point of view in the first year, continued to be inadequate in the second one. In these areas, recently cleared of heavy jungle growth and opened to the sun, if the fields are not regularly cleared they tend to become heavily encumbered with vigorous weed growths, with adverse effect on harvests. The effect of the continuing inadequacy of the work carried out was that yields, which on the farms of the other groups improved, on these farms were merely maintained at the same level for the crops which had received the most attention previously, namely tobacco and cotton. In corn there was some improvement, and the excessively high using up of manioc disappeared which indicates increased ability to produce or to buy alternative foodstuffs. In minor crops, yields were again poor. Over all analyzed crops together, excepting manioc, yields per hectare fell almost 14%. The quality level of the crops, as evidenced by relative prices, was only slightly affected during the malarious crop year (and indeed in cotton it was high), and the following year it continued much the same in the other crops but fell somewhat in cotton.

The effects that malaria produced on the farmers of Groups 2 and 3 were not restricted to the pre-eradication-campaign year in which the disease ran wild in the area, nor even to the carry-over of work in the following year. The decisions farmers make concerning what to plant are influenced, naturally, by the kinds of land they have available. The land loses fertility when farmed, and after four or five years is usually left fallow for an extended period. During the years it is in use, the crop is adapted to its 'age'; this if deforestation has not been carried out as planned, a rearrangement may be necessary in the plans for planting various crops, or else lower yields must be accepted.

The findings of this study have implications in the larger subject of the relationship between health and economic development in a number of subject-areas. The first is the light it throws on the question of whether the existence of underemployment or unemployment in a given sector of an economy prevents illness from producing an effect on economic activity, by providing a pool of labor so that persons who are

ill are merely replaced by others previously unemployed. Underemployment in the Paraguayan rural areas is estimated at about 40%; nevertheless the study shows that under two quite different situations the amount of work actually carried out was reduced by illness--the situation in Group 2, which relied primarily on family workers, and that in Group 3, which used a large input of hired labor.

Related to this point in the functioning of the system of mutual assistance among neighbors. This institution is firmly established in Paraguay and even has a special name, "minga"; nonetheless, the effect of serious illness was actually intensified rather than offset by this labor-exchange system. The families with illness were unable to assist their neighbors and there was therefore nothing for their neighbors to repay, so that work which might well ordinarily have been done more efficiently in a group, had to be done by the family alone, if at all.

Still related to this point is the matter of the participation in the farm work of family members who did not normally work in the fields. This certainly occurred, and prevented losses from being as great as they would otherwise have been. It was not sufficient to maintain production at its usual level.

A second subject of great interest in connection with the economics of development is that of the growth of capital. To develop, a region must increase its stock of capital or in other words, not consume everything produced but save a part. In subsistence and semi-subsistence farming areas such as that studied, which in fact make up a large part of the developing regions of the world, capital formation takes the form of improvements on the land, gradual acquisition of tools, and the construction of farm buildings. In the study areas a major form is the clearing and bringing into use of new land surfaces taken from the jungle. Money is involved very little in this kind of investment' it is work which is invested in the future rather than in current consumption. Capital formation was clearly reduced by malaria in our study area.

It is an objective of the Government of Paraguay to develop and to integrate into the national economy vast stretches of forested areas of which the colonization zone where the study was located forms a part. The aim is to clear these hectares and utilize them for agriculture. The study farmers mostly had 30 ha lots so that there was no practical limit on their possibilities for expansion. Nevertheless, after the year when malaria struck hard in the study localities, a general exodus of men of working age took place. Alternative employ-

ments were scarce and not very attractive, but farming no longer looked promising to these men, despite the availability of abundant good land.

One additional point deserves mention. Integration of subsistence farmers into the money economy is a necessary first step in bringing about economic development. But illness can be seen in the study findings to have greatly increased the risk which the farmer takes when he departs from the traditional pattern of raising only staple crops for his own consumption (crops which have been raised in the area over generations and which are adapted to the condition of life including malaria at certain times of year). If he invests his time and land in growing crops for market, and because of illness loses them or gets a small harvest, his income may fall below the long-run survival level. He is poor, and he can only afford to take risks with that part of his income that he can manage without should he lose it. In places with unstable malaria, the disease increases the risk and thus diminishes the farmers' willingness to try cash crops, to innovate, to enter into the main stream of the economy. In places with stable, high-endemicity malaria, uncertainty about the disease is much less but it acts to reduce income to such a level that there may be nothing which <u>can</u> be risked, no margin over survival levels.

The results of this research may perhaps be of use to you, the Directors of the NMES, in your discussions with the Ministries of Health, of Finance and perhaps of Agriculture, especially in connection with the funds assigned to the eradication campaign. With respect to areas within your countries where there already exist or are planned projects for economic development, the results of the study are particularly appropriate to support requests for funds for anti-malaria activities.

We also hope that you will be able to use the study to further the use of this method for the study of the relation between health and the economy, based on research on a micro-economic scale but with concrete data--for example, as a methodology suitable for doctoral candidates in the economics faculties of the universities. Research into many points of great interest both to public health workers and to economists and planners can usefully be carried out in the field in this way.