Transient Health Shocks and Agricultural Labor Demand in Rice-producing Households in Mali

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Introduction

Malaria and other transient illnesses have been recognized as factors constraining economic development in tropical countries. Gallup and Sachs (1998) found that the presence of malaria partially explains differences in GDP per capita even when factors such as accessibility to the coast, resource availability, tropical location, government, colonial status, quality of public institutions, and trade openness were controlled for. Countries severely affected by malaria had only 33 percent of the income level of countries that were malaria free in 1995 and grew 1.3 percent slower per year over the period of 1965-1990. Estimates by McCarthy *et al.* (2000) are lower but still indicate that malaria reduces annual economic growth by 0.55 percent per year.

The intensity of malaria prevalence in a region is greatly influenced by environmental factors such as rainfall and temperature. In addition to these climatic factors, human activities can influence malaria transmission. A number of studies show that irrigation, especially irrigation schemes used in rice cultivation, are associated with higher mosquito density (Boelee, 2003; Mutero *et al*., 2004). In addition, many studies have examined the difference in mosquito species and malaria prevalence between irrigated farming and non-irrigated farming villages (De Plaen *et al.* 2003, 2004; Mutero *et al.*, 2004; Sissoko *et al*., 2004; Dolo *et al*., 2004). Surprisingly, the introduction of irrigation/rice cultivation does not necessarily lead to higher malaria prevalence in areas where malaria transmission is stable (Ijumba and Lindsay, 2001).

The purpose of this paper is to determine the direct and the indirect impact of transient illness shocks, caused primarily by malaria but also including other tropical illness, on family labor use in irrigated rice production in Mali. Family labor is the most important factor of production used in rice production in Mali and transient illness shocks may negatively impact labor supply, production and hence household welfare derived from agricultural income and consumption. Two labor demand models are estimated to determine whether illness does indeed reduce labor supply: one where the dependent variable only includes family labor and a second that combines family and hired labor. These models can be used to test two sets of hypotheses on the relationship between illness and labor supply. First, we hypothesize that short-term transient illness shocks affect household labor supply implying that intrahousehold coping mechanisms are not wholly effective. Secondly, we hypothesize that hired labor markets are ineffective in mitigating illness shocks.

Health and Agricultural Labor Use Literature

Audibert (1986) attempted to measure the impact of malaria on rice production using a production function model without controlling for illness endogeneity. Two explanatory variables related to the health status of the households were included in the model: one captured the impact of malaria and another impact of schistosomiasis on rice output. Audibert found that a 10 percent increase in schistosomiasis prevalence reduces agricultural output by 4.9 percent but that malaria had no effect. Wang'ombe and Mwabu (1993) also used the level of parasitaemia as a proxy for malaria prevalence. The coefficient for malaria was insignificant and the explanatory power of the regression was extremely low. Audibert (1997) and Audibert and Etard (1998) collected data from a quasi-experimental study to measure the impact of schistosomiasis on rice production in

Mali and found that treatment for schistosomiasis had a significant effect on technical efficiency, that better health increased labor productivity and reduced the number of people required to accomplish the agricultural tasks. Baldwin and Weisbrod (1974) analyzed the impact of five parasitic diseases on labor productivity (*i.e.* schistosomiasis, ascariasis, trichuriasis, stongyloidiasis, and hookworm infection) and found that stongyloidiasis reduced weekly earnings, productivity per day, and the number of days worked per week for women.

Measuring with accuracy the economic costs of malaria, whether directly or through its impact on agricultural production, is extremely complex. One difficulty in obtaining accurate estimates lies in disentangling anticipatory coping strategies employed by individuals who constantly face the burden of disease (adaptation of routine behavior to mitigate the negative impacts of illness, such as labor specialization or timing labor-intensive crop management activities with periods of low disease prevalence) from inefficiency. In addition to these preventive routine behaviors, households employ "reactionary" coping strategies causally related to illness. Through the use of qualitative interviews, Sauerborn and Adams (1996) identified eleven strategies used by rural households in Burkina Faso to cope with illness. Seven of them were used to financially cope with illness and four with labor losses (referred by the authors as "indirect costs") due to illness. The primary financial strategy was savings mobilization. Intra-family labor substitution was the main strategy to compensate for lost labor due to disease. Substitution of labor for capital through greater use of mechanical or animal traction allowed families to reduce agricultural production losses.

Mock *et al.* (2003) interviewed over twenty-one thousand people living in the urban and rural areas of Ghana in order to determine the economic consequences of injury and the coping strategies that employed at the family level. They found that coping strategies reported by the Ghanaian families are similar to the ones described by Adams *et al*. (1998). In addition, Mock *et al.* established the secondary economic effects of injury. Almost half of the rural households registered losses of family income, about one-third have reported a reduction in food production, and 41 percent have experienced a decline in food consumption. Moreover, Mock *et al.* found that the burden of labor reallocation was felt primarily on women (81 percent), consistent with findings by Nur (1993). Nur found that 95 percent of the labor substitution was accomplished by women and children. This study also suggests that the substitutes were not as productive as primary workers since the substitutes worked 20 percent more to accomplish the same tasks.

Coping mechanisms in developing countries are widespread and ignoring them can lead to misleading conclusions. Chima *et al.* (2003) underlined that valuing the productive time lost based on the average wage without allowing for labor reallocation probably overestimates the burden of disease on the economy as a whole. On the other hand, the economic costs of disease will be under-estimated if the secondary effects of coping strategies, as such loss of savings, capital depletion, and withdrawal of children from school are not taken into account. By contrast, Wang'ombe and Mwabu (1993) documented that the number of malaria cases per household did not have a significant effect on income and acreage planted. Substitution of family labor was one hypothesized explanation. Also, Audibert and Etard (1998) found that the paddy yields were not significantly greater when health is improved which suggests that coping strategies are present and effective.

Finally, Sauerborn and Adams (1996) suggested that the dependency ratio affects a household's ability to substitute labor. According to these authors, agricultural production losses due to illness would be greater for households with a high dependency ratio because labor substitution is limited. This last aspect will be considered in the current study in order to verify if their finding holds for rice production in Mali.

Modelling Effective Labor in Agriculture

This study develops two measures of transient health shocks: the first captures the direct impact of illness on family labor supply and the second the indirect impact. These health shocks are then transmitted to labor shocks by building upon the health-labor productivity models of Grossman (1972). Assume that farm production, *Y*, is a function of labor, *L*, (subscripted *F* for family and *M* for non-family), land, *A*, capital, *K* as well as health shocks *H* and a vector of household and environmental characteristics *Z*.

(1) $Y = Y(L_F, L_M A, K; H, Z)$

In this study, the direct impact refers to workdays lost caused by an illness episode affecting a family member participating in agricultural production activities. The indirect impact refers to illness episodes that occur during the agricultural season to family members who do not participate in agriculture. This type of illness might also lead in workdays lost because of time reallocation towards care-giving as opposed to cultivating rice and therefore reduce the effective amount of labor supplied (L_F^E) by the household:

(2) $L_F^E = \psi L_f (L_M A, K; H, Z)$

This is done by estimating two models: one for illness with a direct impact on labor, and a second model for illness with an indirect impact on labor. The first model, a survival model, identifies factors that explain the number of workdays lost per illness episode of a family agricultural worker. The second model, a Poisson model, explains the number of illness episodes, per household, that occurred to family members who are not active in agriculture[1]. Therefore, health shocks can be represented:

(3) $H = \begin{bmatrix} \hat{I} \\ \hat{D} \end{bmatrix}$

Where I and D are the predicted results from the firsts stage regression used as explanatory regressors in OLS effective labor demand models (2).

The data used in this research was collected for a joint study by the *Institut d'Economie Rurale* of Mali and Human Health Consortium based at the West Africa Rice Development Association. The data collection took place in three villages from September 1995 to February 1998 with detailed information gathered over three cropping

[1] These regressions are documented in Larochelle (2005) and are available from the authors. The regression results are provided in the appendix due to space limitations.

seasons: the dry season in 1996 and the rainy season in 1996 and 1997. We restrict our analysis to the rainy seasons. In each village, 30 households were surveyed on household demographics, a daily recall of agricultural production activities and final questionnaire, administered every ten days, about the ill-health status of family members including information on diagnosis, treatment, cost of treatment, and personal characteristics of those afflicted. We analyze the labor allocation impacts of short-term illness episodes only and neither chronic nor congenital disorders.

Family Labor Demand

The dependent variable for the family labor demand model is the number of family labor hours allocated to manual labor in rice production. This variable was created by summing family labor applied in field preparation, planting, weeding, bio-chemical input application, and harvesting. Other types of labor, such as that using draft-animals or tractors, are not included as family labor because these activities are often custom hired. These types of labor will be referred to later as "mechanical labor".

A quasi-fixed family labor demand model is developed. We build upon a standard formulation by including variable and quasi-fixed factors of production and exploit price information wherever possible. To explain labor demand we include the price of fertilizer to capture implicit substitution/complementarities, the area of rice paddy under cultivation, and two measures of labor specialization in household production. Family wage information is unavailable since it is determined endogenously. As a proxy for this variable, measures of labor specialization and management are developed. The first measure is the proportion of hired labor hours relative to household supplied manual labor and the second is the proportion of mechanized labor relative to household supplied manual labor. Both will affect the virtual price of household labor. Lower values suggest that rice production is more reliant upon household-supplied labor and more susceptible to transient health shocks.

Secondly we integrate household characteristics into the model to account for managerial and household heterogeneity including the age and literacy of the household head, family size, and the household dependency ratio. The age of the household head should influence the authority over the family members and influence crop and labor management decisions. Older household heads are expected to have greater managerial authority than young ones and the squared term captures declining authority where management decisions may be contested and opposed (Audibert *et al.*, 1999). As a result, age is expected to have a positive effect on labor supply up to a certain point, and then, negatively impact labor supply.

Literacy is a proxy measure for education and a dummy variable indicates if the head of the household is literate (1) or not (0). The effect of literacy on family labor is indeterminate. A positive relationship is expected between family size and labor. The dependency ratio is measured as the number of children under the age of 15 plus the number of elderly divided by the number of adults aged between 15 and 59. The dependency ratio and family agricultural labor should be negatively correlated. Raising young children may decrease the time available for farming in families composed of several dependents and few working adults. Environmental characteristics are expected to affect family labor and are controlled through dummy variables to differentiate between villages and across years. Descriptive statistics of this sample are presented in Table 1.

[TABLE 1 GOES ABOUT HERE]

Identifying Transient Health Shocks and Labor Impacts

Transient illness shocks are captured using two variables: (1) the count of illness episodes that occurred to family members who do not participate in agriculture and, (2) the number of workdays lost for individuals who produce rice. The first variable measures the indirect impact of illness on family labor and the second, the direct impact. Illness that occurred to individuals who do not contribute labor to rice production is hypothesized to generate labor shocks because of the time working adults shift from rice cultivation to care-giving. The magnitude of the indirect impact of illness on labor is a function of length and the severity of the illness.

The impact of one day of illness on family labor varies greatly according to the sign and the size of the coefficient associated with the number of workdays lost. The implication of one day of illness is based on the assumption that a normal workday is eight hours. If the coefficient associated with workdays lost is negative and greater than eight in absolute value, one day of illness causes more than one workday to be lost. This suggests that family labor substitution did not occur and a working member might have shifted time toward care-giving as opposed to cultivating rice. If the coefficient remains negative but is less than eight in absolute value, one day of illness results in less than one workday lost implying that intra-family labor substitution might have taken place. If the coefficient associated with the number of workdays lost is insignificant, one day of illness does not translate into labor loss. Working time lost caused by one day of illness might have been fully compensated by family labor substitution. Finally, if the estimated parameter for the number of workdays lost is positive, one day of illness would increase family labor. This could indicate that labor substitution took place, but the substitutes were not as productive as the individual who usually does the work. This may force to substitutes, such as women and children, to work more than eight hours to compensate for one day of illness (Nur, 1993; Mock et al., 2003).

Sauerborn and Adams (1996) suggests that the impact of illness on farm family labor depends on the household's dependency ratio. In order to verify this assumption, an interaction term between the dependency ratio and the number of the workdays lost was included in addition to the two variables that capture transient illness shocks. Households with a high dependency ratio might have more difficulty coping with illness because intra-family labor substitution opportunities are limited. Families composed of few dependents and several working age adults, *i.e.* households with a low dependency ratio, might be in better position to compensate for the time lost resulting from illness.

[TABLE 2 GOES ABOUT HERE]

The marginal effect of the area cultivated on labor demand is consistent with theory. The positive sign on the price of fertilizer indicates that labor and fertilizer are economically competitive or rival in demand. The parameter related to the proportion of hired labor is insignificant in this model. This implies that family and hired labor might not be perfect substitutes, which supports the assumption of non-separability in household production and consumption decisions. However, the variable associated with the proportion of mechanized labor relative to manual labor is significant and the coefficient is negative as hypothesized. This result suggests that households who can supply greater amount of mechanized work need to devote less hours to manual labor.

All the variables describing household characteristics, except the literacy of the household head, are significant. This model supports the hypothesis that the authority of the household head increases with age, reaches a plateau, and then decreases. The authority of the household head is greatest when the household head is 60 years old. In this model, an additional family member increases family labor by 37 hours per agricultural season.

Table 2 reveals that illness affects household labor supply. The variable that represents the number of illness cases for family members who do not participate in rice cultivation (who are mostly children) is significant at the five percent level. The estimate indicates that a sick child would reduce family labor supply by 893 hours per cropping season, suggesting that time was shifted toward caring for the sick child as opposed to working. The high value for this parameter is not unusual. Pitt and Rosenzweig (1986) found that illness of the household head, or the household head's spouse, reduces family labor by almost 70 hours a week. These authors suggest that the low incidence of illnesses and the strong impact of illness on labor supply indicate that only highly incapacitating illnesses were reported. In this research, it is also very likely that only severe illness episodes were reported since low illness incidence is found, *i.e.* 0.51 cases per agricultural season per family. At the mean, illness episodes that occurred to individuals who do not produce rice reduce agricultural family labor by 455 hours[2] per agricultural season or about 109 hours per hectare. This value represents an average measure of the indirect impact of illness on agricultural family labor.

The coefficient associated with the number of workdays lost for family members who participate in agriculture is also significant as is the dependency ratio variable interacted with the number of workdays lost. This equation confirms that the impact of illness on labor varies according to the household composition. Because of the interaction variable, the partial derivative of family labor with respect to the number of workdays lost is taken in order to obtain the marginal effect of one debilitating day. The marginal effect of one sick day, at the dependency ratio mean of 1.16, is a loss of little over nine hours of agricultural labor. This equation suggests that the average household is unable to cope with illness through family labor substitution. Moreover, one day of illness in an adult agricultural worker results in more than one day of work lost, signaling, perhaps, that remaining healthy adults may devote time to caring for the sick family member instead of on agricultural work. If only severely debilitating illnesses were reported, ill adults might require help from other family members. Another justification might be that the effective labor supplied by a recovering individual is lower than the pre-illness level.

To show the importance of considering household composition when estimating the affect of illness on labor family, the marginal effect of one day of illness is compared

[2] 893 hours times an average of 0.51 illness cases

between households with different dependency ratios. Households having a dependency ratio of one are able to fully compensate for the time lost due to illness since the marginal effect of illness on labor is zero. The marginal effect of one day of sickness increases with the value of the dependency ratio and reaches 28 hours for a family with a dependency ratio equals to 1.5. The dependency ratio has a maximum value of 2 in this sample meaning that for these households, one day of illness would reduce labor supply by 56 hours. These results demonstrate that labor substitution is limited when the number of dependents becomes greater than the number of active members.

The average measure of the direct impact of illness is a loss of 24 hours of labor per agricultural season. The average indirect impact of illness (a loss of 495 hours of labor) remains greater than the direct impact (a loss of 24 hours of labor) even with the inclusion of the interaction term. These results are not consistent with previous research that failed to detect the impact of illness on farm labor or farm output (Audibert, 1986; Nur, 1993). We suggest that coarse measurement of labor use and of high degree of labor aggregation might explain why these previous studies failed to detect the impact of transient labor shocks[3].

Coping and Labor Substitution

The previous model indicated that illness significantly reduces manual family labor supply. However, if hired and family labors are perfect substitutes, illness should not affect total labor input, as suggested by Pitt and Rosenzweig. They found that "although family labor supply is significantly reduced by illness, total labor input, and

[3] Aggregation bias is evaluated in Larochelle (2005) and confounds the explanatory power of the illness variables.

hence farm profits, remain unaffected" (Pitt and Rosenzweig, 1986). Labor demand is reestimated with the objective to determine if hired labor compensates for time lost due to family illness. To test this hypothesis, the same explanatory variables are regressed on the total hours of labor, which is composed of family and hired labor[4]. If illness does not significantly reduce total labor, family and hired labor can be considered as substitutes, implying that consumption and production decisions are separable in the household framework. It also implies that if total labor is unaffected by illness, rice production will not vary with the health status of the household. This second regression is presented in Table 3.

[TABLE 3 GOES ABOUT HERE]

Consistent results were found across the two models. All the variables related to the quasi-fixed factors of production, the household characteristics, and the environmental factors that were significant in the family labor demand model are significant in the total labor demand model except for the fertilizer price variable.

The value of the coefficient associated with cultivated area is greater in the second model than in the family labor demand. This expected difference is due to the additional hours devoted to rice cultivation by the hired labor. As found in the previous model, the proportion of hired labor relative to manual labor is insignificant, suggesting the imperfect substitutability between the two types of labor. Regressing the variables on total labor instead of on family labor lead to a higher coefficient value for the variable associated with the proportion of mechanized labor. This result suggests that as the

[4]Total labor referred as family and hired labor applied in field preparation, planting, weeding and bio-chemical application, and harvesting. Post-harvest activities are excluded because the do not impact the level of rice production. Moreover, heavy aggregation might bias the estimates toward zero as suggested in the previous section.

amount of work done mechanically increases, the need for both family and hired manual labor decreases.

The coefficient associated with the number of illnesses occurring to individuals who do not produce rice remains significant although its magnitude is smaller. One illness episode reduces total labor by 665 hours while it reduces family labor by 892 hours. This suggests that the time family members spent attending an ill individual, instead of working in the rice fields, was not fully compensated by hired labor. The variable associated with the number of workdays lost is insignificant while the interaction term is significant at the 10 percent level. Even though the direct impact of illness on total labor is not as clear as on family labor model, household composition does impact the ability to cope. The variable measuring the indirect impact of illness suggests that labor substitution, between family and hired labor, took place on a limited scale. There may be transaction, search, supervision or other labor market imperfections associated with hiring labor that reduces the effectiveness of hired labor.

Conclusions

This research shows that illness reduces labor; however, it would be interesting to determine if the reduction in labor induces crop losses. To test this hypothesis a production function could be modeled. A positive marginal productivity of labor would indicate that illness would cause a reduction in rice production. If this occurred, the coefficient associated with labor could be used to estimate the decrease in rice output due to illness. Sensitivity analysis could also be conducted with households experiencing different level of illness. For example, the impact of illness on rice production could be determined for an average household, a household having a higher dependency ratio, a household experiencing more illnesses, and a household having a higher dependency ratio and more illnesses in order to identify successful health-agricultural production intervention strategies.

Hired labor does not appear to be a perfect substitute for family labor. The lack of substitutability between family and hired labors and the significant affect of household composition on family labor implies non-separability between production and consumption decisions in the household sampled in this study. Assuming that labor has a positive marginal productivity on rice cultivation, illness would decrease the quantity of rice produced. Based on this assumption, this research suggests that improving health would increase the rice production and improve household food security in the Office du Niger.

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Table 1: Descriptive Statistics of the Variables Used in the Labor Demand Models

Variables	Description	N	Mean	Std. Dev.	Minimum	Maximum
Family Labor (Hours)	Number of family labor hours applied per wet cropping season in four agricultural activities: filed preparation, planting, weeding and bio-chemical applications, and harvesting. Labor applied in post-harvest activities is excluded.	102	1723.44	1255.66	238	7275
Total Labor (Hours)	Number of family and hired labor hours applied per wet cropping season in four agricultural activities: filed preparation, planting, weeding and bio-chemical applications, and harvesting. Labor applied in post-harvest activities is excluded.	102	2007.19	1360.18	338	7870
Area Cultivated (Ha)	Land cultivated in hectare	102	4.16	2.89	0.69	15.99
Fertilizer Price (Fcfa/Kg)	Average price of one kilogram of fertilizer in Fcfa	102	233.13	13.53	210	271.39
Proportion of Hired Labor	The number of manual hired labor divided by the number of manual family labor applied in the four agricultural activities	102	0.17	0.11	0	0.47
Proportion of Mechanized Labor	The number mechanized family labor divided by the number of manual family labor applied in the four agricultural activities	102	0.08	0.02	0.03	0.18
Age of the Household Head		102	50.99	15.08	26	102
Age^2 of the Household Head		102	2825.26	1750.60	676	10404
Literacy of the Household Head		102	0.39	0.49	0	1
Family Size	The number of family members in the household	102	17.79	11.43	3	48
Dependency Ratio	The number of dependents (individuals under the age of 15 and over the age of 60) divided by the number of active members (individuals between the age of 15 and 59)	102	1.16	0.42	0.40	2.00
Tissana		102	0.48	0.50	0	1
Niessoumana	The base village is Niessoumana	102	0.52	0.50	0	1
Dummy Year	The base year is 1996	102	0.54	0.50	0	1
Household Illness Count	The number of illness case per household that occurred during the wet cropping season excluding the post-harvest period to family members who do not participate in agriculture (who are mostly children)	102	0.51	0.33	0.15	2.09
Workdays Lost	The number of workdays lost during the wet cropping season excluding the post-harvest period resulting from illness episodes that occurred to family members who participate in agriculture	102	2.58	3.53	0	16.54
Workdays Lost*Dependency Ratio	Interaction term between the number of workdays lost and the dependency ratio. The dependency ratio is the number of dependents (individuals under the age of 15 and over the age of 60) divided by the number of active members (individuals between the age of 15 and 59)	102	2.81	4.02	0	21.74

Table 2: OLS Regression Results of Family Labor Demand with Two Illness Variables and One Interaction Term

	OLS			Heteroscedasticity Consistent		
	Parameters		**Std. Err.**	**Parameters**		**Std. Err.**
Intercept	-1208.37		855.47	-1208.37		964.65
Area Cultivated (Ha)	288.95	***	25.82	288.95	***	40.00
Fertilizer Price (Fcfa/Kg)	6.99	**	3.30	6.99	*	3.89
Proportion of Hired Labor	-727.75		461.50	-727.75		445.42
Proportion of Mechanized Labor	-8408.08	***	1989.89	-8408.08	***	2677.11
Age of the Household Head	21.38		13.54	21.38	*	11.41
Age^2 of the Household Head	-0.18		0.12	-0.18	*	0.10
Literacy of the Household Head	47.28		100.14	47.28		70.79
Family Size	37.00	***	10.68	37.00	**	14.10
Tissana	231.94	**	109.73	231.94	***	83.23
Dummy Year	-37.31		105.13	-37.31		99.53
Predicted Household Illness Count	-892.92	***	307.70	-892.92	***	328.68
Predicted Workdays Lost	55.72	*	32.05	55.72	*	28.60
Dependency ratio * Predicted Workdays Lost	-55.96	**	27.09	-55.96	**	21.29
R-squared	0.92			0.92		
Adjusted R-squared	0.91			0.91		
Log-Likelihood	-743.96			-743.96		
Breusch-Pagan	95.97			95.97		
Degree of freedom	13			13		

Note: *, **, and *** represent a level of significance of 10 percent, 5 percent, and 1 percent respectively and sample size of 102 observations.

Table 3: OLS Regression Results of Total Labor Demand with Two Illness Variables and One Interaction Term

	OLS			Heteroscedasticity Consistent		
	Parameters		**Std. Err.**	**Parameters**		**Std. Err.**
Intercept	-1394.41		954.21	-1394.41		1108.61
Area Cultivated (Ha)	339.36	***	28.80	339.36	***	43.97
Fertilizer Price (Fcfa/Kg)	7.07	*	3.68	7.07		4.53
Proportion of Hired Labor	707.15		514.77	707.15		519.19
Proportion of Mechanized Labor	-11047.00	***	2219.57	-11047.00	***	3168.62
Age of the Household Head	24.52		15.11	24.52	*	12.64
Age^2 of the Household Head	-0.20		0.13	-0.20	*	0.11
Literacy of the Household Head	34.84		111.69	34.84		73.11
Family Size	32.39	***	11.91	32.39	**	15.76
Tissana	328.44	***	122.39	328.44	***	90.90
Dummy Year	26.37		117.27	26.37		111.04
Predicted Household Illness Count	-664.91	*	343.22	-664.91	*	351.37
Predicted Workdays Lost	37.45		35.75	37.45		31.36
Dependency ratio * Predicted Workdays Lost	-41.23		30.22	-41.23	*	23.79
R-squared	0.91			0.91		
Adjusted R-squared	0.90			0.90		
Log-Likelihood	-755.10			-755.10		
Breusch-Pagan	100.10			100.10		
Degree of freedom	13			13		

Note: *, **, and *** represent a level of significance of 10 percent, 5 percent, and 1 percent respectively and sample size of 102 observations.

Appendix Regressions

Appendix Table A: Poisson Regression for the Number of Illness Episode per Household (Indirect Effect)

	MODEL 1: Aggregate Wealth			MODEL 2: Disaggregate Wealth		
Variables	**Estimates**		**Marginal Effects**	**Estimates**		**Marginal Effects**
Intercept	-0.143		-0.151	-0.135		-0.142
	(0.246)			(0.250)		
Tissana	-0.739	***	-0.778	-0.751	***	-0.791
	(0.265)			(0.271)		
Niessoumana	-0.808	***	-0.850	-0.814	***	-0.856
	(0.268)			(0.270)		
Dummy Year	0.026		0.028	0.027		0.029
	(0.034)			(0.213)		
Family Size	0.019	**	0.020	0.019	**	0.020
	(0.009)			(0.010)		
Number of Literate Adult	0.098	**	0.103	0.097	**	0.102
	(0.044)			(0.044)		
Number of Malaria Treatment	0.149	***	0.157	0.154	***	0.162
	(0.034)			(0.041)		
Value of Livestock	(-)			-0.013		-0.014
				(0.023)		
Value of Agricultural Equipment	(-)			-0.008	*	-0.008
				(0.005)		
Total Value of Farm Assets	-0.008	*	-0.008	(-)		
	(0.005)					
Deviance	1.059			1.067		
Scaled Deviance	1.059			1.067		
Pearson Chi-Square	0.972			0.980		
Scaled Pearson Chi-Square	0.972			0.980		
Log Likelihood	-96.367			-96.343		

Note: Standard errors in parentheses, *, **, and *** represent a level of significance of 10 percent, 5 percent, and 1 percent respectively, and sample size of 134 observations.

Dependent Variable: Count of illness episodes at the household level

Appendix Table B: Survival Model Regression Results for the Number of Workdays Lost (Direct Effect)

Variables	MODEL 1: Aggregate Wealth Estimates		MODEL 1: Effects of the Covariates	MODEL 2: Disaggregate Wealth Estimates		MODEL 2: Effects of the Covariates
Intercept	1.941	***	(-)	1.977	***	(-)
	(0.177)			(0.184)		
Age	0.008	***	0.81	0.008	**	0.78
	(0.003)			(0.003)		
Gender	0.073		7.52	0.071		7.38
	(0.068)			(0.068)		
Household Head Literacy	0.018		1.78	0.034		3.43
	(0.076)			(0.080)		
Family Size	0.002		0.22	0.003		0.28
	(0.003)			(0.003)		
Value of Livestock	(-)		(-)	-0.006		-0.55
				(0.009)		
Value of Agricultural Equipment	(-)		(-)	0.001		0.09
				(0.001)		
Total Value of Farm Assets	0.001		0.07	(-)		(-)
	(0.001)					
Tissana	-1.027	***	-64.2	-1.065	***	-65.52
	(0.109)			(0.122)		
Niessoumana	-0.927	***	-60.41	-0.947	***	-61.2
	(0.103)			(0.111)		
Dummy Year	0.147	*	15.84	0.147	*	15.79
	(0.087)			(0.087)		
Malaria Treatment	-0.245	**	-21.77	-0.248	**	-21.93
	(0.117)			(0.117)		
Antibiotic	0.28		32.3	0.236		26.57
	(0.197)			(0.206)		
Analgesic	-0.565	***	-43.19	-0.553	***	-42.47
	(0.123)			(0.123)		
Other Medical Treatment	0.029		2.96	0.019		1.88
	(0.114)			(0.115)		
Traditional Treatment	-0.317	***	-27.15	-0.310	**	-26.67
	(0.121)			(0.121)		
Field Preparation	0.245	*	27.74	0.233	*	26.25
	(0.139)			(0.140)		
Planting	-0.296	**	-25.6	-0.302	**	-26.07
	(0.146)			(0.147)		
Weeding	0.194	**	21.39	0.206	**	22.89
	(0.087)			(0.089)		
Harvesting	-0.022		-2.17	-0.023		-2.3
	(0.093)			(0.093)		
Post-Harvest	0.021		2.12	0.019		1.92
	(0.087)			(0.087)		
Scale parameter	0.405			0.404		
Log Likelihood	-123.36			-123.110		

Note: Standard errors in parentheses, *, **, and *** represent a level of significance of 10 percent, 5 percent, and 1 percent respectively and the sample size is 184 observations.
Dependent Variable: Number of workdays lost due to illness at the individual level. These are aggregated to the household level for the labor demand regressions.