Micronutrient Deprivation and Poverty Nutrition Traps in Rural India[*]

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ABSTRACT

We test for the existence of a Poverty Nutrition Trap (PNT) in the case of calories and four important micronutrients — carotene, iron, riboflavin, and thiamine- for three categories of wages: sowing, harvesting, and other for male and female workers separately. We use household level national data for rural India for the period January to June 1994 and robust sample selection procedures due to Heckman to arrive at consistent and efficient estimates. It is discovered that the PNT exists in ten cases. It exists for calories for female harvesting and sowing wages. In the case of carotene male workers engaged in harvesting are subject to the PNT, whereas both male and female workers engaged in harvesting are subject to PNT in the case of iron. In the case of riboflavin female workers engaged in harvesting and sowing and male workers engaged in harvesting are subject to PNT**,** and, in the case of thiamine, female workers engaged in harvesting and sowing are subject to PNT. Thus micronutrient deficiency is pervasive and has a significant impact on labour productivity of agricultural workers in rural India. In particular, female workers are more prone to PNT than male workers.

KEYWORDS: Calorie and Micronutrient deprivation, Poverty Nutrition Trap, Heckman Models

JEL Classification Number: C34, I32, J21, J43

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I. Introduction

UNICEF (2006) has noted that as many as 57 million children under 5 are undernourished in India. While this is an immediate area of concern since reducing undernutrition forms one of the Millennium Development Goals, another important concern is whether such undernutrition impacts upon labour productivity, thus reducing the possibility that earnings from the labour market could be used to reduce undernutrition. World Bank (2006) estimates that India lost $2.5 billion in 2005 because of reduced productivity from malnutrition.

The effect of nutritional intake on labour productivity and wage rates has been an important area for research for health economists and nutritionists for some time. This found initial expression in the form of the efficiency wage hypothesis developed by Leibenstein (1957) and Mazumdar (1959) and formalized and extended by Mirrlees (1975), Dasgupta and Ray (1986, 1987), and Dasgupta (1993), among others. Early surveys include Bliss and Stern (1978a, 1978b) and Binswanger and Rosenzweig (1984). The efficiency wage hypothesis postulated that in developing countries, particularly at low levels of nutrition, workers are physically incapable of doing hard manual labour. Hence their productivity is low which then implies that they get low wages, have low purchasing power and, therefore, low levels of nutrition, completing a vicious cycle of deprivation. These workers are unable to save very much so their assets — both physical and human — are minimal. This reduces their chances of escaping the poverty-nutrition trap (henceforth PNT).[1]

There is a substantial literature on empirically testing for the existence of PNT.[2] Strauss (1986) tests and quantifies the effects of nutritional status as measured by annual calorie intake on annual farm production and, hence, labour productivity using farm household level data from Sierra Leone. He finds significant and sizable effect of calorie intake on farm output, even after accounting for endogeneity. These effects are stronger at lower levels of calorie intake with this being determined through the presence of non-linear terms. Thomas and Strauss (1997) investigate the impact of four indicators of health (height, body mass index, per capita calorie intake and per capita protein intake) on wages of workers in urban Brazil. They discover that even after accounting for endogeneity issues and controlling for education and other dimensions of health, these four indicators have significant positive effects on wages. The effect of the nutritional variables — per capita calorie intake and per capita protein intake — was higher at low levels of nutrition, again determined through non-linear terms. In contrast Deolalikar (1988) finds in a (panel fixed effects) joint regression of the wage equation and farm production in rural South India that calorie intake does not affect either but a measure of weight-for-height does. He concludes that calorie intake does not affect wages or productivity indicating that the human body can adapt to short-run shortfalls in calorie intake. However, the fact that weight-for-height affects wages and productivity indicates that chronic undernutrition is an important determinant of productivity and wages. Swamy (1997) argues that there is only weak support for the efficiency wage hypothesis in the data set on India that he worked with since a cut in the wage rate would lower the efficiency cost of labour without reducing productivity. However, this analysis is based on very small sample sizes and does not involve a formal test for the efficiency wage hypotheses, as it is confined to computing the cost per efficiency unit labour.

Furthermore, the PNT argument has often been motivated in terms of calorie deficiency. It has further been argued that, to the extent that deficiencies of other nutrients are correlated with calorie deficiency, it may not be necessary to model the PNT in terms of nutrients other than calories. However, if deprivation in terms of other nutrients is higher than that for calories and different categories of workers are affected by calorie deprivation and other nutrient deprivation, a modeling of the PNT in terms of other nutrients is still relevant.[3] Furthermore, micronutrient deficiency has independent deleterious effects on health and productivity. Thus Barrett (2002) indicates that micronutrient deficiency directly reduces cognitive and physical activity and, hence, labour productivity. Further, such deficiency indirectly reduces labour productivity by increasing susceptibility to diseases and infections. Similarly Lorch (2001) shows that vitamin A (carotene) deficiency is a serious form of malnutrition which weakens the immune system and may cause blindness. Lukaski (2004) argues that micronutrient deficiency can have profound impacts on productivity and performance. Specifically, thiamine (vitamin B1) deficiency can cause weakness, decreased endurance, muscle wasting and weight loss; riboflavin (vitamin B2) deficiency can lead to altered skin and mucus membrane and nervous system function; vitamin A (carotene) deficiency can lead to appetite loss and increased proneness to infection whereas iron deficiency leads to anemia, cognitive impairment and immune abnormalities. Hence, it is important to examine the productivity effects, in particular, the PNT implications of micronutrient deficiency in addition to calorie deficiency, on which most of the literature has concentrated[4] (Stamoulis et al., 2004).

A significant gap in the extant literature is the neglect of the impact of micronutrient deprivation on labour productivity -including the possibility of the existence of a PNT with respect to micronutrients. In an important contribution, Weinberger (2003) discusses the impact of iron deficiency on labour productivity in rural India but does not model the impact of micronutrient deficiency on PNT. To the best of our knowledge there does not exist any study quantifying the importance of micronutrient deficiency in the formation of PNT. The present analysis attempts to fill this gap. We test for the existence of a PNT in the case of calories and four key micronutrients[5] — carotene, iron, riboflavin and thiamine — for three categories of wages (sowing, harvesting, and other) and for male and female workers separately. We use robust sample selection procedures due to Heckman (1976, 1979) to arrive at consistent estimates. It is discovered that the PNT exists in ten cases. Thus micronutrient deficiency has a significant impact on labour productivity in rural India. The plan of this paper is as follows. In section II we motivate the analysis of PNT and then discuss the data and present the estimation methodology in section III. Section IV discusses the results of the estimation and section V concludes.

II. Poverty Nutrition Traps

In Figure 1, a stylised version of the relationship between work capacity and nutrition is given.[6] The vertical axis represents a measure of work capacity and the horizontal axis income. Note first that work capacity is a measure of the tasks that an individual can perform during a period, say, the number of bushels of wheat that s/he can harvest during a day. Income is used synonymously with nutrition in the sense that all income is converted into nutrition. Nothing of importance changes if 70 or 80 per cent of income share is spent on nutrition. The shape of the capacity curve reflects the assumption that much of the nutrition goes into maintaining the body’s resting metabolism.

Figure 1 here

Assume that working in a labour market generates income, and that piece rates are paid. A piece rate, then, appears as a relationship between the number of tasks performed and the total income of a person. Using these assumptions, a supply curve of labour could be constructed that shows different quantities of labour supplied at different piece rates. Aggregation across individuals yields an aggregate supply curve, as shown in Figure 2.

Figure 2 here

At a piece rate of v_3 there is a gap in labour supply and a discontinuous jump. Introducing a downward sloping demand curve, an interesting case is that in which the demand curve passes through the dotted supply curve. If the piece rate is larger than v^*, there is excess supply, which lowers this rate. On the other hand, if the piece rate is lower than v^*, there is excess demand, so that wages rise. Note, however, that a piece rate of v^* is an equilibrium wage, provided we allow for unemployment.

Figure 3 here

Having some people work and restricting labour market access to others could fill the gap in labour supply. Those rationed out will be relatively undernourished. This completes the vicious cycle of poverty. Lack of labour market opportunities results in low wages and consequently low work capacity which feeds back by lowering access to labour markets. It is easy to show that higher non-labour assets (e.g. land) lead to higher wage incomes. Thus the poor without assets are doubly disadvantaged: not only do they not enjoy non-labour income but also have restricted access to labour market opportunities.

Note that nutritional status depends on both current consumption of nutrients (e.g. micronutrients) and the history of that consumption. In the analysis that follows, we focus on the effects of differences in calorie and micronutrient intake.[7]

The essence of an empirical test for the PNT hypothesis is the specification of a wage equation conditional on nutrient intake and control variables as:

$$w_h = f(nutrient_h, p_1, p_2, p_3, p_4, X)$$

where w_h and 'nutrient' represents the wage and nutrient intake of the h^{th} individual respectively. p_i is the probability of being occupied in the ith occupation with i =1 indicating employment in agriculture, i=2 employment in non-agriculture, i=3 self employment and i = 4 other employment. This set of variables controls for labour market participation. '*X*' represents control variables such as prices of various food products, income of the household from the non-agricultural sector, some household characteristics as well as some regional dummies. The probabilities are taken as the control variables to incorporate the impact of labour market participation on wage rate. It is thus argued that the wage rate of the worker depends on his/her nutrition proxied by micronutrient intake, which in turn depends on his/her wages. Hence the wage rate and micronutrient intake are both endogenous in this model.

III. Data and Methodology

The data used in this paper comes from the National Council for Applied Economic Research (NCAER). The data were collected through a multi-purpose household survey, designed and conducted by the NCAER. This survey was spread over six months, from January to June, 1994. The data were collected using varied reference periods based on some conventional rules. For example, to estimate household income in rural agricultural households, cultivation and output figures used refer to the previous agricultural year. Similarly, to estimate short duration morbidity, occurrence of sickness during the preceding 30 days was recorded, but for major morbidity the reference period was the previous year.

A multi-stage sample design was chosen, in light of cost and time considerations, operational feasibility, and precision of the estimates. In each of the 16 states covered, the districts were cross-classified by income from agriculture and rural female literacy rate to form homogeneous strata in terms of these two variables. From each of these strata a pre-assigned number of districts, depending on the size of the stratum, were selected with probability proportional to the rural population in the district. Given the list of villages in the sample districts in the 1991 Census records, a pre-assigned number of villages were then selected linear systematically after arranging the villages in a *tehsil* (an administrative block) alternately in ascending and descending order of rural female literacy. The households in the sample villages were listed along with information such as religion, caste, major sources of income, cultivable land, and other social and demographic characteristics as well as the occupation of the head of the household. Sample households from each of the strata so formed were selected linear systematically. Thus a total sample of 35,130 households spread over 1765 villages and 195 districts in 16 states was covered in the survey. Data used in this paper cover 6594 households.

A detailed commodity classification was used together with careful measurement of physical quantities of food items consumed. In addition, data on household expenditure on these items were canvassed. Food intake was converted into nutrients consumed using the conversion factors in Gopalan et al. (1971) — these are the most detailed and widely used conversion factors in India. The NCAER survey combines a detailed classification of food commodities with a careful measurement of physical quantities consumed. The conversion of food items consumed into nutrient intakes is thus reliable.

The wage data used are those for harvesting, sowing and other occupations for male and female workers separately. Table 1 shows the distribution of male and female workers over the various occupational categories in these households. Mean wage rates per day for specific tasks were: Male Sowing (Rs. 12.26), Male Harvesting (Rs. 17.56), Male Other (Rs. 15.28), Female Sowing (Rs. 7.86), Female Harvesting (Rs. 12.06), and Female Other (Rs.7.94).

Table 1 here

Although the data are 12 years old, detailed data for a more recent year — covering food consumption, employment, wages-disaggregated by agricultural tasks and by gender-were not available. Further, in view of UNICEF (2006), Svedberg (2004) and Sengupta (2006), the problem of undernutrition for both adults and children remains severe in India.

Any empirical strategy to estimate the PNT must deal with the mutual endogeneity of wage and nutrition. In the literature two standard approaches to doing this have been followed. The first predicts the probabilities of labour market participation from a Maximum Likelihood Multinomial Logistic Regression (multi-logit) model and then uses these as determinants of the wage in an appropriately specified Tobit model of the PNT (Tobin 1958). The second method uses the well-known Heckman self selection procedure.

The Tobit model has some notable limitations (Greene, 2003; Smith and Brame, 2003). The first limitation is that in the Tobit model the same set of variables and coefficients determine both the probability that an observation will be censored and the value of the dependent variable. Second, the Tobit analysis is not based on a full theoretical explanation of why the observations that are censored are censored. These limitations can be remedied by replacing the Tobit model with a sample selection model.

Sample selection models have the advantage that a different set of variables and coefficients determine the probability of censoring and the value of the dependent variable given that it is observed, unlike in the Tobit model. These variables may *overlap*, to a point, or may be *completely* different. Second, sample selection models allow for greater theoretical development because the observations are said to be censored by some other variable, which we call *Z*. This allows us to take account of the censoring process since selection and outcome are not independent. A popular empirical strategy to pursue this is the Heckman procedure. We use the Heckman technique in the present paper. This methodology allows consistent estimates of the individual parameters. In this paper we present Heckman estimates for the wages for which we have a PNT in case of calories and four major micronutrient categories — carotene, iron, riboflavin, and thiamine.

Our choice of variables for the two stages of the estimation is justified as follows. In the selection equation higher rainfall increases the intensity of agricultural activity and, hence, employment. In addition we employ a number of household characteristics that are commonly used in the literature, e.g., age of household head and its square, gender of household head, number of adult males and females in the household, land possessed by the household and its square, and the social group (SC or ST) to which the household belongs. In addition, we control for state level effects such as economic backwardness or whether they are coastal through dummy variables. These variables have implications for job-search (e.g. job search is less costly with better infrastructure, and easier access to labour markets), and farm and non-farm employment opportunities.

For the second stage estimation the wage rates are modelled as a function of predicted nutrient intake and its square (separately for each regression), rainfall and all other household characteristics used in the first stage. The inclusion of the predicted nutrient and its square are motivated by the PNT analysis, rainfall will affect agricultural output and hence agricultural wages, and household characteristics are included because these might independently affect the wage earned (for example, reservation wage would vary with the amount of land possessed, and inversely with SC/ST affiliation). Dummy variables for BIMARU and Coastal states are included because these may have state level effects on the agricultural wage. In addition, prices for four food groups, pulses, gur/ sugar, edible oil and milk, are included. These are the only food groups for which complete data covering the whole sample are available. These food items cover the most important categories of foods: pulses are consumed as a major food item, gur/ sugar and edible oil are intermediates and milk is a relative luxury for the poor. The extant literature places emphasis on both direct and indirect effects of food prices on agricultural wages. The indirect effect is through the nutrient intake (Pitt and Rosenzweig, 1986; Behrman and Deolaikar, 1990; Lakdawalla et al. 2005) whereas the direct effect is through labour market responses emanating from changes in the food market (Bardhan, 1984; Ravallion, 1990; Datt and Olmsted, 2004; Sah and Stiglitz, 1987; Gaiha, 1995; Barret and Dorosh, 1996).

We include the nutritional status and food prices in the wage equation to capture both types of effects.

A table in the Appendix lists the variables used in our analysis.

IV. Results

The case for analysing PNT with respect to micronutrients gathers additional relevance if the level of deprivation in respect of the micronutrients is greater than that for calories, the traditional nutrient used in the analysis of PNT. In Table 2 we depict the deficiency in respect of calories and the selected four micronutrients.

Table 2 here

The extent of deprivation in respect of calories is lower than that for all other nutrients except thiamine. In view of the fact that micronutrient deficiency affects labour productivity, it can be surmised that there is a strong case for studying the PNT for nutrients other than calories.

Heckman estimation of the PNT model shows that PNT exists in ten cases. It exists for female harvest wage and female sowing wage for calories. In the case of carotene male workers engaged in harvesting are subject to the PNT, whereas both male and female workers engaged in harvesting are subject to PNT in the case of iron. In the case of riboflavin female workers engaged in harvesting and sowing and male workers engaged in harvesting are subject to PNT and in the case of thiamine female workers engaged in harvesting and sowing are subject to PNT. In all these cases the coefficients of the predicted nutrient and its square are strongly significant and have the right signs, thus indicating the presence of a PNT in these cases. These results are shown in Table 3.

Table 3 here

It should be noted that whereas the PNT holds for calories only in the cases of female sowing and female harvesting wages it holds for males in the case of male harvesting wages (carotene, iron and riboflavin). Furthermore, for females PNT holds in respect of harvest and sowing wages for calories, thiamine, and riboflavin, PNT does not exist for females in the case of carotene and it exists only for harvesting wages in the case of iron. Hence, an analysis which concentrates exclusively on energy intake may present an incomplete picture of the existence of PNT.

Most of the variables have the expected signs. In the selection equation rainfall is positive and significant at about the 10 per cent level, although coefficients vary across the equations. The age of the head of the household and its square are not significant. A larger number of adult males in the household has a significant and negative effect, probably because adult males are substitutes for females in agricultural employment. A larger number of adult females in the household has a significant and positive effect as this increases the number of workers available for working in agricultural activity. On the other hand, adult females are complements, since one or two could handle household chores. It is well-known that the share of households belonging to backward groups (SC and ST in particular) is disproportionately higher among the poor. Hence this variable is associated with a positive and significant impact on opting for agricultural activity. Consistent with this, since BIMARU states have higher than average incidence of poverty, households in such states show a greater tendency to opt for agricultural employment. Coastal states experience less uncertainty about rainfall and, hence, have greater intensity of agricultural activity, *ceteris paribus*. Hence this variable has a positive and significant coefficient in the selection equation. Finally, the share of female-headed households in the rural poor is in excess of their proportion in the population of households. Hence female headed households show greater proclivity to engage in agricultural activity and this variable has a positive and significant effect on the selection equation.

In the wage equation for sowing, rainfall has a negative and significant effect, reflecting the possibility that higher rainfall reduces the need for re-sowing and hence lowers wages. Higher rainfall raises harvest prospects and, since female harvest wages are lower than male harvest wages, more females are employed and their wages go up. Commensurately, fewer males are employed for harvesting and male harvesting wages go down. The BIMARU dummy has a negative sign indicating that wages in such states are lower, relative to other states- particularly the more prosperous coastal states the dummy for which has, in accordance with this argument, a positive and significant sign. Higher prices indicate lower availability of nutrients, *ceteris paribus*. Hence, in agreement with earlier studies, (e.g. Bardhan, 1984; Ravallion, 1990; Gaiha, 1995), higher food prices are typically associated with a negative and significant sign in the wage equations. The impact of age of head and its square varies over the various wage equations. Female wage rates drop as the number of adult males in the household rises, presumably because, *ceteris paribus*, more males are available for agricultural work (as noted earlier, because of the substitutability of males for females). The impact of the number of males on male wage rates is, however, insignificant because some of them might migrate to non-agricultural work. Households with more adult females will have more female workers available for working on agricultural occupations, hence female wages rise**.** The number of adult females does not have a significant impact on male wage rates, since some of the males might migrate. The effect of household size varies over the wage and gender categories. Since SC and ST have a disproportionately higher share of the poor, such households have higher number of agricultural labourers so that wage rates are higher, *ceteris paribus,* as our results indicate.

As Tables 3 a to 3j indicate the null of no selection bias (as captured by the statistical significance of Mills lambda) is rejected for (i) male harvest wages carotene, (ii) male harvest wages iron, and (iii) male harvest wages riboflavin. The standard errors reported for these three cases are corrected for the sample bias.

In all these cases the signs on the coefficients of predicted value of the nutrient and its square (say the coefficients of enepchat and enepchat2) support the hypothesis that agricultural wages are non-linear functions of the respective nutrient intakes of workers and also confirm the existence of PNT. In view of this it becomes necessary to calculate the marginal effects of nutrients on wages. If these are positive and significant then augmenting nutrient intake would help increase rural wages and, since agricultural workers are disproportionately represented in the rural poor, reduce rural poverty as well. This is an important implication for policy purposes. Before estimating marginal effects we first find out whether the effect of predicted micronutrients (and squared values) on wages is increasing or inversely U shaped. The effect of nutrient intake on wages is inversely U shaped if the value of, say, enepc that maximizes the linear prediction falls within the range of enepc (Greene 2003). The values of nutrients intake that maximize the linear prediction[8] are reported in the second column of Table 4.

Table 4 here

These values are outside the observed ranges of nutrient intake and thus the effect is not inversely U shaped but increasing at a decreasing rate. Thus the effect of nutrient intake on wages, in each case, is always positive. We compute marginal effects of nutrient intake on wages using STATA. Since our empirical equation contains square of nutrient intake as a separate variable, total marginal effects at mean (MEM) are calculated as weighted sum of marginal effects of the relevant nutrient intake, say enepc and enepchat2. The marginal effects along with the p-values are reported in the third column of Table 4.

The marginal effects are significant for all but one of the micronutrients and wage categories and indicate that a policy to increase nutritional intake among the malnourished population can lead to increase in their wage earnings. Thus, for example a policy to sell rice and other foodgrain varieties (with increased bio-availability of micro nutrients) through an improved Public Distribution System could be one way to transmit the fruits of economic growth to rural India.

V. Conclusions

The possibility that when workers have inadequate intakes of micronutrient they may not be able to exert sufficient effort so that their wages remain low which then leads to further poor nutritional outcomes has been known in the literature for almost fifty years now. A number of authors have tried to empirically test for the existence of this trap but none has been able to establish unambiguously that this holds for a subset of the working population and not the whole, and there has been no attempt to do so for micronutrients. Further, the extant literature also has not explored the existence of PNT by gender and occupation.

This paper has attempted to quantify and formally test for the presence of PNT in rural India. It outlines a methodology that can identify the impact of micronutrient consumption on wage rates, even in the presence of mutual endogeneity.

This paper has an important policy implication in that it shifts the focus to lack of nutritional adequacy as a precondition for participation in labour market activities. Even if some succeed in participating, their wage earnings will not allow them to escape the poverty — nutrition trap. Indeed, a mild labour market shock (e.g. associated with a crop shortfall) would worsen their plight, as the risk of loss of employment would be considerably higher. In particular, female workers are more prone to PNT than male workers and there is persistent gender inequality in rural India. Breaking these traps should be a matter of urgent policy concern. We show that improving nutrient intakes can have significant effects on rural wages and, therefore, on the possibility of breaking the PNT as well as reducing poverty in rural India. Thus a principal focus of public health policy should be the awareness building of nutritional implications of diet, especially among women. This could be realised by selling higher nutritional content food grains through the public distribution system with substantial subsidies and amalgamated into Integrated Child Development Schemes (ICDS) without much additional cost.

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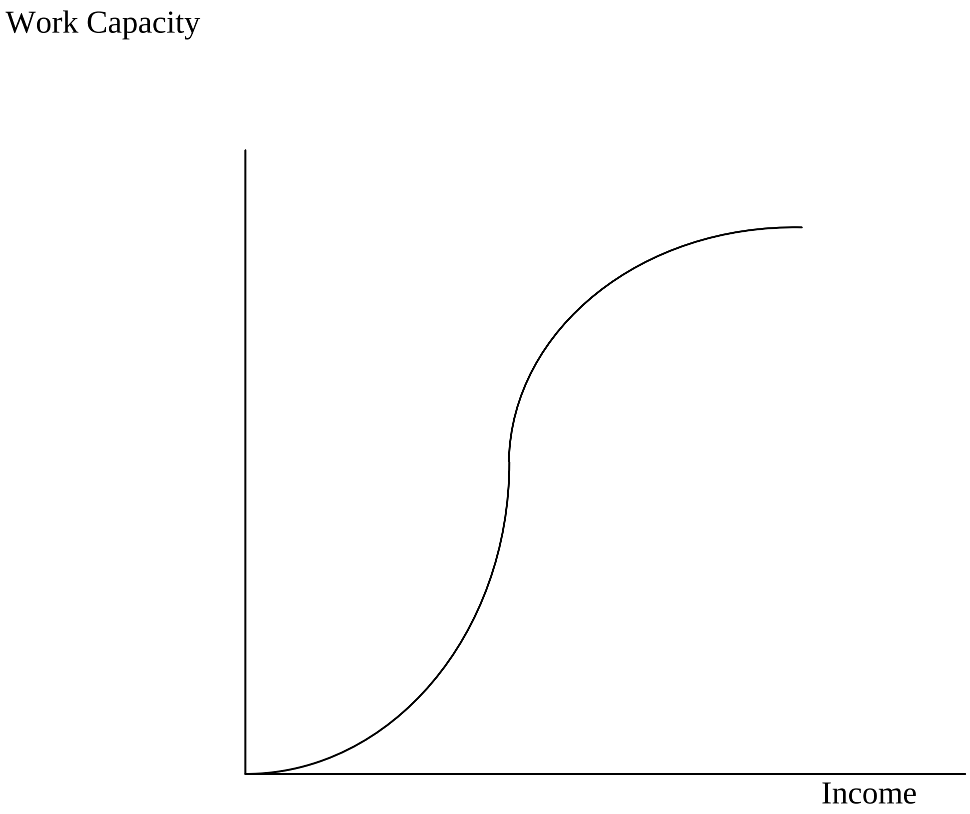
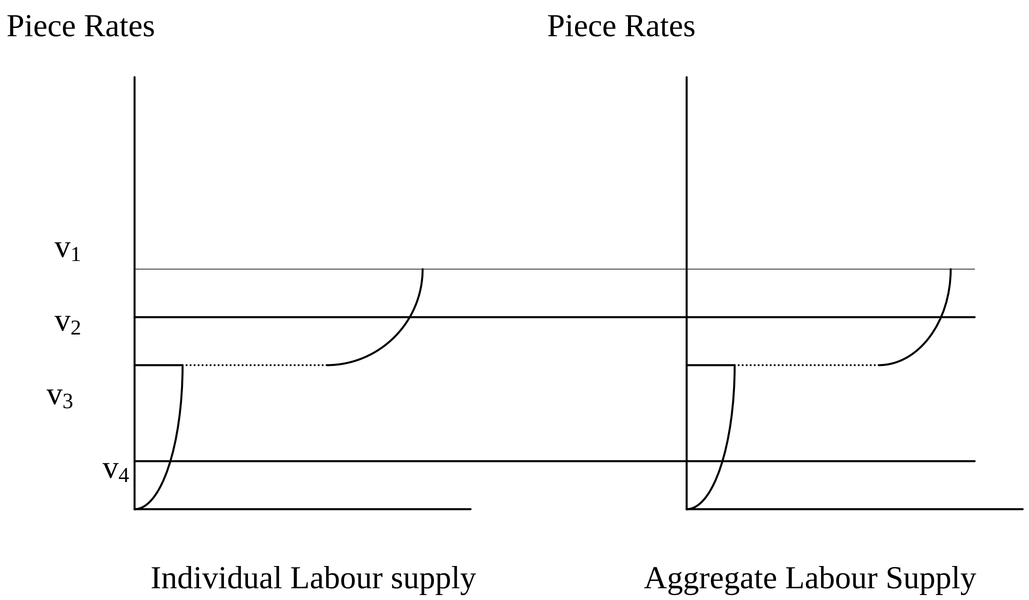
Figure 1: The Capacity Curve



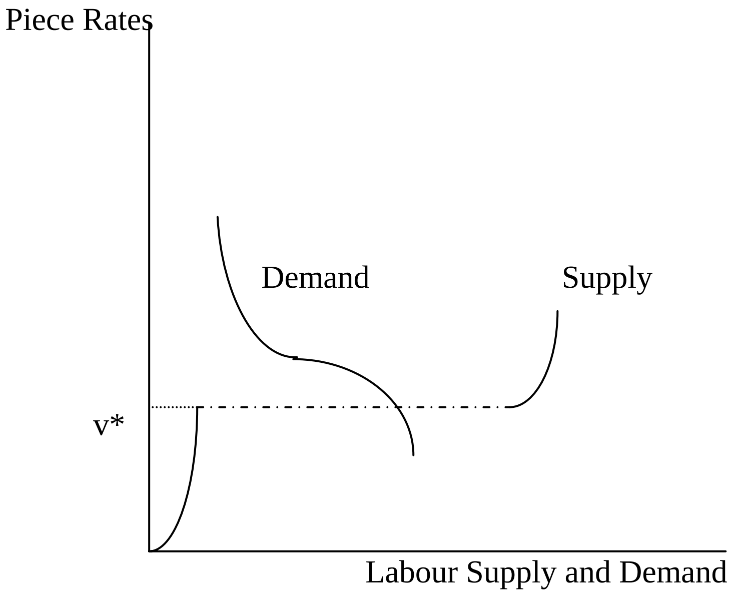
Source: Ray (1998)

Figure 2: Individual and Aggregate Labour Supply



Source: Ray (1998)

Figure 3: "Equilibrium" in the Labour Market



Source: Ray (1998)

Table 1: Number of Male and Female Workers in Different Occupational Categories

Employment Category	No. of Male Workers	No. of Female Workers
Sowing	2151	1800
Harvesting	2717	2201
Other	2660	1922

Table 2: Nutrient Deficiency: Summary Statistics

Micronutrient	Extent Of Deficiency (percentage of households.)***	Minimum recommended daily Allowance **
Energy*	77.3	2800 (Calories)
Iron	77.6	20 (mg.)
Carotene	100	3000 (μg.)
Thiamine*	42.5	1.4 (mg.)
Riboflavin*	90.24	1.5 (mg.)

* Daily Allowance for Moderate Work
** Allowance for Indians based on Recommendations by Nutrition Expert Groups (Table 2), Gopalan et al. (1971).
*** Deficiency computed in terms of adult male equivalent size of household; see Lanjouw et al. (1995).

Table 3a: Existence of PNT in the Case of Calories — Female Sowing Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1175.47
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
Fem_sowing				
Bimaru	-5.88153	0.627624	-9.37	0
Enepchat	0.017007	0.003599	4.73	0
enepchat2	-3.39E-06	7.30E-07	-4.65	0
pr_pulses	-0.0691	0.05287	-1.31	0.191
pr_gur_sugar	0.103302	0.137909	0.75	0.454
pr_oil	-0.08489	0.011671	-7.27	0
pr_milk	-0.07162	0.029082	-2.46	0.014
Headage	0.180339	0.072909	2.47	0.013
headage2	-0.00209	0.000741	-2.82	0.005
NO.ADULTMALE	-0.73618	0.243956	-3.02	0.003
NO.ADULTFEMALE	0.912363	0.245196	3.72	0
Hhsize	-0.53584	0.195397	-2.74	0.006
SC/ST	4.987092	0.655711	7.61	0
RAINFALLINDEX	-0.00227	0.000422	-5.38	0
Coastal	3.226689	0.8655	3.73	0
_cons	-7.22458	3.722152	-1.94	0.052
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
Land_own	-0.00463	0.000427	-10.84	0
Land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	0.867331	1.527327	0.57	0.57
Rho	0.08649			
Sigma	10.02806			
Lambda	0.867331	1.527327		

Table 3b: Existence of PNT in the Case of Calories — Female Harvesting Wages

Heckman Selection Model				
Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1313.11
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
Fem_harvest				
Bimaru	-8.31628	0.736491	-11.29	0
Enepchat	0.013905	0.004224	3.29	0.001
enepchat2	-2.13E-06	8.57E-07	-2.48	0.013
pr_pulses	-0.19393	0.06206	-3.12	0.002
pr_gur_sugar	-0.27138	0.161881	-1.68	0.094
pr_oil	0.068766	0.013702	5.02	0
pr_milk	-0.07809	0.034139	-2.29	0.022
Headage	0.054676	0.085533	0.64	0.523
Headage2	-0.00097	0.000869	-1.12	0.263
NO.ADULTMALE	-1.44647	0.28626	-5.05	0
NO.ADULTFEMALE	1.331039	0.28769	4.63	0
Hhsize	0.067531	0.229362	0.29	0.768
SC/ST	2.477348	0.769413	3.22	0.001
RAINFALLINDEX	0.002109	0.000495	4.26	0
Coastal	3.215776	1.01557	3.17	0.002
_cons	0.554281	4.368315	0.13	0.899
Select				
Headage	-0.00384	0.007484	-0.51	0.608
Headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
Land_own	-0.00463	0.000427	-10.84	0
Land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	-0.5846	1.792234	-0.33	0.744
Rho	-0.04972			
Sigma	11.75735			
Lambda	-0.5846	1.792234		

Table 3c: Existence of PNT in the Case of Carotene — Male Harvest Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	855.78
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
male_harvest				
Bimaru	-4.56189	0.838686	-5.44	0
Coastal	8.536757	1.247139	6.85	0
Carothat	0.042226	0.025161	1.68	0.093
carothat2	-3.6E-05	5.48E-05	-0.66	0.512
pr_pulses	-0.09016	0.081245	-1.11	0.267
pr_gur_sugar	-0.75888	0.167689	-4.53	0
pr_oil	0.07944	0.032429	2.45	0.014
pr_milk	-0.21556	0.045148	-4.77	0
Headage	-0.19455	0.129314	-1.5	0.132
headage2	0.001972	0.001283	1.54	0.124
NO.ADULTMALE	-0.33049	0.330673	-1	0.318
NO.ADULTFEMALE	-0.35287	0.415004	-0.85	0.395
Hhsize	0.16192	0.178945	0.9	0.366
SC/ST	3.456164	0.801135	4.31	0
RAINFALLINDEX	-0.00418	0.000706	-5.92	0
_cons	23.65583	4.10081	5.77	0
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	5.950737	2.459262	2.42	0.016
Rho	0.3613			
Sigma	16.47056			
Lambda	5.950737	2.459262		

Table 3d: Existence of PNT in the Case of Iron — Female Harvest Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1307.95
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
Fem_harvest				
Bimaru	-9.75545	0.768342	-12.7	0
Coastal	4.095827	0.949288	4.31	0
Ironpchat	0.406556	0.156977	2.59	0.01
ironpchat2	-0.00108	0.001051	-1.03	0.303
Pr_pulses	-0.15073	0.060789	-2.48	0.013
Pr_gur_sugar	0.066958	0.104089	0.64	0.52
Pr_oil	0.053591	0.013637	3.93	0
Pr_milk	-0.1079	0.034045	-3.17	0.002
Headage	-0.00831	0.084869	-0.1	0.922
headage2	-0.00029	0.000861	-0.34	0.737
NO.ADULTMALE	-1.53716	0.288819	-5.32	0
NO.ADULTFEMALE	1.324359	0.296754	4.46	0
Hhsize	0.287801	0.190837	1.51	0.132
SC/ST	1.509875	0.658751	2.29	0.022
RAINFALLINDEX	0.002067	0.0005	4.13	0
_cons	5.353557	3.751462	1.43	0.154
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	-0.13373	1.77995	-0.08	0.94
Rho	-0.01137			
Sigma	11.75714			
Lambda	-0.13373	1.77995		

Table 3e: Existence of PNT in the Case of Iron — Male Harvest Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	857.62
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
male_harvest				
Bimaru	-5.85683	1.05078	-5.57	0
Coastal	6.155161	1.304095	4.72	0
Ironpchat	0.598753	0.213019	2.81	0.005
ironpchat2	-0.00192	0.001424	-1.35	0.176
pr_pulses	-0.08201	0.08254	-0.99	0.32
pr_gur_sugar	-1.01802	0.141314	-7.2	0
pr_oil	0.140011	0.018439	7.59	0
pr_milk	-0.22575	0.046168	-4.89	0
Headage	-0.28626	0.117056	-2.45	0.014
Headage2	0.002674	0.001188	2.25	0.024
NO.ADULTMALE	-0.75653	0.395835	-1.91	0.056
NO.ADULTFEMALE	-0.60186	0.40731	-1.48	0.14
Hhsize	0.713695	0.259034	2.76	0.006
SC/ST	4.249521	0.904818	4.7	0
RAINFALLINDEX	-0.00382	0.000692	-5.53	0
_cons	17.93737	5.123513	3.5	0
Select				
Headage	-0.00384	0.007484	-0.51	0.608
Headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	5.965028	2.438496	2.45	0.014
Rho	0.36217			
Sigma	16.47008			
Lambda	5.965028	2.438496		

Table 3f: Existence of PNT in the Case of Riboflavin — Female Harvest Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1315.04
		Prob > chi2	=	0
	Coef.	Std. Err.	Z	P>z
Fem_harvest				
Bimaru	-8.69979	0.682973	-12.74	0
Coastal	4.856649	0.874654	5.55	0
Ribopchat	19.68506	5.33042	3.69	0
Ribopchat2	-3.10063	0.884144	-3.51	0
pr_pulses	-0.32036	0.0766	-4.18	0
pr_gur_sugar	-0.46444	0.212682	-2.18	0.029
pr_oil	0.014812	0.019389	0.76	0.445
pr_milk	-0.07253	0.035181	-2.06	0.039
Headage	0.029473	0.078239	0.38	0.706
headage2	-0.00083	0.000812	-1.02	0.31
NO.ADULTMALE	-1.32507	0.254593	-5.2	0
NO.ADULTFEMALE	2.14764	0.326558	6.58	0
Hhsize	-0.45924	0.186634	-2.46	0.014
SC/ST	3.532966	0.917421	3.85	0
RAINFALLINDEX	0.001959	0.000498	3.93	0
_cons	17.70938	3.919207	4.52	0
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	-0.93	1.805126	-0.52	0.606
Rho	-0.07905			
Sigma	11.76476			
Lambda	-0.93	1.805126		

Table 3g: Existence of PNT in the Case of Riboflavin— Female Sowing Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1163.96
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
Fem_sowing				
Bimaru	-6.25982	0.582979	-10.74	0
Coastal	4.59119	0.746842	6.15	0
Ribopchat	7.953568	4.54607	1.75	0.08
Ribopchat2	-2.65996	0.754095	-3.53	0
pr_pulses	-0.21417	0.065345	-3.28	0.001
pr_gur_sugar	0.025202	0.181411	0.14	0.89
pr_oil	-0.09891	0.016536	-5.98	0
pr_milk	-0.05186	0.030008	-1.73	0.084
Headage	0.111524	0.066825	1.67	0.095
headage2	-0.00146	0.000693	-2.1	0.035
NO.ADULTMALE	-0.57902	0.217344	-2.66	0.008
NO.ADULTFEMALE	1.540435	0.278725	5.53	0
Hhsize	-0.82952	0.159207	-5.21	0
SC/ST	5.095268	0.782903	6.51	0
RAINFALLINDEX	-0.00231	0.000426	-5.43	0
_cons	13.21408	3.344257	3.95	0
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	1.255952	1.540643	0.82	0.415
Rho	0.12488			
Sigma	10.05737			
Lambda	1.255953	1.540643		

Table 3h: Existence of PNT in the Case of Riboflavin — Male Harvest Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	855.85
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
male_harvest				
Bimaru	-5.02615	0.93709	-5.36	0
Coastal	7.754375	1.205664	6.43	0
Ribopchat	16.57579	7.224245	2.29	0.022
Ribopchat2	-1.01885	1.1994	-0.85	0.396
pr_pulses	-0.11481	0.104198	-1.1	0.271
pr_gur_sugar	-0.99214	0.28879	-3.44	0.001
pr_oil	0.096188	0.026285	3.66	0
pr_milk	-0.21793	0.047769	-4.56	0
Headage	-0.26531	0.108266	-2.45	0.014
headage2	0.002524	0.001123	2.25	0.025
NO.ADULTMALE	-0.47042	0.349914	-1.34	0.179
NO.ADULTFEMALE	-0.06158	0.447569	-0.14	0.891
Hhsize	0.233556	0.253754	0.92	0.357
SC/ST	4.184962	1.254253	3.34	0.001
RAINFALLINDEX	-0.00401	0.00069	-5.81	0
_cons	24.6572	5.351575	4.61	0
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	6.014543	2.472365	2.43	0.015
Rho	0.36493			
Sigma	16.4812			
Lambda	6.014543	2.472365		

Table 3i: Existence of PNT in the Case of Thiamine — Female Harvest Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1313
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
Fem_harvest				
Bimaru	-9.05127	0.717627	-12.61	0
Coastal	4.730654	0.880668	5.37	0
Thiapchat	6.997471	2.034776	3.44	0.001
Thiapchat2	-0.37406	0.129869	-2.88	0.004
pr_pulses	-0.27722	0.077499	-3.58	0
pr_gur_sugar	-0.34702	0.212143	-1.64	0.102
pr_oil	0.026536	0.017349	1.53	0.126
pr_milk	-0.07771	0.036087	-2.15	0.031
Headage	0.013247	0.078387	0.17	0.866
headage2	-0.00062	0.000808	-0.76	0.445
NO.ADULTMALE	-1.28784	0.262139	-4.91	0
NO.ADULTFEMALE	2.030463	0.334037	6.08	0
Hhsize	-0.3516	0.208711	-1.68	0.092
SC/ST	3.131536	0.934811	3.35	0.001
RAINFALLINDEX	0.00204	0.000495	4.12	0
_cons	14.79265	4.084994	3.62	0
Select				
Headage	-0.00384	0.007484	-0.51	0.608
headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
land_own	-0.00463	0.000427	-10.84	0
land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	-0.57224	1.789614	-0.32	0.749
Rho	-0.04867			

Table 3j: Existence of PNT in the Case of Thiamine — Female Sowing Wages

Heckman selection	model -- two-step estimates	Number of obs	=	6594
(regression model	with sample selection)	Censored obs	=	2134
		Uncensored obs	=	4460
		Wald chi2(23)	=	1161.76
		Prob > chi2	=	0
	Coef.	Std. Err.	z	P>z
Fem_sowing				
Bimaru	-6.71154	0.612547	-10.96	0
Coastal	4.516915	0.752	6.01	0
Thiapchat	4.062358	1.735448	2.34	0.019
Thiapchat2	-0.3821	0.110773	-3.45	0.001
pr_pulses	-0.16762	0.066114	-2.54	0.011
pr_gur_sugar	0.094087	0.180957	0.52	0.603
pr_oil	-0.10361	0.014797	-7	0
pr_milk	-0.06626	0.030781	-2.15	0.031
Headage	0.089459	0.066956	1.34	0.182
Headage2	-0.00125	0.00069	-1.81	0.071
NO.ADULTMALE	-0.59356	0.223791	-2.65	0.008
NO.ADULTFEMALE	1.568734	0.285119	5.5	0
Hhsize	-0.77374	0.178048	-4.35	0
SC/ST	5.064527	0.797781	6.35	0
RAINFALLINDEX	-0.00236	0.000423	-5.59	0
_cons	10.62989	3.485853	3.05	0.002
Select				
Headage	-0.00384	0.007484	-0.51	0.608
Headage2	2.98E-05	7.67E-05	0.39	0.698
NO.ADULTMALE	-0.03827	0.019037	-2.01	0.044
NO.ADULTFEMALE	0.049924	0.022145	2.25	0.024
SC/ST	0.496191	0.036991	13.41	0
Land_own	-0.00463	0.000427	-10.84	0
Land_own2	-6.04E-08	1.77E-07	-0.34	0.734
RAINFALLINDEX	8.92E-05	0.000052	1.71	0.087
Landrain	4.84E-06	6.13E-07	7.9	0
Bimaru	0.306848	0.041688	7.36	0
Coastal	1.004761	0.066374	15.14	0
FEMALE_HHHEAD	0.246493	0.085797	2.87	0.004
_cons	0.289162	0.166635	1.74	0.083
Mills				
Lambda	1.121481	1.527492	0.73	0.463
Rho	0.11156			
Sigma	10.05244			
Lambda	1.121481	1.527492		

Table 4: Value Maximizing Linear Prediction and Marginal Effects

Nutrient Category	*Value Maximizing Linear Prediction*	*Marginal Effects*
Calories (Calories/day)		
HFS	2,508.41	0.004 (0.003)
HFH	3,366.08	0.006 (0.001)
Carotene (microgram/day)		
HMH	586.47	0.031 (0.012)
Iron (milligram/day)		
HFH	188.22	0.356 (0.003)
HMH	155.93	0.594 (0.005)
Riboflavin (milligram/day)		
HFH	3.17	16.52 (0.000)
HFS	1.50	5.24 (0.19)
HMH	8.13	15.53 (0.015)
Thiamine (milligram/day)		
HFH	9.35	5.93 (0.001)
HFS	5.32	2.97 (0.053)

N.B. The first letter in the acronyms used in this table refers to technique of estimation, i.e. “H” for Heckman; the second refers to gender of workers “M” for male and “F” for female and the third refers to wage category: “H” for harvesting, and “S” for sowing..

Figures in parentheses in the third column indicate respective p-values.

Appendix Table: Variables Used in the Analysis

Household Level Variables	
Variable Name	Variable Description
headage	Age of Household Head
headage2	Square of Age of Household Head
NO.ADULTMALE	no. of adult males in Household (HH)
NO.ADULTFEMALE	no. of adult females in HH
hhgrp	HH Group Dummy Variable 1 if SC/ST HH and 0 Otherwise
HINDU, MUSLIM, CHRISTIAN, SIKH, BUDDHIST, TRIBAL, JAIN, OTHERS	Religion dummies.
FEMALE_HHHEAD	Whether head of household is female.
HIGHESTFEMEDUPRIMARY	Highest level of education for any adult female in household is primary
HIGHESTFEMEDUMIDDLE	Highest level of education for any adult female in household is middle
HIGHESTFEMEDUMATRIC	Highest level of education for any adult female in household is matric
Land_own	Land Owned in Acres
Land_own2	Square of Land Owned
Other Variables	
RAINFALLINDEX	Rainfall Index (actual - normal rain fall) for 76 agroclimatic zones in India.
bimaru	Dummy for Bimaru states (Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh)
coastal	Dummy for Coastal districts
landrain	Landowned*rainfall
pr_pulses	Price of Pulses
pr_gur_sugar	Price of Gur/ sugar
pr_oil	Price of Oil
pr_milk	Price of Milk
Generated Variables	
Enepchat	Predicted value of calorie consumption per capita
enepchat2	Predicted value of square of calorie consumption per capita
Carothat	Predicted value of carotene consumption per capita
carothat2	Predicted value of square of carotene consumption per capita
ironpchat	Predicted value of iron consumption per capita
ironpchat2	Predicted value of square of iron consumption per capita
Ribopchat	Predicted value of riboflavin consumption per capita
ribopchat2	Predicted value of square of riboflavin consumption per capita
Thiapchat	Predicted value of thiamine consumption per capita
thiapchat2	Predicted value of square of thiamine consumption per capita

Endnotes

[1] In this paper we use the terms efficiency wage hypothesis and PNT interchangeably.

[2] For a comprehensive review see Strauss and Thomas (1998). See also Lipton (2001).

[3] We are grateful to an anonymous referee for pointing out this argument.

[4] An exception is Lakdawalla et al. (2005) who found that micronutrient deficiency needed to be considered in addition to calorie deficiency in the case of the US and conjectured that this was probably also true of developing countries.

[5] From a policy perspective it is likely to be more useful to test for PNT for different nutrients separately. An aggregate of deprivation across various nutrients is essentially arbitrary and does not indicate which the most pressing deprivation is.

[6] The following exposition is based on Ray (1998).

[7] For critiques of PNT hypothesis, see Srinivasan (1994), and Subramanian and Deaton (1996).

[8] As can be seen from any of the tables 3a to 3j, the coefficient of the predicted nutrient is positive whereas that of the square is negative. If we set the first derivative of any of the estimated equations with respect to the corresponding predicted nutrient equal to zero we get the maximum linear prediction since the derivative with respect to the square term is always negative**.**