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Labor Productivity Within the African Agricultural Household: The Household Production Model Revisited

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ABSTRACT---The benchmark concept is used to understand changes in farm household response to development dynamics. 1996-97 cropping seasons data from Cameroon is used to develop and test a "separate spheres" household model. Labor productivity for men and women is discussed, along with their implications for research and resource management policies.

-------- KEYWORDS -------
Agriculture, labor productivity, gender, production, consumption developing countries

LABOR PRODUCTIVITY WITHIN THE AFRICAN AGRICULTURAL HOUSEHOLD: THE HOUSEHOLD PRODUCTION MODEL REVISITED

Introduction

A growing body of evidence suggests that the household's response to new opportunities and incentives is affected by internal resource allocation patterns. This study addresses gender-specific impacts of resource use patterns in Cameroon. We develop and utilize a model incorporating the benchmark concept, which is a comparative spatial analysis wherein farm household behavior is observed across a wide area (figure 1). Studies have observed that, in sub-Saharan Africa, the farm household would effect changes in the structure of its resource base in response to perceived pressure to improve performance, or in response to land degradation (Gockowski and Baker, 1996; Baker and Dvorak, 1993). As such, sustainability of the African farm household increasingly is being brought to question in the light of present population pressures, deepening economic crises, and the ever present natural resource/environmental constraints. The issue is whether current agricultural policies, extension services, and technology transfers are capable of helping to create reliable agricultural surplus needed to sustain farm households.

Farming systems research and extension methodology development give substantial attention to research domain definition. Understanding the main factors driving or reflecting resource use and change can facilitate the choice of possible target areas that provide the greatest stimulus for resource use management. Ideally, observations over time are best used to understand the central processes that characterize farm household resource use in response to development dynamics. However, obtaining reliable time series data from sub-Saharan Africa is almost impossible. The best available alternative to the time series approach is the benchmark concept, an approach that uses a comparative spatial analysis (Baker and Dvorak, 1993; IITA, 1992). This approach does not rely directly on farmer perception, or recall of changes, since it is in current time. Furthermore, being a geographical spread approach, it immediately ties into

area-based analyses, allowing for spatial delineation of domains where resource use changes are taking place.

It is well understood that the ability of the household to respond to new opportunities and incentives to increase productivity is often affected by inequalities of resource allocation within the household[1]. This has led to the development and adaptation of the farm household production model made popular by Singh *et. al.* (1986), that aims at explaining the economic choice structures within the farm household. The household model treats the farm household as a solitary unit undifferentiated by age or gender, thus obscuring not only the gender differentiated effects of technical strategies, but also some of the key forces responsible for bringing about changes in these strategies. While not entirely invalidating this aggregate model, sufficient doubt has been cast on its validity in explaining intra-household resource use and allocation. For instance, Christopher Udry et al (1995), provided striking evidence of substantial inefficiencies in the allocation of factors of production across plots controlled by different members of the farm household, in Burkina Faso. The authors demonstrated that a richer household model which recognizes that individuals comprising a household, compete as well as cooperate had important implication for the structure of agricultural production and the design of agricultural policy. Similarly, Gillian Hart (1992), pointed out the limitations of such an approach for understanding technical and economic change within and among farm households in the Muda region of Malaysia. Recognizing these theoretically crucial features of the farm household, the approach used in this study will be a hybridization of the "new home economics" theory complemented by contributions on theory of the family farm by Singh, Squire, and Strauss (1986). This allows for an economic analysis of not just the interdependence of consumption and production decisions of the household but also the incorporation of the socio-economic environment which shapes production relation within which the household participates, and the cultural organization of the household.

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[1]Alderman *et al*., 1994 and Doss, 1996, provide compelling evidence through a review of different household models.

The "separate spheres" agricultural household model employed here is a modification of the bargaining model in that the adults in the household conduct separate enterprises, manage separate budgets, and bargaining is implicit rather than explicit. The sources of bargaining power, which include access to resources, relationship to household head and one's social and/or biological positioning within the household, do not represent a withdrawal option, as in the bargaining model. Rather, they provide leverage in household decision making in such a way as to influence preferences and expenditures. In the “separate spheres” approach, the household is modeled as a single unit of consumption with decision-making control separated over two production processes. These production processes are the husband’s production and wife’s production with both of their labor input jointly shared. The household profit function results from the sum of the husband and wife's restricted profit functions subject to the labor constraints.

This study develops and tests the hypothesis of a “separate spheres” household production model to measure and explain the valuation of household agricultural labor. Spatial analysis in the developmental policy context is guided by the existence of a resource use gradient, in the humid forest zone of Cameroon.

Separate Spheres Household Production Model

The “separate spheres” agricultural household model we propose, emphasizes the valuation of labor as determined by household responses to existent output and input markets (figure 1). This characterization is highly plausible in view of the African farm household setting, where the economic role of women is significant. Here, much greater contribution by women is observed relative to other developing countries (Singh 1988). Based on the female farming system predominant in the HFZ of west and central Africa, this model integrates the works of several authors, including Alderman and Sahn 1993, Moore and Negri 1992, Thijssen 1988, and Singh, 1986.

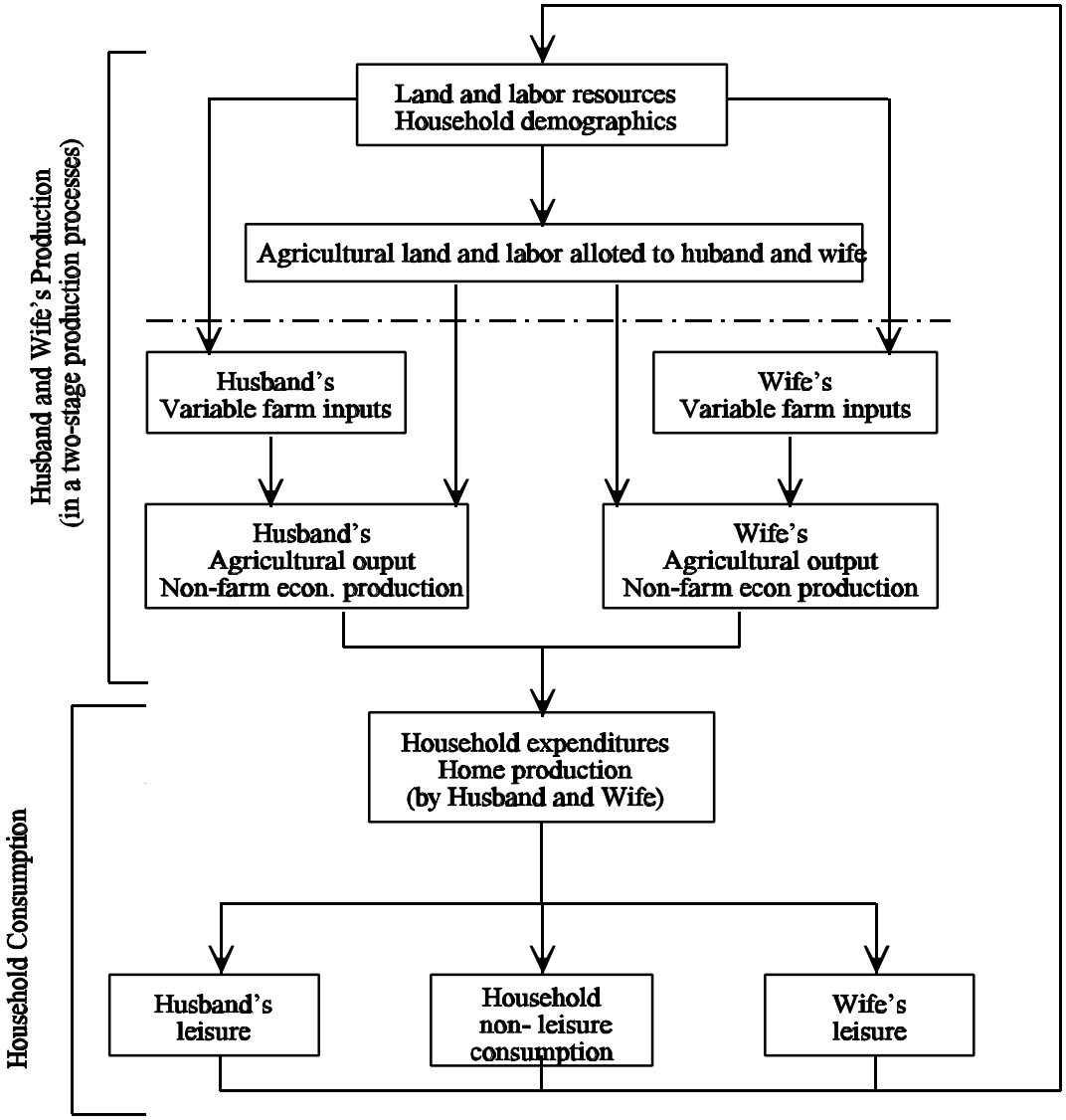

Figure 1. "Separate Spheres" household production model.

Under the separate spheres characterization, household technology consists husband's agricultural labor, wife's agricultural labor available, non-labor inputs variable, and fixed inputs such as land and other family labor. For simplicity, it is assumed at this stage that household resources of land and labor have been allocated to the separate production processes. Further, the decision rule governing this allocation is largely influence by the cultural and historical endowments of the household and thus taken as given. These considerations lead to the

specification of the household agricultural production technology as consisting of two separate production functions with two outputs: Male aggregate output from the husband's fields and female aggregate output from the wife's fields. The household is however, is considered to function under an "economy of affection" (Hyde 1986), which springs from the needs and dynamics of the micro-structures within the household. Therefore, three assumptions guide this specification (Just, Zilberman, and Hochman 1983):

1. Labor, which is the major input to the production process in the HFZ, is also considered to be a major limiting factor to production. The existence of an economy of affection, implies that the labor input of husband and wife are jointly shared by both as fixed allocable inputs.
2. Non-labor inputs are allocated to the husband and wife's production activities separately.
3. As such, the husband and wife's output combinations are determined uniquely by their individual combination of inputs.

The first assumption provides the source of jointness in the household's multioutput production. On the other hand, the last two assumptions, allow for the specification of separate production functions, corresponding to the two outputs. These assumptions thus represent the essential features of the agricultural production within the African farm household, that is, gender-specific production activities within an 'economy of affection'.

With competitive behavior, and regular technology, the duality theory ensures consistency between profit and production functions. The principles of duality and flexible functional forms have found many applications in the agricultural sector (Binswanger 1974, Lopez 1980, Shumway 1983, Weaver 1983, Moschini 1988 and Elhorst 1994). Here, the profit function approach is used, because of its versatility in examining the production behavior and price responsiveness of farmers in developing countries, under a variety of market and institutional structures (Sevilla-Siero 1991). The basic behavioral assumptions required for using the profit function are that both husband and wife maximize profit given household utility, and act as price takers in the output price and variable input markets.

Two equivalent approaches exist for obtaining the multicrop profit function. The one employed here makes use of the gender-specific profit functions, by choosing the fixed input allocations that maximize:

eq. 1)

$$\Pi(p,r,M,F,k;z) \;=\; Max_{m_i,f_i}\left[\sum_i^2 \pi_i(p_i r_i m_i f_i, k_i; z):\; \sum_i^2 m_i = M;\quad \sum_i^2 f_i = F\right]$$

This is the key to obtaining variable input allocations when fixed input allocations are observed across the different production processes (Chambers and Just 1989), with the household profit function formally presented as resulting from maximizing the gender-specific profit functions subject to the fixed allocatable labor constraints, *M* and *F*. Under regularity conditions and since quantities of the fixed allocatable inputs are observable, the two profit functions contain sufficient information about the underlying production technology at the profit-maximizing points, and can be used to obtain the output supply q_i and variable input demand x_i functions.

On the consumption side, the household is modeled as a single consumption unit wherein, farm-produced goods and market-purchase goods are defined as public goods, and jointly consumed by both all household members. Leisure is defined as a private good, determined by the amount of time spent in agricultural production. This is as good as implying that the identity of the individual supplying the "public goods" does not affect the household's demand for these goods, and that only "wage" effects are felt through the substitution of leisure and non-leisure consumption--income pooling. With the household members facing the same market prices for purchased goods and the absence of income transfers, an aggregate household utility function is justified. Furthermore, where production activities are determined by gender, dis-aggregating utility is not expected to yield further information, and what is usually tested as the alternate hypothesis (female-controlled income is more likely to be spent on household consumption goods) is taken as given.

This model assumes that the household maximizes a monotonic twice differentiable utility function, which depends on consumed farm-produced goods *c*, market-purchased goods *g*, husband's leisure l_m, and wife's leisure l_f, and is conditioned by household characteristics *h*. This aggregate household utility

eq. 9) $U = U(c, g, l_m, l_f; h)$,

is maximized subject to the full income constraint:

eq. 10) $p_c c + p_g g + w_m l_m + w_f l_f = \Pi(p_i, r_i, T_m - l_m, T_f - l_f, k_i; z) + E$

where $T_m - l_m = M$, the total time available to the husband for agricultural work and $T_f - l_f = F$. Here also, socially ascribed roles of gender imply a differentiated representation, with each person's time allocated potentially to leisure, farm or non-farm work. This constraint incorporates both the household's time constraint and cash income constraint with cash income constraint determined by the household profit function as defined in equation 6. For simplicity of estimation, all non-farm income is aggregated into *E* and considered exogenous to the households agricultural decision making process. Such an assumption would not be far-fetched given that all of the wives and roughly seventy percent of the husbands in the sample indicated farming to be their primary economic activity.

The household constraint defined above is the crux of the separate spheres household model being proposed. By explicitly providing for a measurement of labor productivity difference between men and women, this approach to modeling the African farm household situates the household production model within its socio-cultural context. The fact that household profits depend on *M* and *F*, and that preferences are allowed to be affected differently by *M* and *F* signifies that household utility and profit maximization cannot in general be dichotomized. That is, labor supply and production decisions are interdependent as the shadow prices of *M* and *F* are endogenous.

An implication of this endogeneity is that the budget constraint is non-linear. Following Thijssen (1988) and Deaton and Muelbauer (1980), the farm household considered to operate according to a two-stage decision process. In the first stage, the household maximizes farm

profits as a function of exogenous variables, p and r, and the endogenous labor variables M and F. In the second stage, the farm household maximizes utility while making the choice decision on farm profits and the level of leisure. That is, the household maximizes its utility at the equilibrium point, where the demand for agricultural labor from the production part of the model equals the labor supply from the consumption part of the model such that the marginal value of agricultural labor equals the marginal rate of substitution of leisure for consumption. This tangency condition can be obtained from the first order approximation of our budget constraint around the endogenous good leisure/labor. Using the first stage equilibrium values of $\Pi^*(.)$:

$$\equiv \Pi(p_i, r_i, T_m - l_m^*, T_f - l_f^*, k_i; z) + E$$
$$+ dl_m \{ \Pi(p_i, r_i, T_m - l_m^*, T_f - l_f^*, k_i; z) / l_m \}$$
$$+ dl_f \{ \Pi(p_i, r_i, T_m - l_m^*, T_f - l_f^*, k_i; z) / l_f \}$$

with the $T_m - l_m^*$ and, $T_f - l_f^*$ representing the equilibrium levels of M and F at which the household members maximizes their profits as well as leisure;

and $dl_m = l_m^* - l_m = M^* - M$, and $dl_f = l_f^* - l_f = F^* - F$. and $i = 1,2$

Thus, $\equiv \Pi_0 + E + dl_m . w_m + dl_f . w_f = \Pi_0 + E + w_m M + w_f F.$

where w is the derivative of full income at the optimum value of leisure (l_m^*, l_f^*), Π_0 is the constant term of the 'linearized' income constraint, that is, the income at the equilibrium quantity of labor minus the value of labor. The 'linearized' full income constraint is:

eq. 14) $p_c c + p_g g + w_m l_m + w_f l_f = \equiv \Pi_0 + E + w_m l_m + w_f l_f.$

This full-income budget constraint differs from the conventional constraint equating income with total expenditure in that the constraint includes leisure as a commodity. In addition, it highlights how household composition and differences in opportunity costs among various members contribute to the value of time available to the household. Assuming the usual well-behaved utility function, the household maximization problem will then give the following set of demand equations for leisure and agricultural goods

eq. 15) $c = c^*(p_c, p_g, w_m, w_f, ; h)$

eq. 16) $g = g^*(p_c, p_g, w_m, w_f, ; h)$

eq. 17) $l_m = l_m^*(p_c, p_g, w_m, w_f, \quad ; h)$

eq. 18) $l_f = l_f^*(p_c, p_g, w_m, w_f, \quad ; h)$

with defined as $\Pi_0 + E - w_m l_m - w_f l_f$.

To explore the impact of making prices endogenous to the household, duality results are used to define an expenditure function as the minimum expenditure required to meet a specified level of utility. In other words, the model can be thought of as an expenditure minimizing problem, such as in the standard theory of the consumer, where the household is minimizing its total expenditure--left-hand-side of equation (14), given its income--the right-hand-side of equation (14), subject to its utility--equation (9). Although the endogeneity of prices renders the usual demand and supply parameter estimates statistically inconsistent, it is most important to this model where a single good may have different prices due to imperfect markets.

Econometric Specification

The quadratic functional form belongs to the class of linear functional forms is used to estimate the production technology because, it is possible to observe negative profits, values, that cannot be ruled out from our data. The household profit can be consistently disaggregated into the gender-specific profit functions:

eq1.2) $^s(q, M, F, k; z) = \quad ^s + \sum_i^6 \; _i^s q_i + \quad _m M + \quad _f F + \mu^s k_s$

$$+ \tfrac{1}{2} \left[\sum_i^6 \sum_j^6 \; ^s_{ij} q_i q_j + \quad _m M^2 + \quad _f F^2 + \mu^s k_s^2 \right]$$

$$+ \sum_i^6 \; ^s_{im} q_i M + \sum_i^6 \; ^s_{if} q_i F + \sum_i^6 \; ^s_{ik} q_i k_s + \; ^s_i M k_s + \; ^s_i F k_s.$$

Where for simplicity and clarity in presentation q_i = vector of netputs $q = \{p, r\}$.

M, F = fixed allocatable inputs;

k = vector of fixed inputs, such that $k = k_1 + k_2$;

, , μ, , and are parameters to be estimated and

s = 1 for husband's restricted profit, and 2 for wife's restricted profit.

Closed-form expressions for m_i and f_i, the labor allocation equations, are tractable with the quadratic functional form because its derivatives are linear. These are derived from the profit-maximizing condition in given in **eq. 5** as:

eq. 1.3) $m^i = {}^i_0 + \sum_j^6 {}^i_{1j}\, q_j + {}^i_2\, M + {}^i_3\, F + {}^i_4\, k_i$

eq. 1.4) $f^i = {}^i_0 + \sum_j^6 {}^i_{1j}\, q_j + {}^i_2\, M + {}^i_3\, F + {}^i_4\, k_i$

With fixed allocatable inputs set at their optimum, output supply and variable input follow directly from the standard duality results. The output supply function for each production technology results directly from applying Hotelling's lemma to the associated gender-differentiated profit function:

$y_i = {}_i\,(q, M, F, k) / q_i = {}_i + \sum_j^6 {}_{ij} + {}_m\, m_i + {}_f\, f_i + {}_{ik}\, k.$

As an application of the Envelop theorem, this form is equivalent to using the aggregate household profit function $\Pi(q, M, F, k; z)$. We then substitute into the supply functions, the expressions for m^*_i and f^*_i. This is necessary because the output and input prices are treated explicitly rather than some of their effects being embedded in the m_i and f_i terms. The reduced form supply equations from the husband and wife's profit functions are then obtained as:

eq 1.4) $y^i = {}^i_0 + \sum_j^6 {}^i_{1j}\, q_j + {}^i_2\, M + {}^i_3\, F + {}^i_4\, k.$

Similarly the variable input equations are:

eq 1.5) $x^i = {}_i\,(q, m_i, f_i, k; z) / q_i$

$= {}_i + \sum_j^3 {}_{ij} q_j + {}_i\, m_i + {}_i\, f_i + {}_{ik}\, k_i.$

For consistency with competitive theory, and a twice-continuous differentiable technology, requires linear homogeneity of the profit function in prices of inputs and outputs. This is not imposed but along with monotonicity, is checked for at each observation using the final model estimates.

To derive the equatins for the consumption side of the household model we employ the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer. That the AIDS found to be consistent with household budget data in developing countries (Bezuneh, Deaton and Norton 1988) is of importance. Another advantage of the AIDS is that it can be adapted to

include the estimation of leisure demand by treating leisure as a branch in a weakly separable utility function or as another commodity (Alderman and Sahn 1993). Adopting their method, the demand functions are modified such that total expenditure on the ith good is dependent on total cash expenditures as well as the value of total time endowment. In cross sectional data, the price index would be expected to be constant as not much price variability is expected across households. This, it is assumed would circumvent the inconsistency problem posed by the choice of the price index. Following Alderman and Sahn (1993), weights in the price index are internally derived internally and the new budget share are given by:

eq 2.4) $S_i = \ _i + \sum_j \ ^*_{ij} \ln p_j + \sum_h \ ^*_{ih} \ln w_h + \ _i \ln (\ / P^*)$

where is household full income defined in **eq.14** and

$\ln P^* = \sum_j S \ln p_j + \sum_h s_h \ln w_h$, **for** $h = m, f$.

The marginal income of labor is used as the measure of the opportunity cost of leisure, in the absence of labor markets (Fafchamps 1993; Thijssen 1988). This is obtained from the derivative of the income from agricultural production with respect to agricultural labor (Thijssen 1988):

eq 2.5) $w_m = \ \Pi_0 / \ M = q[\ y^1 / \ M] = q[\ ^2 \ ^1 / \ q \ M]$

and

$$w_f = \ \Pi_0 / \ F = q \ [\ y^2 / \ F] = q[\ ^2 \ ^2 / \ q \ F].$$

The budget shares add up to one therefore one equation is dropped from the system estimation. Homogeneity is imposed by restricting $\sum_h \gamma_{ij} = 0$ and symmetry, by restricting $\gamma_{ij} = \gamma_{ji}$.

Study Area

Semi-subsistence households were targeted for this research, therefore, the choice of villages was determined by market access. Yaounde, the capital city was considered the market-access focal point. In addition, access to rural town was also important. Three villages in a 60 km radius of Yaounde--Nkongmesse, Evindissi, and Bondjock-- were selected (figure 2).

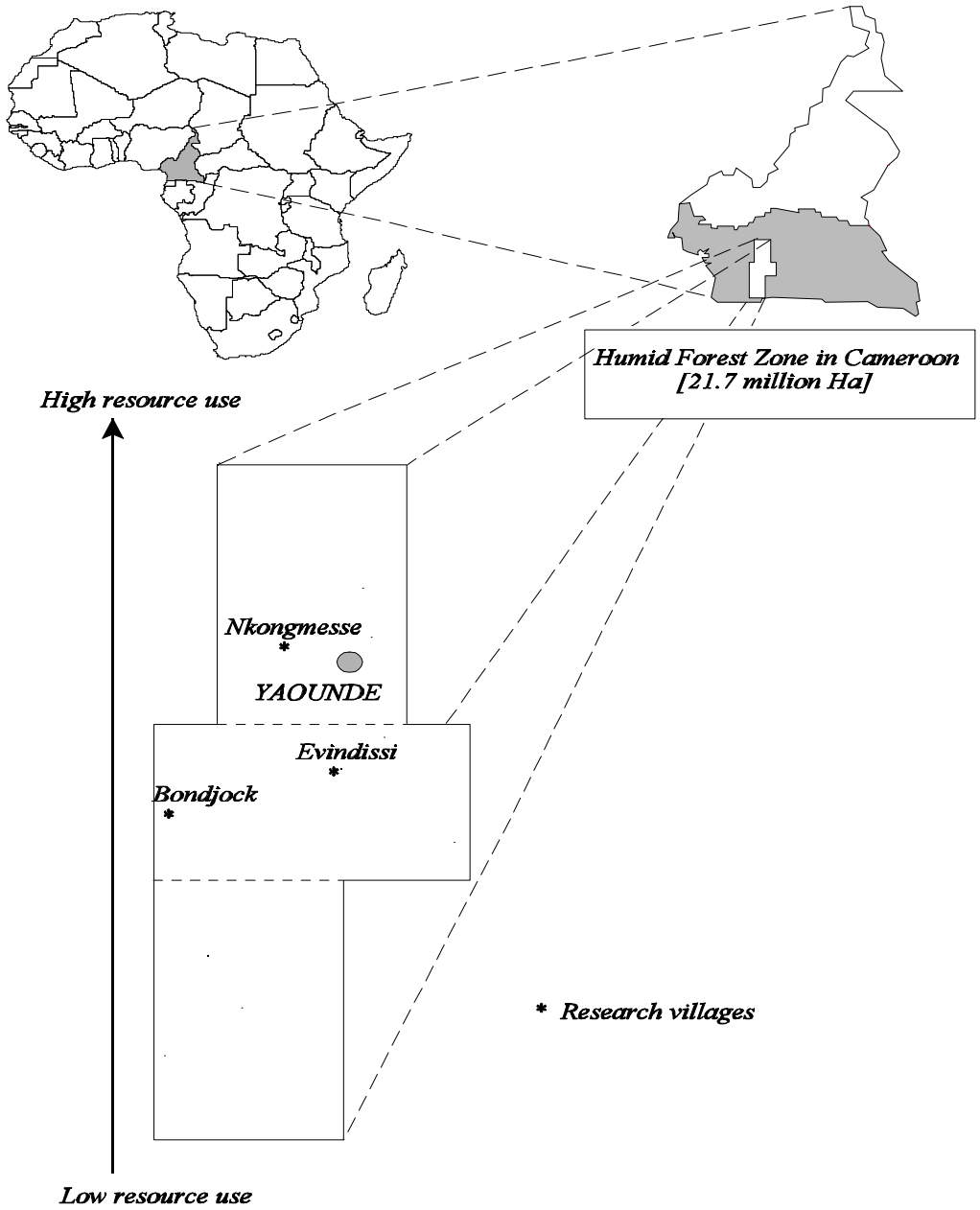

Figure 2. Forest margin benchmark within the IITA-EPHTA Humid Forest Consortium.

The data for the period July 1996, to August 1997, covers a typical cropping calendar which consists of two cropping seasons. These data were obtained on a bimonthly basis from approximately 35 surveyed households per village in the three villages. Expenditures were obtained on a bimonthly basis from approximately 35 surveyed households per village in the three villages.

Crop production is the major economic activity for 92% of the heads of household and 99% of their spouses. Wage labor was nonexistent for women but 40% of the women engaged in other income earning activities. Just 2% of the men engaged in wage labor while 41% of them had no other source income part from agricultural sales. The cropping system is adapted to the weather pattern, with two growing seasons in a calendar year. The major growing season starts after the long dry season in February and extends to July. The minor growing season starts after the short dry season in August and extends to December.

Farming in the benchmark, is characterized by family labor. In every farm household, a typical cropping season thus includes the cultivation of the groundnut field and at least one of the other field types. The female groundnut field, which is cultivated with the short handled hoe, more intensively cultivated and highly intercropped. This field is the pillar of the household, and serves primarily to meet household nutritional needs. Other field types include the female-controlled mixed food crop field, the male-controlled forest field, and the cocoa field which is the major source of income for men (and the household). The economic unit of the household, is the standard nuclear family. Other adult family members of marriageable age, (i.e., roughly 26 and above) living under the same roof usually maintain a separate economy and very rarely participate in joint consumption and/or production with the household head and his spouse. This relationship is best expressed by a survey participant who was living with his widowed mother and sister:

> "They [sister and mother] only live here because this is my father's house, but I am not responsible for them. My sister eats from my mother's pot and cultivates with her. I only help out say in case of a medical emergency."

The final exogenous variables in the production part of the model for both the husband and wife’s agricultural production, includes the following: aggregate price and quantity measures of output and a variable input, labor hours by husband, wife, other family members, and external or hired labor; and total land cultivated. The Tornqvist index was used to aggregate the data into two output groups and four input groups. Since the data is cross sectional, the base for this index is the average of the sample, so the index has an average value of zero.

Other farmer and field characteristics included were; decision choice variables on the timing and selection of agricultural activities; age, years of formal education and years of full residence in the village; measure of economic contribution to the household; cropping intensity of the field (years of fallow / number of consecutive cultivation); type of field cultivated and years since deforestation.

To estimate the household demand functions, perception of benefit received from own and spouse's agricultural production and non-farm economic activities, and perception of labor contribution to all these activities are used to condition the individual's demand for leisure. Finally, in addition to the commodity aggregates, the AIDS model includes household characteristic variables that reflect the household's consumption and labor supply patterns.

In a cross-sectional sample, questions arise as to the nature of price variation across farms for output and inputs. Agriculture in most developing countries is by it's very nature, a geographically dispersed activity characterized by asymmetrical information. Paradoxically, it is this wide geographic dispersion and asymmetric information characteristic and the geographic price variability occasioned by it, that makes feasible the estimation of a profit function. Further, whether prices are formed in competitive market structures or not, does not invalidate the application of the standard profit function for the study of household behavior (Sevilla-Siero 1991). Also, price differences may also arise because of differences between farmers in interpreting market signals, some households may be better at timing their purchases and sales than others. This kind of variation is not accounted for in this study and if it exists, could tend to bias the parameter estimates.

Results

In the absence of labor markets, farm household utility and profit maximization decisions cannot be dichotomized. Thus, both the production and consumption parts of the model are estimated by the Three Stage Least Squares method. Allocation of labor to agricultural production is made in the first stage and estimated along with variable inputs and output supply to

obtain an estimate for marginal wage rates. The household output supply for male and female production are then estimated, along with the expenditure shares for leisure and market goods. Utility maximization requires concavity of the expenditure function. This was checked on an observation-by-observation basis, and for about 75% of the points, expenditure function was concave.

As fixed allocatable inputs, the coefficients on total agricultural labor in the labor allocation functions measure the change in hours allocated to agricultural production in ones own field, given a one-hour increase in total agricultural labor of either the husband or wife. Estimated labor allocation equations reveal that the husband's total agricultural labor constraint performs strongly as a determinant of both he, and his wife's labor allocation decisions, but not so for the wife's total labor constraint. In output supply equations show, however, that only their individual l labor constraints are significant in their production decisions. This result supports the major tenet of this study that household production consists of two separate enterprises operated independently of each other. At the same time, we see that only the husband's production is responsive to other sources of labor, output decisions are responsive to non family labor while labor allocation decisions are responsive to other family labor available. This, and the fact that the wife's labor is not a binding constraint in the husband's production decisions could well be because traditionally, men have greater control over household resources such that the wife's production does not receive significant amounts of labor other than hers. The negative impact of the husband's labor constraint on his overall agricultural output supply may be attributed to the impact of cocoa production on the husband's utility maximization. This study was conducted on households in a transitional economy and not a cash economy. Therefore it is possible that the equilibrium between the supply of agricultural labor and the demand for leisure does not concur with profit maximizing output supply conditions. Price variables were found to be significant to the husband's production but not to the wife's, thus verifying our tenet that male production is more commercial oriented while female production more for subsistence.

Table 2 shows the labor allocation elasticities at the mean values. While theory is silent on the signs of the coefficients used in the estimation of the cross elasticities, one perspective for interpretation would be based on the labor requirements of the fields in question and their importance to the household. It could be said that the husband would allocate more of his labor from the field with lower labor requirements to the field with higher labor requirements as his total agricultural labor constraint is relaxed. With the wife doing likewise, this would require more labor to be allocated to the female fields as both of their total agricultural labor constraints are relaxed. The highly elastic response of labor allocation to the men's field, coupled with the relatively inelastic response for the women's field verifies the assertion of fixed allocatable inputs, however there is a twist.

Elasticity estimates reveal that labor allocation to the husband's field increases in response to a relaxation of his agricultural labor constraint. There is a 2.7 % increase in the husband's labor allotted to his field with a 1 % increase in his total agricultural labor, but a 1.7 % decrease in his labor allotted to his field with a 1% increase in the wife's total agricultural labor. Meaning even though the wife's field is more labor intensive the husband prefers to use his additional labor on his field but the more time the wife puts into agricultural production the more time he is willing to contribute to her field.

With respect to the wife's labor allocation to her fields, a 1% increase in the husband's total agricultural labor results only in a 0.2 % decrease in the wife's labor allotment, while a 1% increase in her total agricultural labor leads to a 1% increase in her labor allotment to her fields. In other words the more time the husband puts into agriculture the more time the wife contributes to his production but at a relatively very small percentage. On the other hand all of her additional agricultural labor goes to her field. So, even though the wife's agricultural production is more labor intensive, at the margin, household labor allocation is made based on a cultural, as well as an economic, decision rule. The impact of intra-household property rights on labor productivity lends further support.

The binary variables indicating decision control over household labor during key farm activities were used. For men, the key labor control activity is weeding and for women it is land clearing (by default, the reverse would be true so men having control over women's weeding labor and women having control over men's clearing labor would reflect a degree of control) . Although this variable was of the right sign, it was significant only for husband's labor allocation function, further indicating a greater level of resource control.

The "separate spheres" household model is based on the tenet that husband and wife operate separate enterprises and contribute in their separate ways to the household economy. The husband provides most of the cash income while the wife meets household subsistence needs. Two variables--one measuring the percentage of daily cash consumption met by the husband's agricultural activities, and another measuring whether or not the household had other sources of cash income other that agriculture--were used as measures of the household's decision making process. The percentage of cash contribution from the husband's field has a positive effect on the husband's output supply and a significantly negative effect on the wife's output supply. It also has a positive effect on his labor allocation to his field and an inverse effect (though not significant) on the wife's labor allocation to her fields. The absence of other income earning activity within the household significantly affected only the wife's output supply, although it had the expected signs on all its coefficients. Although not significant, the absence of other income earning activity has the effect of decreasing the husband's marginal output. Such would be the case where the household functions under a subsistence economy: the wife who has the obligation of meeting household food needs adjusts her output supply, and the husband having no cash obligations to meet would observe a reduction in his output.

The creation of the HFZ benchmark is based on a natural resource use/intensification gradient which is hypothesized to be the result of farmer response to perceived environment. Geographically, this is observed as a north-south continuum of high to low resource degradation and population density. From the data and the construct of the village dummy, the expected negative intercept shifters were obtained for all the villages. Another variable used to verify the

benchmark hypothesis is land availability variable. Land surplus is associated with an environment of relative abundance, leading to lower levels of labor input and output supply. Note that men's labor input would be affected inversely. This is because land surplus is usually accompanied by more frequent forest clearing, a more labor-intensive activity for men. Our results verified this hypothesis.

On the household consumption side, only the husband's output supply affects both husband's and wife's demand for leisure, and market goods (though not significant for this variable). Also, the percentage of daily cash contribution from the husband's field positively shifts the wife's demand for leisure, lending further credibility to the dichotomous nature of household economic production. The positive shift effect of the land surplus variable, on the other hand, lends further support to the existence of a resource gradient within the HFZ, with less resource-constrained households expected to consume more leisure, as was revealed in the results.

Estimated elasticities (Table 3) show that husband's and wife's leisure are complements, but substitutes with respect to market goods. These latter elasticities are highly inelastic, except for the cross-price elasticity of husband's leisure. In other words, higher market prices for purchased goods would lead to a greater reduction in the consumption of husband's leisure. This again supports our hypothesis of dichotomous household production where the husband is primarily responsible for household cash income and the wife for subsistence food needs. The own-price elasticities all have the correct sign and are reasonably elastic, even more so the demand for market goods, as would be expected in a transitional economy.

Discussion

In this study, we have tested the importance of a "separate spheres" agricultural model for the HFZ which is characterized by the female farming system. The results demonstrate that the theoretical framework proposed appears to fit the data quite well, strongly indicating the existence of separate production activities for both the husband and wife within the household. The use of agricultural labor within the household implied that it was a fixed allocatable input, but

with a cultural twist. Overall, it was interesting to see that the wife's output supply was more responsive to intra- household dynamics variables, but not her labor allocation. While for the husband his labor allocations decision were more responsive to intra-household variables. These variables are measured by decision control over timing of the execution of agricultural activities, the level of contribution to daily cash consumption by the husband's agricultural sales, and the absence of other income-earning activities.

Table 1. Parameter Estimates of "Separate Spheres" Agricultural Household Model, HFZ Cameroon 1996-1997.

	Output Supply		Labor Allocation		Leisure		Market Goods
Variables	Husband	Wife	Husband	Wife	Husband	Wife	Household
Male output	--	--	-0.64 (3.47)	--	-2.3E-5(1.98)	-3.9E-5(2.40)	3.8E-5(1.46)
Female output	--	--	--	-0.01 (0.11)	-1.2E-5(0.72)	-6.4E-6(0.03)	-3.0E-5(0.65)
Peanut price	--	-0.31 (1.22)	--	-0.12 (0.83)	--	--	--
Cocoa price	0.36 (2.19)	--	-0.16 (0.92)	--	--	--	--
Variable inputs	1.68 (4.94)	1.75 (2.78)	0.42 (1.22)	1.24 (2.68)	--	--	--
Total huband's labor	-0.12 (1.64)	0.03 (0.42)	0.33 (4.46)	-0.14 (3.90)	-4.5E-6(0.98)	--	1.3E-6(0.11)
Total wife's labor	0.03 (0.55)	0.07 (1.64)	-0.03 (0.45)	0.88 (25.3)	--	-4.1E-6(0.73)	-2.0E-5(1.42)
Other family labor	0.03 (0.43)	0.03 (1.13)	0.19 (2.37)	-3.4E-3(0.20)	--	--	--
Non-family labor	0.14 (1.98)	0.18 (1.21)	-0.02 (0.31)	0.11(1.23)	--	--	--
Field size	0.03 (4.66)	0.01 (2.69)	0.03 (3.81)	1.9E-3(0.62)	--	--	--
Cocoa field	35.3 (0.97)	-3.18 (0.11)	-95.5 (2.39)	-19.1 (1.22)	1.6E-4(0.53)	4.3E-3(1.05)	0.01 (1.14)
Land surplus	-63.9 (1.66)	-50.2 (1.98)	-1.11 (0.03)	-21.7 (1.65)	0.01 (3.64)	0.01 (2.84)	-0.2 (2.65)
Labor control	4.79 (0.21)	72.1 (2.58)	99.8 (2.59)	-2.12 (0.13)	-3.4E-5(0.13)	-1.9E-3(0.73)	--
Cash contribution	0.70 (1.19)	-1.08 (2.18)	1.28 (2.29)	-0.16 (0.60)	8.4E-5(1.50)	1.4E-4(1.98)	-2.2E-5(0.15)
No other income	-15.1 (0.60)	46.8 (2.13)	12.7 (0.52)	12.2 (0.95)	-1.4E-3(0.40)	-4.2E-3(1.17)	-9.5E-5(0.14)
Male wage rate	--	--	--	--	0.19 (20.7)	-0.18 (32.8)	-6.3E-3(3.26)
Female wage rate	--	--	--	--	-0.18 (32.8)	0.22 (27.5)	-0.01 (3.95)
Household size	--	--	-5.64 (1.35)	-2.23 (1.03)	5.6E-4(0.83)	6.3E-4(0.90)	-1.3E-3(0.61)
Children in school	--	--	--	--	-1.7E-3(1.97)	-2.6E-3(2.04)	6.5E-3(2.57)
Village2	-15.7 (0.22)	-167.3(2.98)	-174.4(2.54)	-1.73 (0.05)	0.01(2.35)	0.01 (0.86)	0.02 (1.59)
Village3	-9.97 (0.21)	-106.2(1.55)	-	-45.3 (1.19)	-0.01(1.27)	-0.01 (0.60)	0.01 (0.85)

t values in parentheses.

Table 2. Labor allocation elasticities (at the mean).

	Husband Labor to Husband's Field	Wife's Labor to Wife's Field
Husband's Agricultural Labor	0.84	-0.13
Wife's Agricultural Labor	-0.08	1

Table3. Demand elasticities, expenditure elasticites and expenditure shares (at the mean).

	Male Leisure	Female Leisure	Market Goods	Expenditure Elasticities	Expenditure Shares
Male leisure	-0.45	-0.32	0.08	0.89	0.33
Female Leisure	-0.48	-0.51	0.1	0.89	0.51
Market goods	-0.01	-0.01	-0.67	0.6	0.11

Appendix table 1. Household Resource Allocation Summary Statistics Cameroon, 1996/97.

	Husband	Wife
Marginal wage rate (coeff. of labor)	0.34235	0.88432
Leisure portion of total time	68.4 (15.6)	50.6 (12.3)
Field size (meters square)	3084.14 (211.06)	2022.40 (89.27)
Own time portion of labor to own field	56.83 (2.61)	78.18 (1.47)
Portion of food consumption from field	--	84.96 (1.23)
[1]Portion of cash consumption from field	16.51 (2.26)	--
[2]Control over own field size & location (%)	94.74	46.07
[2]Control over own crop combination (%)	85	85
[2]Control over start of clearing of own field (%)	92.5	41
[2]Control over start of weeding of own field (%)	77	92

Standard deviations in paranthesis

[1] Excludes cocoa harvest.
[2] Percentage of households in the sample

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