SUSTAINABLE AGRICULTURAL DEVELOPMENT: THE ROLE OF INTERNATIONAL COOPERATION

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Household Time Allocation – The Ultimate Determinant of Improved Agricultural Technology Adoption in Nigeria: An Empirical Activity Interphase Impact Model

INTRODUCTION

Nigeria's small-scale and resource-poor rural farmers are very conscious of the one production resource they possess and have complete control over: family labour (time). They know that food production in the continent has not been keeping pace with population growth, and that crop technological advances abound that could appreciably improve the situation. However, they have been equally aware of the time demands that accompany the adoption of such new improved agricultural technologies. They have, therefore, been rather careful in adopting available technologies. They carefully determine their household activities and attitudes towards improved technology adoption according to family time allocation considerations.

Because of their seeming reluctance to adopt available improved crop technologies that could dramatically increase food production in the continent, many observers have described them differently. For instance, whereas some classify average Nigerian farmers as irrational resource allocators who are conservative, ignorant and superstitious and so cannot operate a viable farming system (Aribisala, 1983), others still have enough confidence in them to use their experience and capacity to manage their meagre resources and produce food for the growing population most economically (Swaminathan, 1983; Hartmans, 1984). Many others attribute the poor performance of these small-scale, resource-poor farmers to unnecessary preponderant intervention in agricultural production by the continent's public sector (Olayide, 1976), increasing pressure of population growth, poor extension services and contact with farmers (Okigbo, 1983), increasing environmental degradation and adoption of non-sustainable agricultural practices (Eicher, 1985; Brown and Wolf, 1985) and insufficient investment in agricultural research and technology (Stifel, 1986).

Thus, although so many know something about the factors that cause failure in the agricultural systems of Nigeria, very few appear to understand and appreciate the real reasons for the average Nigerian farmer's reluctance to adopt available improved agricultural technologies. The problem really centres around farming systems research and intra-household dynamics in the

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Nigerian rural farm family – especially with respect to the farmers' ability to manage time *vis-à-vis* the labour demands of the agricultural technology packages being offered by research centres.

RESEARCH METHOD

This study was designed to generate information and data that would facilitate an understanding of the Nigerian rural farmer and household so that agronomic and biological research designs of national and international agricultural research centres could focus more on relevant beneficiary-perceived farming needs. Emphasis was on the determination of the existing priority in rural household activities and family time allocation in order to support the estimation of an empirical time budget and the establishment of a realistic basis for predicting the impact of new technological packages on Nigeria's agriculture.

Consequently, the study was a participatory observation survey in which 420 representative households (with 1978 respondents in them having and operating farm plots) were selected from seven states of Nigeria and studied for nine months. The selection of these households was based on a four-stage random sampling procedure in which seven states with notable agro-ecological differences were selected. From these, a total of 18 representative local government areas (LGAs) were covered. In each selected LGA, five representative villages or village communities were selected from a complete village listing obtained from each state's Agricultural Development Programme (ADP) and/or the affected Local Government Secretariat. The final stage of random sampling involved the selection of the 420 households from a comprehensive listing of households in each included village or village community. Thus, the basic sampling frame for this study was a comprehensive village/household listing – the former obtained from ADPs or LGA secretariats, and the latter by enumerators themselves with the cooperation of the village head or chief prior to the survey proper.

In all, 24 male and 25 female enumerators were employed to administer the 38-page survey instrument (structured questionnaire) in the seven states. They were recruited in such a way that they came from their States/ LGAs of study, so that language of communication with respondents was never a barrier. They were trained for seven days and paired during interviews to facilitate quick rapport with the respondents. Arrangements were made for them to reside throughout the survey period with the selected households in the villages.

EMPIRICAL ANALYSIS AND FINDINGS

Rural household time allocation and activity clocks

Rural household activities are dictated by family time allocation which shows the order of importance of these activities. Although intercultural and interstate differences exist in the relative importance of, and time allocation to

these activities, a detailed family time use analysis shows that there are basically three principal activity sectors within the rural household. These are the farming activity sector, the non-farming commercial activity sector, and the non-monetized home production activity sector. Whereas the first two ativity sectors are monetized, the third is not. Time for leisure in rural households is treated as a residual of the overall time available to household members after netting out the sum of the three activity sectors identified above. Because it is a residual, where individual activities are dependent upon whether its value is positive or zero, it is not treated or recognized as an activity sector within the household.

The farming activity sector encompasses all activities related to agricultural production starting from land preparation for crop and livestock production to the marketing of the agricultural output. Table 1 lists the activities in this sector and summarizes the average time in hours that is spent by family members and hired labour. The table shows that, for an average farm size of 6.10 hectares, a total of 6368 work hours is spent by family and non-family labour on all aspects of farm production in one cropping season. The gender disaggregation of the time input shows that male labour supplied 49.94 per cent of all the work hours (that is, 3180 hours), while female labour accounted for the remaining 50.06 per cent (or 3188 hours) of all the work hours. On an age basis, adults (male and female) accounted for 70.57 per cent (or 4494 hours) of the total, while children who were up to working age (male and female) accounted for the remaining 29.43 per cent (or 1874 hours) of the total work hours. At a time that the educational policy of the Nigerian government is calling for universal primary and secondary education, 29.43 per cent is too high a labour time demand on children for agricultural activities. It implies that, if children's time is withdrawn, most of the technological and financial impacts that are envisaged for most new improved agricultural technologies will be unrealized, or children will continue to be held back from going to school in order to provide child labour, for most of which they are grossly underpaid, if paid at all. Finally, Table 1 shows that family-supplied labour time accounted for 63.30 per cent, while hired labour accounted for 36.70 per cent, of all the work hours put into farming activities in the surveyed states.

The non-farm activity sector includes those endeavours of household members for the sole purpose of making money. They range from outright labour provision for a fee to direct trading in things not even related to agricultural production. Sometimes family members may engage in the trading of agricultural produce that is not from their own farms; such trading is not classified under agricultural produce marketing of the farming activity sector but comes under the non-farming commercial activity sector. Table 2 summarizes the six main activities identified under the non-farm commercial sector and indicates the average number of hours spent each year by members of the family.

Rural farmers spend on the average a total of 2212 work hours on non-farm commercial activities in a year. Thus the time spent by these same people on farming activities is approximately thrice that spent on the non-farm commercial sector. Among the six major non-farm commercial activities, trading takes the highest proportion (26.40 per cent) of the farmers' non-farming

TABLE 1 *List of farming activities and the combined average time (hours) spent on them per season per average total family farm size of 6.10 ha in the states studied, 1987/8*

Farming activities	Time spent (in hours) Family				Hired labour		
			Children				
	Husband	Wife	Male	Female	Male	Female	Total
(i) Land preparation							
Land clearing	46	24	9	11	52	2	144 (2.26)
	(0.1)	(0.3)	(0.2)	(0.4)	(0.1)	(0.1)	
Tree felling	21	12	10	13	25	14	95 (1.49)
	(0.2)	(0.6)	(0.4)	(0.9)	(0.2)	(1.1)	
Farm burning	13	16	13	18	20	22	102 (1.60)
	(0.2)	(0.5)	(0.3)	(0.8)	(0.3)	(0.9)	
Stumping and raking	18	54	19	24	24	45	184 (2.89)
	(0.3)	(0.9)	(0.7)	(2.3)	(0.3)	(1.6)	
Land tillage	23	54	21	25	54	29	205 (3.22)
	(0.1)	(0.3)	(0.3)	(0.5)	(0.1)	(0.3)	
(ii) Planting							
Seed dressing	18	34	17	24	21	36	150 (2.36)
	(0.2)	(0.9)	(0.8)	(0.9)	(0.6)	(3.5)	
Crop/seed planting	21	49	21	24	24	55	194 (3.05)
	(0.1)	(0.2)	(0.2)	(0.4)	(0.2)	(0.3)	
Fertilizer application	19	11	10	11	22	12	85 (1.33)
	(0.1)	(0.3)	(0.3)	(0.5)	(0.3)	(0.5)	
(iii) Weeding							
Hand weeding	12	106	31	50	13	107	319 (5.01)
	(0.4)	(0.2)	(0.3)	(0.3)	(0.2)	(0.2)	
Herbicide application	19	20	8	11	20	22	100 (1.57)
	(0.2)	(0.6)	(0.5)	(0.5)	(0.5)	(1.4)	
(iv) Harvesting							
Harvesting	182	186	77	43	189	202	879 (13.80)
	(0.1)	(0.2)	(0.2)	(0.6)	(0.2)	(0.3)	
Collection/ transport	44	82	50	74	44	74	368 (5.78)
	(0.2)	(0.2)	(0.7)	(0.3)	(0.2)	(0.5)	
(v) Processing							
Direct processing (cassava)	23	72	17	19	18	86	235 (3.69)
	(0.3)	(0.4)	(0.6)	(0.6)	(0.6)	(0.6)	
Threshing (other crops)	21	32	19	19	24	32	147 (2.31)
	(0.2)	(0.2)	(0.2)	(0.3)	(0.5)	(0.6)	
Cleaning (other crops)	24	23	26	22	—	26	121 (1.90)
	(0.2)	(0.2)	(0.4)	(0.5)	(—)	(0.4)	
Crop grading (other crops)	25	23	9	9	35	35	136 (2.14)
	(0.2)	(0.4)	(0.6)	(0.8)	(0.4)	(0.8)	
(vi) Compound gardening	165	255	135	185	108	66	914 (14.35)
	(0.3)	(0.4)	(0.3)	(0.6)	(0.9)	(0.9)	
(vii) Livestock husbandry:							
Within home	160	150	440	220	560	130	1 660 (26.07)
	(0.1)	(0.2)	(0.4)	(0.9)	(1.1)	(0.3)	
Slaughtering work	60	40	46	94	36	54	330 (5.18)
Total	914	1 243	978	896	1 288	1 049	6 368 (100.0)
Percentage of total	14.35	19.52	15.36	14.07	20.23	16.47	100.00

Note: Figures in parentheses below the hours spent on each activity are the calculated standard errors of the means, while those in parentheses beside the entries in the last (total) column are the calculated percentages.

Source: *Nigerian Rural Household Economics Field Survey*, 1988.

time, closely followed by the gathering of wild edible fruits (with 22.20 per cent). This is one activity in which time could be saved and transferred to the home production sector if both the yield and naira returns from the farming sector were sufficiently high to make wild food gathering unnecessary and/or uneconomical. Labour provision for a fee, interestingly, came fourth (with 17.09 per cent) indicating that the rural farmer would rather spend time on home production activities if income generated from the farming sector was sufficient for the daily needs. It is kept from the last position by fishing (10.67 per cent) and hunting wildlife (5.65 per cent) because children do not participate in those activities.

TABLE 2 *List of non-farm commercial activities and the combined average time (hours) spent on them per annum in the states surveyed, 1987/8*

	Time allocation (hours) Family				
			Children		
Non-farming activities	Husband	Wife	Male	Female	Total
Trading	143	154	120	167	584(26.40)
	(0.3)	(0.3)	(1.4)	(5.9)	
Handcrafts making	182	144	72	—	398.4 (17.99)
	(0.8)	(—)	(0.3)	(—)	
Hunting wildlife	125	—	—	—	125 (5.65)
	(0.5)	(—)	(—)	(—)	
Fishing	82	154	—	—	236 (10.67)
	(0.5)	(0.6)	(—)	(—)	
Gathering wild edible fruits	124	144	103	120	491 (22.20)
	(0.6)	(0.6)	(0.8)	(1.3)	
Labour provision	63	140	85	90	378 (17.09)
	(0.2)	(0.3)	(0.9)	(0.9)	
Total	719	736	380	377.4	2 212.4 (100.0)
Percentage of total	32.51	33.27	17.18	17.04	100.00

Note: Figures in parentheses below the hours spent on each activity are the calculated standard errors of the means, while those in parentheses beside the entries in the last (total) column are the calculated percentages.

Source: *Nigerian Rural Household Economics Field Survey*, 1988.

The non-monetized home production activity sector covers those activities that do not fall into the other two sectors but which relate to home care and maintenance, food preparation and childcare. Detailed activities of this sector are summarized in Table 3, along with the gender and age disaggregated time spent on them by an average household. According to the table, wives alone contribute 42.23 per cent (or 750 hours) of the total 1776 work hours per

TABLE 3 *List of home production/consumption activities and the combined average time (hours) spent on them per annum by an average family of 4 working members in the states surveyed, 1987/8*

Home productivity consumption activities	Time spent in (hours) Family				
	Husband	Wife	Children Male	Children Female	Total
Food preparation					
Peeling	20	55	25	30	130 (7.32)
	(7.0)	(0.1)	(.05)	(0.1)	
Grating	10	40	18	30	98 (5.52)
Grinding (pepper, etc.)	5	10	5	7	27 (1.52)
	(0.2)	(0.3)	(0.1)	(—)	
Dehusking/milling	15	20	15	20	70 (3.94)
	(1.2)	(0.1)	(0.3)	(0.1)	
Pounding	15	35	15	20	85 (4.79)
	(0.1)	(—)	(0.1)	(0.1)	
Cooking					
Breakfast	10	40	15	20	85 (4.79)
	(0.1)	(0.9)	(—)	(0.1)	
Lunch	10	35	10	20	75 (4.22)
	(0.2)	(0.1)	(0.1)	(0.1)	
Dinner	12	45	15	20	92 (5.18)
	(0.1)	(0.6)	(—)	(0.1)	
Dish and pot washing	5	20	10	15	50 (2.82)
	(0.7)	(0.6)	(—)	(0.1)	
Firewood gathering	35	35	15	20	105 (5.91)
	(0.1)	(0.1)	(0.1)	(0.1)	
Water fetching	10	35	30	35	110 (6.19)
	(0.1)	(0.1)	(0.1)	(0.1)	
Childcare:					
Washing and dressing child	12	75	15	30	132 (7.43)
	(0.3)	(0.1)	(0.5)	(0.4)	
Feeding	8	35	15	20	78 (4.39)
	(0.2)	(0.1)	(0.1)	(0.1)	
Child petting, mothering	15	80	20	35	150 (8.45)
	(0.4)	(0.3)	(0.4)	(0.3)	
Tending the sick	7	25	5	10	47 (2.65)
	(0.5)	(0.2)	(—)	(0.1)	
Clothes washing and ironing	12	20	10	15	57 (3.21)
	(0.1)	(0.1)	(0.1)	(0.1)	
Home Maintenance					
House cleaning	40	90	40	10	180 (10.13)
	(0.3)	(0.3)	(0.1)	(0.1)	
Fence repair	25	20	10	5	60 (2.38)
	(1.1)	(0.3)	(0.4)	(0.7)	
House repairs/construction	35	20	15	10	80 (4.50)
	(0.2)	(0.4)	(0.7)	(1.3)	
Digging/repairing latrines	10	5	5	5	25 (1.41)
	(0.4)	(0.5)	(0.9)	(1.9)	
Other maintenance	15	10	8	7	40 (2.25)
	(0.3)	(0.3)	(0.3)	(0.3)	
Total	326	750	316	384	1776 (100.0)
Percentage of total	18.36	42.23	17.79	21.62	100.0

Note: Figures in parentheses below the hours spent on each activity are the calculated standard errors of the means, while those in parentheses beside the entries in the last (total) column are the calculated percentages.

Source: *Nigerian Rural Household Economics Field Survey*, 1988.

annum, while husbands contribute 18.36 per cent (or 326 hours) of the total home production work hours. The children put in a total of 39.41 percent (or 700 hours) of all home production time. Taken on a gender basis, male members of an average household contribute 36.15 per cent (or 642 hours), while the female members contribute 63.85 per cent (or 1134 hours) of the work hours needed for home production. Thus the wife of such a household alone contributes more to home production than do all the male members put together. On an activity basis, Table 3 shows that the three principal activity groups in the home production sector are food preparation (which takes up 40.10 per cent of the family time), followed by home maintenance (which consumes 21.67 per cent of the time), and childcare (which accounts for 20.27 per cent of the time spent on home production/consumption).

Household activity clock

The usual assumption when attempting to assess rural farmers' output is that they spend 12 hours in their farms doing nothing else but farming. Practical experience, however, shows that the household activity clock of a rural farmer is made up of many activity segments whose dimension depends on the day of the week, the gender of the farmer and his or her religious affiliation. There are also some discernible inter-state differences when a detailed data-pool is analysed.

Figures 1 to 3 show the generalized time use pattern or activity clock of households Monday to Saturday and on Sunday using the aggregated data from the seven states surveyed.

With minor inter-state differences, the generalized 24-hour activity clocks for Nigerian rural farmers show that, on the average:

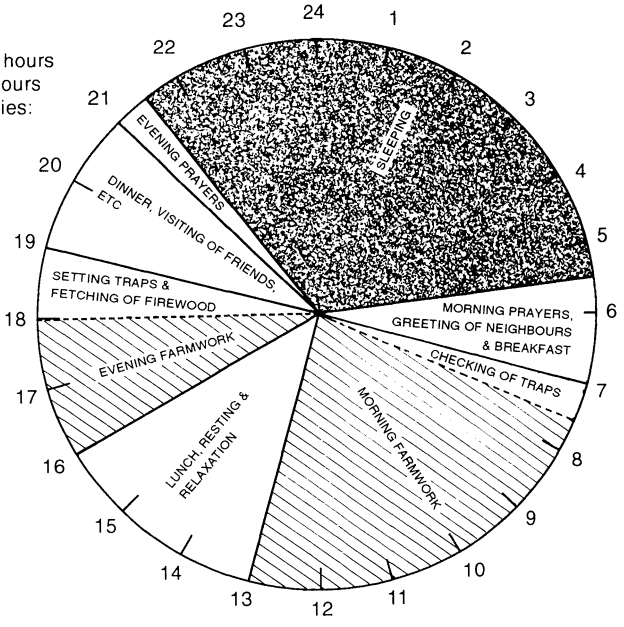
(1) Nigerian rural farmers (male and female and Christians and Muslims) stay awake for 16 hours each day from Monday to Saturday. On Sundays, however, the Christian farmers sleep longer, with the men staying awake for 14 hours and the women for 15 hours. Both men and women wake up on Mondays to Saturdays around 5.30 am and stay up till 9.30 pm. On Sundays, the women wake up by 6.00 am, while the men generally get up around 7.00 am.

(2) The general order of activities, Monday to Saturday, for *male Christians* is:

5.30 am to 7.00 am: morning prayers, greeting of neighbours and breakfast;
7.00 am to 7.30 am: checking of traps;
7.30 am to 1.00 pm: morning farmwork;
1.00 pm to 4.00 pm: lunch, rest and relaxation in the farm;
4.00 pm to 6.00 pm: evening farmwork;
6.00 pm to 7.00 pm: setting of traps and fetching of firewood;
7.00 pm to 9.00 pm: dinner, visiting of friends;

MALE CHRISTIAN

(1) Total time awake: 16 hours
(2) Total farmwork: 7.5 hours
(3) Total non-farm activities: 8.5 hours



FEMALE CHRISTIAN

(1) Total time awake: 16 hours
(2) Total farmwork: 6.5 hours
(3) Total non-farm activities: 9.5 hours

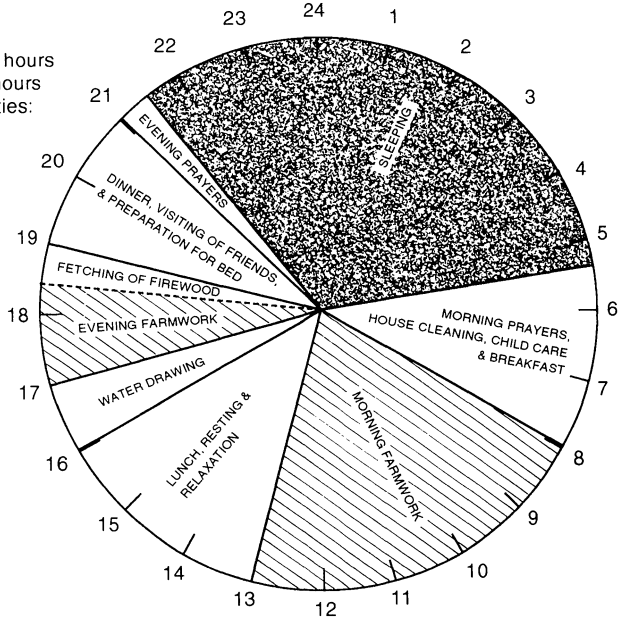
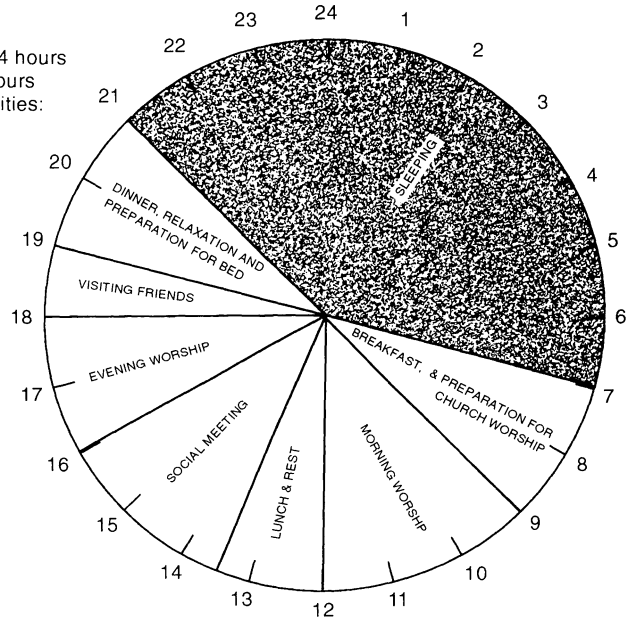


FIGURE 1 *Household activity clocks in selected states of Nigeria, Monday to Saturday*

MALE CHRISTIAN

(1) Total time awake: 14 hours
(2) Total farmwork: 0 hours
(3) Total non-farm activities: 14 hours



FEMALE CHRISTIAN

(1) Total time awake: 15 hours
(2) Total farmwork: 0 hours
(3) Total non-farm activities: 15 hours

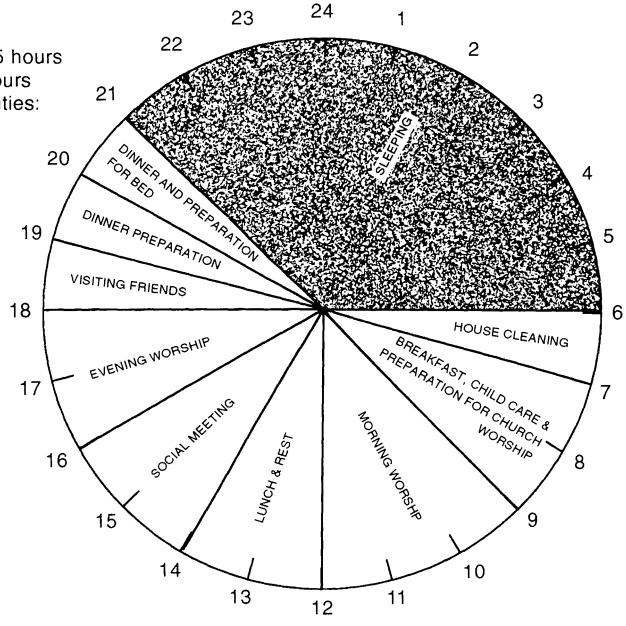
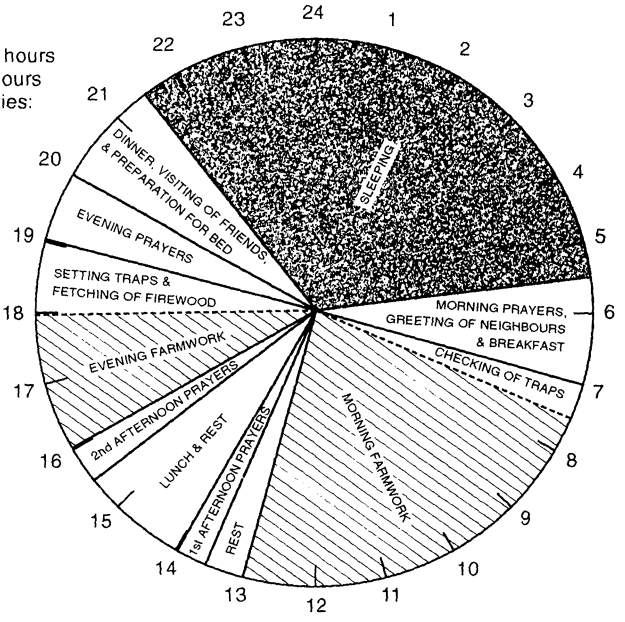


FIGURE 2 *Household activity clocks in selected states of Nigeria, Sundays*

MALE MOSLEM

(1) Total time awake: 16 hours
(2) Total farmwork: 7.5 hours
(3) Total non-farm activities: 8.5 hours



FEMALE MOSLEM

(1) Total time awake: 16 hours
(2) Total farmwork: 6 hours
(3) Total non-farm activities: 10 hours

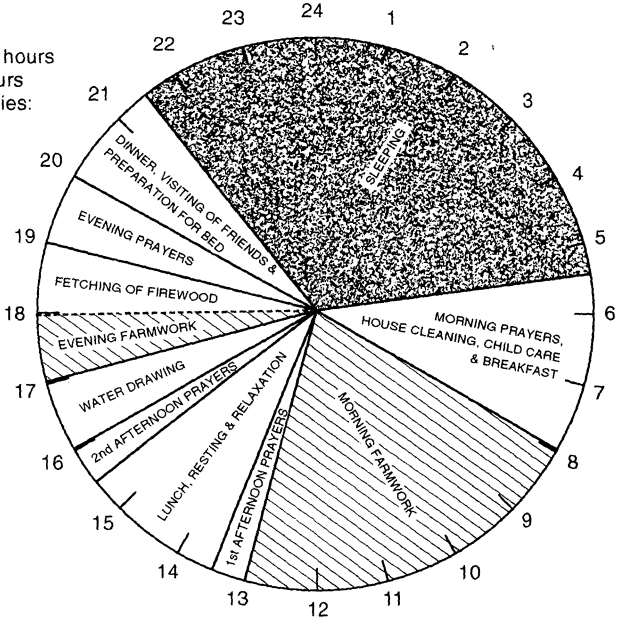


FIGURE 3 *Household activity clocks in selected states of Nigeria, Monday to Saturday*

9.00 pm to 9.30 pm: evening prayers and preparation for bed; and
9.30 pm to 5.30 am: sleeping.

For the *female Christians*, the general pattern of activities, Monday to Saturday, is very similar to that of the male, but with a few differences:

5.30 am to 8.00 am: morning prayers, house cleaning, childcare and breakfast;
8.00 am to 1.00 pm: morning farmwork;
1.00 pm to 4.00 pm: lunch, rest and relaxation in the farm;
4.00 pm to 5.00 pm: drawing of water from stream or well;
5.00 pm to 6.30 pm: evening farmwork;
6.30 pm to 7.00 pm: fetching of firewood;
7.00 pm to 9.00 pm: dinner, visiting friends;
9.00 pm to 9.30 pm: evening prayers and preparation for bed; and
9.30 pm to 5.30 am: sleeping.

For the *male Moslems*, the Monday to Saturday (excluding Friday) daily routine is:

5.30 am to 7.00 am: morning prayers, greeting of neighbours and breakfast;
7.00 am to 7.30 am: checking of traps;
7.30 am to 1.00 pm: morning farmwork;
1.00 pm to 1.30 pm: rest;
1.30 pm to 2.00 pm: first afternoon prayers;
2.00 pm to 3.30 pm: lunch and rest;
3.30 pm to 4.00 pm: second afternoon prayers;
4.00 pm to 6.00 pm: evening farmwork;
6.00 pm to 7.00 pm: setting of traps and fetching of firewood;
7.00 pm to 8.00 pm: evening prayers;
8.00 pm to 9.30 pm: dinner, visiting friends and preparation for bed; and
9.30 pm to 5.30 am: sleeping.

For the *female Moslems*, the Monday to Saturday (excluding Friday) time use pattern is:

5.30 am to 8.00 am: morning prayers, house cleaning, child care and breakfast;
8.00 am to 1.00 pm: morning farmwork.
1.00 pm to 1.30 pm: first afternoon prayers;
1.30 pm to 3.30 pm: lunch, rest and relaxation in the farm;
3.30 pm to 4.00 pm: second afternoon prayers;
4.00 pm to 5.00 pm: drawing of water from stream or well;
5.00 pm to 6.00 pm: evening farmwork;
6.00 pm to 7.00 pm: fetching of firewood;
7.00 pm to 8.00 pm: evening prayers;
8.00 pm to 9.30 pm: dinner, visiting friends and preparation for bed; and

9.30 pm to 5.30 am: sleeping.

On Fridays, the afternoon prayer times take one hour each instead of the usual 30 minutes, so that there is no evening farmwork in most cases. Like their male counterparts, Moslem women devote two hours to afternoon prayers on Fridays and usually do not perform any evening farmwork on Fridays.

For Christian farmers (male and female), Sundays are primarily for worship and socializing throughout the 14 to 15 hours the farmers stay awake. No farmwork is undertaken at all on Sundays.

(3) Total farmwork hours range from 6 hours for Moslem women, through 6.5 hours for Christian women to 7.5 hours for both Moslem and Christian males.

(4) Non-farm activities (including both commercial and home production ones) take between 8.5 hours for Christian and Moslem men and 10 hours for Moslem women; Christian women average about 9.5 hours on non-farm activities.

Although, these activity clocks suggest some element of rigid routine, there is a lot of flexibility in the time scheduling of rural farmers, except when it comes to farmwork related to certain specific practices like land preparation, planting and weeding, when they do not like other activities to disturb them. The relative amount of time spent on each of these identified activities actually depends on the pressure of work and the interest of the farmer in the job, but, where 'emergencies' do not arise, one could literally tell the time of day in rural areas by examining what a farmer is doing.

Rural household activity interphase impact model

Data generated from the household activity/time allocation study provide a basis for impact modelling. For example, from the evidence above, it becomes obvious that, although it is normally considered to be primarily agricultural, a rural household in Nigeria is basically an economic entity comprising three principal components; a farm firm component, a non-farm entrepreneurial firm component and a home production and consumption firm component.

The farm firm component usually carries out farming activities from which the entire household not only feeds itself but also derives income from the sale of some of its produce to meet other family needs. On the other hand, the non-farm enterprise component normally conducts non-farming commercial activities that principally generate funds with which farm incomes are supplemented to meet household expenses. The home production/consumption component basically carries out non-monetized home management activities that are necessary for the existence of the household as a unit. The first two components can thus be seen to be economic activity sectors, while the third may be viewed more as a social activity sector, but, because they are all so

closely related, competing for time and decision making from the same individual(s) (especially the household head) in the family, the behavioural principle of the rural household as an entity is one of the maximization of the following utility function:

$$U = U(h,y)$$

where h is the amount of time in hours per year that is at the disposal of all family members up to working age; and y is the total household money income obtained during the same year by working members of the household.

The basic assumptions of this utility function are that: (1) the marginal utility of labour, U_h, is negative (that is $U_h<0$) since labour in use causes physical and/or mental pain – a direct disutility; and (2) the marginal utility of the money income earned, U_y is positive (that is $U_y>0$) since money in use results in pleasure (a direct utility) (see Nakajima, 1986). These two simple assumptions therefore make it imperative that time available to a rural household be shared out among the component sectors in such a way that maximum benefits are derived whenever an externality is introduced into the household that tends to destabilize its equilibrium time allocation among its activities.

However, the individual maximization behaviour of each of the three component sectors of the rural household differs from this general utility maximization principle. For instance, the farm firm component is basically an economic production unit whose central interest is to maximize the total farm output of the household. Similarly, the non-farm enterprise component is an economic unit whose basic objective is to maximize the income earned from those non-farm commercial activities including the provision and 'sale' of household members' time as direct labour to outsiders. Finally, the home production and consumption component of the household acts more as a social buffer than an economic coordinating unit whose objective function is to maximize the utility of family time involved in home production, although it is not paid for in cash.

In other words, using the Marshallian concept of 'economic surplus' (that is, economic benefits over costs obtained by economic entities or units from their economic activities), the first household component (the farm firm) continuously tries to maximize its *producer's surplus* resulting from its farming activities, while the second household component (the non-farm commercial enterprise) attempts to maximize its *labourer's surplus* resulting from its commercial labour supply activities. The third component attempts to maximize its '*prosumer's surplus*' which is obtained from the family's home production and consumption activities. In order to explain how all three surpluses can be maximized, it is necessary to describe how the three component firms are brought together in a juxtaposition determined by the commonality of household decision making. The result of such a juxtaposition is what constitutes the empirical rural household activity interphase impact model shown below in a diagrammatic form.

To get the exact relationship between the three component sectors, each activity sector is represented by a circle whose relative area is determined by the proportional distribution of work hours spent by the household on that

sector. Since all three activity sectors are controlled by the same decision maker(s) and their basic factor relationship is defined by time (hours), the relative positions of the centres of the circles representing these sectors have to be equidistant from one another and so are delineated by the vertices of an equilateral triangle. With each vertex of the triangle acting as the centre of one of the circles, the three sectors are drawn in according to their proportionally determined areas. Under such geometrical construction, the three activity sectors interlink and create interphases at three different overlapping areas. Each interphase defines a predetermined impact area whose size gives, in a pictorial format, the relative magnitude of that impact area.

Figures 4 to 6 show the three typologies of activity interphase impact models derived respectively for Ondo and Oyo States (Figure 4), Imo and Katsina States (Figure 5) and Bauchi, Cross River and Kwara States (Figure 6). Categorized information received from farmers shows that there are four principal impacts that an exogenous factor like improved crop technology can create if introduced into a rural household and is imbibed or used to such an extent that it affects the household's existing time allocation equilibrium. These are the *technological*, *social*, *financial* and *economic* impacts (Gittinger, 1984). Each principal impact interphase is a composite of several sub-impact indices.

For instance, the technological impact index comprises sub-indices such as: the rate and level of adoption, the level and mode of land development resulting from the adoption of the new technology, the yield of (or resulting from the introduction of) the improved variety of species, the resulting resource allocation demands such as labour flows, and the level of secondary and tertiary post-harvest infrastructure for food handling and processing. The social impact index is a composite of the volume of employment created by the newly introduced factor, the income-generation and distribution capacity caused by the factor among gender and class, the quality of life, the effect on the nutritional and health statuses of the affected people, the effect on the environment, the creation of markets for the resulting new products, and the effect on household, regional and national food security. The financial impact index comprises the change in output prices emanating from the new introduction, the effect of the introduction on input cost subsidization, and the level of government price support on output, if any. The economic impact index consists of the value and level of product prices, and the contribution to the gross domestic product (GDP) (of the community or state) resulting from the new introduction.

The interphase created by the interlink of the farming and non-farming commercial activity sectors constitutes the technological impacts, while that created by the farming and home production activity sectors is the social impacts. The interphase between the non-farming commercial and home production activity sectors constitutes the financial impacts and the common grounds (the union) of these first three impact interphases are what constitute the economic impacts.

Agricultural technology adoption primarily affects the farming activity sector (or the farm firm component) of the household. Simultaneously, however, because of the dynamic relationship of this sector with the rest of the household

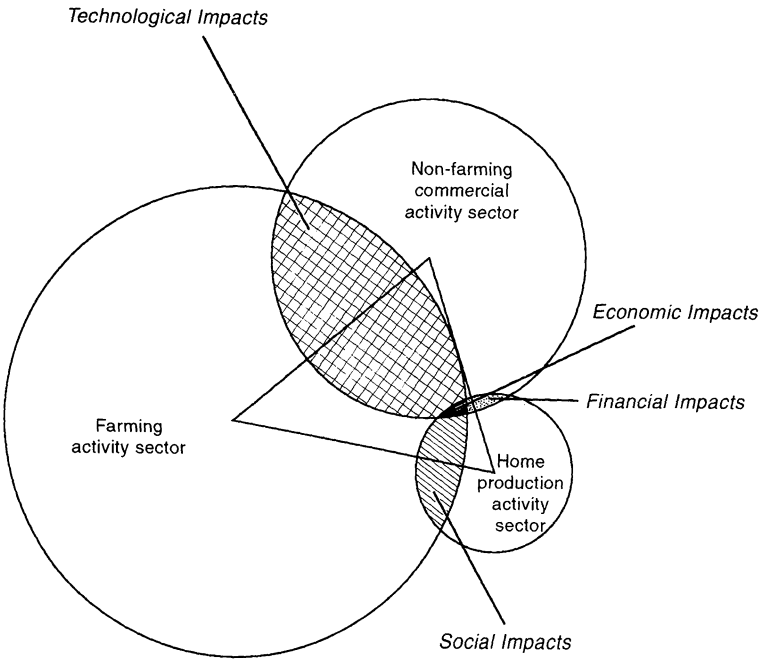


FIGURE 4 *Rural household activity interphase impact model, Ondo and Oyo States*

sectors, once a newly introduced improved agricultural technology is adopted by that household, it constitutes an exogenous factor which immediately disorganizes the existing household time allocation equilibrium. The net effect is a shift in time use patterns within the household but between the three activity sectors, resulting in the creation of new sizes of all the major impacts – the technological, social, financial and economic. The magnitude of shock created by the introduced externality determines the new impact equilibrium and the size of the resultant impact indices that are now established.

Thus, in Figure 4, we see that, where the introduction and adoption of some new agricultural technologies had caused the household time to be distributed among the farming, non-farming and home production sectors in the approximate ratio 3:2:1 (as is the case in Ondo and Oyo States), there is created a disproportionate impacting on the household. In other words, the time demands of the new technology concentrated relatively too many hours in the farming sector and caused what superficially might have appeared an attractive technological impact (such as yields increasing dramatically, or more land being brought under cultivation). But then the accompanying social, financial and economic impacts are so relatively small that desired economic welfare effects are not achieved in those states. If this continues, the farmers will in future years subsequently cut down on the adoption of the new technology.

There are two immediate possible explanations for this outcome. One is that the new technology was not time-saving, with the result that in order for it to be adopted, the household had to withdraw time from the home production sector. Secondly, the new technology may by itself have been rather expensive to acquire and/or involved the complementary and simultaneous adoption of other expensive 'attachments', so that all financial and economic benefits were drastically reduced, leaving behind a poor producer's surplus.

Figures 5 and 6 present other actual typologies of impact that were observed in the other states surveyed. In each case, this household activity interphase impact model is sending out a strong research policy implication message or signal: that each new agricultural technology is intended ultimately to benefit the adopter by greatly enhancing general economic and social welfare. This can only be done by increasing the level and magnitude of financial, economic and social impacts without necessarily losing much on the technological impact indices. This will require a major shift in the number of hours spent on the farming actitivy sector to, especially, the home production activity sector. In other words, the crop technologies, for instance, that have been found to be high-yielding and resistant to diseases should be sufficiently time-saving that their adoption will preferably release the farmer's time from the farm firm sector to the home production one, or at best not upset any previously established time allocation equilibrium that gave a better economic and financial reward to the adopting family or household.

To arrive at some optimum time allocation between the three principal activity sectors of the rural household, there has to be a systematic and measured transfer of hours from the farming to the non-farming, and/or home production sectors. Theoretically, such optimum time allocation between the household sectors will require the determination of a time contract or conflict curve which will be the locus of all points of tangency between one sector's

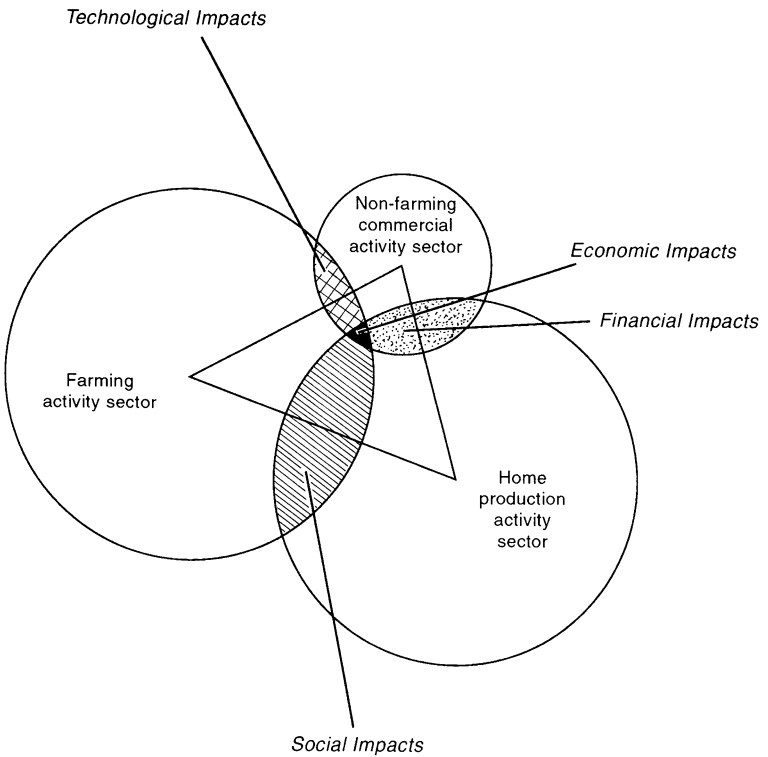


FIGURE 5 *Rural household activity interphase impact model, Imo and Katsina States*

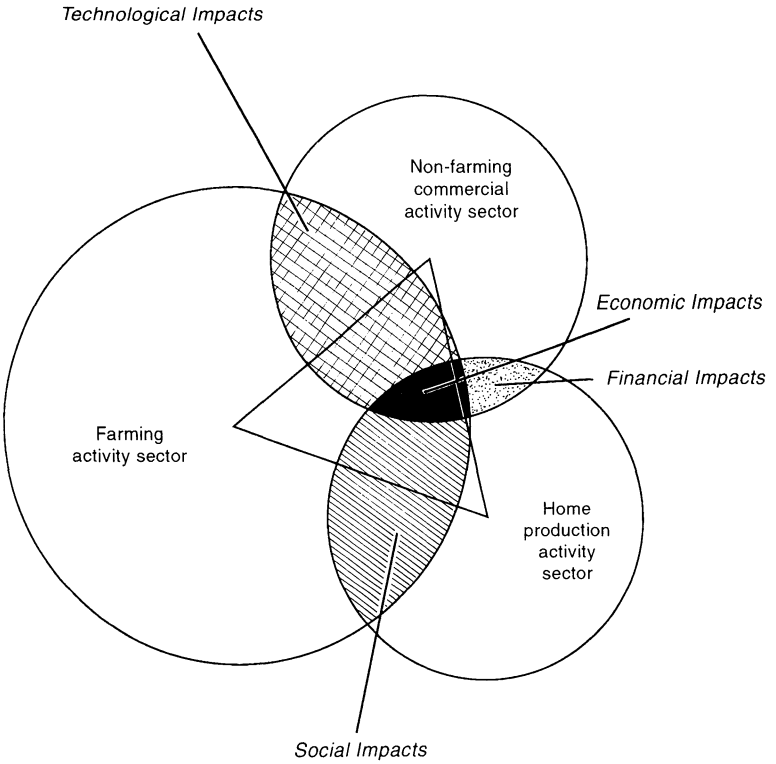


FIGURE 6 *Rural household activity interphase impact model, Bauchi, Cross River and Kwara States*

time indifference curves and those of another sector, given a particular technology being adopted. In practical terms, however, the closest approximation to this optimum condition will be the point where the marginal cost of transfer (or hour substitution) of farming to (or for) non-farming hours is zero.

The average income-generating capacity of rural households under existing conditions and present component activity analysis shows that, for all the surveyed states combined, the average farm income generated by a respondent household amounted to ₦ 5395.20 (US$830.00) per annum, while the average non-farm income generated by the same household from commercial activities was ₦ 1384.51 (US$213.00) per annum. With the hours put into farming activities by the average household totalling 6368 hours and those spent on non-farming commercial activites amounting to 2212 hours, an hour of farming activites brought in ₦ 0.85 (US$0.13) to the household, while an hour of non-farm commercial activities grossed ₦ 0.63 (US$0.10) to the same household. This immediately suggests that 'extra' hours from the farming sector should not be transferred to the non-farming commercial sector, since the marginal rate of hour transfer (or substitution) from farming to non-farming enterprise will be negative.

The most rational thing to do will then be to implement the earlier suggested use of 'extra' time (hours), namely to move such time from the farm production sector into the home production sector or even add it to the leisure time of the household. With such hour transfer, the relative adjustment factor between the various impact indices shows that the technological impacts will reduce a little while the social, financial and economic impacts will increase. The exact amount of increase of the latter indices will depend upon the criticality of those aspects of the farming activity time savings that are actually transferred to the home production sector. For instance, time savings from those practices such as weeding and fertilizer/pesticide application that usually demand a peak labour profile at the same time as some non-farm commercial and home production activities will be more critical and desirable than those from, say, land preparation.

CONCLUSION

Such savings in time can only come from the derived advantages of using new improved agricultural technology packages from research centres like the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. If such time savings cannot be achieved by crop breeder scientists, the alternative will be that agricultural technology packages from centres like the IITA and other international and national agricultural research centres will have to increase the relative net farm income of rural households to at least one and a half times its present level in order to induce the farmers to adopt such technologies. Given the fact that prices of agricultural produce are usually low and fixed outside the rural households' control, this means that existing yield levels of improved crop varieties will have to be increased more than three-fold in the farmers' fields when cultivated within the traditionally established cropping systems of rural Nigeria.

REFERENCES

Aribisala, T.S.B., 1983, Nigeria's Green Revolution: Achievements, Problems and Prospects', *Distinguished Lecture No. 1*, Nigerian Institute of Social and Economic Research (NISER), Ibadan, Nigeria.

Brown, L.R. and Wolf, E.C., 1985, 'Reversing Africa's Decline', *Worldwatch Paper 65*, Worldwatch Institute, Washington, DC.

Eicher, C.K., 1985, 'Famine Prevention in Africa: The long view', *Food for the Future: Proceedings of the Bicentennial forum*, Philadelphia Society for Promoting Agriculture, Philadelphia, USA.

Gittinger, J.P., 1984, *Economic Analysis of Agricultural Projects*, 2nd edn. Economic Development Institute of the World Bank, Washington, DC.

Hartmans, E.H., 1984, 'Prospects for Nigerian Agriculture, *Distinguished Lecture No. 2*, NISER, Ibadan, Nigeria.

Moock, J.K.L., 1986, *Understanding Africa's Rural Households and Farming Systems*, Westview Press, Boulder, Co. and London.

Nakajima, C., 1986, *Subjective Equilibrium Theory of the Farm Household*, Elsevier, Amsterdam, Oxford, New York and Tokyo.

Okigbo, P., 1983, 'Planning the Nigerian Economy for less Dependence on Oil', *Distinguished Lecture No.3*, NISER, Ibadan, Nigeria.

Olayide, S.O., 1976, 'The Food Problem: Tractable or the Mere Chase of the Mirage?' Inaugural Lecture, 1975/76, University of Ibadan, Nigeria.

Stifel, L.D., 1986, 'Director-General's Report, in *IITA's 1985 Annual Report and Research Highlights*.

Swaminathan, M.S., 1983, 'Agricultural Progress – Key to Third World Prosperity', *Third World Quarterly, 5(3) pp.55–66*, (Third World Lecture).

DISCUSSION OPENING – WILLIS OLNOCH-KOSURA*

Professor Ikpi deserves congratulations for making a bold attempt to revisit the important, but somewhat neglected, issue of time allocation in households, considered to be both production and consumption units. To my knowledge, since Becker's theory of time allocation was published in 1965, very few empirical studies have appeared in anything like the detail provided for us. I think part of the reason for that neglect is the complexity of the field work required. It requires careful organization and much patience for good results to be obtained. This is evident from the research method used in Ikpi's study in Nigeria, where we find a participatory observation survey of 420 households (1978 respondents), a 38-page structured questionnaire, and the need for enumerators to reside with the selected village households. No wonder support for such studies has been limited.

Nevertheless, it is clear that relevant work has great potential for providing valuable results, as Ikpi's study shows. For instance, until now, there have been those who think that there is surplus labour in contemporary developing countries and that agricultural technologies which are developed should be labour-intensive (or labour-using). To the extent that most agricultural operations in rain-fed agriculture are 'time-bound', if they are to be optimal, the reason for lack of effectiveness of the green revolution in some parts of Africa may lie in lack of understanding of the mechanics of household time allocation.

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When one travels casually through some villages in Africa, one may get the impression that a great deal of labour is available but that it is under-utilized. However, transforming apparently idle hands into effective farm labour requires the individuals concerned to calculate their own opportunity cost.

Ikpi has divided time allocations into three groups: farm activity, non-farm activity and non-monetized home production activity. I would suggest that these activities be collapsed into two in order to distinguish only monetized and non-monetized activities. In effect his category of non-monetized home production activity actually either facilitates commercial production on the farm or elsewhere, or home consumption. Thus the opportunity costs of the under-utilized labour seen in villages may be high or low, depending on the season, in rain-fed agricultural systems. To the casual observer many individuals who are doing little more than loitering, both during slack agricultural seasons and at other times, may represent surplus labour which could be exploited for agricultural work. Yet these individuals may genuinely be enjoying well deserved leisure after working extremely hard during the peak season. In any case, working in the field for more than five hours a day in the tropics is almost impossible. Improved technology should therefore be aimed to fit within the framework of known activity clocks among individuals or communities. If the activity clocks are not recognized, the rate of technology adoption will be relatively low, as Ikpi has demonstrated in his paper. This will of course reinforce the other reasons for lack of adoption, such as lack of awareness, high cost, or complexity of technology.

The other potential contribution of this type of study is in the area of differences in productivity by age and gender. For a long time, farm management specialists have been arbitrarily allocating productivity weights in such a way that women and children are weighted at providing half the amount of work provided by men. Such biases can be removed by fitting production functions, using the type of data collected by Ikpi, to determine the marginal productivity of each category of individual. This is not done by Ikpi, but it could be a worthwhile extension. In any case, it may add weight to the call for more support for time allocation studies, since there is current emphasis on the way to improve the welfare of women who are actually major participants, as producers and managers, in smallholder farms.

Ikpi's finding that children devote 30 per cent of their time to farmwork has serious implications for education by diverting them from schooling. It also has an important bearing on the whole question of the 'demand' for children by rural households, and the consequent high rate of population growth. If available technologies are time-using during critical periods of farm production, there may be pressure on households to have more children to support farmwork. This also explains why children are not 'inferior goods' in the new household economics framework.

I would like to conclude with a plea to researchers and research-funding agencies to take greater interest in time allocation studies if agricultural technology adoption is to be increased in farm households.