Laufer, Leslie A.; Vijverberg, Wim P. M.

Working Paper

Time Diary Surveys: What Can We Learn from Them?

Center Discussion Paper, No. 453

Provided in Cooperation with:
Yale University, Economic Growth Center (EGC)

Suggested Citation: Laufer, Leslie A.; Vijverberg, Wim P. M. (1984) : Time Diary Surveys: What Can We Learn from Them?, Center Discussion Paper, No. 453, Yale University, Economic Growth Center, New Haven, CT

This Version is available at:
https://hdl.handle.net/10419/160377

ECONOMIC GROWTH CENTER

YALE UNIVERSITY

P.O. Box 1987, Yale Station
27 Hillhouse Avenue
New Haven, Connecticut 06520

CENTER DISCUSSION PAPER NO. 453

TIME DIARY SURVEYS:

WHAT CAN WE LEARN FROM THEM?

Leslie A. Laufer

and

Wim P.M. Vijverberg

February 1984

Notes: This research was supported in part by grants from NIH Training Grant and The William and Flora Hewlett Foundation to the Economic Demography Program at Yale.

Abstract

The purpose of the paper is to examine a research program that takes advantage of the unique information on time allocation collected in time diary surveys. Time diary surveys, where the individuals record their allocation of time to different activities on a frequent, if not daily, basis, have only recently begun to be subjected to economic analysis. Indeed, time diary surveys open up new areas of empirical research. The detailed nature of the data allows a closer examination of economic theories of supply and demand than has been possible with simple cross-sectional surveys. This may be the main promise of time diary surveys. This paper suggests that this promise may not be realized unless a number of basic questions have been answered. The questions certainly are not new, but because the data necessary to test them has hitherto been unavailable, they have been neglected.

The first question relates to aggregation over commodities and activities. The most appropriate method to deal with the individual's (or the household's) corner solutions must be found. That is, when the record indicates that the individual did not purchase any amount of the commodity, or did not participate in the activity , how is the "zero" to be included in the statistical analysis? The conventional solution is to consider broad aggregates of commodities, say, food rather than dairy products and meat, or activities, say, farm work rather than crop and animal production work. However, this solution implicitly assumes that the components of the aggregates are perfect substitutes in consumption or production, which may not be justifiable.

The second question addresses the reconciliation of the discrepancies between the periodicity of the collected data and the theoretical time dimension of the economic activity. Ideally, these dimensions are identical. Actually, strategies must be developed to examine the timing questions. The minimum requirement for the quality of the time diary data is that the interval between consecutive rounds is at least as small as the relevant time unit for production decisions.

The data collected by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) are considered in order to ascertain the representativeness of the sample: is there is enough variability across years and villages to give us significant statistics, and are they useful for the empirical resolution of the main questions? Briefly, the data will be particularly useful with regards to the problem of aggregation bias. Irregularities in the lengths of the time periods between survey rounds, however, will limit their usefulness with regards to the problem of timing.

TIME DIARY SURVEYS: WHAT CAN WE LEARN FROM THEM?

1. Introduction

The purpose of this paper is to examine a research programme that takes advantage of the unique information on time allocation collected in time diary surveys. While much of the discussion is conducted in the context of data collected by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad, India, it should be applicable to studies of time diary surveys in general.

Time diary surveys, wherein individuals record their allocation of time to different activities (or, in the case of the ICRISAT survey, a member of the household is the respondent for all members) on a frequent, if not daily, basis, have only recently begun to be subjected to economic analysis.[1] To appreciate their potential, and to understand where this paper fits in the economic research programme, one has to view this paper in the light of a historic background (Section 2). Traditional models of labor supply and demand are static by nature. Using time diary surveys for empirical work necessitates a different way of thinking, in which the dynamics of supply (e.g., lifecycle) and demand (e.g., crop cycle) processes is prominent. This appears to extend to both theoretical and econometric research.

Section 3 discusses characteristics of the villages where ICRISAT collected its data, in order to ascertain (1) the representativeness of the sample, and (2) whether or not there will be enough variability across years and villages to give us significant statistics. Section 4 considers the survey methods used by ICRISAT and the type of data collected, with

their applicability and problems for empirical research. Basically, problems arise from the variability of the incidence of interviews for each household, and the duration of the interview rounds, across villages, and within villages across years (it appears that more frequent interviews are scheduled in periods of high activity). Moreover, it appears that some form of condensing (i.e., aggregating) the large amount of information is necessary for empirical research on all but the most detailed issues. Time diary surveys may be particularly suitable for analyzing the effects of this type of aggregation but only if theoretical and econometric problems are resolved.

2.Background to Time Diary Surveys

The allocation of time by individuals has been an important issue in the area of labor analysis over the last decade. Early work by Lewis (1956), Mincer (1962), Becker (1965), Cain (1966) and Bowen and Finegan (1969), among others, focused attention on the fact that time supplied to the labor market is only one among many alternatives open to the individual.

There has also occurred a confluence of household production theory and theory of the firm as an agricultural household.[2] Nakajima (1969), Jorgenson and Lau (1969), Hymer and Resnick (1969), and more recently, Yotopoulos, Lau and Lin (1976), Barnum and Squire (1979), Rosenzweig (1980), concisely surveyed by Strauss (1983), modeled the rural agricultural household that both produced and consumed commodities (including leisure, foodstuffs, and, following Becker, children, health, education of children, and so forth). Data (or lack thereof) have limited empirical studies to testing the theoretical implications of the theory for labor supplied to the market, or male and female labor supplied to the market (Rosenzweig (1980)); supply of a household commodity to the market, or a system of commodities (exemplified by Strauss (1982); and recently, household labor supplied by farmwives as well as capital services (washing machines, driers, etc.) in the United States (Huffman and Lange (1982)). Availability of detailed time allocation data, and complementary expenditure, agricultural production, and household asset data, and particularly, the ICRISAT data, holds forth the possibility of testing the implications of the agricultural household model, and, moreover, testing the validity of the basic assumptions, for example, separability assured by existence of

markets for all household commodities, and implicitly, the homogeneity of the household and market commodities groupings.

A possible research programme could, at the least, estimate the response of more detailed (or disaggregated) commodities within the framework of the separable agricultural household model. For example, it would be interesting to empirically determine the response of labor supply of women in the household and family farm operations to enhanced wage opportunities for men, or technological advances, in the form of high-yielding crops, application of fertilizer, etc., responses that heretofore have been subsumed in the calculated residual after labor is supplied to the market, so-called "leisure." Boserup (1970) called attention to the possibility that economic growth might disrupt traditional occupational patterns, and cause deterioration in the well-being of women in developing societies.

In theory, it would be possible to disaggregate commodities (in the broad sense, the term includes labor) ad infinitum to focus on particular issues— household activities like child care or food processing and preparation could be distinguished; or weeding and thinning and harvesting could be distinquished within the broad category of farmwork; rice and wheat or tomatoes and peppers, rather than grains and vegetables could be considered.

Of course, there is a tradeoff for increasing confidence in the homogeneity of commodity categories.[3] Specialization in production or consumption (across individuals, households, villages and/or regions) would imply empty cells; in other words, the data is censored, with all the statistical problems that follow from such discontinuities in the system of behavioral and production relationships. Aggregation over groups, on the one hand, decreases the probability of observing corner solutions. The statistical

problems associated with censored data are mitigated,and a theoretical framework that does not recognize corner solutions is more easily justified. However, when one aggregates over components (e.g., commodities or labor activities) that are not homogenous, i.e. perfectly substitutable, and that contain corner solutions, biased parameter estimates result (Vijverberg, 1983). Thus, the crucial question thus becomes whether perfect substitutability is an absolute or a relative concept, i.e., relative to the level of aggregation. Can one devise a measure of substitutability within a potential aggregate before using such aggregate in empirical work? This question becomes more acute when one faces detailed data sets like ICRISAT.

Indeed, the question may arise as to whether the aberration of censored data is more a fundamental theoretical problem than an econometric problem. Consider the case of disaggregating market labor into hours worked in family business (called family labor) and hours supplied to the wage labor market (called hired or hired out labor). Do the corners (observations of zero hours of labor bought or sold in the market) arise because of the circumstance that zero hours of labor are demanded, or rather because there is a wedge between the price of family and hired labor due to a fixed cost of hiring and firing, or satisfaction derived from working for the family, etc.? Perhaps the fixed cost should be incorporated into the agricultural household model. Theoretical problems of this nature may imply econometric difficulties as well: unless such fixed costs are observed, which is unlikely, they must be approximated and estimated (Cogan, 1981).

Disaggregation of labor into various components is not a new issue. It has been recognized in the literature that hours of different individuals

or different activities cannot generally be summed due to imperfect substitutability (of inputs in the production process) and/or unequal efficiency. In the area of agricultural production, Deolalikar and Vijverberg (1982,1983) separated family from hired labor; Nath (1974) separated peak season from slack season labor. In manufacturing, Denny and Fuss (1974), Rosen (1976) and Taylor (1982) distinguished labor by skill levels and sex. Vijverberg (1982) found different efficiency determinants when considering wages received in the wage labor market versus wages obtained in self-employment. All in all, there is concurrance on the necessity of dissaggregating labor to better understand the dynamics (or at this stage, the comparative statics) of the labor market, but the literature has empirically shown only that (a) hours of family workers and hired farm workers are not perfectly substitutable, (b) nor are hours worked in the peak season perfectly substitutable with hours worked in the slack season, for the given databases. Probably, family labor and hired labor as defined above will be found to less than perfectly substitutable in the household farm production process. Nonetheless, the detailed nature of the time diary survey may enhance our intuition as well as the testing possibilities with regard to these issues.

Time diary surveys have a unique time dimension to them. Time diary data have a period of less than a year, be it a day, a month, or part of a crop cycle. Analysis of such data demand a dynamic rather than a static model. The most innovative field of endeavor in the research programme would be modeling the seasonal dynamics of agricultural production. Graphical summaries of the time diary data, where the time period is less than a year, depict the timeliness of agricultural operations; plowing, sowing and harvesting labor, for example, are not freely substitutable in the produc

tion process.

For example, when using time periods of a shorter period than an agricultural year, a model of the crop production cycle as well as a model of household behavior is needed: a crop is sowed at, say, time t and harvested and processed at time T. At any point, $t+\tau$, the family works on the growing crop; if the family does not work at $t+\tau$, the state of the crop at $t+\tau+\delta\tau$ until T is somehow worse. Furthermore, at any period between t and T, the crop can be partially or totally destroyed. Finally, the price of the crop at T depends on the total harvest. While this price is uncertain as well, it is likely to be negatively correlated with the uncertain weather outcomes: if weather damages the crop of one farmer, it may have damaged the crops of other farmers (not necessarily all farmers if, for example, not all lands are susceptible to flooding), so that total market supply falls. Crop prices rise if, of course, the production represents a significant share of the total local market supply, which will be true if transport costs are high, or if all "weather" is correlated. Within the context of this model, time is allocated to different tasks, which include capital investment, repairs and maintenance to provide for an environment in which crops are grown periodically. The formal result is a large dynamic optimization model, different, moreover, from standard dynamic models in the labor supply literature. This differences arises from the fact that while standard dynamic labor supply models assume that the value of work equals an exogenous wage rate, the value of work on one's farm depends on the family hours supplied over the crop cycle. One may note a parallel difference between static models of "standard" labor supply (Lewis (1956)) and labor supply models of agricultural households (Section 1), which, as noted above, is not yet sufficiently understood.

The gains from the dynamic model, of course, derive from the enhanced understanding of the labor supply response over the crop cycle. Estimating labor supply response from aggregate annual data may understate the response in the slack periods, and overstate the response in peak periods of labor demand over the crop cycle. So, while the rural agricultural labor force may be, on the average over the year, underemployed, it may be an illusion to think of them as an army of agricultural surplus labor ready to man the factories of development (Boserup (1970), Raj Krishna (1969), Georgescu-Roegen (1966)).

The data inevitably limits the estimable implications of the dynamic model. Disaggregation of the (standard) time period of an agricultural year is, in theory, prescribed by the frequency of the time diary interview rounds. Of course, if one makes the unit of time over which data are aggregated smaller, one may find activities for which time allocated is homogeneous across different labor categories, say, family and hired female labor in weeding and thinning paddy. But on the other hand, problems may arise from increasing probability of empty cells, as the time period is shortened. Empty cells may be due to the fact that not all activities can occur within the same (small) time period: planting and harvesting necessarily follow each other in that order. So one must answer the question what constitutes a suitable time unit. The magnitude of the problem is suggested in Table 1, where the number of observations over all the production activities recorded in the ICRISAT data are listed for increasing level of aggregation of (1) individuals and (2) time periods.

Similar problems are evident on the consumption side of the model. If consumption of the various commodities is disaggregated into smaller time periods, more empty cells may appear, on top of those that appear because

of disaggregation across commodities mentioned above. That is, most individuals do not go shopping or out eating everyday.[4] In the context of agricultural household models, the choice of a suitable time unit involves the question, whether the time unit is similar for consumption and production decisions. (Recourse to the Village Level Expenditures and Incomes Survey would give us information analogous to the information in Table 1. That is, it is possible to ascertain the scheduling of consumption of different commodities, and/or aggregate commodity groups over the course of the years.) The minimum requirement for the quality of time diary data, like ICRISAT, is that the interval between consecutive rounds is the smaller of the suitable time unit for production and consumption decisions.

Table 1
Censoring Possibilities in the Data[1]

	Categories of Activities[2]										
	OBS	HCP	HAH	HDW	HBC	HTM	HRM	HTOT	FCP	FAH	FBC	FTM
ALL ADULT FEMALES FROM LANDHOLDING HOUSEHOLDS												
BY ROUND[3]	23	17	1	19	0	0	0	20	2	1	0	0
BY SEASON[4]	177	135	2	149	1	0	0	152	2	2	1	0
BY YEAR[5]	254	155	3	205	1	0	3	222	2	3	1	0
ALL ADULT FEMALES IN HOUSEHOLD NUMBER 30												
BY ROUND	6	2	1	3	0	0	0	4	0	1	0	0
BY SEASON	36	22	1	26	0	0	0	28	0	1	0	0
BY YEAR	51	26	2	37	0	0	0	38	0	0	0	0
ALL HOUSEHOLD MEMBERS												
BY YEAR	119	26	49	62	0	0	0	65	0	49	0	0

	FRM	FTOT FRM	FDW	FOOD	FUEL	FTOT HW	FTOT
BY ROUND	0	2	19	0	5	19	
BY SEASON	0	2	149	0	5	151	
BY YEAR	0	3	205	0	6	209	
BY ROUND	0	1	3	0	3	5	
BY SEASON	0	1	26	0	3	27	
BY YEAR	0	0	37	0	3	37	
BY YEAR	0	49	62	0	8	66	

Table 1 cont'd

[1] The numbers are the number of non-zero observations in that activity and time period category. The aggregated categories, HTOT, FTOTFRM, and FTOT, are non-zero if, for this example tabulated, adult females from household that own at least .2 hectares of land, in the village of Dokur, recorded positive hours in any of the activities that comprise the aggregated activity categories generally considered in the literature, per force, or choice (described in footnote 2 below)

[2] The activities are described in the text, Section 4. The notation used is as follows:

HCP: Hired Crop Production
HAH: Hired Animal Husbandry
HDW: Hired Domestic Work
HBC: Hired Building and Construction
HTM: Hired Transport and Marketing
HRM: Hired Repairs and Maintenence
HTOT: any of the above, Hired Total hours

FCP: Family Crop Production
FAH: Family Animal Husbandry
FBC: Family Building and Construction
FTM: Family Transport and Marketing
FRM: Family Repairs and Maintenence
FTOTFRM: any of the above, Family FaRMwork

FDW: Family Domestic Work
FOOD: gathering or processing FOOD
FUEL: gathering or processing FUEL
FTOTHW: any of the above

OBS: number of persons in the activity/time period category.

[3] The round is round number 1, July 15 through August 4, 1975.

[4] The season includes rounds numbered 1 through 6, July 15 through November 13, 1975.

[5] The year includes all rounds in the first year of the VLS, July 15, 1975 through July 25, 1976.

3. Village Description

3.1 Survey Methods: The Selection of Villages and Households

The data considered were collected by the International Crops Research Institute in the Semi-Arid Tropics, in Hyderabad, India. The villages were selected for the survey to be representative of all the villages in their respective talukas (subdivisions of districts) and districts in forty agronomic, climatic and social variables.[5] The districts chosen—Mahbubnagar in Andra Pradesh State, and Akola and Sholapur in Maharashtra (see the map)—are representative of three broad agroclimatic regions in semi-arid tropical India in soil type, rainfall and cropping patterns. The talukas were chosen within each district to be representative of the modal value of land-use and cropping patterns, extent of irrigation, population, and livestock population, etc., in all of the talukas in the region.[6] Two villages were chosen within each taluka—Aurepalle and Dokur, Kinkheda and Kanzara, and Shirapur and Kalman. While the villages vary in area and size of population, ranging from 2.00 to 9.20 square miles, and 143 to 476 households, 40 households were selected from each village to comprise the sample.

The Village Level Survey (VLS) sample consists of ten households from four landholding categories, from each of the six villages. Households were classified by landholding size— landless laborer, small-, medium- and large-landholders, the actual range in acres of each category depending on the distribution of landholdings in the village.[7] Ten households were then randomly chosen from each of the classes, so that the landed subsample in a uniform random sample (drawn from three strata with the same number of

households). Generally, the landless laborer households are underrepresented (Table 2) in the sample.[8]

3.2 Income Sources and Labor Demand

Agricultural production is the primary source of income in the village samples, and thus one would expect to see seasonal patterns in time use. Moreover, as soil type, rainfall and, hence, cropping patterns vary across villages, labor demand and the pattern of time use will vary across villages. Peak periods of demand for agricultural labor--corresponding to critical periods of crop production like preparatory tillage, sowing, weeding, harvesting, threshing, etc.--will, in general, differ for types of soil and crops grown. A further distinction may been made between male and female peak periods due to segmentation of market agricultural work. As Table 3 shows, field preparation, fertilization and manuring, sowing, and irrigation, among others, are predominantly male tasks, while weeding and thinning, nursury bed raising, transplanting and planting are predominantly done by women. Men and women, and children as well, share in harvesting and threshing.[9] Thus it is possible in a predominantly agricultural village to indicate periods of peak and slack demand for adult males and adult females (Table 4).

Alternative sources of income from government construction projects, or factory work in neighboring towns, similarly vary across villages, and the differences may be evident in higher levels of wage work, particularly in the activity of building and construction. Moreover, if the project work falls outside of the peak periods of agricultural production, then the counterseasonal demand may fill in the agricultural demand cycles.

TABLE 2

GENERAL INFORMATION ON THE SELECTED VILLAGES

Details	Village name					
	Aurepalle	Dokur	Shirapur (Sholapur)	Kalman	Kanzara	Kinkheda
Area in sq. miles	6.28[a]	4.55[a]	5.70[b]	9.20[b]	2.30[c]	2.00[c]
Total number of households	476	313	297	423	169	143
Total population	2711	1783	1615	2368	930	687
Percentage of literacy	15[a]	15.81[a]	17.17[b]	13.3[b]	33.68[c]	28.64[c]
No. of landless labor households	131	41	70	102	55	58
No. of land owners completely leased-out or rented-out	7	22	44	110	5	2
No. of operational holding households	338	250	183	211	109	83
Area operated in hectares	1193.93	655.87	1195.55	1682.6	664.78	478.14
Average size of landholding in hectares	3.53	2.62	6.53	7.97	6.1	5.76
Percentage of irrigable area to total operated area	12.04	32.28	8.23	9.19	4.45	0.93
Distance from nearest town/ marketing center (km)	8	5	8	35	8	13
Distance from taluka headquarters/block	21	45	8	35	8	13
Distance from nearest pucca road	8	3	2.4	5	7	0.4
Distance from nearest railway station	70	5.6	6.4	37	4	0.4
Distance from nearest bus stand	0	5	2.4	35	0.2	0.4
Distance from nearest sub-post office	2	0	0	0	0	0
Road connection (all weather, fair weather, no road)	All weather	All weather	Fair Weather	All weather	All weather	Fair weather
Frequency of bus services (per day)	4	3	NIL	3	3	10
Education facilities	UP	UP	H	H	UP	P
Medical facilities	NIL	PM	NIL	PHC	NIL	PM
Veterinary facilities	NIL	NIL	NIL	Vet. Hospital	NIL	NIL
Drinking water facilities	Well	Well	Well	Well	Well	Well
Electrified?	Yes	Yes	Yes	Yes	Yes	Yes
Weekly market	NIL	Devarkadra	NIL	Kalman	Murtizapur	Murtizapur

Table 3
Relative Importance of Male, Female and Child Labor
in Six Villages in Semi-Arid Tropical India
By Aggregated Operation Category
(Percentage of Total Hours in Parentheses)

Task[a]	MALE		FEMALE		CHILD	
Ia.	62,676 Hrs.	(72.7%)	23,265 Hrs	(27.0%)	234 Hrs.	(.3%)
Ib.	21,719	(15.6%)	117,105	(84.1%)	391	(.3%)
II.	52,933	(89.4%)	5,590	(9.4%)	716	(1.2%)
III.	54,413	(32.5%)	110,818	(66.1%)	2369	(1.4%)
IV.	712	(81.1%)	165	(18.8%)	0	(0%)
All	192,452	(42.5%)	256,943	(56.7%)	3710	(.8%)

Notes:

[a] Category Ia includes field preparation, manuring and fertilizing land, and minor and annual repairs to bunds, fences, etc. (cultivation activities A-D, and Z in the ICRISAT code).

Category Ib includes sowing, resowing, transplanting or planting, and weeding and thinning (cultivation activities E-H).

Category II includes interculturing, irrigation, plant protection and watching (cultivation activities J-M).

Category III includes harvesting and harvest processing (cultivation activities N-R).

Category IV includes supervision and management (X), and is excluded from further consideration in this paper.

Table 4

PEAK AND SLACK PERIODS FOR ADULT MALES AND FEMALES IN SIX SAT VILLAGES OF SOUTH INDIA, 1975-76

District/ Village	Category	Peak Period		Slack Period Months
		Months	Major Operation	
MAHBUBNAGAR:				
Aurepalle	Males & Females	Dec.-Jan.	Harvesting and threshing sorghum, pearl millet, castor	Feb.-April
Dokur	Males & Females	Nov.-Jan.	Harvesting and threshing sorghum, nursery bed preparation paddy, paddy transplanting	Feb.-June
SHOLAPUR:				
Shirapur	Males	April-May July-Aug.	Preparatory tillage, ploughing, sowing pearl millett, meats, mungbean	Dec., Feb.-March
	Females	Sept.;	Harvesting and threshing pearl millet, mesta mungbean	Apr.-Aug.
		Dec.-Feb.	Sowing & harvesting wheat, sorghum, chickpea, safflower	
Kalman	Males	Jan.-Mar.	Harvesting and threshing wheat, sorghum, chickpea, safflower	Aug.-Oct.
	Females	May	Preparatory tillage, ploughing	
		Mar.-Apr.	Harvesting & threshing wheat, sorghum, chickpea, safflower	Oct.-Dec.-Jan.
		Nov.	Harvesting & threshing pearl millet, mesta.	
AKOLA:				
Kanzara	Males	Mar.	Harvesting cotton; harvesting & threshing pigeonpea	Apr.-Sept.
		Aug.-Sept.		
		Nov.	Preparatory tillage, sowing wheat, chickpea, harvesting sorghum, groundnut	
	Females	Oct.-Dec.	Harvesting & threshing sorghum, groundnut, cotton	Apr.-June
		March	Harvesting cotton	
Kinkheda	Males	April	Preparatory tillage	Aug.-Oct.
		June-July	Sowing, interculturing cotton, sorghum, pigeonpea, mungbean.	May
		Nov.-Dec.	Harvesting & threshing, sorghum, groundnut; sowing wheat and chickpea.	
	Females	May	Field cleaning.	Feb.-March
		Sept.-Dec.	Harvesting & threshing sorghum, groundnut weeding cotton.	

Source: Ryan and Ghodake (1980)

Market labor is primarily cultivation work, except where public and government construction projects are ongoing. Access to various labor markets, as well as specific activities, is denied to women. Binswanger, et.al. (1982) observe that the daily rental market may not be discriminatory according to sex, but that women gain access to the contract jobs (on farms or government projects) mainly via male family members; women are essentially excluded from the market for regular farm servants (only one woman in all six villages was a regular farm servant).[10] However, the impact of limited access to contract jobs may be swamped by hours worked in an active daily rental market.

3.3 Village Profiles of Labor Demand[11]

Alfisol (light red) soils in Aurepalle have low moisture holding capacity,[12] and average rainfall is low (713 mm) and uncertain,[13] so that all non-irrigated crops are grown in the rainy season. Given that only 12% of the gross cropped area is irrigated, 65% of labor use in the fields occurs in the one rainy season. Crops grown include sorghum, groundnuts, pigeonpeas, pearl millet and castor. With few opportunities other than agricultural production, the large seasonal variation due to the single rainy season cropping may be evident in relatively high variation in hours worked in agricultural production jobs.

Binswanger, et.al. (1982) report that caste association influences access to the labor market in contract jobs and regular farm servant jobs, although not in the daily wage market, attributing this phenomenon, not common in the other five sample villages, to the dearth of outside employment opportunities. This dearth may be evident in relatively low levels of

wage work. They also report that wage fixing among farmer-employers is common in Aurepalle, leading to low variation in wages in any time period.

Dokur is in the same district as Aurepalle (Mahbubnagar), but the soils are medium deep vertisols with high moisture holding capacities, so that most non-irrigated cropping occurs in the post-rainy season on residual soil moisture, growing sorghum, chickpea and safflower. Pearl millet and pigeonpeas are grown in the more shallow vertisols in the rainy season. Paddy is grown on irrigated land and 32% of the gross cropped area is irrigated, accounting for the reportedly high average market participation of women , who weed and transplant the rice seedlings. Labor requirements (use) would be more spread out in the double cropped than in the single cropped pattern in Aurepalle. Dokur villagers apparently migrate temporarily from the village to work on government construction projects many miles distant, all of which may be reflected in less variable and higher average levels of hours of work.

The soils of the Sholapur District villages (Shirapur and Kalman) are medium deep to deep vertisols with high moisture holding capacity, but rainfall is low (691 mm) and uncertain. Indeed, Sholapur is drought prone, but most nonirrigated crops are necessarily grown in the post-rainy season on residual soil moisture. Sorghum, chickpeas and safflower are the main crops. Pearl millet and pigeonpeas are grown in shallow vertisol in the rainy season, but more than half of the labor use occurs in the post-rainy season, September to March. The post-rainy season cropping/rainy season fallow pattern means a little demand for female labor, because less handweeding and interculturing is necessary for post-rainy season crops.

The district is the least prosperous of the districts in the sample. Periodic famines, due to droughts, have b[illegible]itigated by government spon

sored relief projects in the past. In the survey period, 1975 through 1978, percolation tanks (to increase the groundwater level) and a canal were being built within walking distance from the villages. While projects, and as well, textile mills in Sholapur (the nearest large town) have provided jobs to villages, labor incomes are notwithstanding reportedly low on average, and highly variable over the year, along with hours of work (Binswanger,et.al (1982)).

Akola district (with the villages Kinkheda and Kanzara) has been famous for cotton for centuries.[14] The soils are medium deep vertisols, and the rainfall is high and assured. Cotton is sown in the rainy season, mixed with sorghum and pigeonpea. Around 90% of the agricultural labor use occurs in the rainy season; large amounts of labor are needed to harvest the (previous season's) cotton after the foodcrops are harvested.

Kinkheda reportedly neither imports nor exports daily laborers, but there is a seasonal labor surplus in Kanzara except during harvest (Binswanger, et.al. (1982)). Government land improvement and irrigation projects as well as "employment guarantee programs" of the state government are important alternative sources of employment to tide laborers over from the cotton harvest to the onset of the next monsoon (there is work for ploughmen in this interim period, to prepare the soil for sowing). Families even work together on government projects with the "food for work" program, and they can buy foodgrains at subsidized prices at the jobsite. Thus sorghum, cotton, and government projects are the sources of employment in the district. The villages have been characterized as highly commercialized, with high labor incomes.

Differences in hours of work and wages across the villages, then, arise from different cropping patterns, opportunities for non-agricultural

employment, and as well, to labor market peculiarities, and should be manifested in the level and variation in hours (spent in various market and nonmarket productive activities) and wages across the villages. This hypothesis is considered only with time diary data, and one can place particular emphasis on associating differences within and across villages with agroclimatic and institutional differences. In the next section, the time allocation survey methods and data collected are described.

4. ICRISAT Time Allocation Data

4.1 Time Allocation Survey Methods[15]

ICRISAT village level investigators[16] interviewed a household respondent in each household every two or three weeks[17] over the three years of the Village Level Studies in the six villages, and recorded the hours or fractions of hours spent by each family member in eleven activities (exhaustive activity categories) the previous day. The survey method is known as one-day recall, as distinct from surveys wherein the investigator observes and records the time use of the household, or the family members keep a record of their time use on the day in question. There are three obvious sources of errors in variables:[18] (1) family members may misstate their actual time use, intentionally or unintentionally, (2) the family respondent may misstate the time use of the family members, and (3) the interviewer may falsify the time diary entries. The magnitude and direction of the error in the first two instances cannot be estimated,[19] and in the third, ICRISAT economists maintained close contact with the village investigators.

Each household respondent was interviewed once per round, unless the household had migrated to another village or district for employment in that round. Table 5 shows that the number of households absent in any village per round was at most 6 households. Households that had temporarily migrated were included in subsequent rounds upon return to the villages. A second source of sample variation across rounds arises from households that had permanently migrated from the village, although only a small proportion of the sample households permanently migrated from the villages over the

Table 5
Sample Variation: Number of Households,
Adult Males, Females and Children Observed Per Round[1]

Round number	DOKUR Households	DOKUR Adult Males	DOKUR Adult Females	DOKUR Children	KALMAN Households	KALMAN Adult Males	KALMAN Adult Female	KALMAN Children
1	40	67	67	26	28	37	32	25
2	38	64	55	26	40	60	56	46
3	39	59	54	27	34	50	47	37
4	40	58	55	29	37	67	64	60
5	38	51	49	25	35	56	49	41
6	28	45	46	23	36	50	45	38
7	37	49	46	26	37	53	43	43
8	40	60	55	31	36	41	38	34
9	39	55	53	25	38	56	55	52
10	40	61	52	27	38	54	49	45
11	40	60	53	27	37	55	53	46
12	39	62	52	27	38	52	52	46
13	38	58	53	27	38	49	54	47
14	40	57	54	28	38	56	56	46
15	39	53	54	27	37	49	51	44
16	39	49	53	28				
17	38	50	52	26				

[1] Obviously, there were only 15 interview rounds in Kalman in the first year of the Village Level Surveys.

survey period . However, these figures understate the sample variation problem. The household respondent answered for household members at home. Members who were temporarily absent, either looking for work in another village, or on holiday, etc., would be included in subsequent rounds, while those who had permanently left the household, e.g. subsidiary families moving to another village, would be missing from all subsequent rounds. The magnitude of this problem is indicated in Table 5. Individuals absent from the village were excluded from the statistics. Discontinuity of the sample is a necessary concern of the researcher, precisely because of the variation of the sample of members within the household, the most disaggregated (e.g., the primary) unit of observation, even when the researcher's interest is in more aggregated units, e.g. males or females within the household, or the households, etc..

Length of the rounds varies within the villages within and across the years, and as well, the period of each round varies across the villages, and apparently, greater frequency is associated with level of activity in the village.[20] The variable round length and the missing observations are potential problems. The former may force one to accept variable round intervals as relevant time periods for consumption and production, as defined in Section 2.[21] The latter may be mitigated in part by excluding households not present in all rounds, or household members not present (although the size of the sample may be seriously diminished). Moreover, standardized time periods (through aggregation, perhaps) is necessary for comparison across villages.

4.2 Activities

A household respondent— usually the wife of the head of house— was queried by the investigator with regard to time spent by each household member in the following eleven (mutually exclusive) categories of activities, on the day prior the interview:

(1) crop production—time spent going to and returning from the fields, as well as field work is counted. Marketing off farms and toddy tapping (brewing the local liquor) are not counted.

(2) animal husbandry—cattleshed cleaning, watering, feeding, feed and fodder processing, milking, animal product processing, and visits to the veterinarian are counted.

(3) capital investment—time spent constructing new buildings, new bunds (an embankment to control the water for the fields), new fences and hedges, road and irrigation works.

(4) repairs and maintenance—time spent on all building repairs, repairs of bunds and farm structures in general, irrigation canals, and farm tools. Categories 3 and 4 could be logically (from the standpoint of the economist) aggregated to "capital accumulation."

(5) transport and marketing—time spent marketing all inputs and outputs and travelling to and from the market. Unfortunately, marketing the products of categories 1 and 2 have not been distinguished.

(6) housekeeping and other domestic work—time spent cleaning, cooking, water-fetching, caring for children, making fires, washing and mending clothes.

(7) other work such as religious services, regular shopkeeping and trading, toddy tapping, ceremonial and social or political func

tions, handicrafting, i.e. weaving, leatherwork, pottery, carpentry, blacksmithy, rope making, basket weaving and goldsmithy.

(8) gathering and processing dung or wood for fuel.

(9) gathering and processing fruit and other food for sale or for home consumption. Market and non-market home production have not been distinguished.

(10) schoolwork—time spent going to and returning from school, as well as class and homework is counted.

(11) regular village jobs—teachers, village level workers, and patwaris (village political workers), for example.

The amount of information collected is large indeed. Most empirical analyses will need some way to condense this material. In doing this, one must realize at least three dimensions of the data set: (i) activities; (ii) time periods; (iii) individuals. Other dimensions of possible concern are landholding categories and villages. Condensing information (i.e., aggregation) necessarily reduces one of these dimensions to a smaller scale. For example, one may reduce the dimension of individuals to the three categories of males, females, and children. In that way, the number of "representative" individuals not participating in a certain activity decreases. Or, when one aggregates over broadly-defined activities, more individuals in the sample will appear to participate in all activities. As discussed in Section 2, such aggregation is not without cost.

5. Summary and Concluding Remarks

Time diary surveys open up new areas of empirical research. The detailed nature of the survey data allows a closer examination of theories than has been possible with simple cross-sectional surveys. This may be the main promise of time diary surveys.

This paper suggests that this promise may not be realized until a number of basic questions have been answered. These questions are certainly not new, but, because the data necessary to test them has not been available, the questions have been neglected.

The first question relates to aggregation over commodities and activities. An appropriate way to deal with the individual's corner solutions, i.e., no purchase of a commodity or nonparticipation in any activity, must be found. Otherwise, one is forced to assume that commodities and activities for which corner solutions occur are components of a broader aggregate and perfect substitutes for other components within that aggregate.

The second question addresses reconciliation of the discrepancies between the periodicity of the collected data and the theoretical time dimension of economic activity. Ideally, these dimensions are identical. Actually, strategies must be developed to examine the timing questions, and applied to data, namely time diary data, to answer this question.

The ICRISAT survey data may be especially useful with regards to the first question, and may be useful with regards to the second. However, the irregularities in the lenghts of the time periods between survey rounds, both within and across villages, will limit their empirical usefulness, even as they forced consideration of the question in the first place.

Footnotes

[1] e.g., Stafford and Hill (1978), Hansen (1969), and Evenson, et.al.(1979).

[2] Interest in agricultural household models presumably arose because time allocation had always played an important, if somewhat implicit, role in theories of development (Ranis and Fei (1961), Sen (1966), and Desai and Mazumdar (1970)). In order to study rural under-employment, one needs to look at how time is actually allocated in agricultural households.

[3] In addition to the arguments mentioned here, it is obvious that disaggregation involves an increase in the "randomness" of the observations, mainly due to (1) idiosyncrasies, (2) time scheduling of holidays, etc..

[4] This adds new meaning to the maxim, "Variety is the spice of life."

[5] Comparative district and taluka level data are presented in Jodha (1977).

[6] Table 2 lists other variables, besides the variables that determined selection of the VLS sample.

[7] The actual range in acres depended on the distribution of landholdings in the village. For example, in Dokur, with a high proportion of irrigated land (to gross cropped area), the average landholding is smaller than in Kinkheda, with .9% gross cropped area irrigated, partly because of higher productivity of wetland.

[8] Furthermore, carpenters, blacksmiths, potters, watercarriers, washermen, and shepherds who own their sheep were excluded from the VLS sample. Households headed by nurses, teachers, village level workers, and village peons were also excluded.

[9] The numbers in Table 3 were calculated from VLS Schedules H and D, the crop and plot rotation schedules and the crop production schedule. Hours of adult males, adult females and children were summed in all the crop production

activities. Predominantly male activities were those for which more than 50 percent of the task was done by male labor, and so on.

[10] Regular farm service was contracted for periods of 3 months to one year, and was usually tied to loans or advances for special events. For example, it was not uncommon that a young man contract his services in order to secure, say, a brideprice. But, women are unable to use this avenue to the credit market for whatever reason.

[11] This section summarizes information gathered from the following papers: Ghodake, et.al. (1978); Ryan and Ghodake (1980); Binswanger, et.al. (1980); and Jodha (1979). (The next section on results reports new findings.)

[12] Although soils have been generally characterized, the quality of soils does vary across landholding in the villages, which is evident in the prevalence of patch cultivation and intercropping. Poor quality soils include saline soils, depressions that fill with water, and gravelly soils.

[13] In 1975-1976, rainfall in Akola was 70% of average. In 1976-1977, rainfall in Sholapur (District) was 55% of average. 1977-1978 was a good crop year in Mahbubnagur and Sholapur. Over the three years of the VLS, rainfall in all the villages was 99 percent of normal, but apparently with high variation. Of course, it is the distribution of rainfall, not just the average, that is important to the farmer.

[14] Cotton from Akola was especially important in world production when the Atlantic Ocean cotton trade was interupted during the American Civil War.

[15] The Village Level Survey methodology is described in Jodha (1977).

[16] Investigators lived in the villages over the course of the Village Level Survey (VLS), June 1975 through June 1978 (the survey was extended beyond June 1978 in three of the six original villages, and to three new villages). The field investigators were either born in the district, or spoke the dialect.

Supervision was coordinated by the Head Economist at ICRISAT, J.G.Ryan, who regularly visited the villages. Special surveys—the health and nutrition survey, and the fertility survey, conducted by a team of medical workers and Mead Cain (now at the Population Council), respectively, augmented the original design of the VLS.

[17] Tables D.1 and D.2 in Appendix D of the ICRISAT VLS Manual (Binswanger, et.al.(1978) list the rounds over only the first two years of the VLS Survey.

[18] See ....

[19] For example, "respondent bias" may be measured by cross-tabulating data from surveys wherein individual family members report their own time use with data from respondent-reported surveys. (reference) This measurement is not possible for the purposes here because corresponding information from family members was not collected.

[20] Apparently, interviews were not conducted on the days after holidays. The response, "on vacation and unable to work," was uncommon among adult males and adult females, more common among schoolchildren.

[21] Any other interpretation implies absence of observations during some intervals, partially applicable observations during others. Serial correlation of error terms may become almost impossible to handle.

[22] There is not a difference in the size of landholdings among landless laborers and farmers across the villages: landless households were defined as households with a daily wage work of regular agricultureal employment as their main source of income, or with less than .2 hectares of land to farm. Landholders, by definition, farm at least .2 hectares of their own or rented land.

[23] Say that on one day, two laborer households were interviewed, but on the next, two farmers, so that on the first, the records show 0 hours spent in own farmwork and 8 in wage work, while on the next, 8 in own farmwork and 0 in wage work.

Bibliography

Asokan, M., "Rural Labor Wages and Bullock Rental Rates for Various Agricultural Operations in the SAT of South India, 1975-76 to 1979-80," Economics Program Progress Report 18, ICRISAT, Hyderabad, India, Decempber 1980.

Barnum, H. and L. Squire, A Model of an Agricultural Household, Washington, D.C., World Bank, Occasional Paper 27, 1979.

Barton, A., "The Systems of Consumer Demand Functions Approach: A Review," Econometrica, vol. 45, 1977, pp. 23-52.

Becker, Gary, "A Theory of the Allocation of Time," Economic Journal, vol. 75, 1965, pp. 493-517.

Boserup, Ester, Woman's Role in Economic Development, New York, St. Martin's Press, 1970.

Binswanger, H.P., V.S.Doherty, T.Balaramaiah, M.J. Bhende, K.G. Kshirsagar, V.B. Rao and P.S.S. Raju, "Common Features and Crontrasts in Labor Relations in the Semi-Arid Tropics of India," Economics Program Progress Report 13, ICRISAT, Hyderabad, India, March 1980.

——, and N.S. Jodha, "Manual of Instructions for Economic Investigators in ICRISAT's Village Level Studies," Vol. II, Village Level Studies Series, November, 1978.

Bowen, W.G. and T.A. Finegan, The Economics of Labor Force Participation, Princeton, New Jersey, Princeton University Press, 1969.

Cain, Glen, Married Women in the Labor Force, Chicago, University of Chicago Press, 1966.

Cogan, John, "Fixed Costs and Labor Supply," Econometrica, vol. 49, 1981, pp. 945-964.

Denny, Michael and Melvyn Fuss, "The Use of Approximation Analysis to Test for Separability and the Existence of Consistent Aggregates," American Economic Review, vol. 67, 1977, pp. 404-418.

Deolalikar, Anil and Wim P.M. Vijverberg, "The Heterogeneity of Family and Hired Labor in Agricultural Production: A Test Using District-Level Data from India," Center Discussion Paper No. 411, Yale University, June 1982, October, 1982 revised.

Desai, M. and D. Mazumdar, "A Test of the Hypothesis of Disguises Unemployment," Economica, February 1970, vol. 37, no. 145, pp.39-53.

Evenson, R.E., "Time Allocation in Rural Phillipine Households," Center Discussion Paper No. 206, Yale University, 1978.

——, B. Popkin and E. King-Quizon, "Nutrition, Work, and Demographic Behavior in Rural Philippine Households: A Synopsis of Several Laguna Household Studies," Center Discussion Paper No. 308, Yale University, January, 1979.

Georgescu-Roegen, Nicholas, Analytical Economics: Issues and Problems, Cambridge, Harvard University Press, 1966.

Ghodake, R.D., J.G. Ryan, and R.Sarin, "Human Labor Use in Existing and Prospective Technologies of the Semi-Arid Tropics of Peninsular India," Economics Program Progress Report 1, ICRISAT, Hyderabad, India, December 1978.

Gronau, Reuben, "Wage Comparisons—A Selectivity Bias," Journal of Political Economy, vol. 82, 1974, pp. 1119-1144.

Hansen, Bent, "Employment and Wages in Rural Egypt," American Economic Review, 59, 1969, pp. 298-313.

——, "Employment and Wages in Rural Egypt: Reply," American Economic Review, 61, 1971, pp. 500-508.

Huffman, W. and M. Lange, "Farm Household Production: Demand for Wife's Labor, Capital Services and the Capital-Labor Ratio," Discussion Paper No. 480, Economic Growth Center, Yale University, June 1982.

Hymer, S. and S. Resnick, "A Model of an Agrarian Economy With Nonagricultural Activities," American Economic Review, vol. 59, 1969, pp. 493-506.

Jodha, N.S., "Intercropping in Traditional Farming Systems," Economics Program Progress Report 3, ICRISAT, Hyderabad, India, April 1979.

——, M. Asokan, and J.G. Ryan, "Village Study Methodology and Resource Endowments of the Selected Villages," Occasional Paper No. 16, Economics Program, ICRISAT, Hyderabad, India, 1977.

Jorgenson, Dale and Lawrence Lau, "An Economic Theory of Agricultural Household Behavior," Paper presented at the 4th Far Eastern Meeting of the Econometric Society, 1969.

Krishna, Raj, "Comment: Models of the Family Farm," in Subsistence Agriculture and Economic Development, ed. by C.F. Wharton, Jr., Chicago, Aldine, 1969.

Lewis, H.G., "Hours of Work and Hours of Leisure," Annual Proc. Industrial Relations Research Association, 1956, pp. 196-206.

Mincer, Jacob, "Labor Force Participation of Married Women: A Study of Labor Supply," in Aspects of Labor Economics, National Bureau of Economic Research, Princeton University Press, Princeton, 1962, pp. 63-105.

Nakijima, C., "Subsistence and Commercial Family Farms: Some Theoretical Models of Subjective Equilibrium," in Subsistence Agriculture and Economic Development, ed. by C.F. Wharton, Jr., Chicago, Aldine, 1969.

Nath, S.K., "Estimating the Seasonal Marginal Products of Labor in Agriculture," Oxford Economic Papers, vol. 26, 1974, pp. 375-387.

Ranis, Gustav and John Fei, "A Theory of Economic Development," American Economic Review, September 1961, 51, pp. 533-565.

Rosen, S., "Substitution and Division of Labor," Economica, 1976, vol. 45, no. 1, pp.861-868.

Rosenzweig, Mark, "Neoclassical Theory and the Optimizing Peasant: An Econometric Analysis of Market Family Labor Supply in a Developing Country," Quarterly Journal of Economics, vol. 94, 1980, pp. 31-55.

Ryan, J.G. and R.D. Ghodake, "Labor Market Behavior in Rural Villages of South India: Effects of Season, Sex and Socioeconomic Status," Economics Program Progress Report 15, ICRISAT, Hyderabad, India, August 1980.

Sen, A.K., "Peasents and Dualism With or Without Surplus Labor," Journal of Political Economy, vol. 74, 1966, pp. 425-450.

Singh, R.P., "Crop Failure and Intercropping in the Semi-Arid Tropics of India," Economics Program Progress Report 21, ICRISAT, Hyderabad, India, May 1981.

Stafford, F.P. and C.R. Hill, "Parental Care of Children: Time Diary Estimates of Quantity Predictability and Variety," Journal of Human Resources, XV, 2, pp. 219.

Strauss, John, "Determinants of Food Consumption in Rural Seirra Leone: Application of the Quadratic Expenditure System to the Consumption-Leisure Component of a Household-Firm Model," Journal of Development Economics, December, 1982, 11 (3), pp. 327-353.

——, "An Overview of Agricultural Household Models: Theory and Empirical Applications," mimeo, University of Virginia, March 1983.

Taylor, Alan, "Substitution in Production of Male and Female Labor," unpublished Ph.D. dissertation, Yale University, April 1982.

Vijverberg, Wim P.M., "Unbiased Estimates of the Wage Equations When Individuals Choose Among Income Earning Activities," Center Discussion Paper No. 429, Yale University, December, 1982.

——, "Aggregation of Heterogeneous Concepts, and Models of Selectivity When Alternatives Are Not Mutually Exclusive," mimeo, Yale University, July 1983.

Yotopoulos, Pan, Lawrence Lau, and Wuu-Long LIn, "Microeconomic Output Supply and Factor Demand Functions in the Agriculture of the Province of Taiwan," American Journal of Agricultural Economics, vol. 58, 1976, pp. 333-340.