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HUMAN LABOR USE IN EXISTING AND PROSPECTIVE TECHNOLOGIES OF THE SEMI-ARID TROPICS OF PENINSULAR INDIA

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Labor is a key resource in most of the developing countries. It is especially so in the semi-arid tropical (SAT) regions, where more than 500 million of the poorest people in the world eke out a livelihood from meager resources of land and capital in an unfriendly climate.[1]

Substantial efforts are presently underway to develop improved agricultural technologies for these SAT regions involving national and international programs. Examples include the All-India Coordinated Research Project for Dryland Agriculture, the Institut du Sahel, and the International Crops Research Institute for the Semi-Arid Tropics. In many of these the research thrusts involve development of technologies that will be viable for all farmers, including the small landholder, and which have potential for augmenting rural employment, particularly in the Asian context.

Experience with the modern varieties of wheat and rice in Asia, which were introduced in the mid-1960's, suggest that new seed/fertilizer/irrigation technology does have scope for creating employment and benefiting small farmers (Hayami and Ruttan, 1970; Hanumantha Rao, 1975) as

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[1] See Kampen, J. and Associates (1974); Krantz, B.A. and Associates (1974); and Ryan J.G. and Associates (1974).

they have been basically land-augmenting and labor-using. However, there is evidence that some mechanization which occurred at the same time may have led to labor displacement with little, if any, gains in productivity (Binswanger, 1977).

It was against this background that the present study was initiated. The aim is to obtain insights into the likely effect of the introduction of prospective improved land-, water-, and crop-management technologies being researched at ICRISAT on existing village labor-use patterns in one of the major SAT regions of concern, namely peninsular India. Without a thorough understanding of the existing seasonal labor availabilities, demands, and their determinants, it can be risky to attempt to introduce improved technologies. This was amply demonstrated by the work of Norman in Northern Nigeria (1974) where he found that new cotton varieties being promoted created a labor bottleneck at peak weeding time for the traditional foodgrain crops, which were given precedence over the new cottons.

Das Gupta *et al.* (1977) have provided a thorough review of a large body of primarily unpublished village study material on labor utilization, including a large number from the various Indian Agro-Economic Research Centres. The limitation in most of the studies reviewed by Das Gupta *et al.* is that they refer to whole villages rather than differentiating between farm-size groups within villages. It is the latter aspect that is of crucial importance in the design of new technology applicable to all types of farms. In the present study, inter-regional and inter-village differences in labor-use patterns are explored and their agroclimatic and socioeconomic determinants discussed. In addition, explicit attention is given to the similarities and differences between small and large farms within villages and their relevance for the adoption of the prospective new technologies being designed at ICRISAT.

The first section of the paper describes the village data sources while the second presents some of the salient socioeconomic and agroclimatic features of the six selected villages. Then follows a comparison of labor-utilization patterns amongst the three agroclimatic regions wherein the six villages are located. Differences in labor use between farm-size groups are discussed in the ensuing section, followed by an analysis of the composition of total labor by sex, age, and type -- again differentiated by farm-size groups. A detailed examination of the seasonality of labor use in the villages occupies the next section, which is then compared with seasonal pattern emerging from the improved soil-, water-, and crop-management technologies being researched at ICRISAT to gauge the likelihood that labor bottlenecks would appear upon introduction of the improved technologies. Then follows the concluding section.

THE DATA

Data for the study were derived from information collected from the ICRISAT village-level studies which have been underway in six villages of SAT peninsular India since May/June 1975. Details of labor utilisation of family and hired labor on the operational holdings of about 30 cultivators in each of the six villages were obtained by resident investigators. Interviews were conducted every 2 to 3 weeks throughout 1975-76 for this purpose.[1] Labor use has been recorded in hours separately for males, females, and children.

The six villages were selected purposefully to represent three broad agroclimatic zones of SAT peninsular India. Aurepalle and Dokur villages in Mahbubnagar District of Andhra Pradesh were selected to

[1]Data pertaining to 1976-77 and 1977-78 have also been obtained, but analysis is not yet complete. It is planned in a subsequent paper to test whether there are significant differences in the seasonal and the total human labor-use patterns within farm-size groups across the 3 years. For a detailed description of the methodology, villages and the complete range of information see Binswanger *et al.* (1977), Jodha *et al.* (1977) and Jodha and Binswanger (1975).

represent the Alfisols, low (713 mm) and uncertain rainfall areas in Andhra Pradesh, Karnataka, and Tamil Nadu. Shirapur and Kalman villages in Sholapur District of Maharashtra represent the deep and medium-deep Vertisols, low (691 mm) and uncertain rainfall areas of Maharashtra, Karnataka, and Madhya Pradesh. The villages of Kanzara and Kinkheda in Akola District of Maharashtra were chosen as typical of the relatively high (819 mm) and more-assured rainfall areas of northern Maharashtra and Madhya Pradesh having medium-deep Vertisols.

The cropping pattern in the Mahbubnagar villages is dominated by sorghum, castor, rice, groundnuts, pearl millet, and pigeonpeas. In Sholapur, sorghum, safflower, and chickpeas are the dominant crops, and these are generally grown in the postrainy season after a rainy season fallow on the deep Vertisols. On the medium-deep Vertisols in Sholapur, pearl millet and pigeonpeas are common. In the Akola region, cotton predominates in the cropping pattern, followed by sorghum, groundnuts, and pigeonpeas, with wheat being grown on the irrigated areas.[1]

Around 30 sample households from the cultivator group in each village were selected using stratified random sampling, with small, medium, and large farm strata represented equally.[2] The ranges of total operated land area for this respondent categorization are presented in Table 1 and are used as the basis for most of the discussion which follows in this paper.

The definition of a small farm in a highly irrigated village such as Dokur is one with between 0.21 and 1 ha of operated land. In Kalman, on the other hand, where there is much less irrigation and lower rainfall, small farms range between 0.21 and 6 ha. Similarly, large farms in Dokur are those that exceed 3 ha, while in Kalman the

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[1]For more details on village cropping patterns, see Jodha (1977).

[2]This allowed for a variable delineation of the cutoff points between farm size categories amongst the different villages. For more details see Ghodake and Asokan (1978).

Table 1. Revised respondent categorization with range of total operated land areas in different villages.[a]

District/ Village	Category			
	Labor	Small Farm	Medium Farm	Large Farm
	(ha)	(ha)	(ha)	(ha)
MAHBUBNAGAR				
Aurepalle	≤ 0.20	0.21 - 2.50	2.51 - 5.25	> 5.25
Dokur	≤ 0.20	0.21 - 1.00	1.01 - 3.00	> 3.00
SHOLAPUR				
Shirapur	≤ 0.20	0.21 - 2.50	2.51 - 6.00	> 6.00
Kalman	≤ 0.20	0.21 - 6.00	6.01 - 10.75	> 10.75
AKOLA				
Kanzara	≤ 0.20	0.21 - 2.25	2.26 - 5.60	> 5.60
Kinkheda	≤ 0.20	0.21 - 3.00	3.01 - 5.60	> 5.60

[a]Total operated land area here includes cultivable land, grazing land, uncultivable land etc. For its comprehensive definition see Ghodake and Asokan (1978).

figure is 10.75 ha. This village-specific and variable delineation of farm-size groupings was felt to be more relevant for making comparisons across agroclimatic zones.

CHARACTERISTICS OF THE VILLAGES

Before discussing labor-utilization patterns, it is useful to examine some socioeconomic characteristics of the six villages. Table 2 contains details of average farm sizes, extent of net cultivated area, extent of irrigation, land values, and cropping intensities. These factors play a role in determining the extent of labor use.

The average operated farm size ranged from 3.37 ha in Dokur to 8.33 ha in Kalman. Other villages fell in between. Generally more than 75 percent of the operated land was cultivated. In general, the proportion of cultivated land was lower in Mahbubnagar villages compared to both Akola and Sholapur villages. Almost 45 percent of Dokur farms were irrigated, while in Kinkheda the extent of irrigated area was less than 1 percent. In general irrigation is much more prevalent in the Alfisol villages than in the Vertisol villages. Villages in the more-assured rainfall Vertisol areas of the Akola region had a lower percentage of irrigation than did those in the Sholapur Vertisols. As a partial result of having more irrigation, the Mahbubnagar Alfisol villages have a higher cropping intensity (around 114) than those in either Sholapur (110) or Akola (106).[1] Besides the small amount of irrigation in the Akola villages, another contributing factor to low cropping intensity is the large area under long-duration cotton crops. Cropping intensity indices do not take into account these types of crops and must, for that reason, be interpreted carefully.

Land values are highest in Dokur (Rs. 6746 per ha) due

[1]Percent cropping intensity is defined as the total gross cropped area divided by the net cultivated area, multiplied by 100.

Table 2. Some socioeconomic characteristics of six SAT villages in India (1975-76)

District/Village	Operational farm-size group	Respondents (no)	Average operated land (ha)	Average net cultivated area (%)	Average irrigated area (%)	Average land value per operated hectare	Average intensity of cropping (%)
MAHBUBNAGAR							
Aurepalle	Small	9	1.33	90	0.0	1855	100
(Alfisols)	Medium	10	3.09	93	15.19	2150	102
	Large	10	12.52	69	10.77***	2937**	118***
	All Farms	29	5.79	75	10.82	2330	113
Dokur	Small	10	0.69	85	69.25	6868	130
(Alfisols)	Medium	10	1.90	89	60.64	6777	127
	Large	10	7.53	70	39.19	6593	111
	All Farms	30	3.37	75	45.25	6746***	116**
SHOLAPUR							
Shirapur	Small	10	1.75	96	13.87	6734	112
(Deep Vertisols)	Medium	9	4.69	87	11.30	5262	115
	Large	10	9.19	86	5.50	5054*	112
	All Farms	29	5.23	87	8.08	5700	113
Kalman	Small	10	3.50	93	9.95	3850	105
(Deep Vertisols)	Medium	9	9.09	97	14.67	3477	111
	Large	9	12.93	96	9.06	3204	107
	All Farms	28	8.33	96	11.17	3522***	108
AKOLA							
Kanzara	Small	10	1.42	96	5.40	3364	106
(Medium-deep Vertisols)	Medium	10	3.58	94	2.26	4130	107
	Large	10	12.70	96	4.14	5807*	104
	All Farms	30	5.90	96	3.89	4434	105
Kinkheda	Small	10	1.62	99	2.49	2884	104
(Medium-deep Vertisols)	Medium	10	4.25	95	0.0	3589	103
	Large	10	14.11	88	0.57	3645*	108
	All Farms	30	6.66	90	0.61	3373*	108

Note: Asterisks used for large farms indicate large farm figures are significantly different from the respective small farm figures and asterisks used for all farms indicate values for the concerned village are significantly different from the respective values of the other village in the same region.

***Significant at 1% probability level
**Significant at 5% probability level
*Significant at 10% probability level

primarily to the presence of extensive irrigation from tanks and wells. Next comes Shirapur (Rs. 5700), which has a large amount of deep Vertisols with high moisture-holding capacity, allowing more-assured post-rainy season crops. In both cases the differences between land values in these two villages and their counterparts Aurepalle and Kalman, respectively, in the same region were statistically significant at 1 percent Kanzara in the Akola region has the next highest land values (Rs. 4434), with Aurepalle the lowest (Rs. 2330).

Some of the differences in characteristics between the small and the large farm-size groups in Table 2 are illuminating.[1] The large farm in the Mahbubnagar region is some 10 times larger than the average small farm. In Akola the figure is nine times, while in Sholapur it is only around four times. There is a tendency for large farms to cultivate a slighly lower percentage of their operated land than small farms, especially in the Mahbubnagar villages where more noncultivable land seems to exist.

Aurepalle is the only village where small farmers have a (statistically significant) lower percentage of their land irrigated than do large farmers. In all other villages the difference was not statistically significant.[2]

In Dokur and Kalman land values were not statistically different between small and large farms. In Aurepalle and the two Akola villages land values are significantly higher on the large farms, while in Shirapur they are significantly lower. There hence does not appear to be a consistent pattern such that small farmers tend to have better quality land than do large farmers. In some cases it appears to be true, in others it does not.

[1]Throughout the paper, most comparisons will be limited to those between the small and large farms only. Data on the medium farms will be presented in tables but not specifically discussed, to enable us to focus on the other two distinct groups.

[2]It is recognized that there may be qualitative differences in the extent of irrigation, but this was not measured here. It is discussed later in the case of the Sholapur villages.

The only case where there was statistically significant difference between farm sizes in cropping intensity was in Aurepalle where large farmers had a much higher intensity (118) than small (100). The reverse was true in Dokur, although not statistically.

Available family labor per 10 ha ranged from a high of 11 man-equivalents in Dokur to only 5 in Kalman (Table 3).[1] This is the reverse of the relative average farm sizes in the two villages. On an average the Sholapur villages have fewer bullocks (around two) per 10 ha than did the other villages because of the effect of successive drought years in the early 1970's, which depleted bullock herds (Jodha, 1977). However, the value of bullocks per head in the Sholapur villages is about 80 percent more than corresponding figures for the other villages. This suggests that farmers may have either saved the higher-valued bullocks during droughts, and/or that prices are higher in Sholapur generally due to depletion of numbers. In addition, Sholapur has large numbers of the higher-valued Khillar bullocks. Implement value per hectare of operated area is highest in Dokur and lowest in Kinkheda. This may be because of differences in the extent of irrigation, as irrigation demands more implements of a higher value. The value of livestock per hectare, including bullocks, sheep, goats, poultry, etc., is highest in Dokur and lowest in Kanzara. Value of non-land assets per hectare of operated area, which includes the value of implements plus the value of livestock, is again highest in Dokur and lowest in Kinkheda.

[1]Man-equivalent family labor has been calculated by considering those members of the household engaged in agricultural occupations partly or fully in the reference year. This includes attached and permanent laborers with the household. The conversion factors used for calculating man-equivalent labor availability were as follows:

Child between the age of 6-14 years	0.50 man-equivalent
Male between the age of 15-64 years	1.00 man-equivalent
Female between the age of 15-64 years	0.75 man-equivalent
Male above 65 years of age	0.50 man-equivalent
Female above 65 years of age	0.50 man-equivalent

Table 3. Labor and non-land asset availabilities by farm-size groups in six SAT villages in India (1975-76)

District/ Village	Farm-size group	Family human labor (man-equiv.) engaged in agric. per 10 ha of operated land	No. of bullocks per 10 ha operated land (no)	Average value of bullocks per head (Rs)	Value of implements per ha of operated land (Rs)	Value of livestock per ha of operated land (Rs)	Total value of non-land[a] assets per ha of operated land (Rs)
MAHBUBNAGAR							
Aurepalle	Small	27.67	5.03	600	140	1495	1635
	Medium	12.12	2.58	400	76	525	600
	Large	5.65***	3.19*	493	293***	352	645
	All Farms	8.41	3.21	491	243	465	707
Dokur	Small	54.50	2.91	300	1228	3399[b]	4627
	Medium	14.90	2.64	440	466	425	891
	Large	6.27***	3.98	663	373	434	806
	All Farms	11.17	3.65	614	449**	634	1083
SHOLAPUR							
Shirapur	Small	19.13	4.00	1050	220	1880	2100
	Medium	10.18	1.67	871	279	434	713
	Large	5.22***	1.42	1004	119	384*	503*
	All Farms	8.21	1.78	981	175	571	746
Kalman	Small	10.43	1.14	619	36	122	157
	Medium	4.31	2.20	978	170	298	468
	Large	3.14***	1.46	1071	127**	254	381*
	All Farms	4.64**	1.67	981	128	250**	378**
AKOLA							
Kanzara	Small	26.86	0.71	250	196	83	280
	Medium	8.79	2.24	588	63	164	228
	Large	3.92***	2.76	620	112	235***	347
	All Farms	6.74	2.48	606	109	208	317
Kinkheda	Small	16.48	4.31	300	108	313	421
	Medium	7.30	2.83	425	53	227	280
	Large	3.42***	2.13	527	66	197**	263*
	All Farms	5.30	2.46	469**	66	213	279

[a]Value of non-land assets comprises of the value of livestock and the value of implements.

[b]Livestock value for one household whose primary activity is sheep/goat raising has been included.

In all the villages, small farmers had a statistically greater supply of family labor per 10 ha than did large farmers (Table 3). Only in Aurepalle was there a statistical difference in the bullock/land ratio, with small farms having more (5 per 10 ha) than large farms (3 per 10 ha). There is a tendency for large farmers to have higher-valued bullocks than small farmers, but differences were not statistically significant. Only in Aurepalle and Kalman did large farmers have statistically more highly valued implements per ha than small farmers. Differences were not significant in the other villages.

The total value of livestock owned per ha on small farms was statistically greater than on large farms in Shirapur and Kinkheda, but statistically less in Kanzara. Statistically there were no differences in the other three villages, in spite of rather large numerical differences in the means.

In general, small farmers seem to have higher non-land assets/land ratios than do the large farmers, although this is true statistically only in two of the five villages. Kalman is the exception to this rule with large farmers having a statistically higher ratio than small farmers.

REGIONAL LABOR-USE PATTERNS

Examination of the regional variation in the intensity of labor utilization (Table 4) reveals as much variation as we observed in the resource endowments in the previous section. Dokur village, primarily due to the extent of irrigation there (45%), uses an average of 1156 man-equivalent hours per ha of net cultivated land. This is more than five times that of Kalman (211 man hours), and more than twice that of Aurepalle (540 man hours), which has similar soils and climate to Dokur but only 11 percent of its land under irrigation.[1] This clearly

[1]The results of the studies conducted on Maharashtra villages by the Gokhale Institute of Economics and Politics (1956-58) showed quite considerable differences between partially irrigated and nonirrigated villages in labor use for sorghum (33.1 and 21.4 man-days per acre) and cotton (34.2 and 26.9 man-days per acre).

Table 4. Human labor use in man-equivalent hours by farm-size groups in [illegible]

District/Village	Farm-size group	Per hectare of net cultivated land	Per hectare of gross cultivated land
MAHBUBNAGAR			
Aurepalle	Small	242	242
	Medium	320	313
	Large	650***	551***
	All Farms	540	479
Dokur	Small	2093	1566
	Medium	1252	989
	Large	1022**	920**
	All Farms	1156***	994***
SHOLAPUR			
Shirapur	Small	613	590
	Medium	426	370
	Large	309*	278*
	All Farms	380	338
Kalman	Small	222	211
	Medium	266	241
	Large	169*	158*
	All Farms	211***	195***
AKOLA			
Kanzara	Small	475	448
	Medium	472	441
	Large	406	389
	All Farms	425	404
Kinkheda	Small	562	540
	Medium	449	438
	Large	484	447
	All Farms	483	453

Note: Asterisks used for large farms indicate large-farm figures are significantly different from the respective small-farm figures and asterisks used for all farms indicate values for the concerned village are significantly different from the respective values of the other village in the same region.

***Significant at 1% probability
**Significant at 5% probability
*Significant at 10% probability

demonstrates the employment-creating potential of the existing tank and well irrigation systems in the Alfisols of peninsular India. New technologies for the rainfed portions of such villages will have to compete with these irrigation systems for labor use at strategic times in the crop-growing season.

The two villages in Akola use about 50 percent more labor per ha than the two Sholapur villages. One may have expected the higher proportion of irrigation in the Sholapur villages to lead to greater overall labor use. However, the agroclimatic differences between the regions largely offset the effect of irrigation differences. Around 60 percent of the cropped area of the two Sholapur villages is fallow during the rainy season and then sown to postrainy season crops, whereas in the two Akola villages, fallows are negligible during the rainy season (Jodha, 1977). In Akola virtually 95 percent of the crops are sown in the rainy season, whereas in Sholapur the figure is only 33 percent. Postrainy season crops require much less labor for weeding and interculture than do rainy season crops. This no doubt contributes to less labor use per ha in Sholapur than in Akola. Furthermore, in 1975-76, the two Sholapur villages averaged 960 mm of rainfall -- 30 percent above normal -- and most of this fell in September-October, the busiest months. This led to even less labor use than normal. In Akola, on the other hand, rainfall was just below normal.

Another factor leading to greater labor use in the Akola villages is the predominance of mixed cropping.[1] Mixed crops require more labor than sole crops. Cotton, grown extensively in Akola, also demands much more labor than the foodgrain crops which predominate in Sholapur.

[1]Kanzara and Kinkheda had 70 and 84 percent of their cropped area sown to mixed crops, while Shirapur and Kalman had 14 and 43 percent, respectively (Jodha, 1977). Norman (1977), while explaining the popularity of intercropping in the African context, showed that the average gross return per man-hour used during the peak labor period was higher for crop mixtures than for sole crops. He further found that total labor input was higher for crop mixtures. This supports our contention.

The reason why Shirapur uses significantly more labor per ha than Kalman (380 compared to 211 man-hours), seems to be related to the type of crops grown under irrigation in the two villages. Although Shirapur has 8.1 percent of irrigated land compared with 11.2 percent in Kalman, it has about 42 percent of its irrigated land sown to labor-intensive crops such as sugarcane, chillies, and maize. In Kalman only 13 percent of its irrigated land is sown to these crops with more than 60 percent sown to relatively labor-extensive crops such as wheat and sorghum. This is probably a reflection of differences in the quality of irrigation in the two villages also, with Shirapur generally having more assured supplies from its wells. This is reflected in the high cropping intensity on irrigated areas in Shirapur (187) compared to Kalman (116). Hence it is not primarily the extent of irrigated command areas which affects labor use, but the reliability of the irrigation source.[1]

The ranking of villages is the same whether labor utilization is expressed on a net cultivated- or a gross cultivated- area basis (Table 4). The ratios of per ha labor use between villlages are also similar, regardless of which land concept one uses. The gross cultivated area labor-use measure implicitly adjusts for the effect of cropping-intensity differences. The fact that cropping intensities are generally low in these villages, together with the similar ranking and proportionalities in labor use (whether on a gross or net cultivated area basis), suggests that the intensity of cropping does not contribute substantially to differences in labor-use intensity in these villages. Other factors such as cropping pattern and resource endowment differences must be the primary determinants of labor intensity differences, as postulated by Vyas (1964).

[1]The amount of labor used per ha of irrigation will be highly correlated with the frequency of irrigations. It is planned to analyze this in more detail in subsequent work.

LABOR USE AND SIZE OF FARM

The size of farm is usually found to have a negative relationship with the use of total human labor (family plus hired) per unit of land. Labor use per hectare may increase with a decrease in the size of holding in one or more of three ways: through an increase in the intensity of cropping; through adoption of a more labor-intensive cropping pattern; and/or through a greater use of labor per hectare under individual crops.

It can be seen (Table 4) that in three of six villages (Dokur, Shirapur, and Kalman) small farms used significantly more labor per hectare of net cultivated land than large farms. In Kanzara and Kinkheda there was no significant difference, and in Aurepalle large farms used significantly more labor per ha than did small farms. The picture is similar when labor use is expressed per hectare of gross cultivated land.

The Aurepalle result seems to be because the extent of irrigation is significantly higher on large compared with small farms (Table 2). This leads to higher land values and cropping intensities on the large farms. In addition large farms in Aurepalle also have more bullocks and implements per ha (Table 3). All these factors complement labor, resulting in a greater use of this resource per ha on large farms than on small farms in Aurepalle.

Using farm data from Hooghly District in West Bengal, Rudra (1973) found a significant negative correlation between labor use per acre of net cultivated land and the size of farm. On the same farms use of material inputs per acre and intensity of irrigation were also inversely correlated with farm size. Farm management data, particularly for the earlier periods in the fifties, indicated that the larger inputs of labor on smaller farms were associated with a greater intensity of cropping and more irrigation per acre (Bharadwaj, 1974; Bardhan, 1973). When one adjusted for the differences in irrigation (or cropping intensity), then the inverse relationship between farm size and labor-use per hectare was much weaker (Bardhan, 1973). Village studies from Asia and Africa confirmed this higher labor intensity on small farms (Norman, 1967; Srivastava, 1966).

Bardhan (1973a), using National Sample Survey data of the 25th round (1972) also found that the average rate of daily wage earnings for hired-out adults per day of work was higher in the households that relied solely on wage earnings for their income, than in small farm households. In addition, there was some evidence (Subrahmanyam and Ryan, 1976) that probabilities of employment were lower in general for workers on small farms than in labor households. Large-farm employers may prefer the continuous commitment of the labor households available more or less for the complete agricultural year. On the other hand, small farmers cannot promise a regular supply of labor for large farmers because their commitment to their own fields at crucial periods is high. Agarwal (1964), Mazumdar (1963 and 1965), and Sen (1966) all allude to this point that for family labor the probability of employment is less than 1 in general. These reasons are often cited as explanations for a greater intensity of family labor use on small farms. Also, family opportunity wages are less than the actual wages of hired landless labor. Small farmers, therefore, tend to employ a higher percentage of family labor (so the argument goes), and wherever this occurs, it also leads to more total labor use per ha. This latter step in the argument is, however, a little questionable, as probabilities of employment are also less than one for medium and large farms.

It seems from Table 5 that in the two Akola villages, hired labor contributes between 70 and 80 percent of the work, with a tendency for large farms to employ more than small farms. In these two villages, there is no significant difference in total labor use per ha between the small and large farms (Table 4). In the two Sholapur villages and

Table 5. Percentage contribution of various labor sources in total labor use by farm-size groups in six SAT villages in India (1975-76).[a]

District/ Village	Farm-size group	Family				Hired				Total			
		Male	Female	Child	Total	Male	Female	Child	Total	Male	Female	Child	Total
MAHBUBNAGAR													
Aurepalle	Small	43	21	6	71	19	7	1	29	62	28	10	100
	Medium	56	20	1	77	14	10	0	23	70	29	1	100
	Large	51	2	0	53	11	37	0	47	61	38	0	100
	All Farms	51	5	0	57	11	31	0	43	63	37	0	100
		(90)[b]	(9)	(1)	(100)	(27)	(73)	(0)	(100)				
Dokur	Small	47	13	0	60	8	32	0	40	55	45	0	100
	Medium	43	17	0	60	4	36	0	40	47	53	0	100
	Large	40	6	0	46	6	48	0	54	46	53	0	100
	All Farms	42	10	0	51	6	43	0	49	48	52	0	100
		(81)	(19)	(0)	(100)	(12)	(88)	(0)	(100)				
SHOLAPUR													
Shirapur	Small	41	19	0	60	16	24	0	40	57	43	0	100
	Medium	34	26	1	62	13	25	0	38	47	52	1	100
	Large	38	16	1	55	17	28	0	45	55	44	2	100
	All Farms	37	20	1	58	16	26	0	42	53	46	1	100
		(64)	(34)	(2)	(100)	(37)	(63)	(0)	(100)				
Kalman	Small	33	24	0	57	27	16	0	43	60	39	0	100
	Medium	22	10	0	32	36	32	0	68	58	42	0	100
	Large	39	9	0	48	23	30	0	52	62	38	0	100
	All Farms	30	12	0	42	29	28	0	58	60	40	0	100
		(72)	(28)	(0)	(100)	(51)	(49)	(0)	(100)				
AKOLA													
Kanzara	Small	14	18	0	32	33	35	0	68	47	53	0	100
	Medium	20	14	0	34	34	32	0	66	54	46	0	100
	Large	20	2	0	23	40	37	0	77	60	39	0	100
	All Farms	19	8	0	27	37	35	0	73	56	40	0	100
		(70)	(29)	(1)	(100)	(51)	(49)	(0)	(100)				
Kinkheda	Small	30	14	0	45	23	32	0	55	54	46	0	100
	Medium	25	10	0	36	22	42	0	64	47	53	0	100
	Large	7	1	0	9	44	47	0	91	51	48	0	100
	All Farms	13	4	0	18	37	45	0	82	51	49	0	100
		(75)	(25)	(0)	(100)	(45)	(54)	(0)	(100)				

[a] All data have been converted into male equivalents prior to calculation of the proportions.

[b] The figures in parentheses are percent values with respect to subcategory total.

in Dokur, however, where small farms do use significantly more total labor per ha, we find a much lower proportion of hired labor being used (between 42 to 58 %). Hence, there does seem to be some relationship between the proportion of family labor use in a village and the variation in total labor use per ha across farm-size groups within the village. The higher the proportion of family labor use, the more likely it is that there will be an inverse relationship between farm size and total labor use per ha.[1] Again, Aurepalle is an exception to this rule, because of significant differences in resource endowments between these two groups. Much more research is required on this issue before the explanations for differential labor-use patterns across different size of farms are clear.

COMPOSITION OF HUMAN LABOR USE

The Akola villages economies are based on a cash-crop enterprise (cotton), and this seems to explain the small proportions of family labor used on the farms there (18 to 27 %).[2] In addition, cotton demands specialized operations like weeding and spraying which are normally done by hired labor, and the payment of wages on the basis of piece rates for cotton-picking operations attracts more hired laborers. The fact that some 50 percent of the farmer respondents in these villages come from Deshmukh and Patil castes also no doubt reduces the proportion of family labor use, as these groups generally avoid manual labor. In the other four villages the cropping patterns are dominated by foodgrain crops, and this explains their more intensive use of family labor (between 40 to 60 %).

In each village there is a clear negative relationship between

[1]This is apparently because opportunity wages of family labor are lower than the actual wages required to be paid for hired-in labor. However, the authors admit that this seems a somewhat tautological explanation.

[2]We do not want to give here the impression that a high proportion of hired labor use is always attributed to cash crop *per se*. Rather it depends upon the type of cash crop.

farm size and proportion of family labor used when small and large farm categories are compared.[1] Contrariwise, there is a positive correlation between hired labor use and farm size. With increasing prosperity many members of wealthy families tend to drop out of the work force, particularly women and children. As noted earlier (Table 3), family labor availability per ha is also negatively related to farm size, and this undoubtedly contributed to the tendency to use more family labor on small farms. Similar results are common in the literature of both Asia and Africa (Rudra and Biswas, 1973; Norman, 1974; Lewis, 1971; Eicher and Byerlee, 1971).

While small farmers hire proportionately less labor than do large farmers, the extent of labor hiring by them is by no means insignificant. It reaches a figure of 68 percent of the labor use in Kanzara. Even in Aurepalle, where such hiring-in is least, it still amounts to 29 percent of the total labor used on small farms. Rudra and Mukhopadhyay (1976), using Farm Management Report data from various areas in India, also found that small farmers hire significant amounts of labor.

Some hypotheses why small farmers hire-in labor, in spite of having apparent abundant supplies of family labor, are:

- Peak periods, which are more prevalent on small farms, require additional labor if the operations are to be completed on time;[2]
- Some small farmers have other main occupations such as weaving, handicrafts, carpentry etc., and hence rely on hired labor for a lot of the farm work;
- Absence of adult male members in the family requires hiring labor for plowing, sowing etc.;

[1]There is no such clear relationship once the medium farm-size categories are also included.

[2]Data showing that there are more peaks in seasonal labor use on small farms will be presented later in this paper.

- Certain specialized operations require the employment of hired labor; e.g. transplanting paddy, cotton picking, etc.;
- Some small farmers come from castes that avoid manual labor;
- Some small farmers have commitments to other farmers which require them to work at peak periods off their own farms, hence leading to a demand for hired labor.

Males and females contribute almost equally to total labor use in Dokur, Shirapur, Kanzara, and Kinkheda (Table 5). In Aurepalle and Kalman, males contribute around 60 percent of the total labor. Employment potential for women seems greatest in the highly irrigated village of Dokur and in the cotton-growing villages in Akola District.

The data in Table 5 represent man-equivalent proportions. When we examine the absolute hours of work instead of man-equivalents in Dokur, Shirapur, Kanzara, and Kinkheda, the total hours of female labor exceed those of males. In Aurepalle and Kalman there are slightly more male than female hours. These data reveal the substantial contribution of female labor in the crop agriculture of SAT peninsular India. Child labor does not seem to be a major contributor.[1]

Comparing the relative contributions of family male versus hired male labor, we find from Table 5 that in the Mahbubnagar villages and in Shirapur, more than 70 percent of the male labor is from the family. In Kalman, hired and family labor make about equal contributions. However, in Akola, more than two-thirds of the total male labor is provided by hired males.

[1]In Africa also, female participation is usually high and, in terms of the number of days worked in agriculture, in many places women record a higher figure than men. Boserup (1970) observed from her survey of empirical data that "in nearly all cases, female African family members did more than half of the work in agriculture. The comparable figure for Asian cultivator families was less than one-fifth."

The picture is quite different with female labor. The contribution of hired female labor is always higher than its family counterpart when the village as a whole is taken. Of the total female labor used in the Mahbubnagar and Akola villages, 80 to 90 percent came from hired females. In the Sholapur villages, the figure was 60 to 70 percent. These comparatively low figures could be because of almost total absence of hand weeding in postrainy season crops. The activities of paddy transplanting and weeding in Mahbubnagar, and cotton picking in Akola, seem to create high demands for hired female labor in these areas.

Males contribute substantially more of the total family labor than do females (Table 5, figures in parentheses).[1] This is especially true in the Mahbubnagar villages, where males contribute 80 to 90 percent of the family labor. In the other villages, between two-thirds and three-quarters of the family labor is provided by males. Of course, again, these proportions relate to man-equivalents and not to total hours of work. The adjustment would reduce the proportions for males by about 5 to 10 percentage points.

Females contribute 63 to 88 percent of the total hired labor used in Aurepalle, Dokur, and Shirapur. In the other three villages males and females provide approximately equal proportions. Children do not enter the hired labor force for crop production.

In Dokur, Shirapur, and Kinkheda, a higher proportion of family male labor is used on small farms than on large. In the other three villages the reverse is true. However, in all six villages the proportion of family female labor used is higher on small farms.

In Aurepalle, Dokur, and Kalman, small farmers use a higher proportion of hired male labor than do large farmers. In the other villages

[1]This is because females undertake more activities in and around the home which have not been included here in total labor use.

the reverse is true. The pattern of hired female labor use is however similar among all villages. There is a clear positive relationship between the proportion of hired female labor employed and the size of farm.

The correlation between variations in total fortnightly labor use and the use of hired labor were derived from and are shown in Appendix Table 1. The aim here was to see to what extent the peaks and slacks in labor demand throughout the year were largely managed by variations in hired or in family labor use.

On both small and large farms there was a highly significant positive correlation between total labor use per ha and hired labor use per ha, although the size of the correlation coefficient for the small farms was somewhat smaller than those for the large farms. The small-farm correlations in Mahbubnagar villages averaged 0.54 while those on the large farms averaged 0.94. Corresponding correlations in Sholapur were 0.74 and 0.89, while in Akola the difference was narrower at 0.92 for the small and 0.99 for the large farms. These results support the hypothesis that variations in total seasonal labor use has a direct and positive effect on demand for hired labor.

Appendix Table 1 also shows that in the case of Mahbubnagar and Akola villages, more than two-thirds of the total labor hired is intended for use on large farms. In the Sholapur villages the figure is less than 50 percent. This, along with the higher correlation coefficients between seasonal total and hired labor use on large farms -- as discussed above -- clearly indicates the importance of the large farms in the generation of employment opportunities for hired labor in these villages.

Appendix Table 2 shows that there is little correlation between variation in total seasonal labor use and the proportion of hired labor used on the small farms in Mahbubnagar and Sholapur villages. This is not the case in Akola, where small farmers do seem to meet peak labor demand periods by increasing the relative size of the hired labor component. In Mahbubnagar and Sholapur, on the other hand, peaks are met by an equal increase in the amount of family and hired labor employed, in numbers and/or hours per person, with the proportion remaining the same. In four of the six villages increased labor demands on large farms are met by increasing the proportion of hired labor. Curiously, in Kalman and Kanzara there appears to be no such relationship.

SEASONALITY OF LABOR USE

The utilization of labor over the agricultural year was calculated on a fortnightly basis for each village and farm size group. Table 6 shows that the coefficients of variations (CVs) of seasonal labor use per ha are significantly higher on the small than on the large farms. One important reason for this seems to be the number of different crops grown on farms of different size. As more crops are cultivated in various seasons, more continuous use of labor ensues, resulting in less seasonal variability. The average number of crops grown on these farms has been given in brackets in Table 6. Generally, small farms grow fewer crops than do large farms. The number of crop combinations and the types of crops grown, influenced by diversification of consumption requirements, change with farm size. The small farmers concentrate on simple and limited crop combinations to meet their subsistence needs. The large farmers seem to prefer to grow a wider variety of crops to meet their own as well as their servants' consumption needs (Jodha, 1977). Another possible reason is that small farmers concentrate only on "key" operations on their own farm, such as sowing and harvesting. Otherwise, they largely ignore their crop to free themselves for work off their farms.

These seasonal variations in labor utilization are plotted in Figures 1-6. By examining the timing of the various peaks and slacks in seasonal labor use throughout the year, we are in a better

Table 6. Coefficient of variation (%) in fortnightly labor use per ha by farm-size group in six SAT villages in India (1975-76).

District/Village	Farm-size Group			
	Small	Medium	Large[b]	All Farms[c]
MAHBUBNAGAR				
Aurepalle	154 (1.8)[a]	150 (2.5)	97*** (7.1)***	133 (3.9)
Dokur	151 (1.6)	175 (3.2)	142* (4.0)***	156 (2.9)
SHOLAPUR				
Shirapur	213 (4.2)	157 (7.4)	139*** (8.7)*	170 (6.8)
Kalman	147 (4.9)	113 (11.0)	95** (11.1)***	121*** (8.9)*
AKOLA				
Kanzara	146 (2.1)	122 (3.2)	94*** (7.1)***	121 (4.1)
Kinkheda	137 (2.4)	120 (2.5)	95*** (5.6)**	117 (3.5)

[a] Bracketed figures are average number of different sole crops or/and different crop mixtures on these farms.

[b] Asterisks here indicate large-farm figures are significantly different from the respective small-farm figures.

[c] Asterisks here indicate significant differences exist between villages in the same district.

***Significant at 1% probability
**Significant at 5% probability
*Significant at 10% probability

position to identify strategic periods when apparent under use of labor exists, and this could conceivably be capitalized upon in evolving new technology. This is particularly relevant in the context of research underway at ICRISAT on improved land and water management techniques which will entail creation of capital for such things as land shaping, beds and furrows, bunds, and possibly tanks. Making use of labor for these tasks at times when its opportunity costs are lowest can substantially improve the benefit/cost calculus of the technology. New cropping systems requiring changes in the timing of labor-intensive operations -- such as sowing, weeding, harvesting, and threshing -- must allow for existing seasonal labor distributions if they are to be adopted.

Cleave (1970) felt that "observed" seasonal variations in labor inputs did not necessarily reflect the "real" seasonality in labor input requirements and observed that "peak" might be nothing more than a reflection of the existence of an unemployed labor supply. He estimated that 15 to 50 percent of under-utilization of labor in African agriculture was caused by seasonality. Krishna Bharadwaj (1974) pointed out that the seasonality in agricultural operations implied a certain pattern of demand for hired labor, predominantly for casual labor. If work available off the farm was mainly agricultural, it implied a synchronous seasonality pattern which caused the total annual employment to be low. The lack of continuous and guaranteed employment might compel small operators to adopt a cropping pattern which eased the seasonality factor.

In Figures 1-6 we have shown the seasonal pattern from the 6th standard fortnight (commencing 12 March) of 1975 to the 7th standard fortnight of 1976 (up to 8 April) for all farms taken together.[1] This period essentially covers the agricultural year from preparatory tillage to postharvest plowing. The two horizontal lines on each figure represent

[1]Graphs for the small and large farm groups in each village are contained in Appendix 1, Figures I to XII.

FIGURE 1 AVERAGE SEASONAL HUMAN LABOR AVAILABILITY AND USE ON ALL FARMS IN AUREPALLE (1975-76)

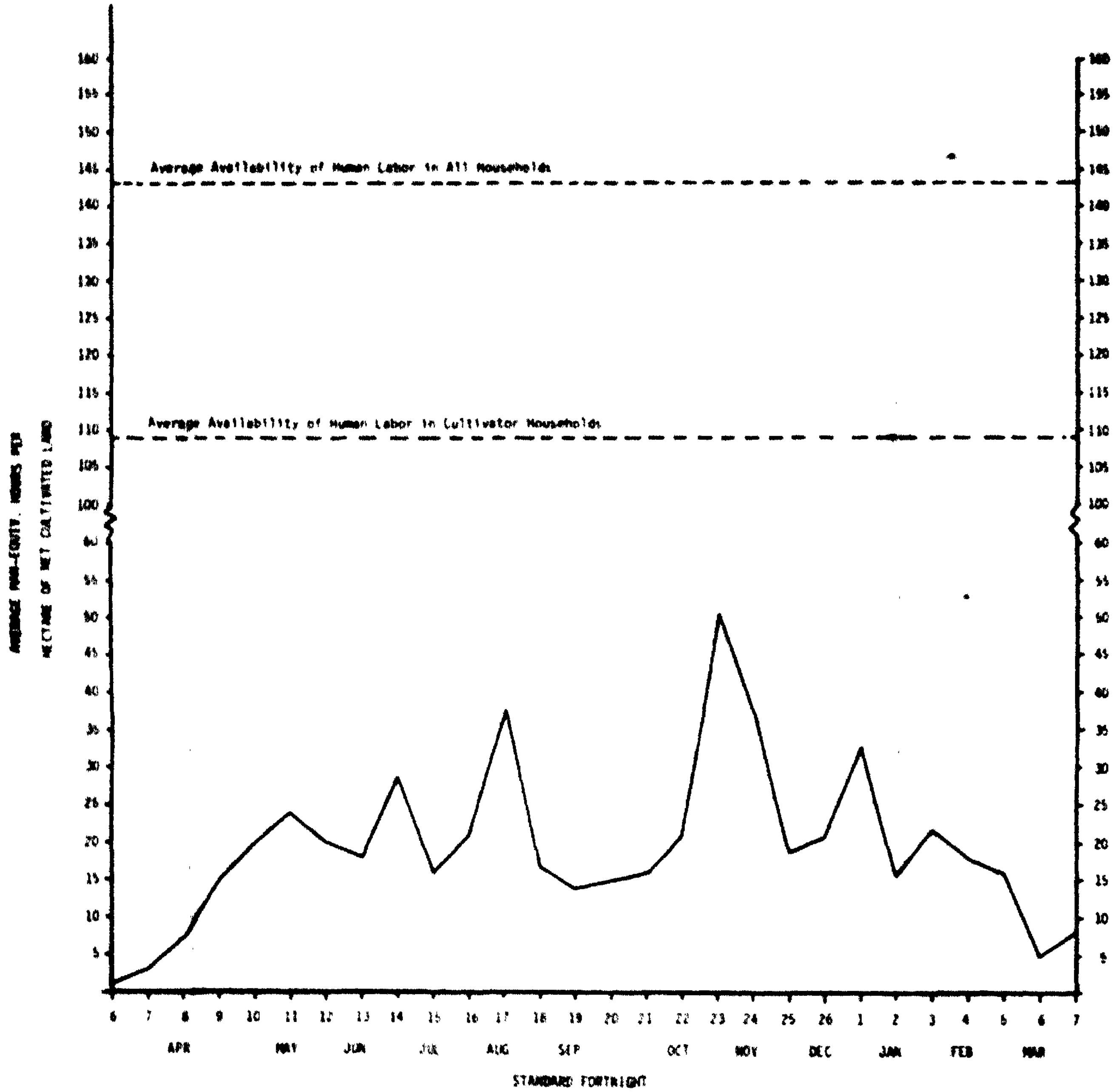
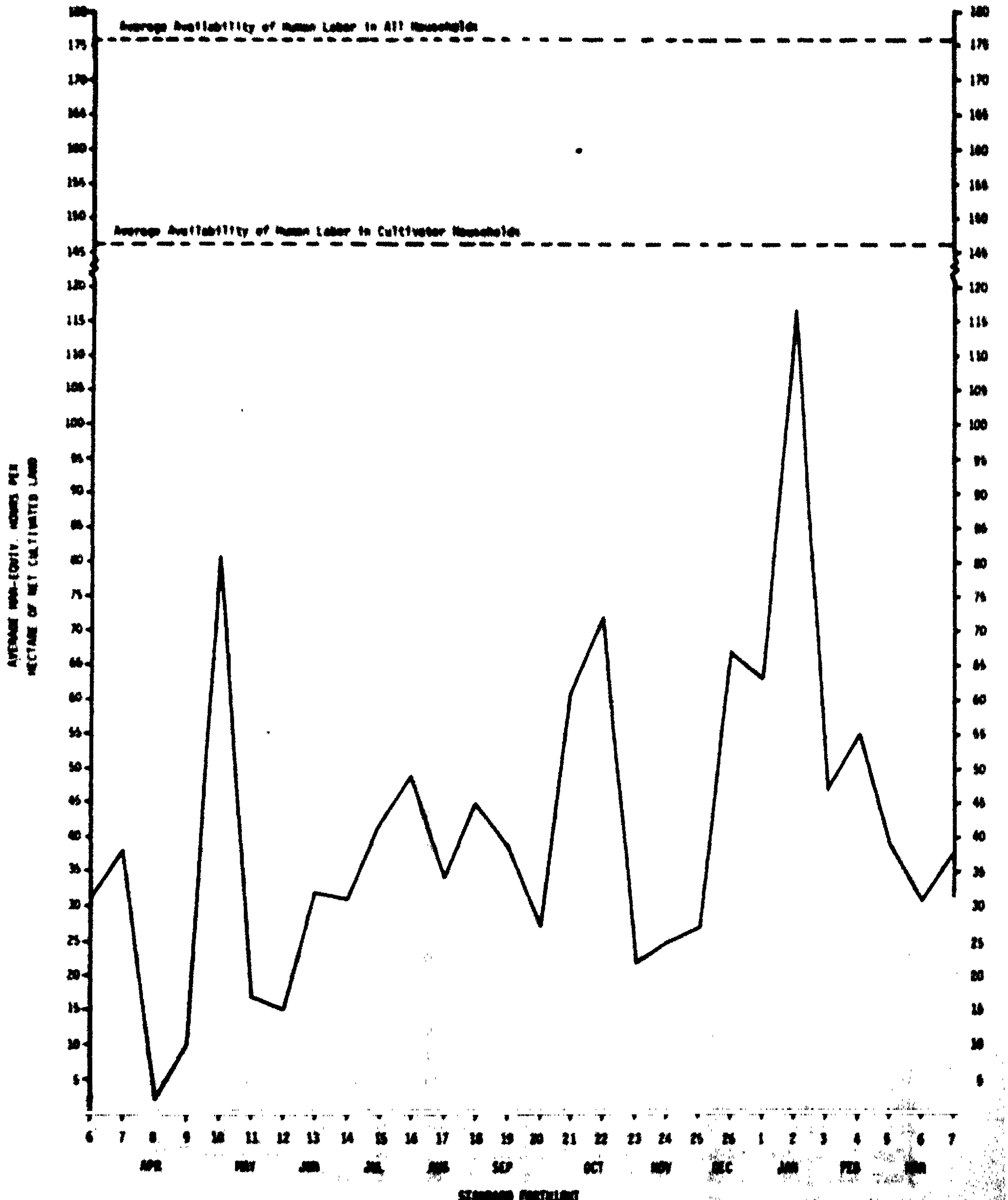


FIGURE 2: AVERAGE SEASONAL HUMAN LABOR AVAILABILITY AND USE ON ALL FARMS IN [illegible]



the estimated total apparent supply of labor per net cultivated ha of land. The lower line indicates the apparent supply of family labor from the cultivator households only, while the upper line indicates the apparent supply from all the households (including labor households) in the village. These have been calculated assuming a 7-hour day and 14 days per fortnight. As a result, these probably reflect absolute upper-bound estimates of available labor on a continuous basis throughout the year. However, they might be considered to reflect the maximum available for short periods of time, such as an individual fortnight, ignoring seasonal labor migrations.[1] In general, the labor available from labor households increases overall availability per ha by between 20 and 74 percent above that provided by family farm labor alone, depending on the village.

In Aurepalle village (Fig 1), two to three moderate labor peaks followed by small slack periods occur in the months of June, July, and August, when sowing of sorghum, pearl millet, and castor takes place. These moderate peaks are followed by a somewhat longer slack period in September and the first week of October, after which the harvest of sorghum, pearl millet, and castor cause a second sharp peak in November and December, with 52 man hours per ha being the highest level in early November. The labor demand continues declining up to March or April and then again increases for preparatory tillage.

In contrast to Aurepalle, Dokur village (Fig 2) with its extensive irrigation, experiences slightly longer slack periods. The figure shows three distinct peaks in the months of May, October, and December-January. The latter peak requires as much as 117 man hours per net cultivated hectare from mid-January to the end of the month, while the other two peaks of

[1]It is realized that calculation of such apparent labor availabilities involve many assumptions, not the least of which is that hours worked per day are fixed. Evidence from these villages is that the time worked per day varies between 6 and 8 hours from the slack to the peak periods. However, use of apparent labor supplies so calculated does enable assessment of the impact of new technologies on the timing of peaks and slacks throughout the year and identification of possible labor bottlenecks.

FIGURE [illegible]: AVERAGE SEASONAL HUMAN LABOR AVAILABILITY AND USE ON ALL FARMS IN [illegible]

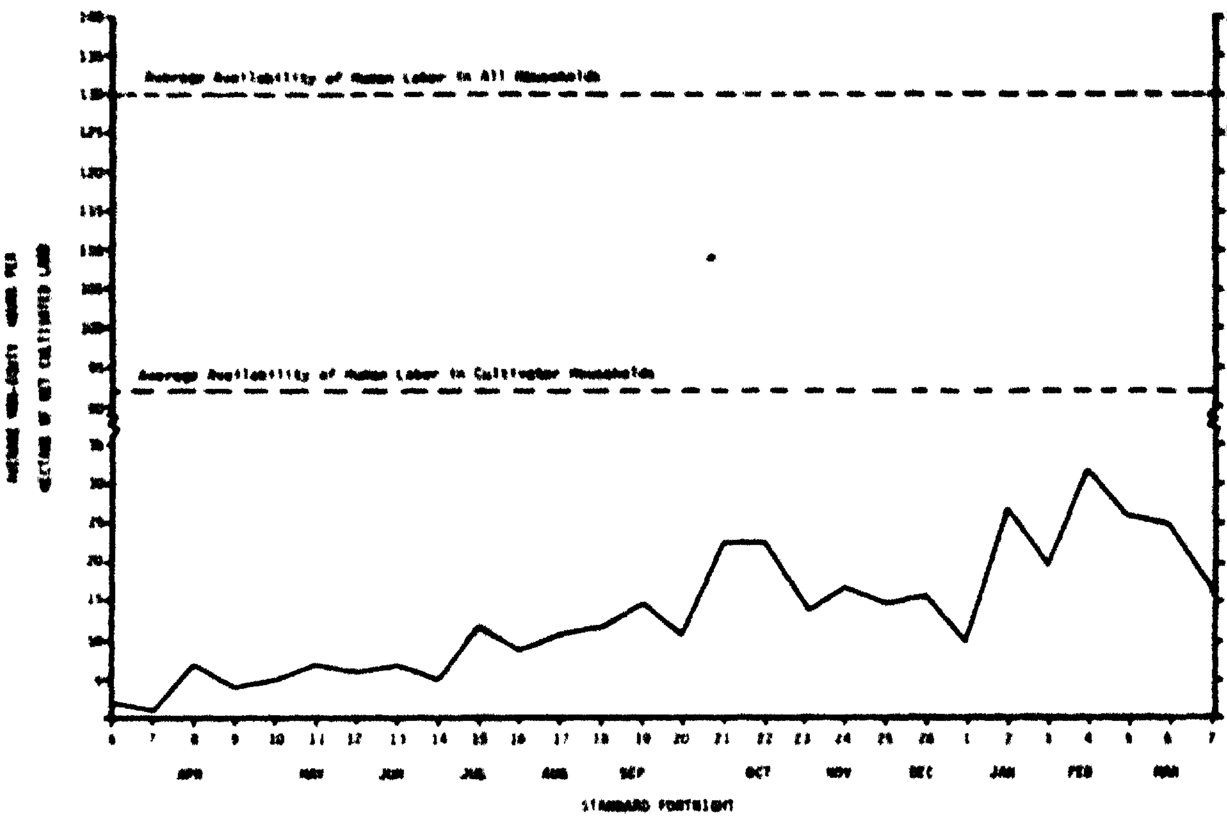
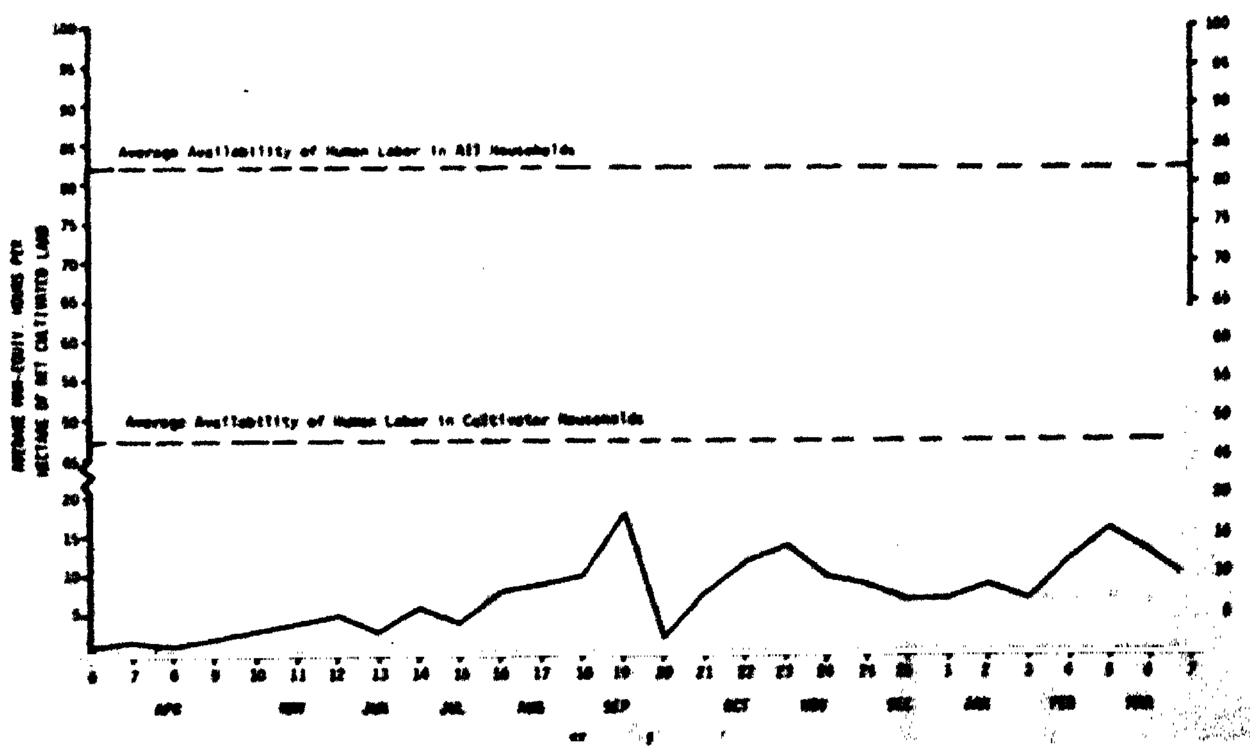


FIGURE 6: AVERAGE SEASONAL HUMAN LABOR AVAILABILITY AND USE ON ALL FARMS IN [illegible]

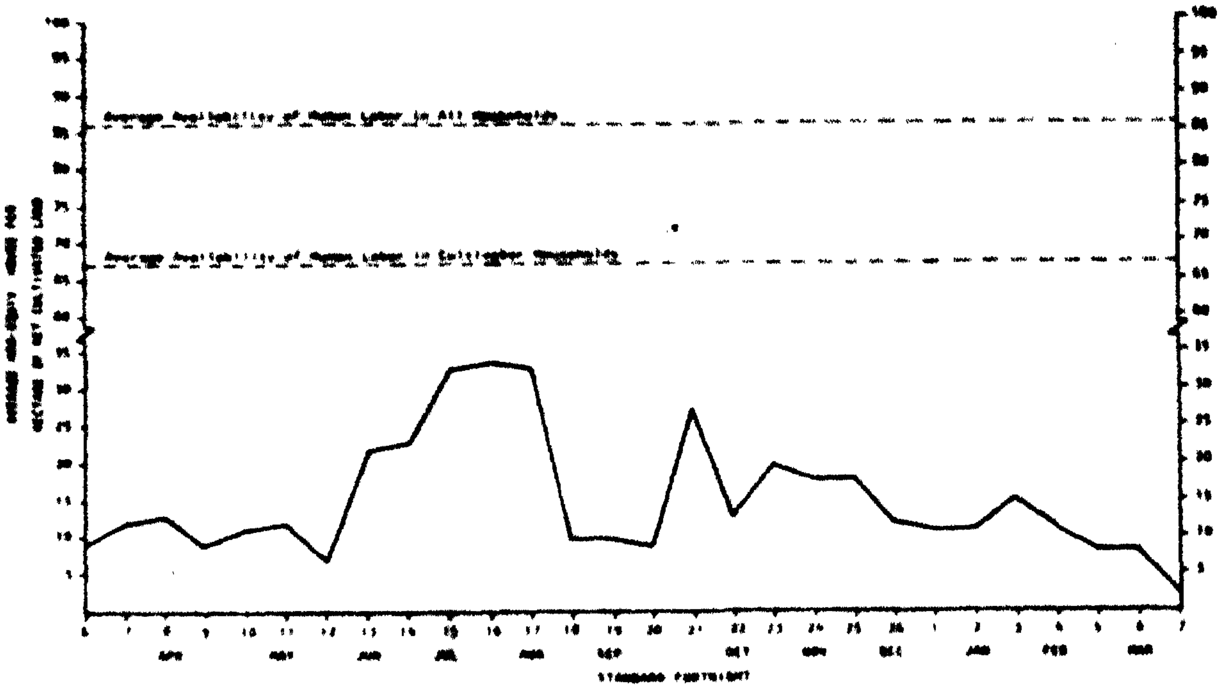


May and October require 83 and 72 man hours per hectare, respectively. The important operations performed in August, September, and October are irrigation, nursery raising of paddy, transplanting, weeding and harvesting of paddy and harvesting of groundnut. The harvesting of sorghum, nursery raising, transplanting, etc. cause the second peak labor-use period. These peak periods are then followed by a small slack period. The differences between slack and peak period labor use are large in this village compared with Aurepalle, as reflected in CVs of 156 and 133, respectively (Table 6). It would seem that the predominance of paddy monocropping on the irrigated areas in Dokur, which have a set labor use pattern, largely contributes to the highly variable intra-seasonal labor use pattern in that village.

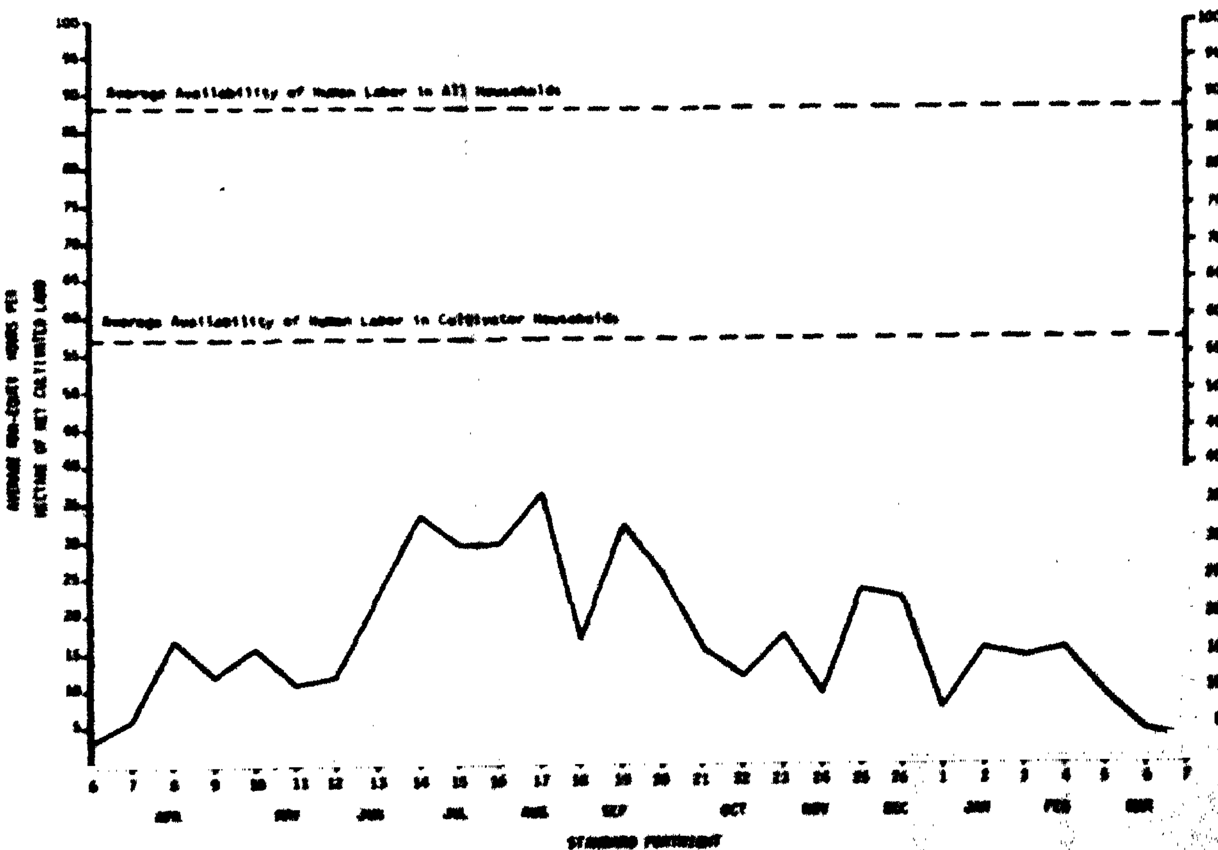
In Shirapur village (Fig 3), not many sharp peak periods can be observed, but two moderate peaks with reasonably long intervals between them seem to exist. The first peak is in the month of October, the second in the months of January and February. There is a steady increase in labor use from April, when land preparation begins, up to the middle of October when sowing of chickpea, wheat, sorghum, and safflower are the important operations. This period is followed by a small period of of moderate slack. The predominance of postrainy season cropping in this village is reflected in increased labor demand from August-September through to January-March. The second peak in the months of January, February, and March occurs because of harvesting of sorghum, pigeonpea, and chickpea. Labor use in Kalman (Fig 4) in the same district is similar to Shirapur, with a small peak in September followed by a small slack period and then prolonged steady labor use up to February. However, Kalman uses comparatively less labor per ha than Shirapur.

The Akola villages of Kanzara and Kinkheda have a similar pattern of labor use (Fig 5, 6). The first peak occurs in the months of June, July, and August, which is the busy period for sowing most of the rainy season crops like groundnut, sorghum, cotton, pigeonpea, mungbean and pearl millet. This period is followed by a small slack period in Septem-

[illegible]


Average Availability of Human Labor in All Households
Average Availability of Human Labor in Cultivator Households
STANDARD FORTNIGHT

[illegible]


Average Availability of Human Labor in All Households
Average Availability of Human Labor in Cultivator Households
APR
JUN
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MAR
STANDARD FORTNIGHT

ber, but then there begins a continuous labor demand for harvesting of sorghum and groundnut and the sowing of chickpea and wheat in the months of October and November, followed by harvesting of pigeonpea and cotton in December, January, and February. The pattern of rainy season cropping in both short- and long-duration crops shows the first peak in June, July, and August followed by continuous demand for labor until February.

An interesting conclusion emerging out of these presentations is that the Mahbubnagar villages, with Alfisols and comparatively more irrigation, experience two to three sharp labor-use peaks in a year with frequent slack periods. On the other hand, the Sholapur villages with mostly postrainy season cropping have only one or two mild but reasonably prolonged peak periods in January-February with relatively less farm labor demand in the rest of the year. In contrast to the Sholapur villages, in Akola, with the high rainfall and rainy season cropping, the first prolonged peak period occurs in June, July, and August, after which there is a steady use of labor up until February-March. This is then followed by a prolonged slack.[1] The graphical presentations based on Malaysian villages studied by Purcal (1971) demonstrates that the level of labor input is considerably higher in double-cropped villages and is polymodal, whereas in single-cropped villages, hours of work per hectare are low and concentrated during transplanting and harvesting periods.

The presentation of family labor availability from cultivator households and from all the households in the village, along with the seasonal crop labor-use pattern, gave a consistent indication in all

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[1]Of course, no account has been taken in this analysis of non-crop labor use such as animal husbandry, marketing, domestic work, handicrafts etc. This will be the subject of a separate study.

the six villages that the labor supply at both these levels was well above the requirement for crops throughout the year. This does not explicitly indicate that there is sufficient labor supply because non-crop labor requirements were not included in seasonal labor use.

In order to obtain an idea regarding the possible amount of surplus or deficit labor under various village situations and under watershed-based improved technology (to be referred to in the next few pages), some crude estimates of village labor surplus over and above farm labor requirements are presented in Table 7. As pointed out earlier, the labor use reported here is only for farm activities. The annual labor availability in each village has been worked out using figures of fortnightly labor supply from all households and giving proper sampling fraction weights to all respondent classes. Such figures (column 2 of Table 7) showed a wide variation ranging from 2296 hours in Kalman to 4298 hours in Dokur. The average estimates of percent surplus supply of each region have been presented along with individual village estimates. This facilitates comparisons of the average regional estimates with the watershed-based technology estimates. The percent surplus labor figures ranged from 77 in Dokur to 91 in Kalman, indicating that a very small proportion of apparent total labor available is used for the purpose of direct farm work.[1]

Interestingly, the village with the highest labor availability per hectare (Dokur) had the highest labor use and lowest proportion of surplus labor, while the village with lowest labor availability (Kalman) had the lowest labor use and the highest proportion of surplus labor. However, this trend could not be observed for all villages. The observation needs further detailed investigation. One possible explanation could be that in a drought-prone situation

[1]The bracketed figures in the table are the man-equivalent labor-use hours per hectare of net cultivated area.

Table 7. Estimates of annual village labor surplus in excess of farm requirements under traditional and improved watershed-based technologies.

District/Village	Annual labor availability per hectare of NCA[a] (man-hours)	Percent surplus labor under	
		Traditional technology. (1975-76)	Watershed-based technology[b]
MAHBUBNAGAR			
Aurepalle	4004	86.5 (540)[c]	
Dokur	4928	76.5 (1156)	
Total/Average	4256	82.9 (726)	75.4 (1048)
SHOLAPUR			
Shirapur	3668	89.6 (380)	
Kalman	2296	90.8 (211)	
Total/Average	2744	90.2 (268)	53.0 (1289)
AKOLA			
Kanzara	2436	82.6 (425)	
Kinkheda	2492	80.6 (483)	
Total/Average	2464	81.7 (450)	45.4 (1345)

[a]NCA = net cultivated area.

[b]Average of two watershed treatments on same type of soil.

[c]Figures in parentheses are man-equivalent labor-use hours per hectare of net cultivated area.

Table 8. Estimates of village labor surplus in excess of farm requirements for the top three peak labor-use fortnights under traditional and improved watershed-based technologies.

District/ Village	Labor availability per ha of NCA for three fortnights (man hours)	Percent surplus/deficit labor under	
		Traditional technology	Watershed technology
MAHBUBNAGAR			
Aurepalle	429	70.6 (126)	
Dokur	528	48.9 (270)	
Total/Average	456	62.9 (169)	- 0.2 (457)
SHOLAPUR			
Shirapur	393	78.4 (85)	
Kalman	246	80.5 (48)	
Total/Average	294	79.3 (61)	-118.7 (643)
AKOLA			
Kanzara	261	61.7 (100)	
Kinkheda	267	61.1 (104)	
Total/Average	264	61.4 (102)	- 78.4 (471)

The figures in parentheses are the total labor use values (man hours) per hectare for the top three fortnights under respective technology.

such as Sholapur, net outmigration occurs to avoid deleterious effects of droughts, with net immigration occurring in highly irrigated situations such as in Dokur.

Besides observing surplus labor estimates over an agricultural year, similar estimates for the top three peak labor-use fortnights can increase insight into the problems of labor-use bottlenecks. Such estimates for all the villages with averages for the watershed technologies are presented in Table 8. The crude estimates of surplus labor ranged between 49 percent in Dokur and 80 percent in Kalman. These figures are much lower than those for the whole year. The rankings of villages on the basis of estimates presented in Table 7 and Table 8 are similar, indicating positive correlation between these two estimates.

Appendix Figures 1 through 12 show that the higher CVs of labor use on small farms are primarily due to the wider range in labor use per ha as one goes from the peak to the slack periods. The actual number of peak periods on small and large farms is approximately the same and average around six in each village. As mentioned previously, the wider variation in seasonal labor-use on small farms derives from the smaller number of crops grown on them. Ashok Rudra and Ramdev Biswas (1973) maintained that the seasonality pattern of employment was largely determined by seasonality of the main crop of the region. The peaks were clearly evident in his analysis in the smallest farm-size group, but the clarity became lost for the larger farm-size group. He did not have data on number of crops, but the inference was that small farms had fewer crops. Rudra (1973), using seasonal data for a sample of farms in Hooghly district of Bengal, found that while for smaller farm-size groups the seasonal peaks of farm labor use were moderate, they went up sharply for the larger farms. This is different from the results presented here. However, Rudra did not show whether on a per acre basis the peaks were sharper on large farms. His graphs, moreover, were on a per farm basis whereas the data presented here are calculated per hectare of net cropped area. He also pointed out that in the smaller size-groups with traditional crop rotations, the seasonal pattern of farm employment had four clear peaks. In the larger groups the peaks were less regular because their cropping pattern was more varied with overlapping sowing and harvesting periods for different crops.

The adequacy of family labor supply from respective farm-size groups, at least to meet their farm-work labor demand, was observed from the Appendix Figures. The horizontal line representing cultivator household labor supply was well above the seasonal farm labor use on small as well as large farms in all the villages. Similar estimates of surplus labor calculated for small and large farm groups are presented in Appendix Tables 3 and 4. Unlike estimates for all farms, these are based on the availability of labor from family sources only. The percent surplus labor on small farms varied between 88 in Kinkheda and 97 in Aurepalle while the corresponding surplus values on large farms ranged from 55 percent in Kinkheda to 82 percent in Shirapur. In general, this indicates a higher proportion of apparent surplus family labor on small farms than on large farms. When only the three top peak labor-use fortnights were considered, estimates of which are reported in Appendix Table 4, the percent surplus figure on small farms was lowest (65) in Shirapur while it was highest (92) in Aurepalle. The corresponding figures on large farms were only 3 in Kinkheda and 61 in Shirapur. From this, one could very well imagine the severity of labor bottlenecks on large farms during most busy fortnights.

In the ensuing section the village seasonal labor-use pattern is compared with the pattern which is emerging from the prospective watershed-based land- and water-management technologies being researched at ICRISAT. Although it is recognised that the prospective technologies may still be modified prior to their eventual adoption, a comparison with existing village labor-use patterns can assist in delineating potential bottlenecks on which attention can then be focused.

LABOR USE WITH IMPROVED WATERSHED-BASED TECHNOLOGIES

The Farming Systems Research Program at ICRISAT has been evolving improved farming systems for rainfed areas of the SAT since 1974. The basic concept involves management of the soil and water on a small catchment or watershed basis ranging in size from 1 to 50 ha. HYVs of crops are sown with improved fertilizers and crop management on broad beds established between furrows. The broad beds and furrows are established with improved animal-drawn implements on a graded slope of between 0.4 and 1.0 percent. This is to enable excess runoff, generally produced during heavy rainfall storms occuring during the rainy season, to be guided slowly across the natural grade (usually 1.5 to 2 %). In this way rainfall penetration into the root profile for use by crops is increased along with improved soil conservation.

We have selected several of the experimental treatments which have been found promising by the scientists of ICRISAT's Farming Systems Program (1977) to compare with the village data. The experimental treatments have been matched with villages having similar soil types in the manner shown in Table 9.

Threshing at ICRISAT Center has mostly been done using stationary combines and/or stationary threshers. Hence to enable a more valid comparison of the labor use under new technology we adjusted the ICRISAT labor requirements for threshing to reflect those in the village situation.[1] Average labor use both with and without this adjustment are presented in Table 10.

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[1]A survey was conducted in maize growing areas of Gajwel taluk of Medak district to work out threshing labor requirements. This gave an estimate of 13 man hours per quintal of main product for the threshing of maize. The estimates for other crops obtained from the village studies were as follows in man-hours per quintal: Sorghum = 9; Pigeonpea = 10; Setaria = 10 and Chickpea = 16.

Table 9. Experimental treatments at ICRISAT used for labor-use comparisons with the villages.

District	Experimental treatments used for comparison
MAHBUBNAGAR VILLAGES	
	Alfisol watersheds with
	(i) Bed planting on a 0.6% grade with hybrid sorghum followed by its ratooning
	(ii) Bed planting on a 0.6% grade with pigeonpea intercropped with setaria
SHOLAPUR VILLAGES	
	Deep Vertisol watersheds with
	(i) Bed planting on a 0.6% slope, hybrid maize followed by sequential chickpea
	(ii) Bed planting on a 0.6% slope, pigeonpea intercropped with hybrid maize
AKOLA VILLAGES	
	Medium-deep Vertisol watersheds with
	(i) Bed planting on a 0.6% slope, hybrid maize followed by sequential chickpea
	(ii) Bed planting on a 0.6% slope, pigeonpea intercropped with hybrid maize

Table 10. Human labor use and its pattern on selected watershed treatments at ICRISAT Center, India (1976-77)

Treatment	Net cultiva - ted area (ha)	Intensity of cropping	Total labor use per hectare of net cultivated area (man hours)		Total labor use per hectare of gross cultivated area (man hours)		Coefficient of variation in fortnightly labor use per ha (%)	
			Excluding threshing	Including threshing	Excluding threshing	Including threshing	Excluding threshing	Including threshing
I. Alfisols								
i) Sorghum followed by ratooning	1.45	200	832	1139	416	569	148	150
ii) Pigeonpea intercropped with setaria	1.26	200	767	944	384	472	176	160
I(i)+I(ii) average/total	2.71	200	802	1048	401	524	130	135
II. Deep Vertisols								
i) Maize followed by chickpea	8.22	200	865	1379	433	690	116	130
ii) Pigeonpea intercropped with maize	7.30	200	716	1183	358	592	157	199
II(i)+II(ii) average/total	15.52	200	795	1287	398	644	106	133
III. Medium-deep Vertisols								
i) Maize followed by chickpea	4.45	200	1093	1448	547	724	195	160
ii) Pigeonpea intercropped with maize	3.87	200	881	1227	441	614	160	165
III(i)+III(ii) average/total	8.32	200	994	1345	497	673	126	106

Comparisons of Tables 10 and 4 show that for the Mahbubnagar villages average labor use per net cultivated ha is some 6 percent higher than the nonadjusted average requirement for watershed treatment I at ICRISAT. If threshing labor is included in the watershed treatment it generates about 24 percent more labor use than do existing village systems. Compared with Aurepalle, which has much less irrigation than Dokur, the new technology (with traditional threshing) requires about twice the labor per ha than do the present systems (1048 and 540 man-equivalent hours, respectively).

Even without including the additional labor for threshing the ICRISAT crops, the prospective technology (treatment II) generates on an average more than 2½ times the employment per net cultivated ha than do existing systems in the Sholapur villages. If we include threshing, the figure is more than 4 times (1287 versus 296 man-equivalent hours per ha).[1]

Improved treatment III would entail more than twice the existing labor use per net cultivated ha in the Akola villages without the threshing adjustment, and three times more with threshing labor included.

From these comparisons it seems clear that even without considering threshing, the prospective technologies being evaluated at ICRISAT offer scope for increased employment, ranging from at least 48 percent in the Alfisols to more than 150 percent in the deep Vertisols. Including threshing, the potential employment increases become about 100 and more than 300 percent, respectively.[2]

[1]1976-1977 was the first year of establishment of the broad ridge and furrow system in the Vertisols at ICRISAT Center. Hence labor requirements will be somewhat higher than what may be expected in subsequent years when "development" is complete. Indications are the reduction may be around 20 percent.

[2]Considerable income gains also seem possible. See for example Ryan and Sarin (1977) and Economics Program (1978).

The estimates of apparent surplus labor supply in excess of farm requirements under a watershed-based technology, in comparison with corresponding surplus estimates under the present village situation (Table 7), indicated very wide differences. Such differences are more on Vertisols than on Alfisols. The watershed technology would result in 7, 37, and 35 percentage points surplus labor per annum on Alfisols, deep Vertisols, and medium deep Vertisols, respectively, as compared with corresponding present average village situations.

When we exclude the effect of the high cropping intensities implicit in the prospective ICRISAT technologies, the potential employment effect of the new technology still remains substantial. This is shown by the data on labor use per gross cultivated ha in Tables 4 and 10. Labor use per gross cultivated ha without threshing, included in the prospective technology on Alfisols, is about 16 percent less than village labor use in Mahbubnagar (401 versus 479 man-equivalent hours). When threshing is included, labor use is 9 percent more with the new technology. On deep Vertisols, the new technology requires 398 man-equivalent hours (excluding threshing), which is 49 percent higher than that used at present in the Sholapur villages. The equivalent figures when threshing labor is included are 644 man-hours, which is 141 percent higher than the current level in villages. In medium-deep Vertisols without threshing, the new technology uses 16 percent more labor than the Akola villages; and 57 percent more when threshing is included.

Hence it appears that, especially on the Vertisols, the overall employment-creating potential of the prospective new technologies may be substantial. However, there are likely to be some increases in the variability of seasonal labor demands as a consequence. This is generally evident from a comparison of the CVs of the existing seasonal village labor utilizations in Table 6 with those of the new technologies in Table 10 (including threshing). Except for Shirapur, the CVs of the new technology are higher than those currently in the villages.

FIGURE 7 AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY
[illegible] ICRISAT Center. Hybrid Sorghum plus Ratooning (1976-77)

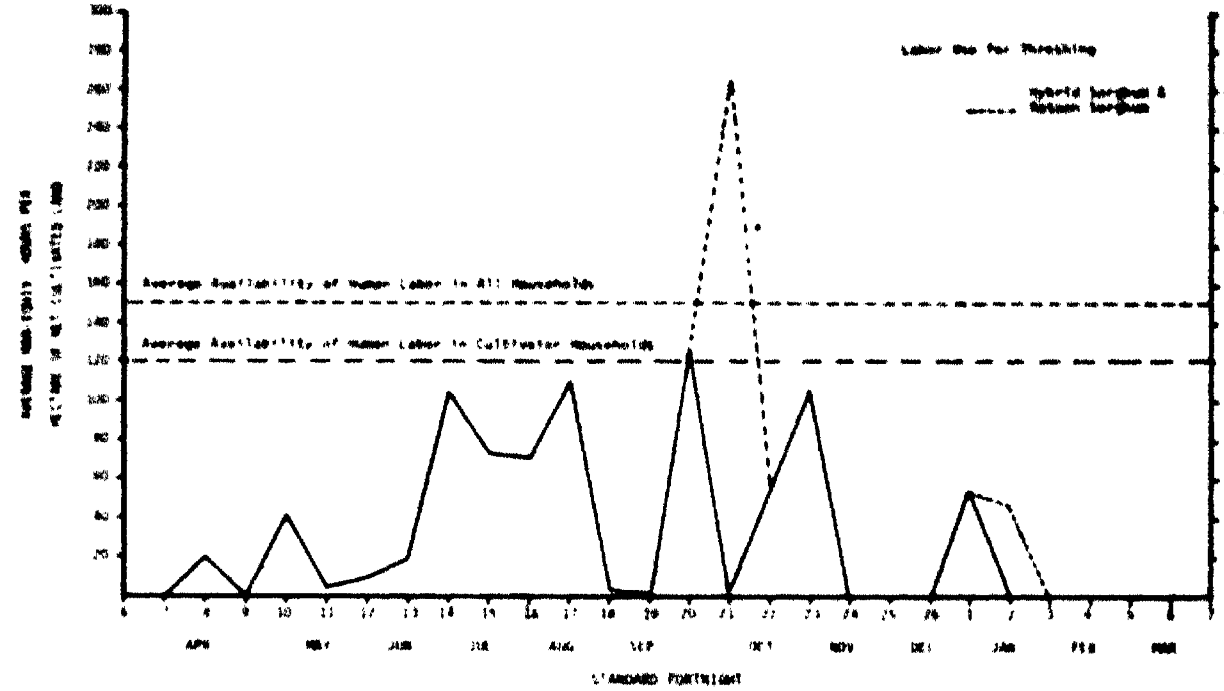


FIGURE 8 AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY
[illegible] ICRISAT Center Pigeonpea/setaria intercrop (1976-77)

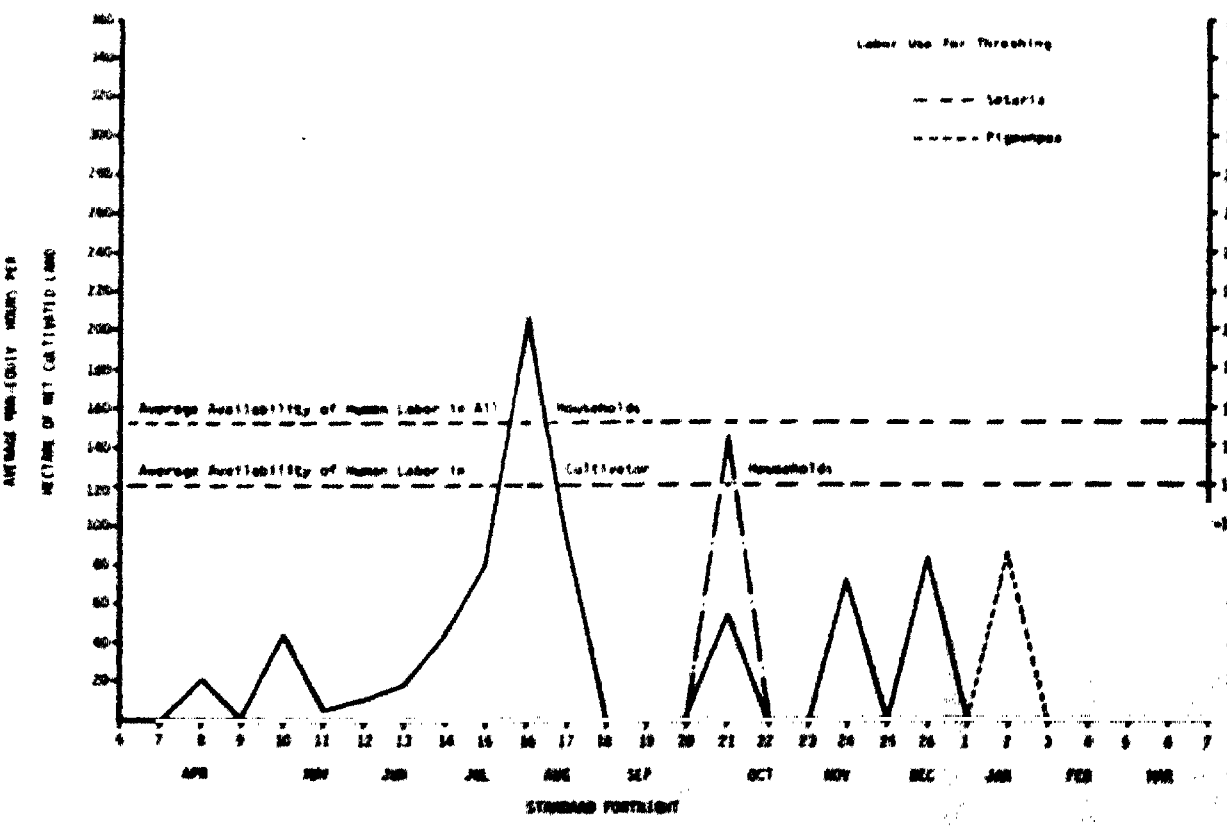


FIGURE 9: AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY
I (i + ii) Alfisols, ICRISAT Center. Combination of i) Hybrid Sorghum plus ratooning and
ii) Pigeonpea/setaria intercrop (1976-77)

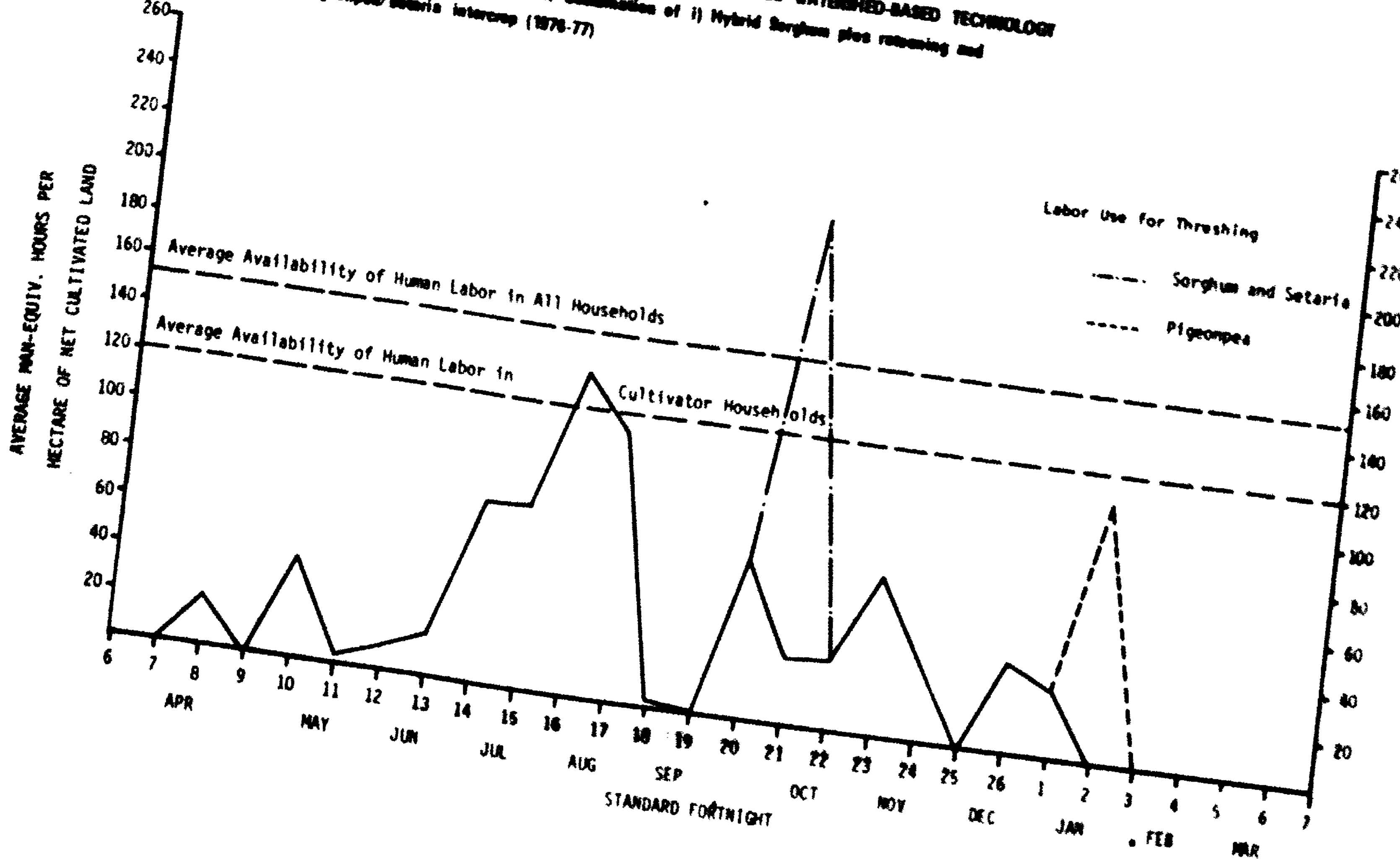


FIGURE 10 AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY
High Deep Vertisols, ICRISAT Center, Maize-Chickpea sequential (1976-77)

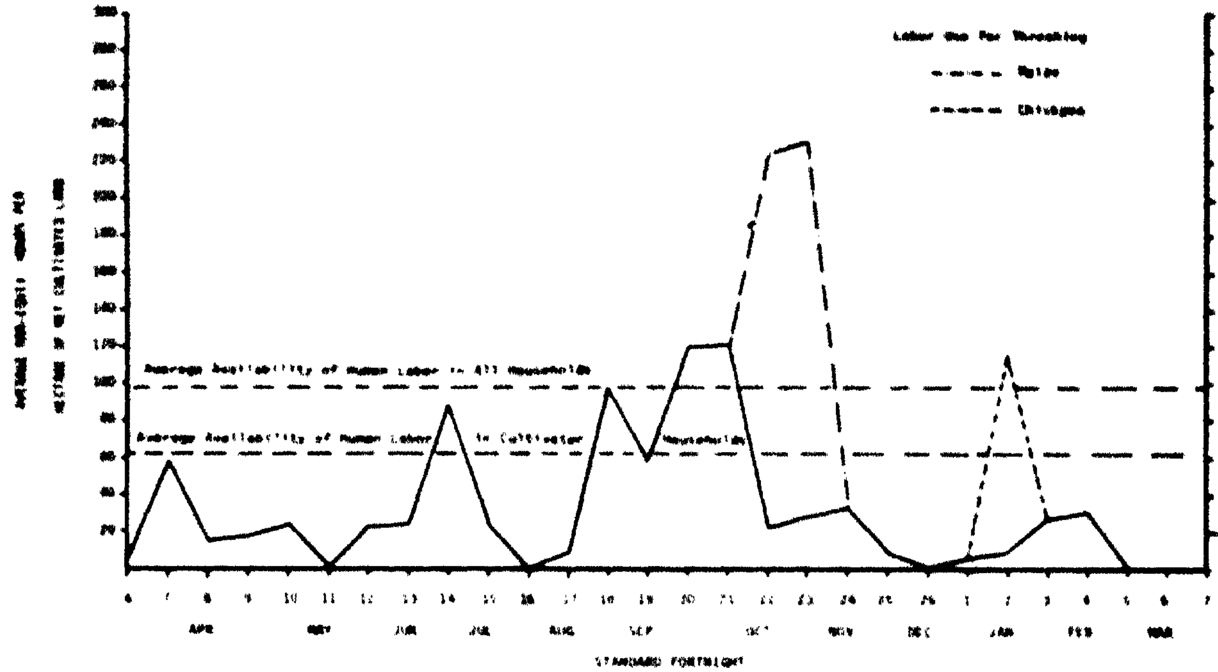


FIGURE 11 AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY
High Deep Vertisols, ICRISAT Center, Pigeonpea/Maize intercrop (1976-77)

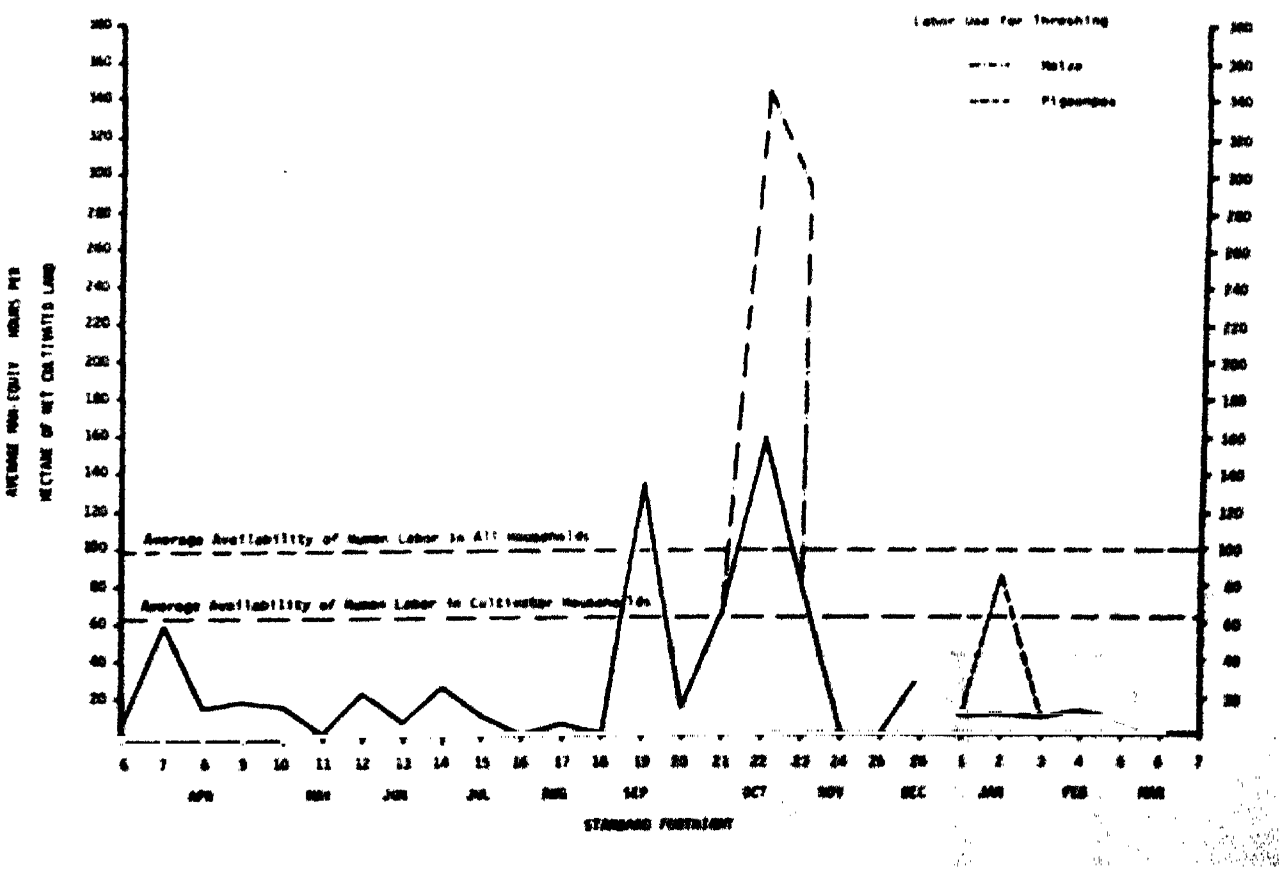
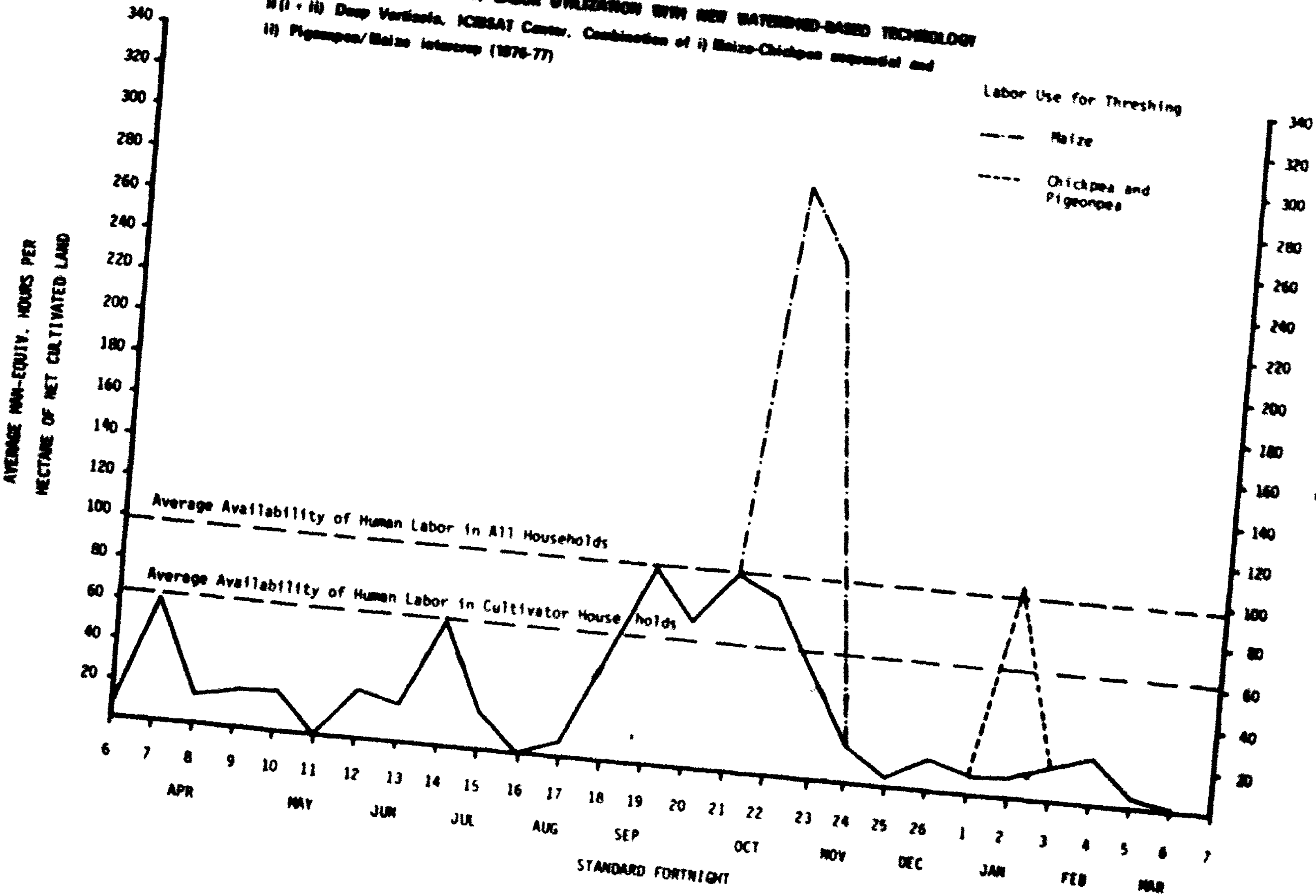
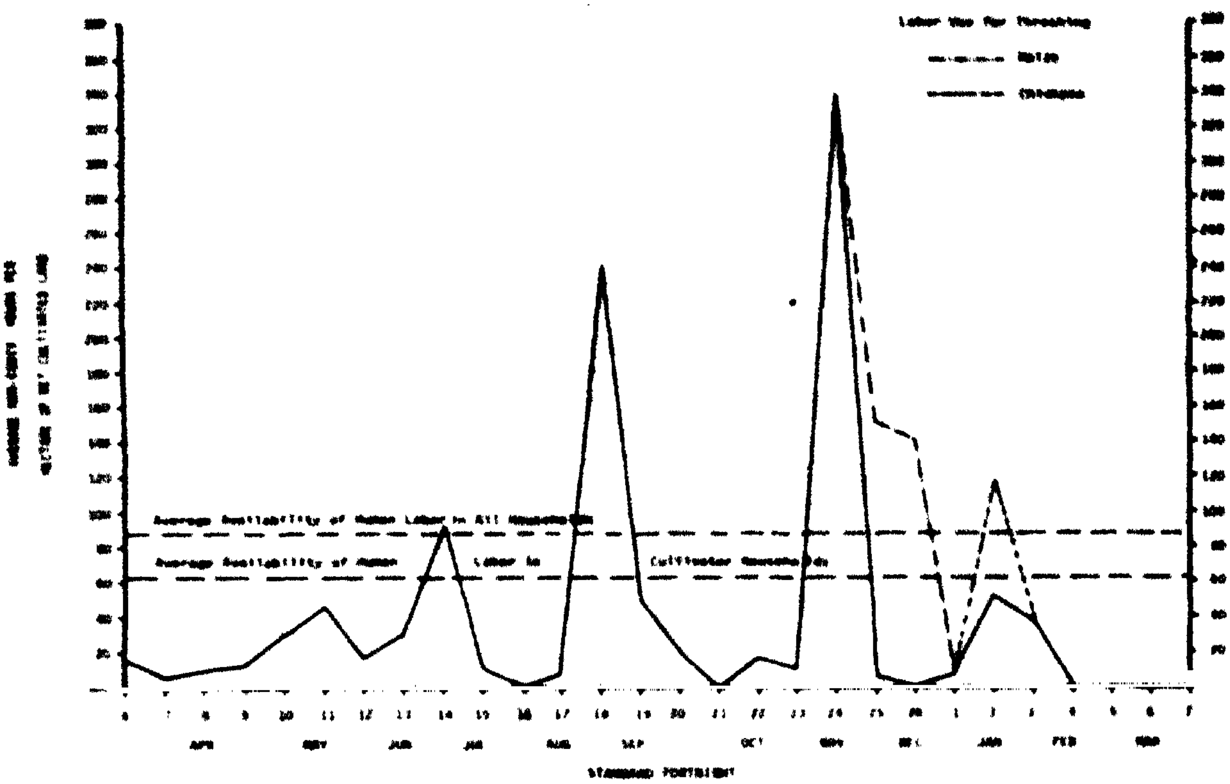


FIGURE 12: AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY

II(i + ii) Deep Vertisols, ICRISAT Center, Combination of i) Maize-Chickpea sequential and ii) Pigeonpea/Maize intercrop (1976-77)




Labor Use for Threshing
Maize
Average Availability of Human Labor in All Households
Average Availability of Human Labor in Cultivator Households
STANDARD FORTNIGHT

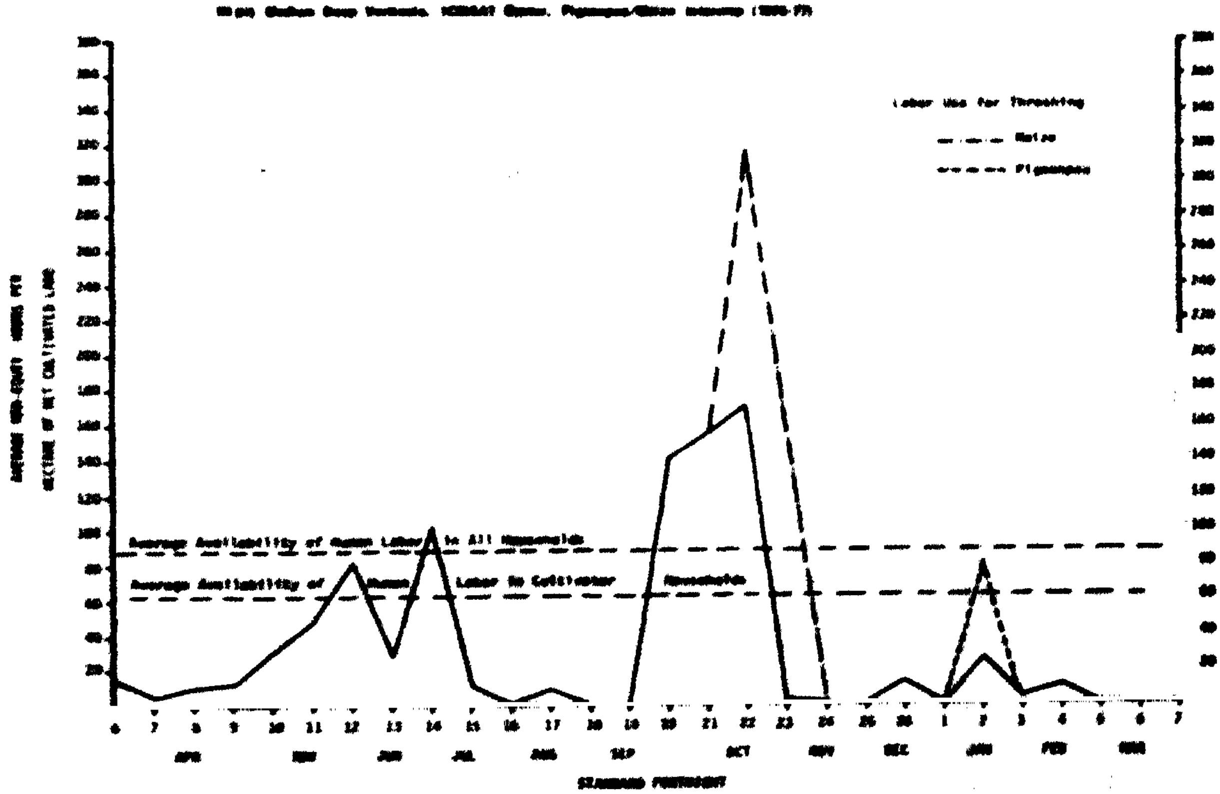
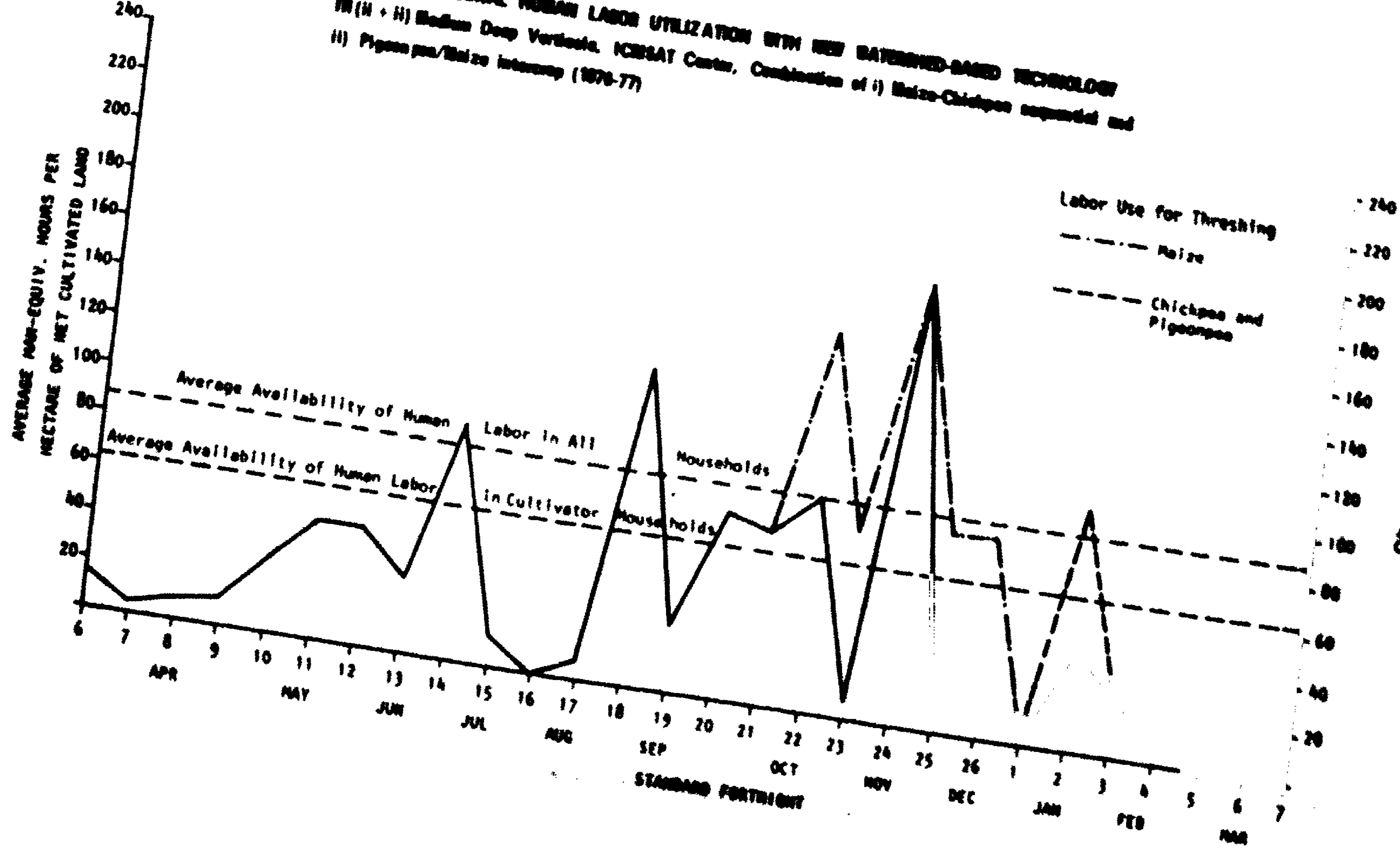

Labor Use for Threshing
Maize
Pigeonpea
Average Availability of Human Labor in All Households
Average Availability of Human Labor in Cultivator Households
STANDARD FORTNIGHT

FIGURE 18: AVERAGE SEASONAL HUMAN LABOR UTILIZATION WITH NEW WATERSHED-BASED TECHNOLOGY
III (i + ii) Medium Deep Vertisols, ICRISAT Center, Combination of i) Maize-Chickpea sequential and
ii) Pigeonpea/Maize intercrop (1976-77)



It is of particular interest to note that when we combine cropping pattern treatments (i) and (ii) under each soil type in Table 10, the CVs of the combined system are less than those of the individual cropping patterns, except for treatment III (i). This clearly demonstrates the complementarity that can exist between enterprises in their seasonal demands on labor. Hence new technologies involving improved land and water mangement should not be evaluated only on the basis of a limited range of cropping systems, but should embrace as many options as feasible to enable individual farmers to select those combinations which suit their particular labor availabilities and commitments. Unless this is done the risk will be that the new technology exacerbates labor peaks and will not be adopted. The work of Jodha (1977) showed that farmers in these villages have a multitude of cropping patterns evolved over long periods by trial and error. This will not easily be changed unless of course a single cropping pattern proves to be so vastly superior in profitability and reduction of risk that it dominates all others.

Comparing the seasonal labor distribution of Aurepalle (Fig 1) with those of the new technology (Fig 7, 8) shows there are approximately the same number of peaks. Compared with Dokur (Fig 2) the new technology has slightly fewer peaks. However, the amplitude of labor fluctuations with the new technology is much greater than at present in these villages. On many occasions labor requirements fall to zero also with the prospective technology. With the sorghum ratoon technology (Fig 7) the major peak occurs in September-October, whereas with the pigeonpea/setaria intercrop (Fig 8) the major peak comes in July-August. Presently in Aurepalle the major peak occurs in October-November. In Dokur it occurs in January. Hence the new technologies in Alfisols would shift the peak labor periods back into the monsoon.[1]

[1]As Dokur is highly irrigated and likely to stay so even after introduction of new dryland technology, the labor-use picture would continue to be dominated by irrigated paddy. This would not be nearly as true in Aurepalle.

This seems to be the case even when the two watershed treatments are combined and labor use is averaged for both (Fig 9). When the present average labor availabilities per ha in the two villages of Mahbubnagar are compared with the requirements of the new technologies in Figures 7-9, it seems clear that there will be major farm labor bottlenecks in July-August and October.

Either a double crop (Fig 10) or an inter-crop improved technology (Fig 11), or a combination of both (Fig 12), on deep Vertisols, would alter the present labor-use practice in Sholapur area (Fig 3,4) to a more unimodal shape. There would be a substantial peak with the new technology in September, October, and November due to weeding prior to chickpea sowing and the harvesting and threshing of maize. This would be in contrast to the more or less steadily rising labor demands from June to March experienced at present in the Sholapur villages. Present average labor availabilities in these villages would be insufficient to meet the demands of the new technologies in September, October, November, and January (Fig 10-12).

The maize-based improved systems on the medium-deep Vertisols (Fig 13-15) generally involve less labor during the late July and August period than in the existing villages in Akola (Fig 5, 6). The demands for sowing after the onset of the rainy season followed by weeding of rainy season crops under the existing cropping patterns in these villages, create the labor peak in the July-August period. With the new technology, rainy season crops are dry-sown in June prior to the onset of the monsoon. This is the main reason for the late-June labor peak in Figures 13 and 14. Again the new technology involves much more prolonged labor peaks with greater amplitudes than with the existing systems during the harvesting and threshing periods for maize from September to early December. When the two new technology treatments are combined and the average labor use is calculated, the resultant effect is to considerably flatten the seasonal labor distribution (Fig 15). The present labor availability in the villages with medium deep Vertisols would become a major limitation for labor use under these new technologies in the months of June, September, October, November, December, and January.

Table 8 demonstrates that during the present three most severe labor peak periods in the villages, the apparent labor surplus percentages ranged from 61 and 79. Under the prospective technologies there would be considerably more demand for labor in the (new) peak periods. This apparent excess demand would be a maximum in the Sholapur deep Vertisols and minimum in the Mahbubnagar Alfisols. It seems clear that the prospective watershed-based technologies being evaluated at ICRISAT would be faced with substantial labor bottlenecks, particularly during harvest/threshing periods. So far the analysis has been carried out using only comparisons of human labor use per hectare under existing crop technology and under the prospective new watershed technologies. We have not considered the relative impacts of the new technologies on use of other resources such as bullock power. It may well be that bottlenecks would arise in use of resources other than human labor. However, evaluation of these was beyond the scope of the present paper.

CONCLUSIONS

Examination of regional variation in the intensity of labor utilization reveals that there is a tremendous employment-creating potential in existing tank and well irrigation systems in the Alfisols of peninsular India. New technologies for the rainfed portions of such villages will have to compete with these irrigation systems for labor at strategic times in the crop-growing seasons. Besides irrigation, other factors -- like the extent and distribution of rainfall, the extent of rainy and postrainy season cropping, cropping patterns, the extent of mixed cropping, and the quality of irrigation -- also play an important role in determining the intensity of labor use. The intensity of cropping does not explain much of the difference in labor-use intensity observed in these villages.

Previous literature suggests that the size of the farm is usually negatively related to the amount of human labor use per unit of land. However, we did not find such a consistent relationship in these villages. Of six villages, only three showed a significant negative relationship while two villages had nonsignificant negative relationships and one village showed a significant positive relationship. Before drawing further conclusions about this phenomenon, further analysis using data from the second year is planned.

In general, there is a tendency for large farms to employ a higher proportion of hired labor than do small farms in these villages. In addition, there does seem to be some relationship between the proportion of family labor use in a village and the variation in total labor use per hectare across farm-size groups within the village. The higher the proportion of family labor use in a village the more likely that there will be an inverse relationship between farm size and total labor use per hectare. Much more research is required on this issue also before the explanations for differential labor use patterns across different size farms are clear.

The predominance of cash crops (cotton) in the Akola region, together with the fact that almost half the farmers belong to castes which avoid manual labor, seems to explain the small proportion of family labor used on farms there. On the other hand, the more intensive use of family labor in Sholapur and Mahbubnagar villages is associated with a predominance of food-grain crops.

While small farmers hired proportionately less labor than did large farmers, the extent of labor hiring by them is by no means insignificant.

Employment potential for women seems greatest in the highly irrigated Alfisol village of Dokur and in the cotton-growing villages of the Akola district. The data on hours of work reveal there is a substantial contribution of female labor in the crop agriculture of SAT peninsular India. Child labor is not a major contributor. The contribution of hired female labor to total labor is always higher than its family counterpart when the village as a whole is considered. Males contribute substantially more of the total family labor than do females; females contribute substantially more of the total hired labor than do males. In the six villages, the proportion of family female labor use is higher on small farms than on large farms. There is a clear, positive relationship between the proportion of hired female labor employed and the size of the farm.

The high positive and significant correlation coefficients, worked out between fortnightly total labor use and the use of hired labor on all types of farms, support the hypothesis that variations in total seasonal labor use has a direct and positive effect on demand for hired labor. The results further indicate the importance of large farms in the generation of employment opportunities in these villages. The coefficients of variation of seasonal labor use per hectare are significantly higher on the small compared to the large farms, and the reason for this seems to be the fewer crops grown on the small farms. When more types of crops are cultivated in various seasons, this generally entails a more continuous use of labor with less seasonal variability.

The Mahbubnagar villages, with Alfisols and comparatively more irrigation, experience two to three sharp labor-use peaks in a year with frequent slack periods. On the other hand, the Sholapur villages, with mostly postrainy season cropping, have only one or two mild but reasonably prolonged peak periods in January-February while there is a relatively less farm labor demand during the rest of the year. In contrast to this, in Akola, with relatively high rainfall and rainy season cropping, the first prolonged peak periods occur in June, July, and August after which there is a steady use of labor up until February and March. This is followed by a prolonged slack.

The prospective technologies being evaluated at ICRISAT offer scope for increased employment compared with existing technologies, ranging from at least 48 percent more employment in the Alfisols to more than 150 percent more in the deep Vertisols. If traditional threshing methods are utilized, the potential employment increases could reach 100 and more than 300 percent, respectively. However, there appears to be some increase in the variability of seasonal labor demand as a consequence. Except for Shirapur, the coefficients of variation of the new technologies are higher than those currently in the villages. Combining the two cropping-pattern treatments under each soil type demonstrates the complementarities in labor-use patterns of different crops. The CVs of combined systems are always less than those of the individual treatments. Hence the new technologies should not be evaluated only on the basis of a limited range of cropping systems, but should embrace as many options as feasible to enable individual farmers to select those combinations which suit their particular labor availabilities and commitments. Unless this is done, the risk will be that the new technology exacerbates labor peaks and will not be adopted.

It is clear that, given the existing availabilities of labor in these villages, there will be with the improved watershed technologies major farm labor bottlenecks in July-August and October on Alfisols. On deep Vertisols such bottlenecks will be in the months of September, October, November, and January, while medium deep Vertisols will experience major bottlenecks in two periods, in June and from September to January. The top three labor-use peak fortnights with the improved technologies faced apparent labor deficits ranging between a low of 0.22 percent on Alfisols and a high of 119 percent on deep Vertisols.

No doubt such bottlenecks would generate increased wage rates and employment potentials, which would be desirable from the point of view of those relying on daily wages for most of their sustenance. However, there would be adverse effects on the timeliness of operations critical to the success of a double-cropping and/or intercropping technology aiming at greatly increased yields. This would be expected to create demands for selective mechanization of operations such as threshing. We already observe this in Kanzara village in Akola, where three mechanical threshers were introduced in 1976. They now thresh almost all of the sorghum and wheat grown there and are also hired out extensively in neighboring villages. We are now studying the effects of these threshers on productivity and employment in order to determine if trade-offs may be involved.

The next step in this research will be to examine, with the aid of activity-analysis models, the place of the improved watershed-based technologies in existing farming systems in a way similar to that of Arifin (1978). This will be done by decomposing the technology into activities or options involving its various elements or steps (for example new seeds, new fertilizers, both together, etc.). These can then be introduced into activity models which simulate existing farming systems to determine desirable changes under a range of constraint situations.

Appendix Table 1. Simple correlation coefficients between fortnightly total and hired labor utilization in six SAT villages in India.

Village	Farm-size group			
	Small	Medium	Large	All Farms
Aurepalle	0.40* (0.49)[a]	0.68** (7.53)	0.93** (91.98)	0.91** (100)
Dokur	0.67** (11.41)	0.80** (20.17)	0.95** (68.43)	0.91** (100)
Shirapur	0.66** (19.41)	0.79** (28.34)	0.87** (52.25)	0.87** (100)
Kalman	0.82** (11.32)	0.94** (52.42)	0.92** (36.26)	0.94** (100)
Kanzara	0.97** (8.11)	0.97** (18.80)	0.99** (73.09)	0.99** (100)
Kinkheda	0.86** (6.99)	0.96** (16.42)	0.99** (76.59)	0.99** (100)

[a]The bracketed figures are percent hired labor use values out of total hired labor use by all farmer respondents in a village.

*Significant at 5% level of probability

**Significant at 0.1% level of probability

Appendix Table 2. Simple correlation coefficients between fortnightly total labor utilization and its hired proportion (%) in six SAT villages in India.

Village	Farm-size group			
	Small	Medium	Large	All Farms
Aurepalle	0.25	0.23	0.51***	0.45**
Dokur	-0.08	0.15	0.60++	0.46**
Shirapur	-0.20	0.19	0.53+	0.34*
Kalman	0.08	-0.03	0.30	-0.18
Kanzara	0.53+	0.22	0.12	0.30
Kinkheda	0.55+	0.63++	0.43**	0.44**

*Significant at 10% level of probability
**Significant at 5% level of probability
***Significant at 1% level of probability
+Significant at 0.5% level of probability
++Significant at 0.1% level of probability

Appendix Table 3. Estimates of annual family labor surplus in excess of farm labor requirement by farm-size groups in six SAT villages in India.

Village	Farm-size group: Small farm: Total annual availability per hectare of NCA (man hours)	Small farm: Percent surplus labor	Large farm: Total annual availability per hectare of NCA (man hours)	Large farm: Percent surplus labor
Aurepalle	8428	97.1 (242)[a]	2240	71.0 (650)
Dokur	17640	88.1 (2093)	2436	58.1 (1022)
Shirapur	5488	88.8 (613)	1680	81.6 (309)
Kalman	3108	92.9 (222)	896	81.1 (169)
Kanzara	7700	93.8 (475)	1064	61.8 (406)
Kinkheda	4592	87.8 (562)	1064	54.5 (484)

[a]Figures in parentheses are labor use values in man hours per hectare of net cultivated area for the year 1975-76.

Appendix Table 4. Estimates of family labor surplus in excess of farm requirements for top three peak labor-use fortnights by farm-size groups in six SAT villages in India.

Village	Farm-size group			
	Small farm		Large farm	
	Labor availability per hectare of NCA for 3 fortnights (man hours)	Percent surplus labor	Labor availability per hectare of NCA for 3 fortnights (man hours)	Percent surplus labor
Aurepalle	903	92.5 (68)[a]	240	35.0 (156)
Dokur	1890	75.2 (468)	261	3.5 (252)
Shirapur	588	65.0 (206)	180	60.6 (71)
Kalman	333	84.1 (53)	96	57.3 (41)
Kanzara	825	81.9 (149)	114	19.3 (92)
Kinkheda	492	72.8 (134)	114	2.6 (111)

[a]Figures in parentheses are the total labor use values (man hours) for the top 3 peak fortnights.

FIGURE 1 AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON SMALL FARMS IN AUREPALLE

APPENDIX - 1

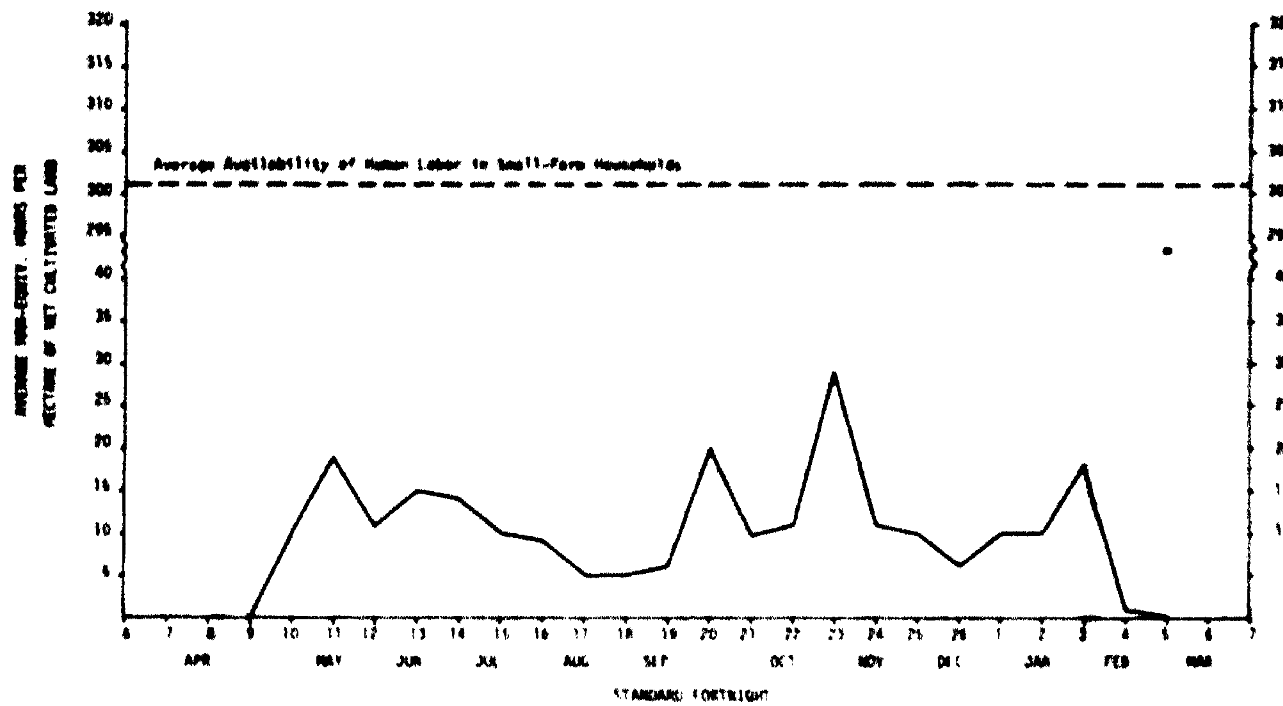
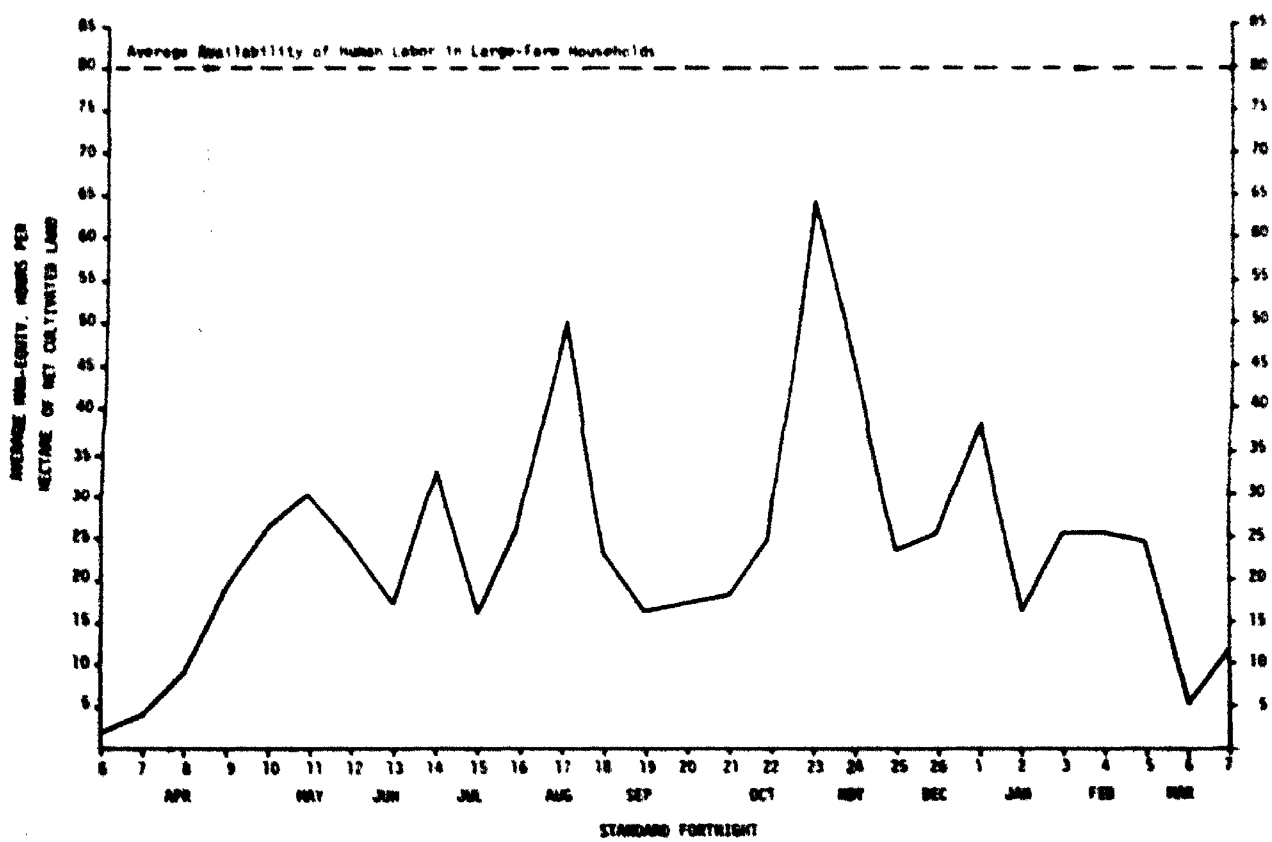
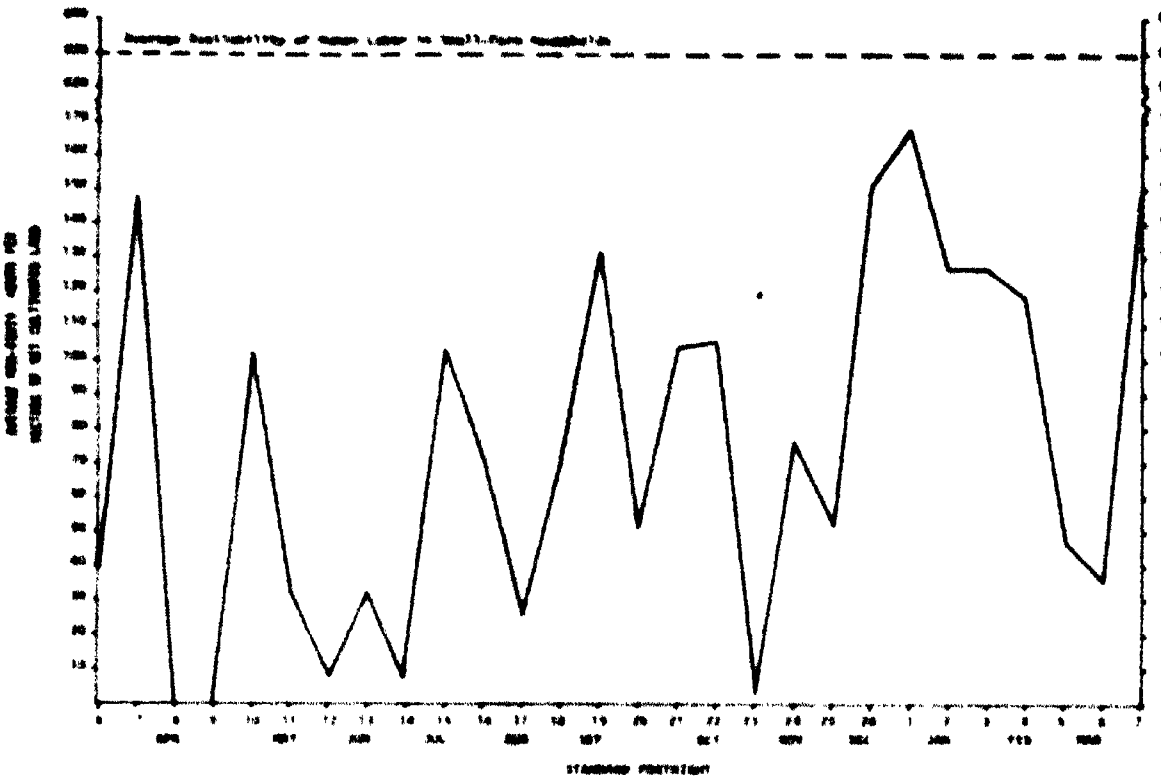


FIGURE 2 AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON LARGE FARMS IN AUREPALLE





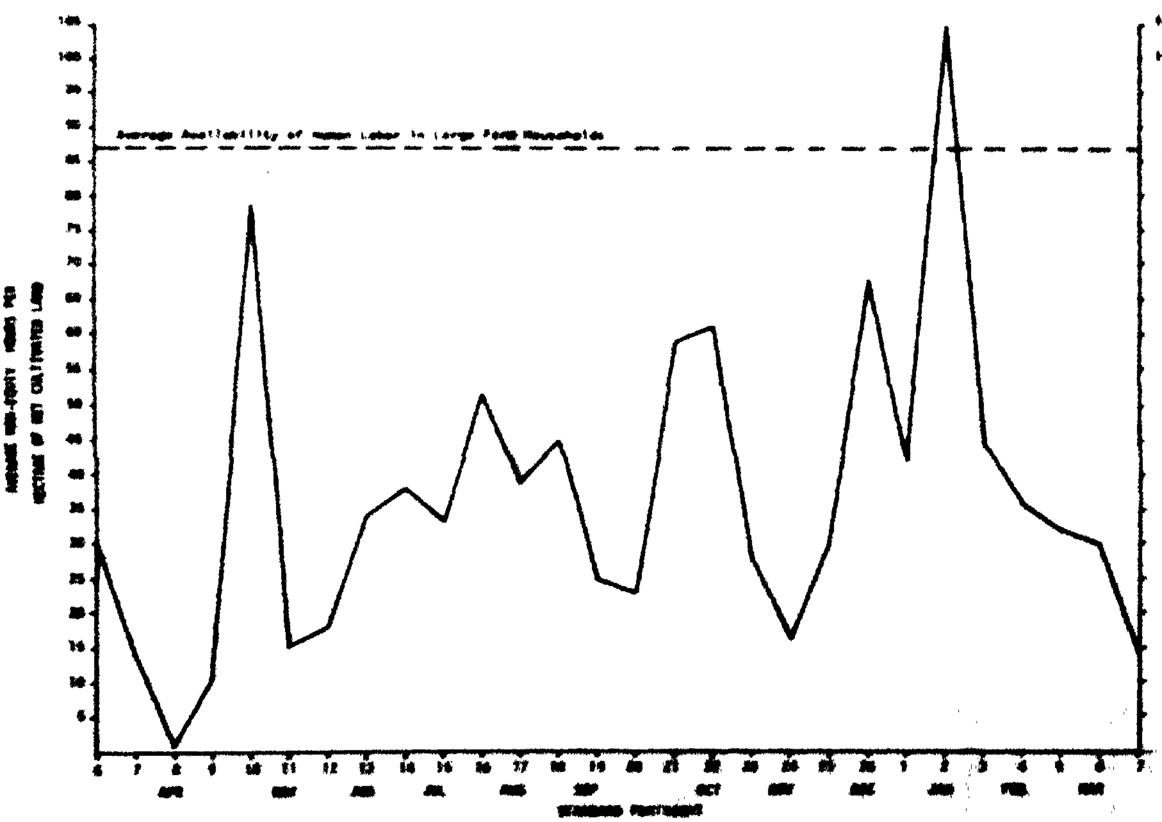


FIGURE 5: AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON SMALL FARMS IN [illegible]

Appendix 1

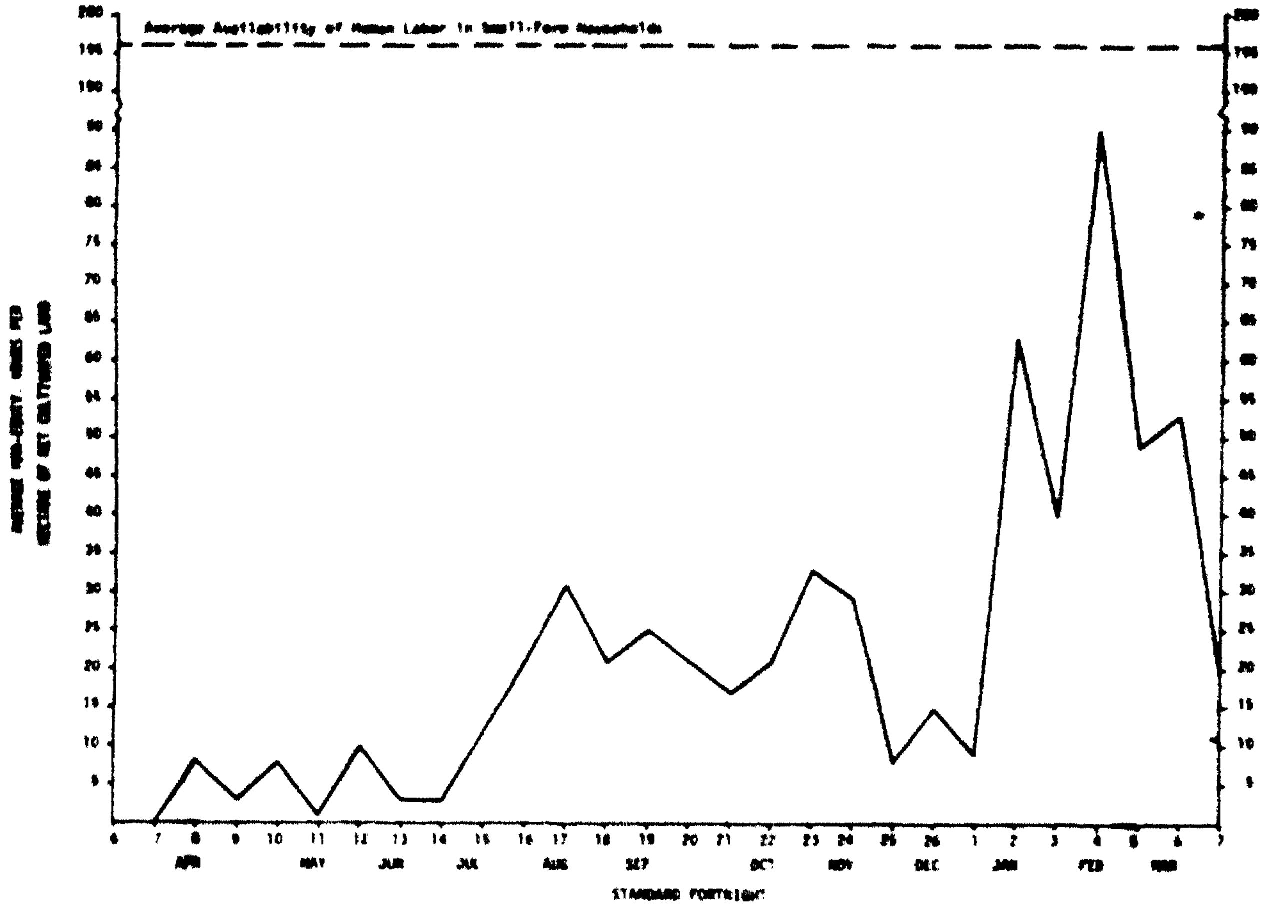


FIGURE 6: AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON LARGE FARMS IN [illegible]

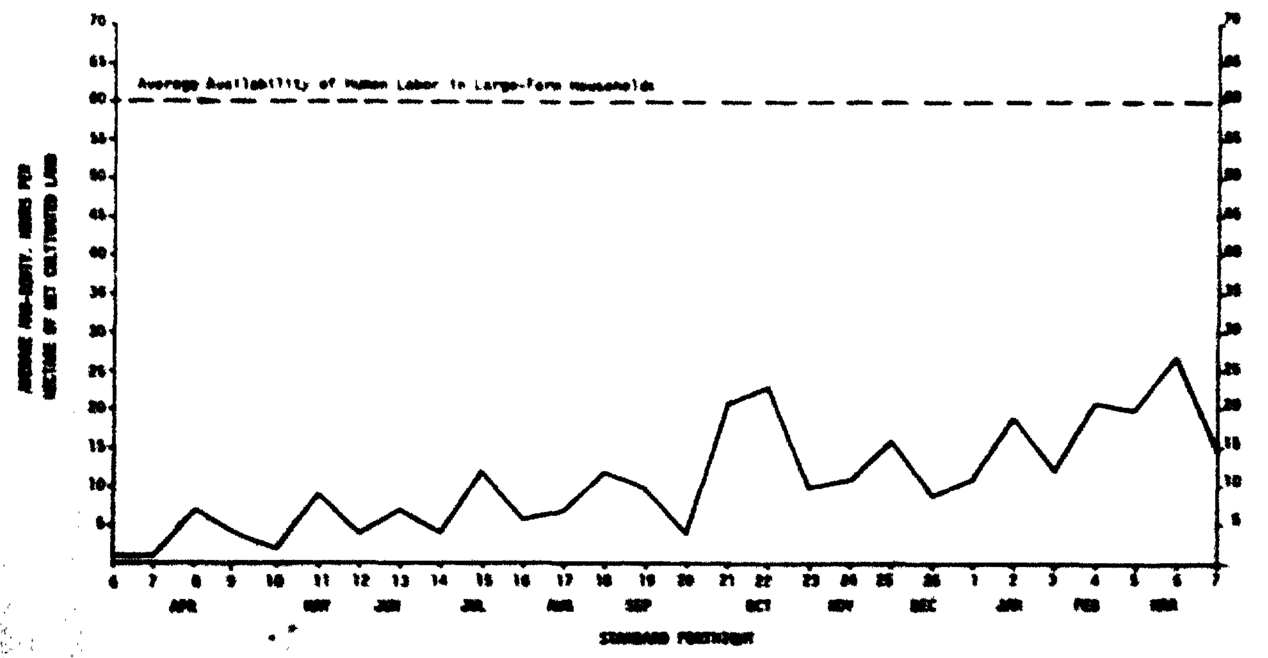


FIGURE 7: AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON [illegible] FARMS IN [illegible].

Appendix I

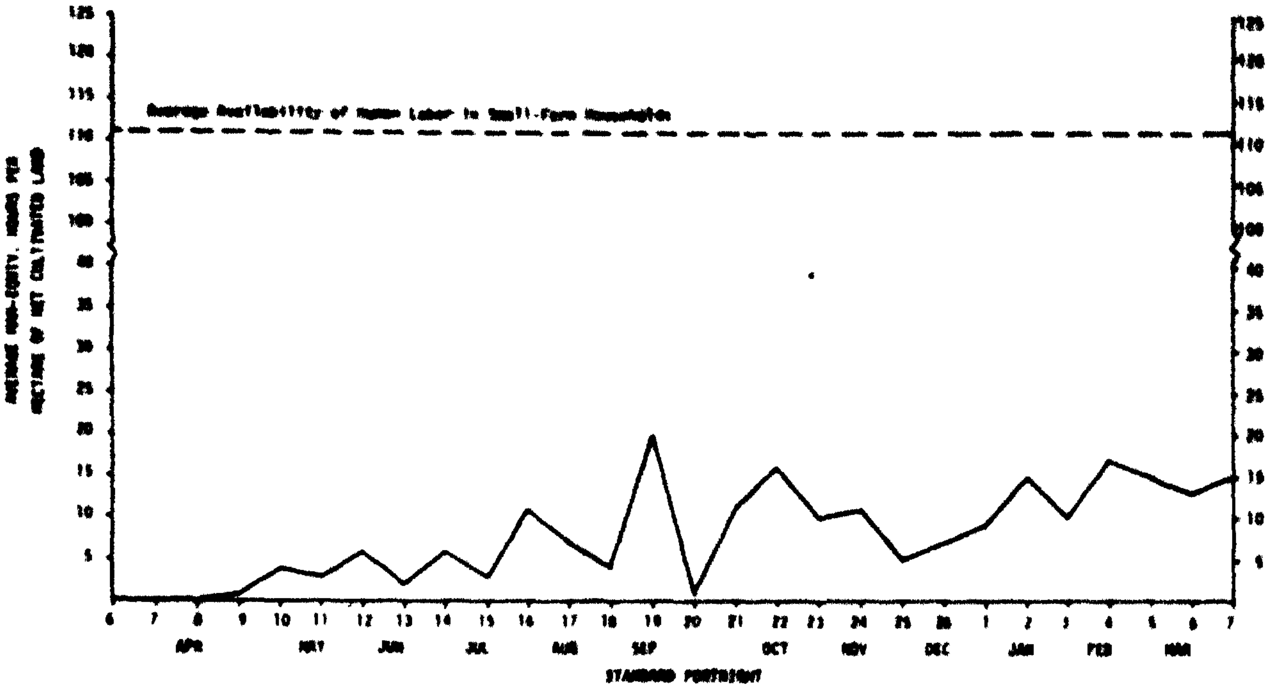


FIGURE 8: AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON LARGE FARMS IN [illegible].

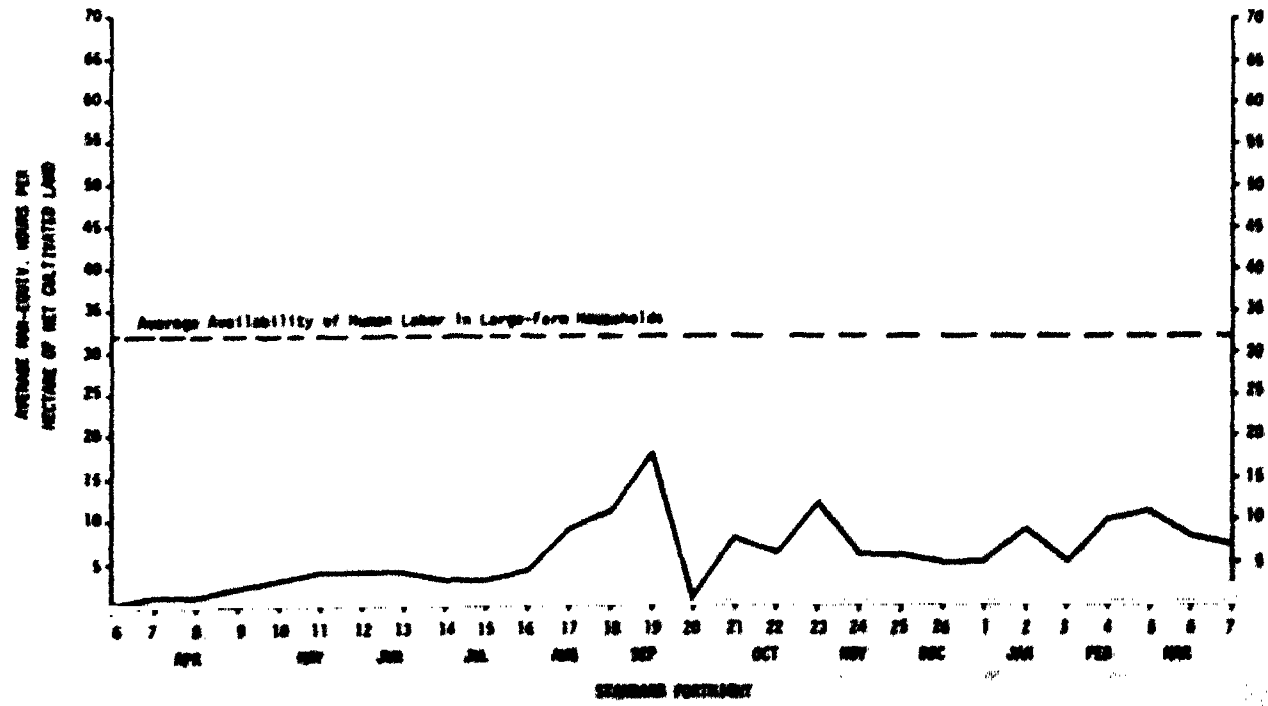


FIGURE 9 AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON SMALL FARMS IN [illegible] Appendix [illegible]

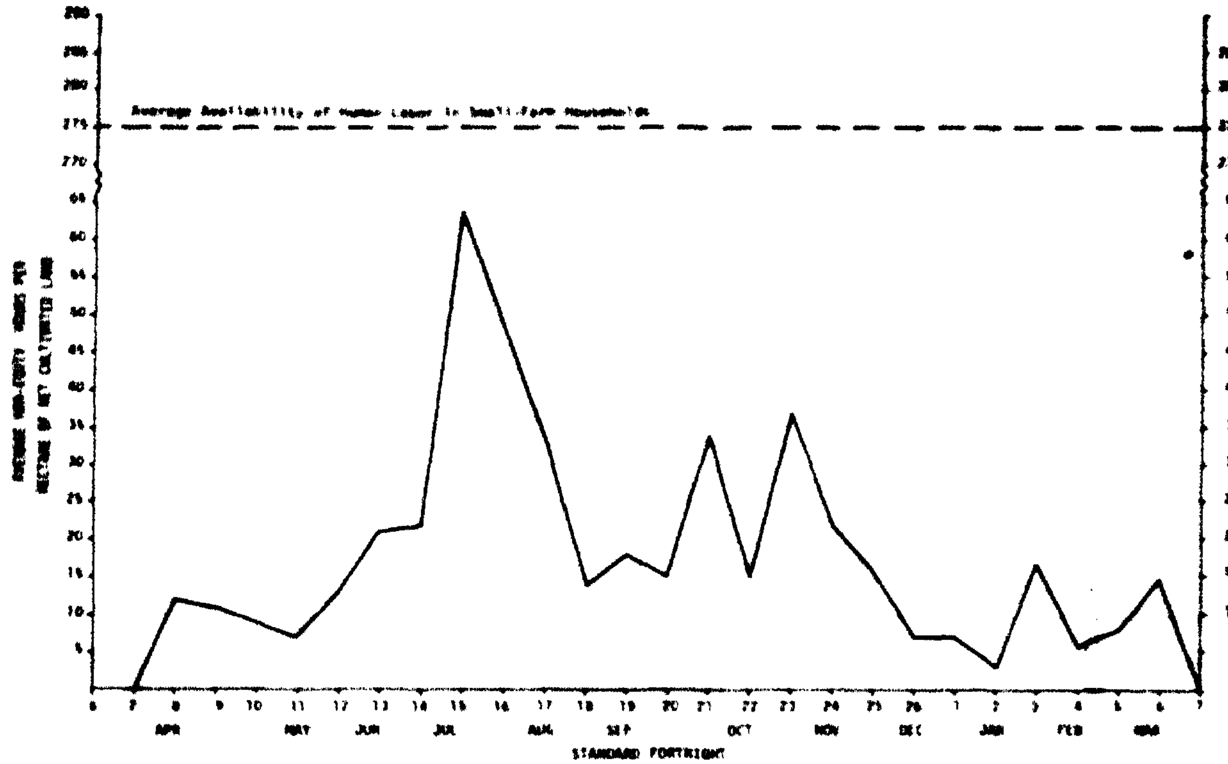


FIGURE 10 AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON LARGE FARMS IN [illegible]

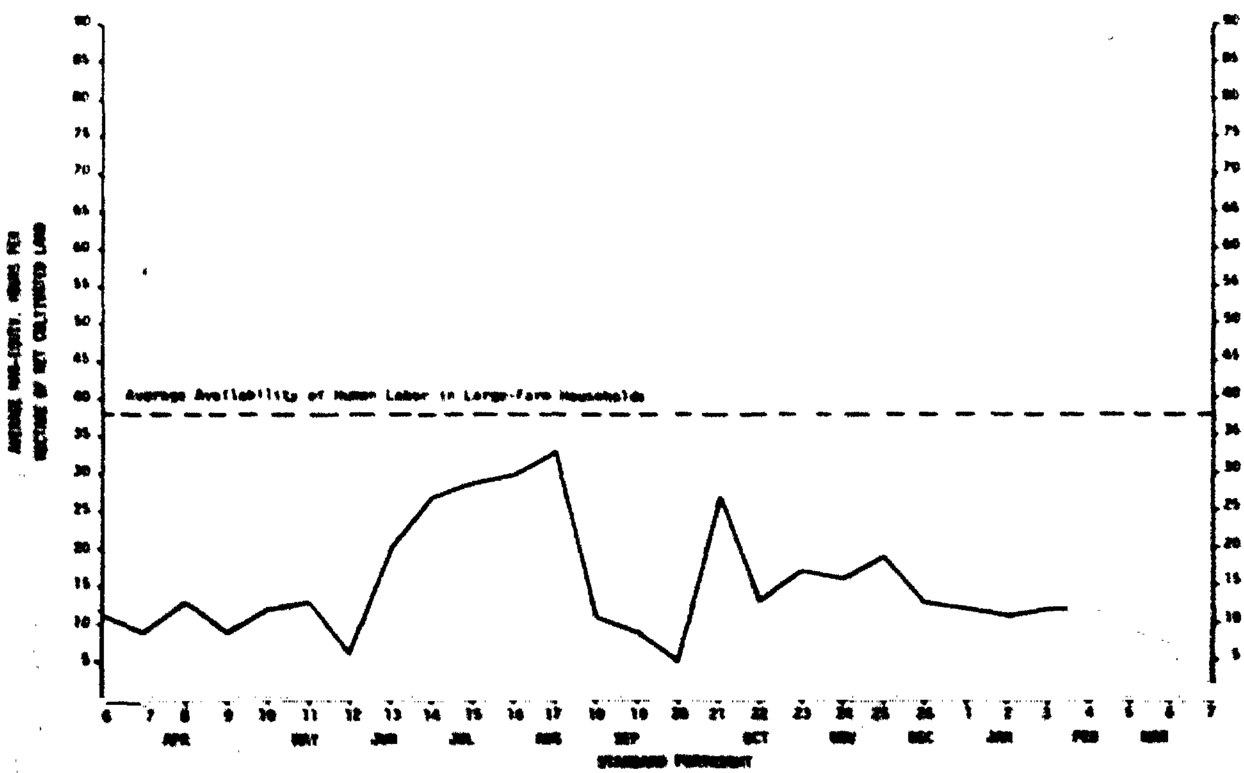


FIGURE 11. AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON SMALL FARMS IN [illegible].

Appendix I

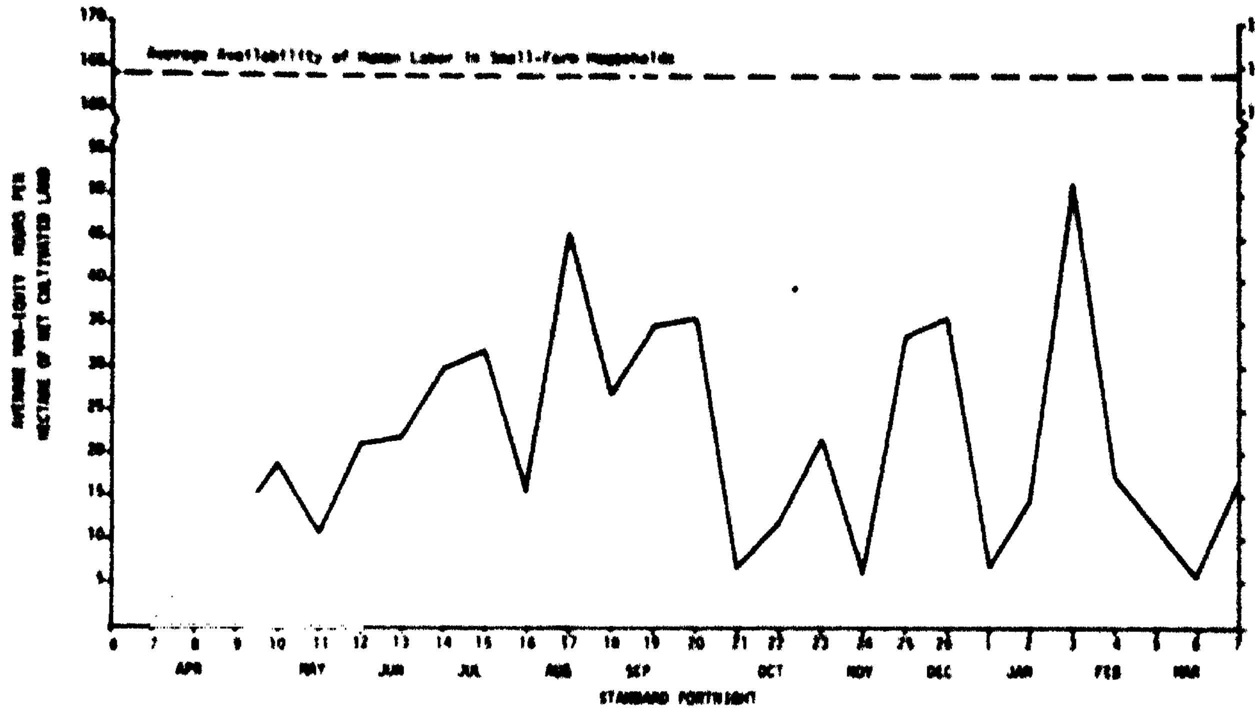
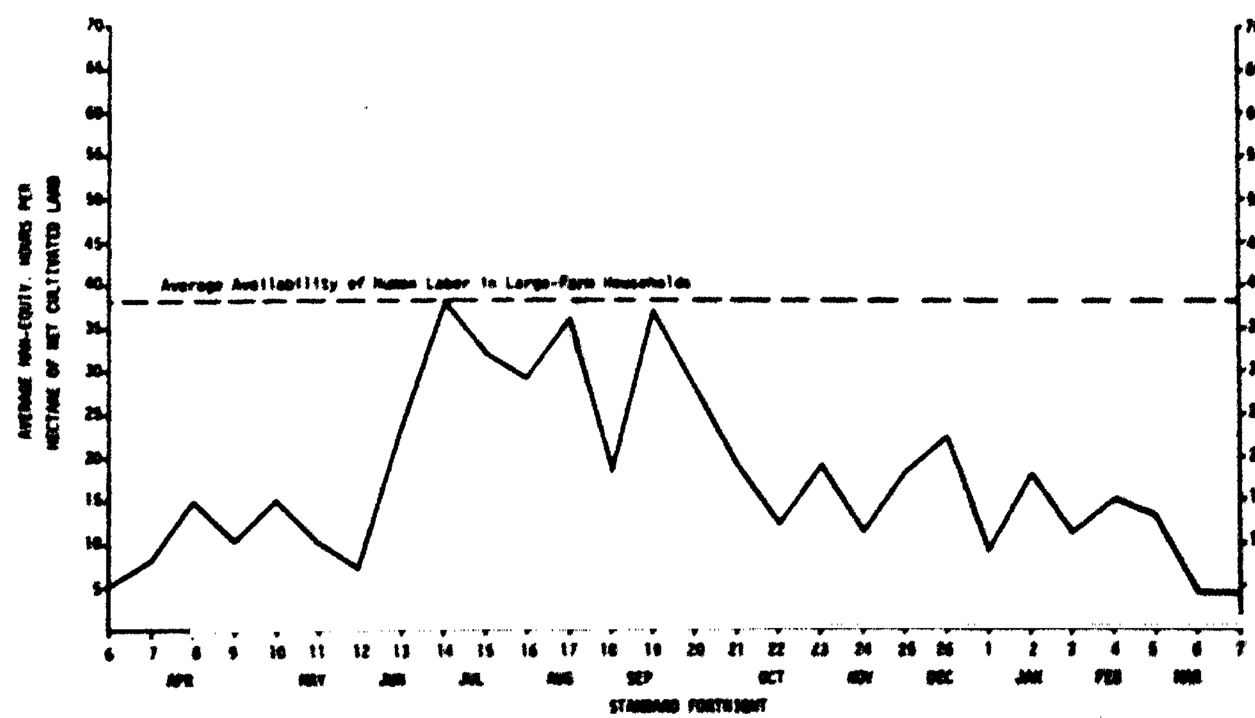


FIGURE 12. AVERAGE SEASONAL HUMAN LABOR UTILIZATION ON LARGE FARMS IN [illegible]



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