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Local Varieties, Planting Strategies, and Early Season Farming Activities in Two Villages of Central Upper Volta

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LOCAL VARIETIES, PLANTING STRATEGIES, AND EARLY SEASON FARMING ACTIVITIES IN TWO VILLAGES OF CENTRAL UPPER VOLTA

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This is the second in a series of periodic reports presenting preliminary findings of ICRISAT/West Africa socioeconomics village research.[1] The objective of these reports is to make available on a timely basis highlights of results emerging from ongoing village studies, thereby stimulating discussion and early feedback from other scientists.

The present paper examines early-season operations carried out by sample households in the Mossi villages of Nakomtenga and Nabitenga.[2] In the first section information on local varieties of sorghum and millet are presented, followed by a discussion of strategies pursued by farmers in their planting and replanting decisions. Data for these sections were obtained through in-depth qualitative interviews with a subsample of farmers participating in the study. Subsequent sections present analyses of cost-route data and results of field observations obtained from more than 40 sample farmers. These data describe soil

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1. For the first report see P.J. Matlon, "Profile of Farm Units in Two Villages of Central Upper Volta," Progress Report 1, June 1980, Economics Program, ICRISAT/West Africa.

2. Both villages are located 35 kilometers northeast of Ouagadougou.

preparation, planting, replanting, and thinning activities on sorghum and millet fields. Preliminary performance indicators for E35-1 and local-check fields are also presented.

OBJECTIVES AND APPROACH OF THE STUDY

The goals of the current village research are:

1. to analyze production systems of the most common crops and crop associations cultivated under local technology in the central region of Upper Volta;
2. to evaluate the performance of an improved short-duration sorghum variety (E35-1) in combination with improved technicultural practices under farmers' management;
3. to develop and test survey methodologies for use in an expanded program of village studies to be initiated in 1981.

To these ends, 44 farmers are participating in weekly interviews. Detailed input-output data are being obtained for approximately 300 fields representing more than 10 crops or distinct crop associations. Included among the sample fields are two test plots for each farmer: one parcel of E35-1, and a control parcel planted to a local white sorghum and cultivated under improved management. Each treatment is 500 m^2 in area. At the beginning of the season, farmers were given sufficient chemical fertilizer (14-23-15) to treat both trial plots at a rate of 100 kg/ha. Farmers were also advised to plow each field before planting and to perform identical thinning and weeding operations.

Although activities on these and other local-check fields are being monitored closely, it should be stressed that all operations are executed by farmers under their own management. The objective of this approach is to determine not only how the variety performs in the more variable off-station physical environment, but once assured that farmers understand the required set of management practices associated with E35-1, to determine how farmers modify the recommendations, why they modify them, and how these modifications affect production stability and productivity. This approach should provide a reasonable estimate of the variety's performance if distributed to farmers more generally. In addition, the ways in which farmers modify recommended practices can help identify points of conflict with other elements in farmers' overall production systems. Such information can be utilized to change recommendations or to help reevaluate objectives in plant breeding programs from the point of view of farmer adoption.

The present study involves close cooperation with ICRISAT programs in sorghum improvement, agronomy, and entomology. Results presented in this report benefited from the advice and field observations of scientists in those programs.

LOCAL VARIETIES OF SORGHUM AND MILLET

Through farmer interviews 23 local varieties of sorghum and millet were identified and characterized. Among the total, 12 varieties have been sown on sample fields this season and their production is being monitored. In this section qualitative information obtained in the interviews describing the local varieties is presented.

A summary of crop characteristics is presented in Table 1.

WHITE SORGHUM

Ten local white sorghum varieties were distinguished, of which three are being observed on sample fields this year. While most varieties were described as being between 2.5 and 4.0 m in height, three varieties described as approximately 2 m tall were also reported. Head sizes ranged between 20 and 50 cm, with all but two described as open. Tillering capacity was said to be good (four to six tillers under good conditions) for only two varieties (Fibmiga and Pissyopoué). No important distinctions were made with respect to soil preferences (all prefered relatively richer and deeper soils with none reported to be noticeably better on shallow or sandy/gravelly soils); and none were reported resistant to Striga. Questions on resistances to insects or diseases did not produce responses that could be easily interpreted, primarily due to inadequate precision in farmers' diagnosis.

All but two varieties were reported to have optimal planting dates during the first two weeks of June with a steady decline in yields thereafter. One variety (Kobga la Pisnou) was known to require planting in the second half of May, and one (Pissyopoué) could be planted as late as early July with little reduction in potential yield. Harvest dates for all but two varieties (Fibmiga and Pissyopoué) are early November, giving an estimated average crop cycle of 150 days.

Table 1. Farmer descriptions of local sorghum and millet varieties

Crop and variety	Percent of fields planted[a]	Relative yields	End use	Date of planting	Date of harvest	Tillering capacity	Yield potential on poor soils	Resistance to[b] Drought	Resistance to[b] Striga	Height in m.	Head length in cm.
<u>White sorghum</u>											
Pissyopoué	64	+++	To, Dolo	1-20 Jn 14 Jy Mx	20-30 Oct	++	0	+	0	3.0	30
Fibmiga	32	++	To	1-10 Jn	20-30 Oct	+	0	-	0	3.0	30
Belko	4	+	To, Dolo	1-15 Jn	1-10 Nov	0	0	0	0	4.0	30
Wedzouré	-	0	To	1-15 Jn	1-10 Nov	0	0	0	0	2.5	40-50
Zondbodo-Banisilini	-	0	To	1-15 Jn	1-10 Nov	0	0	++	0	1.5	25
Wangue Nombri	-	0	To	1-15 Jn	1-10 Nov	0	0	0	0	1.5-2.0	20
Mouindmaassa	-	0	To, Dolo	1-15 Jn	1-10 Nov	0	0	0	0	2.0	35
Kobga la pisnou	-	0	To	15 M -5Jn	1-10 Nov	0	0	0	0	?	40
Pawom Messaaga	-	0	To	1-15 Jn	1-10 Nov	0	0	0	0	4.0	40
Zouanga	-	0	To	1-15 Jn	1-10 Nov	0	0	0	0	1.5	30-40
<u>Red sorghum</u>											
Kazinga	46	++	Dolo, To	25 M-10Jn	20-30 Oct	0	-	++	--	2.5-3.0	20
Zouguilsi	25	+++	Dolo, To	1-15 Jn	20-30 Oct	0	+	+	0	3.0	15-20
Karoulga	23	+	Fresh	1-15 Jn	1-10 Oct	0	0	+++	++	4.0	30-40
Zouwoko	4	0	Dolo, To Fresh	1-15 Jn	20-30 Oct	0	+	-	0	2.5	25-30
Wedzouré	2	0	Dolo, To	1-15 Jn	20-30 Oct	0	--	0	-	3.0	40-50
Nonome	-	0	Forage Tanning	1-15 Jn	20-30 Oct	0	++	0	+	2.0	25
Kassanrga	-	0	Fresh	15-30 Jn	10-20 Oct	0	0	0	+	2.5	15
Papessaana	-	0	Fresh, To	15-30 Jn	10-20 Oct	0	0	0	+	3.0	25

Contd.

Table 1. Contd.

Crop and variety	Percent of fields planted[a]	Relative yields	End use	Date of planting	Date of harvest	Tiller-ing ca-pacity	Yield po-tential on poor soils	Resistance to[b] Drought	Resistance to[b] Striga	Height in m.	Head length in cm.
Millet											
Kapelga	57	+	Fura, To	1-15 Jn	25 Oct - 10 Nov	+	+	+	0	2.0-2.5	20-30
Kamiougou	29	++	To, Fura	1-15 Jn	25 Oct - 10 Nov	++	+	+	0	2.0	30-40
Kassablaga	8	+	To, Fura	20-30 Jn	25 Oct - 10 Nov	++	0	0	+	1.5-2.0	30-40
Kagnanga	6	0	To, Fura	1-15 Jn	25 Oct - 10 Nov	++	+	+	0	2.0-2.5	30-40
Zouraaga	-	0	To, Fura	25M - 10 Jn	25 Oct - 10 Nov	0	0	-	-	2.5-3.0	50-80

a. Percent of fields planted to each variety by 44 households on fields of household head.

b. Efforts to identify susceptibility and resistance to insects and diseases were not successful due to lack of clarity in farmers' diagnosis of problems.

Of the three varieties sown on sample fields, Pissyopoué and Fibmiga represented 96% of all plantings. The characteristics that explained the popularity of these varieties were clear. Each was described as having better than average tillering capacity, the highest yield potential, and the most preferred tô.[3] Pissyopoué, which was sown on nearly two-thirds of all white sorghum fields, had the additional advantage of retaining its yield potential under conditions of late planting.

RED SORGHUM

Somewhat greater planting diversity was observed among red sorghum varieties, with six out of nine identified actually sown. The preferred end use of most varieties was in the preparation of sorghum beer (dolo). Tô was also mentioned as a non-preferred alternative use. In contrast to the dolo sorghums, four sweet red sorghum varieties (Karculga, Zouwoko, Kassangra, and Pabessana) are sown almost exclusively as border crops on maize fields and eaten fresh in the field. One variety which is not presently sown (Monome) is fed to animals as forage and an extract from its leaves is used in tanning. Although Monome grows well on poor soils and is the most drought-resistant variety, it was described as causing skin disorders when consumed by humans.[4]

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3. Tô is a thick paste made of milled sorghum or millet eaten with a sauce.

4. This is probably attributable to high leucine content.

With the exception of the short Monome, all red sorghum varieties were described as being between 2.0 and 4.0 m tall. Head sizes varied between 15 and 50 cm, with the most popular variety (Kazinga) characterized by a short, semicompact head. No varieties were said to tiller even under excellent conditions. Some distinctions in varietal soil preferences were identified. Between the two most common dolo sorghums, Kazinga required moderately rich, preferably bas-fond soils, while Zouguilsi was said to better withstand somewhat poorer soils.

Among the varieties observed planted this year by sample farmers, optimum planting dates were consistently reported to be late May to early June. Two varieties no longer common, but which were formerly planted as maize field border crops (Kassanrga and Pabessaana), were said to be optimally planted in the latter half of June with little relative yield loss when planted as late as mid-July. The freshly eaten red sorghums can generally be harvested as early as the beginning of October for cycles of between 90 and 120 days. In contrast, the more popular dolo sorghums require a period of 40 to 150 days. As shown in Table 1 clear varietal differences were identified with respect to resistance to drought and Striga.

The criteria explaining the popularity of Kazinga and Zouguilsi were greater yield potential and production stability. Both were said to outyield alternative dolo varieties and to have better than average drought resistance.

MILLET

Among five millet varieties identified, four were observed sown on sample fields. All varieties were described as outperforming the sorghums on shallower sandy/gravelly soils, and in some instances under conditions cf late planting. The preferred end use of all varieties are tô and fura.[5]

Plant stature for millet varieties is less variable than for the sorghums, with plant heights between 2 and 3 m and head sizes ranging between 30 and 50 cm. One exception is the variety Zouraogo, which was not observed this season on sample fields but which is said to be calable of producing heads in excess of 80 cm. Tillering capacity for all varieties, with the exception of Zouraogo, was said to be good, producing approximately five tillers under good conditions. No importance distinctions were made among varieties with respect to planting or harvest dates. Optimal planting dates for all varieties were said to be late May through the second week of June; yields were reported to be reduced but adequate with planting as late as 1 July. With harvest in late October to early November, the average life cycle was estimated to be approximately 150 to 160 days. Only modest variation in drought resistance was identified, with somewhat more pronounced variation in Striga tolerance.

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5. Fura is a thin gruel of millet flour mixed with either water or milk.

The popularity of the two most commonly planted varieties, Kamiougou and Kapelga, was attributed to yield potential and grain quality. The two varieties ranked first and second, respectively, with respect to yield potential and both had moderate resistance to drought and Striga. Kapelga, sown on more than half of all millet fields, was also described as producing the finest quality fura.

VARIETAL DIVERSIFICATION

If varieties possess distinct mixes of yield potential and resistance qualities (to insects, disease, drought Striga), and if farmers are even moderately risk averse, it might be expected that some diversification in varietal use would be observed within given farm units. Instead, an analysis of plantings showed that individual families generally planted only a single variety of white sorghum, red sorghum, and millet. Among the 44 sample households, only eight planted more than one variety of either sorghum or millet on fields of the household head. And in only four additional households did other members use different varieties on their personal grain fields.

These results suggest that varietal diversification may not be a management strategy used by sample farmers to reduce yield variability or to avoid major loss situations. Possible explanations are: (1) positive relationship between resistance qualities, yield potential, and taste characteristics (partially supported by the present evidence), (2) lack of sufficient variation in resistance qualities, and/or (3) satisfaction of a risk-avoidance goal through crop diversification.

Data on planting dates were also examined to determine the extent to which varietal diversification was incorporated into planting decisions over time (Tables 2-5). The data show that although first plantings extend over a period of approximately 18 days for white sorghum, nearly 40 days for red sorghum, and 30 days for millet, there were no important changes in variety as the season progressed.[6] Moreover, among 28 replantings (concentrated during the periods 20 to 29 June and 14 to 15 July) in no cases were varietal changes made on the affected fields. In only three instances did farmers change crops in late season replanting - from red sorghum to millet or white sorghum, and from white sorghum to millet. These patterns indicate that farmers in the study villages do not have access to preferred local varieties that perform better than full season materials in late-planting situations.

PLANTING STRATEGIES

In response to considerable micro soil differences and rainfall variability, farmers have developed planting strategies that adapt plantings to soil heterogeneity and permit a degree of flexibility in determining plantings sequentially as a function of the evolving rainfall pattern. Through farmer interviews, the general outlines of local planting strategies for the sorghums and millet were identified in order to place the current season's patterns into a more general perspective. The discussions were structured in such a manner as to determine the order

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6. The red sorghums Karoulga and Zouwoko, which are planted as border crops on maize fields, are a minor exception.

Table 2. Planting dates for E35-1 and for local sorghum varieties, 14 May - 15 June.[a]

	May 14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rainfall (mm)	<5				32										18							28				15			5		20		
White sorghum																																	
E35-1																								1							7	19	9
Pissyopoué															2	6	2	1	1			1	5	7	5	6	2	2	2	1	1	2	1
Fibmiga															1		1	1		1		1	3	2	1	3	2*	2	1	2	1	2	
Belko																								2								1	
Red sorghum																																	
Kazinga					1	1	1					1			1	9	1					1	2*	*	1*	2*	1*	1				*	
Zouguilsi					1										1	5	1			1		2	3									**	
Karoulga																				1											2	3	
Zouwoko																																	
Wedzouré																							1										

a. Figures represent the number of first plantings which occurred on each date. Each asterix represents a single replanting on the respective date.

Table 3. Planting dates for local millet varieties, 14 May - 15 June.[a]

May

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Rainfall (mm)	<5				32										18			
Kapelga		1	2										1		5	8	5	3
Kamiougou					1											4	7	
Kassablaga													1			1	1	2
Kagnanga															1	1		

June

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rainfall (mm)				28				15			5		20		
Kapelga		2	2	5	*3	*5	*3	*1	2	*	1		2	**1	*
Kamiougou	2	1		3	4		2	1		1	1		2	*	
Kassablaga		1			1		1								
Kagnanga				2			1	3							

a. Figures represent the number of first plantings which occurred on each date. Each asterix represents a single replanting on the respective date.

Table 4. Planting dates for E35-1 and for local sorghum varieties, 16 June - 21 July.[a]

June

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Rainfall (mm)	21			13					29							
White sorghum																
E35-1	3	6	1					*		*	****			**		
Pissyopoué							1				*					
Fibmiga								*						*		
Belko																
Red sorghum																
Kazinga	1							1						1		
Zouguilsi																
Karoulga	1	2						1				1	1			
Zouwoko						1	1									
Wedzouré																

July

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Rainfall (mm)													85				60				9
White sorghum																					
E35-1														*							
Pissyopoué														1 **							
Fibmiga														*	*						
Belko																					
Red sorghum																					
Kazinga																					
Zouguilsi														*							
Karoulga																					
Zouwoko															*						
Wedzouré																					

a. Figures represent the number of first plantings which occurred on each date. Each asterix represents a single replanting on the respective date.

Table 5. Planting dates for local millet varieties, 16 June - 21 July.[a]

June:

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Rainfall (mm)	21		13						29							
Kapelga																
Kamiougou																
Kassablaga																
Kagnanga																

July:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Rainfall (mm)													85				60				9
Kapelga															1						
Kamiougou																					
Kassablaga																					
Kagnanga																					

a. Figures represent the number of first plantings which occurred on each date. Each asterix represents a single replanting on the respective date.

of planting normally followed for each major crop by soil type under several distinct rainfall conditions.

Farmers tended to distinguish five general soil types in their crop allocation decisions: (1) bas-fond,[7] (2) sandy-loam soils located adjacent to the compound, (3) rich soils located adjacent to the compound, (4) sandy-loam soils located at some distance in the bush, (5) rich loamy soils located in the bush, and (6) shallow gravelly soils irrespective of location. While distribution is not uniform, it appears that a majority of farmers have at least one plot on each general soil type.

Three general rainfall patterns were also distinguished. The first was an average or early arrival of rains with good distribution throughout the period of planting (i.e. through early August). The second pattern was an early or average arrival of rains followed by a drought extending over several weeks, such that major replantings were necessary. The third pattern involved late arrival of first planting rains during early July.

PATTERN ONE: GOOD INITIATION AND CONTINUATION OF PLANTING RAINS

Farmers indicated that if the first rain of the season is sufficiently heavy, red sorghum can be planted immediately on bas-fond soils. Early planting is practiced to permit the red sorghum to establish itself

7. Low-lying fields with a high water table which are occassionally inundated.

before weed growth is substantial and before the soils become water-logged. Soil preparation is typically nil or minor, limited to clearing or light scarification. Plowing is almost never performed. First plantings on bas-fond soils often involve a mixture with cowpea and, in limited cases, white sorghum (especially the variety Fibmiga). Population densities for red sorghum on bas-fond fields are typically similar to those on upper slope sites.

Upon completion of the early bas-fond plantings, subsequent rains are followed by plantings of millet and/or white sorghum, often mixed with cowpea, on sandy-loam soils located near the compound. However, compound plots that have received the heaviest applications of organic manures are not planted at this time but are reserved for later planting of maize. The degree of soil preparation depends on available equipment and labor, with direct planting or clearing and light scarification most common. As with red sorghum, farmers claimed generally not to change the population density of either millet or white sorghum as a function of soil type, but rather to follow a uniform density on both moderately heavy and light soils. An exception to this rule is on extremely heavy clay soils and on very gravelly soils. Where farmers claim to plant more seeds per pocket to assure seedling emergence.

The third stage in the planting sequence involves bush fields located at some distance from the compound. Millet, often mixed with cowpea, is sown on sandy-loam soils. Red or white sorghum, again mixed with cowpea, is sown on those bush fields with higher loam or clay fractions. As with fields adjacent to the compound, light scarification is performed to the extent that equipment and labor permit.

The final planting of the cereal staples occurs on shallow, gravelly soils typically located on the upper portion of the toposequence. Millet and occassionally white sorghum--but rarely red sorghum--are planted on these soils at approximately the same time as weeding begins on the bas-fond fields planted earlier. The standard plant density is followed with no change in the occurrence of cowpea intercrops. Soil scarification may be somewhat less frequent on these upper slope fields.

PATTERN TWO: GOOD INITIATION OF RAINS FOLLOWED BY DROUGHT AND REPLANTING

If a drought of sufficient duration requires replanting of bas-fond fields, the first or second replanting is normally pure red sorghum with no change in pocket spacing or seeds per pocket. Replanting is normally preceded by a thorough weeding or plowing, the latter when the soils are sufficiently moist following recommencement of the rains. If a third or fourth replanting is required, the farmer must chose among several options. He may leave the field to concentrate his efforts elsewhere: he may occasionally plant white sorghum (a late--planted variety such as Pyssyopoué, if he has access to seed): or he may replant the identical variety of sorghum. Under no circumstances does the farmer consider switching to millet on his bas-fond fields.

First replantings of millet and white sorghum on sandy-loam soils near the compound generally involve no changes in crop, variety, or crop mixture (pure or with cowpea) compared with first plantings; population densities also remain at first-planting levels. As on bas-fond soils, a thorough weeding or, as labor permits, plowing usually precedes the first replanting. Second and subsequent replanting on sandy-loam soils adjacent to the compound, however, may involve either a change in crop or variety. Fields previously sown to red sorghum are likely to be replanted to either white sorghum or millet. If farmers have access to Pissyopoué, it may be planted in place of Fibmiga due to its relative advantage in late-planting situations.

Replanting of bush fields follow a similar pattern as those near the compound. First replantings involve essentially no changes. In subsequent replantings, however, red sorghum is eliminated with emphasis being given to millet. White sorghum may be retained on the better bush soils.

Shallow gravelly soils are replanted as necessary to the same variety of millet as originally planted and with no change in density or intercrop. Some farmers suggested that if major replanting occurred as late as mid or late August on shallow soils, they would consider planting recently acquired short cycle (70-day) cowpea, either in pure stands or as the dominant component in a millet intercrop.

PATTERN THREE: LATE (BEGINNING OF JULY) ARRIVAL OF RAINS

Farmers explained that a 6-week delay in the start of rains would force a major revision of planting patterns. Lacking relatively short-season materials that can flourish on wet soils, bas-fond fields would normally be left unplanted. Effort instead would shift to the sandy-loam and loamy-clay soils, with emphasis placed first on those near the compound, and then on those in the bush. Planting would consist almost exclusively of millet intercropped with cowpea. Millet would also be sown to fields set aside for maize, groundnut, and bambara nut, but shallow gravelly soils normally sown to millet might be left idle. No change in method of soil preparation or population density would occur.

In summary, planting patterns remain relatively stable except under extreme situations of late planting or replanting. The lack of consumer-acceptable millet or sorghum varieties with clearly superior drought resistance, compared with preferred locals, or with relatively high-yield potential in late-planting situations, results in few important varietal shifts. Some reallocation of fields to specific crops, generally away from red sorghum and toward millet tends to occur. Population densities remain remarkably fixed, with short-season cowpea likely emerging as a more important intercrop on sandy soils along with millet in extreme late plantings.

SOIL PREPARATION

Methods of soil preparation are largely determined by available equipment, power, and soil and crop characteristics. Among the 44 farm units participating in the study, 24 are equipped with animal traction equipment capable of either light scarification or shallow plowing.[8] Two farmers possess oxen-drawn plows, and 22 possess the lighter donkey-drawn houe manga. For reasons discussed in Matlon (1980) the rate of equipped farmers in the sample is believed to be substantially higher than the population rate in the study village.[9]

Farmers without animal traction equipment are generally limited to two types of tools for soil preparation; the handhoe (daba), which is used for weeding and can also be used for shallow hand-plowing, and the hand scarifier. The latter consists of a large wooden T-frame with metal spikes driven at approximately 60 to 80 cm intervals through the crosspiece. The tool is drawn across the soil, often by two persons, to break the surface crust immediately before planting.

Due to limited traction power, the depth of soil tillage with animal-drawn equipment is relatively shallow. Depending on soil type and moisture, plowing depth with the houe manga varies between 5 and 10 cm. Scarification rarely exceeds 3 to 5 cm in depth. The benefits of shallow scarification are believed to be more rapid planting and

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8. Since the first village studies report was prepared, one additional farmer purchased a donkey-drawn houe manga.

9. See Matlon, ibid.

improved infiltration of early rains, as well as facilitating line planting, which permits subsequent weeding by animal traction. The extent to which these effects are realized will be examined when the full data set is available at the end of the season.

Thorough soil preparation, either by means of handhoes or animal-drawn equipment, is considered to be an important element in the management package recommended for E35-1. The data indicate that this is a major departure from existing cultural practices. Tables 6 and 7 shows that under local practices, plowing is rarely performed on either sorghum or millet fields.[10] In the entire sample, two of 26 nontrial white sorghum fields and only one of 64 millet fields were plowed. Scarification was considerably more common. Among farmers using animal traction, more than half of all local sorghum and millet fields were scarified. In contrast, essentially all farmers lacking animal traction equipment planted their cereals directly without any tillage.

It seems clear that rather then substituting for soil-preparation labor, the use of animal traction equipment at observed levels is complementary to labor, generating additional employment in operations not normally performed by nonequipped farmers. The possibility of reduced labor requirements in planting (due to breaking of surface crust) and weeding will be examined as the labor data become available. The

10. In this and all subsequent tables, millet and sorghum fields shown include both pure stands and associations with cowpea and/or sorrel. Preliminary evidence indicate no significant differences in method of soil preparation, date of planting, or population density between pure and intercropped stands.

Table 6. Percent of fields prepared by method of soil preparation for handtool farmers.

Crop	Method of soil preparation									No. of obs.
	Not prepared	Hand scarified only	A.T. scarified only	Hand plowed only	Hand plowed and hand scarified	Hand plowed and A.T. scarified	A.T. plowed only	A.T. plowed and hand scarified	A.T. Plowed and A.T. scarified	
E35-1 sorghum				15	75			5	5	20
White sorghum, local/improved management		5		25	65				5	20
White sorghum, local	100									13
Red sorghum, local	94	6								17
Millet, local	100									32
Maize				100						25
Groundnut	6			94						16

Table 7. Percent of fields prepared by method of soil preparation for animal traction farmers.

Crop	Method of soil preparation									No. of obs.
	Not prepared	Hand scarified only	A.T, scarified only	Hand plowed only	Hand plowed and hand scarified	A.T. plowed and A.T. scarified	A.T. plowed only	A.T. plowed and hand scarified	A.T. plowed and A.T. scarified	
E35-1 sorghum				4	4	4		27	62	26
White sorghum, local/improved management					13		17	17	54	24
White sorghum, local	23	8	54	8					8	13
Red sorghum, local	44		56							16
Millet, local	35		58						5	43
Maize							83	8	8	12
Groundnut							36		64	14

latter may be particularly important as a factor contributing to area expansion if weeding labor constitutes a major production bottleneck.

The low incidence of plowing cereal fields is probably related to conflict with planting activities being conducted simultaneously. This is particularly true for plowing with the houe manga for which preliminary data from the trial plots indicate labor requirements in excess of 40 man-hours/ha. This estimate is derived from plots of 500 m^2 and thus does not include the rest and donkey-recovery time expected on large-plots. Nevertheless, even this figure implies approximately 10 days to plow 3 ha of sorghum or millet with two laborers and one set of donkey-drawn equipment. Given the need for humid soils to facilitate plowing and the periodic occurrence of rains, this could delay planting on some fields as much as 2 to 3 weeks.

It is important to note that farmers recognize the benefits of plowing groundnut and maize. Essentially all fields planted to these crops were plowed by both animal-traction and handtool farmers. However, these crops occupied much smaller areas than sorghum and millet and were planted after the major plantings of sorghum and millet. As such, soil preparation for maize and groundnut probably does not pose as serious a labor conflict as does the plowing of the staple grains.

DATE OF PLANTING

A least four factors influence the timing of planting for sorghum and millet in local systems: (1) arrival and distribution of early rains; (2) variety of crop (optimum cycle length, tolerance to early drought stress, rate of potential yield loss due to delayed planting, degree of photosensitivity); (3) soil type (depth and water holding capacity; and (4) adequacy of soil preparation.

Moreover, two dimensions of planting timeliness can be distinguished. The first is how soon in the season a farmer is able to plant. This is known to be an important determinant of yield in full-season photosensitive materials. The second, is how soon after a rain a farmer is able to plant. The latter aspect may be critical in determining germination rate and seedling establishment.

It was seen earlier that farmers in the study villages do not make important distinctions among local varieties of sorghum and millet from the point of view of optimum planting dates. Also farmers attempt to follow a planting sequence in allocating crops to soils of different types. In this section we examine planting patterns as they actually occurred during the current season. He examine the use of local varieties in planting and replanting decisions, the timing of planting with respect to both dimensions identified above, and the correlation between average of soil preparation and time of first planting.

The data show that although the first plantings occurred for red sorghum and millet immediately after the first heavy rains, the majority of plantings were initiated nearly 2 weeks later (Tables 2-5). It might be expected that animal-traction farmers would have taken advantage of the moist soils during the slack planting period of 18 to 28 May to prepare their fields for rapid planting following subsequent rains. However, it was found that less than 20% of all soil preparation occurred during that 10-day period. The more common practice was to plow or scarify each field immediately before planting. Thus, approximately 75% of all fields plowed and 90% of all fields scarified were prepared within 2 days of first planting. Possible consequences of delayed soil preparation are reduced preplanting water infiltration and an increased labor conflict between adequate preparation and timely planting.

Farmers explained the delay in soil preparation to be a function of soil type. On soils with a dominant loan or clay fraction, such as constitute a minor portion of the observed sorghum fields in the study villages, the soils retain their structure and remain open to increased water infiltration, even after several rains. In contrast, plowed sandy soils tend to collapse and cap with subsequent rains, thereby losing much of the advantage of early plowing. This suggests that if farmers are given access to improved later-planted materials, some of the advantage of reducing the preparation/planting labor conflict through later planting may not be realized on a substantial proportion of grain fields.

EFFECT OF SOIL PREPARATION ON DATE OF FIRST PLANTING

The effect of soil preparation activities on date of planting is examined more directly in Table 8 and 9. In Table 8 fields for each crop have been grouped by method of soil preparation. Earliness of planting can be compared across preparation techniques through two measures:

Table 8. Planting dates of sorghum and millet by method of soil preparation.

Crop	Method of soil preparation	Average date of Planting[b]	Percent of fields sown Early[c]	Percent of fields sown Late[d]	Number of observations[e]
E35-1 sorghum	Plowed by hand	June 14.9 (1.55)	-	100	21
	Plowed with A.T.	June 14.1 (2.01)	-	100	25
	Total	June 14.4 (1.83)	-	100	46
White sorghum, local/ Improved management	Plowed by hand	June 7.8 (2.11)	-	100	22
	Plowed with A.T.	June 9.8 (3.79)	-	100	21
	Total	June 8.6 (3.16)	-	100	43
White sorghum, local[a]	Not prepared	June 3.5 (6.54)	45	55	20
	Scarified with A.T.	June 3.5 (4.97)	50	50	6
	Plowed with A.T.	June 4.5 (5.82)	33	67	6
	Total	June 3.6 (6.21)	44	56	32
Red sorghum, local	Not prepared	May 31.3* (6.54)	57	43	23
	Scarified with A.T.	May 29.2 (4.17)	83	17	12
	Plowed with A.T.	June 10.3* (13.3)	33	67	3
	Total	May 31.6 (7.01)	63	37	38
Millet, local	Not prepared	June 1.4* (5.[illegible]4)	55	45	60
	Scarified with A.T.	June 2.8 (5.33)	45	55	31
	Plowed with A.T.	June 7.7* (5.51)	-	100	3
	Total	June 2.0 (5.70)	50	50	94

a. Excludes all E35-1 fields and local variety/improved management check fields. Also excluded are three white sorghum fields scarified by hand.

b. Average calculated as simple mean of first planting dates. In parenthesis is standard deviation.

c. Before June 4.

d. June 4 and later.

e. Observations are the number of first plantings in each field category.

* Significantly different at 5% level, using two-tailed student's t test.

Table 9. Planting dates of sorghum and millet for handtool and animal traction farmers.

Crop	Farmer group	Average date of planting[a]	Percent of fields sown: Early[b]	Percent of fields sown: Late[c]	Number of observations[d]
E35-1 sorghum	Handtool	June 14 (1.30)	-	100	20
	A.T.	June 14.3 (2.21)	-	100	26
	Total	June 14.5 (1.83)	-	100	46
White sorghum, local/improved management	Handtool	June 7.9 (2.07)	-	100	20
	A.T.	June 9.7 (3.92)	-	100	24
	Total	June 8.6 (3.10)	-	100	44
White sorghum, local	Handtool	June 2.1 (5.27)	53	47	16
	A.T.	June 3.8 (6.85)	33	67	18
	Total	June 3.9 (6.21)	44	56	34
Red sorghum, local	Handtool	June 2.1 (5.73)	50	50	18
	A.T.	May 30.3 (7.82)	73	27	22
	Total	May 31.6 (7.01)	63	37	38
Millet, local	Handtool	May 31.8 (5.54)	64	36	42
	A.T.	June 3.0 (5.69)	38	62	52
	Total	June 2.0 (5.70)	50	50	94

a. Average calculated as simple mean of first planting dates. In parenthesis is standard deviation. No differences are significant at the 5 percent level.

b. Before June 4.

c. June 4 and later.

d. Observations are the number of first planting on all fields of each respective crop.

the average date of first planting and the proportion of first plantings that took place before 4 June, that is, following the first three major planting rains. The second measure reduces the effect of extremely late plantings that occurred on plots for which the decision to plant was taken late, due either to newly obtained land or excess seed and labor (a result of minimal replanting during the current season).

Although the number of planting observations on traditionally plowed fields is limited, the results show that average planting occurred significantly later on plowed than on nonplowed fields for both red sorghum and millet. In contrast, scarification by animal traction had no delaying effect compared to fields planted directly. The last result is due to the fact that scarification is normally performed with planting and may indeed accelerate the planting component of the joint activity.

The control fields of local white sorghum cultivated with improved management were sown, on average, 5 days later than traditionally cultivated white sorghum fields, with no plantings before 4 June. This may be attributed to the additional labor requirements involved in the soil preparation and fertilizer activities. Moreover, the delayed plantings occurred in spite of recommendations to farmers to plant the local check plot at the same time as other local white sorghums.

In Table 9 similar comparisons are made, with the exception that fields have been grouped by handtool and animal-traction farmers, irrespective of the method of soil preparation on each field. The hypothesis examined is whether the additional logistics involved in scarifying and plowing a portion of their fields significantly delayed aggregate planting for equipped farmers. While the general direction of differences are consistent with those in Table 8, none of the differences are significant. This indicates that while soil preparation tends to delay planting on given fields, the delays are not substantial on a full system basis, possibly due to earlier planting on nonprepared fields by equipped households.

It was suggested earlier that the speed with which plantings follow a rainfall may importantly affect rates of germination and seedling establishment. This second dimension of planting timeliness is examined in Tables 10 and 11. Table 10 shows that the majority of first plantings of all crops occurred the day of or immediately following a rain, with less than 12% being sown 4 or more days after a rainfall. The data reveal no consistent or significant differences by method of soil preparation.

Similar comparisons are made in Table 11 with fields grouped by animal-traction or handtool households, irrespective of method of soil preparation. Plantings on fields of animal-traction households were found to be significantly less timely for both white sorghum and red sorghum.[11]

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11. At 2% and 10%, respectively, using a Chi^2 test with 2 degrees of freedom.

Table 10. Timing of planting in relation to most recent rainfall by method of soil preparation.

Crop	Method of soil preparation	Percent of first plantings by no. of days after rainfall				Number of observations[a]
		0,1	2	3	>4	
E35-1 sorghum	Plowed by hand	81	10	9	-	21
	Plowed with A.T.	64	32	4	-	25
	Total	72	22	7	-	46
White sorghum, local/ improved management	Plowed by hand	48	29	24	-	22
	Plowed with A.T.	71	29	-	-	21
	Total	58	29	14	-	44[b]
White sorghum, local	Not prepared	60	15	20	5	20
	Scarified with A.T.	50	33	17	-	6
	Plowed with A.T.	67	17	17	-	6
	Total	54	20	14	11	34[c]
Red sorghum, local	Not prepared	78	13	4	4	23
	Scarified with A.T.	75	8	-	17	12
	Plowed with A.T.	-	50	50	-	2
	Total	74	13	5	8	38[d]
Millet, local	Not prepared	57	22	12	10	60
	Scarified with A.T.	61	23	13	3	31
	Plowed with A.T.	6	-	-	33	3
	Total	59	21	12	8	94

a. Because each occurrence of a first planting of a portion of a field constitutes an observation, a given field may have more than one observation. Replantings due to poor germination or seeding loss are excluded.

b. One additional field was scarified by animal traction.

c. Two additional fields were prepared hy hand.

d. One additional field was scarified by hand.

Table 11. Timing of first plantings in relation to most recent rainfall for handtool and animal traction farmers.

Crop	Farmer group	Percent of fields sown by number of days after rainfall				Number of observations[a]
		0, 1	2	3	≥4	
E35-1 sorghum	Handtool	70	20	10	-	20
	A.T.	73	23	4	-	26
	Total	72	22	7	-	46
White sorghum, local/improved management	Handtool	40	30	30	-	20
	A.T.	74	26	-	-	24
	Total	58	29	14	-	44
White sorghum, local	Handtool	71	17	12	-	16
	A.T.	39	22	17	22	18
	Total	54	20	14	11	34
Red sorghum, local	Handtool	81	19	-	-	16
	A.T.	68	9	9	14	22
	Total	74	13	5	8	38
Millet, local	Handtool	52	26	14	7	42
	A.T.	64	17	10	9	52
	Total	59	21	12	8	94

a. Because each occurrence of a first planting of a portion of a field constitutes an observation, a given field may have more than one observation. Replantings due to poor germination or seedling loss are excluded.

In summary, the results indicate that fields prepared by animal traction before planting tend to be planted later than those planted directly. Furthermore, due to additional competing operations, animal-traction farmers tend to be less able to respond with rapid planting following each rainfall. Against these possible timing disadvantages, of course, must be weighed the other agronomic benefits associated with plowing. These include greater water infiltration, more thorough incorporation of organic matter, and improved soil structure.

GERMINATION OF E35-1 AND LOCAL CHECKS

During the first week of July (approximately 4 to 5 weeks after the major planting of local sorghums and millet, and 2 to 3 weeks after E35-1) observations were taken at each trial site for germination, current stand, soil type, slope, situation on the toposequence and insect damage. When direct observation of germination was impossible (due to replanting and transplanting, or post-germination loss) farmers were asked to estimate germination rates. Observations were made on all E35-1 and local sorghum/improved management plots, as well as on immediately adjacent local sorghum or millet fields cultivated under local management practices.[12] Germination rates were estimated as the percent of pockets with at least one plant germinated. Since farmers were generally observed to plant between eight and ten seeds per hill, these germination rates overestimate the respective grain rates, often by a considerable margin.

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12. Thirty such local variety/traditional management fields were identified.

Factors potentially affecting germination include seed quality, soil type and preparation, soil moisture, incidence of pest or disease damage (in storage or once planted), and varietal traits. Tables 12 through 14 show the correlation of germination performance with several of these factors.

VARIETY, SOIL TYPE, AND LOCATION ON TOPOSEQUENCE

The frequency distribution of fields falling into three germination categories are presented by soil type and location on the toposequence in Tables 12 and 13. In aggregate, the proportion of fields with germination rates less than 80% was greatest for E35-1, followed by the local variety/traditional management check, and local variety/improved management check.[13] No significant differences were found relating germination to either soil type or to location on toposequence. In part this may be due to the small number of observations and limited soil variability for the test sites.

TIME OF PLANTING

Two dimensions of time of planting - earliness in the season, and period after and preceeding rainfall - were also examined to determine their correlation with germination. Due in part to insufficient variation in

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13. A comparison of E35-1 with the latter revealed the difference to be significant at the 15% level using a Chi-square test with 2 degrees of freedom.

Table 12. Germination of E35-1 and two local checks by soil type.

Crop and soil type	Frequency distribution of fields by germination rate[a]		
	<60 %	60-80 %	>80 %
E35-1/sorghum improved management			
Sandy	-	1	1
Sandy-loam/loamy-sand	2	4	22
Clayey-sand	1	1	11
Gravelly-sand	-	-	2
Gravelly-loam	-	-	-
Clayey-loam	-	1	-
Percent:	7	15	78
White sorghum, local/ improved management			
Sandy	-	-	1
Sandy-loam/loamy-sand	1	2	25
Clayey-sand	-	-	13
Gravelly-sand	-	-	2
Gravelly-loam	-	-	-
Clayey-loam	-	-	-
Percent:	2	5	93
Local variety/ local management[b]			
Sandy	-	-	2
Sandy-loam/loamy-sand	2	1	15
Clayey-sand	2	-	6
Gravelly-sand	-	1	-
Gravelly-loam	-	-	3
Clayey-loam	-	-	-
Percent:	13	6	81

a. Percent germination represents proportion of hills with the emergence of at least one seedling.

b. Local variety of sorghum or millet cultivated with local management practices and located adjacent to trial plots.

Table 13. Germination of E35-1 and two local checks by location on toposequence.

Crop and location on toposequence	Frequency distribution of fields by germination rate[a]		
	< 60 %	60-80 %	> 80 %
E35-1/sorghum Improved management			
Plateau	-	-	3
Upper slope	2	5	22
Intermediate	1	1	6
Lower slope	-	-	5
Bas-fond	-	1	-
Percent:	7	15	78
White sorghum, local/ Improved management			
Plateau	-	-	2
Upper slope	1	1	26
Intermediate	-	1	7
Lower slope	-	-	6
Bas-fond	-	-	-
Percent:	2	5	93
Local variety/ traditional management[b]			
Plateau	-	-	2
Upper slope	1	2	18
Intermediate	2	-	4
Lower slope	1	-	2
Bas-fond	-	-	-
Percent:	13	6	81

a. Percent germination represents proportion of hills with the emergence of at least one seedling.

b. Local variety of sorghum or millet cultivated with local management practices and located adjacent to trial plots.

the data, no relationship was found between germination and days after the most recent rain (a proxy for soil moisture) for any of the treatments. Similarly no relationship was observed between germination and days preceding a rainfall.[14]

Because planting dates for both E35-1 and the local variety/improved management fields showed little variation within each treatment, it was not possible to determine the effect of earliness of planting on germination independently for those plots. Greater variation for the local variety/tradition management fields permitted that comparison and it was found that germination was somewhat lower on earlier planted fields. Among 14 fields planted before 30 May, five (38%) had less than 80% germination. This compared with poor germination on only one of 15 fields (7%) planted on 30 May or later. A consistent relationship was also found between replanting and transplanting activities (which reflect poor germination and/or seedling loss) and earliness of planting. Those results are presented in a subsequent section.

METHOD OF SOIL PREPARATION

Although method of soil preparation was not found to be significantly related to germination rates for local varieties, the relatively poor germination for E35-1 was found to be closely correlated with plowing

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14. The latter was examined to test the hypothesis that a heavy rainfall immediately following planting could result in soil capping, thereby restricting seedling emergence.

technique. Table 14 shows that when plowed only by hand, eight of 21 (38%) of E35-1 fields experienced less than 80% germination. This compares with only one of 25 E35-1 fields (4%) that experienced germination problems when plowed by animal traction, a difference significant at 1%.[15] These results indicate that animal traction may be a necessary component of the E35-1 package, at least from the point of view of early stand establishment.

Under handplowing only, the germination rates of local varieties were significantly greater than E35-1 at the 1% level. Unfortunately, no plots were established in the current program to test the performance of E35-1 and local varieties under scarification or direct seeding. This comparison would appear to be critical since, as seen in Tables 6-7 earlier, under current practice more than 90% of sorghum fields were not plowed before planting.

INSECT DAMAGE

Observations were also made on trial and check fields during the second week in July to determine the incidence of dead hearts caused by shoot fly or stem borer and to assess crop damage resulting from a localized attack of army worm.

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15. Using a Chi^2 test with 2 degrees of freedom.

Table 14. Germination of E35-1 and two local checks by method of soil preparation.

Method of soil preparation	Crop	Percent distribution of fields by germination rate[a] <60 %	60-80 %	> 80 %	No. of obs.
Not prepared	E35-1 sorghum	N.A.	N.A.	N.A.	-
	White sorghum, local/improved management	N.A.	N.A.	N.A.	-
	Local variety/ traditional management[b]	19	10	71	21
Hand plowed	E35-1 sorghum	14	24	62	21
	White sorghum, local/improved management	-	-	100	22
	Local variety/ traditional management[b]	N.A.	N.A.	N.A.	-
A.T. plowed	E35-1 sorghum	-	4	96	25
	White sorghum, local/improved management	5	9	86	22
	Local variety/ traditional management[b]	-	-	100	1
Total	E35-1 sorghum	7	15	78	46
	White sorghum, local/improved management	2	5	93	44
	Local variety traditional management[c]	13	7	80	30

a. Percent germination represents proportion of pockets with at least one seedling.

b. Local variety of sorghum or millet cultivated with local management practices and located adjacent to trial plots.

c. Includes eight fields only A.T. scarified.

N.A. = Not applicable

In no site and for no treatment was dead heart found to be a problem. Data on the incidence of army worm damage are summarized in Table 15. Three categories reflecting the severity of damage were distinguished. Category 1 includes fields for which no or very minor destruction of leaves was found. Fields on which moderate damage was observed, but from which it was judged that plants would recover with no significant effect on yields, were grouped under category 2. In category 3 were included all heavily damaged fields on which yields would be reduced in the absence of considerable replanting or transplanting.

The highest incidence of attack and greatest damage were observed on E35-1 plots, followed by the local variety/improved management treatment.[16] It can not be concluded, however, that these necessarily point toward greater varietal susceptibility of E35-1. An alternative explanation is that later planted crops less advanced in their growth cycle were more succulent at the time of attack and presented a more attractive host than the earlier planted, more fibrous locals. The somewhat higher incidence of attack on the local variety/improved management fields as compared with the attacks on local variety, traditional management fields tends to support this interpretation

The severity of army worm damage also appeared to be related to the date and thoroughness of first weeding. Fields that were well-weeded early in the season (before or in early stages of the drought)

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16. The difference between E35-1 and the local/traditional check was found to be significant at the 15% level using a Chi^2 test with 2 degrees of freedom.

Table 15. Percent of fields suffering army worm damage.[a]

Crop	Severity of attack		
	1 Minor	2 Moderate	3 Heavy
E35-1 sorghum	80	11	9
White sorghum, local/ improved management	91	5	5
Local/traditional management[b]	97	0	3

a. Observations taken 12 July.

b. Local variety of sorghum or millet cultivated with local management practices and located adjacent to trial plots.

generally escaped attack, whereas fields weeded inadequately or late in the drought suffered the greatest damage. It is likely that fields heavily infested with weeds provided a more conductive environment for an increase in the worm population during the drought. With the late removal of weeds on which the worms had been feeding, the worms concentrated their attack on the remaining sorghum and millet plants. Because the trial plots were generally planted and thus weeded later, the timing of weeding probably contributed to the greater damage observed on those plots.

REPLANTING AND TRANSPLANTING

With the exception of an 18-day drought between 25 June and 13 July, the rains were well-distributed during the early half of the season. As a result, only a small proportion of fields were replanted due to poor germination or subsequent seedling loss. Moreover, no field was replanted more than once. This is in contrast to previous years when as many four or more replantings of the same field were reported.

Shown below is the percentage of fields by crop on which replanting was done. No attempt was made to estimate the relative areas, or percent of hills involved in these replantings.

PERCENT OF FIELDS REPLANTED AT LEAST ONCE

E35-1 Sorghum	20
White Sorghum, Local/ Improved Management	5
White Sorghum, Local	23
Red Sorghum, Local	27
Millet, Local	16

Transplanting is the second means by which farmers replaced empty hills caused by poor germination or seedling loss. Transplanting is generally performed jointly with thinning several weeks after planting. Table 16 summarizes the incidence of transplanting by crop grouped by handtool and animal traction farmers.[17] The particularly high transplanting on E35-1 fields of handtool farmers reflects the lower germination rates seen earlier for those plots plowed by hand.

When fields are ordered by date of first planting in Table 17 it is clear that a disproportionate number of early planted fields were replanted or had portions transplanted. Both the E35-1 and local sorghum/improved management fields had unusually high rates of replanting when compared with other late plantings. This is believed to reflect in part the atypical care farmers are giving to the test plots.

Reasons for the consistently higher replacement rates on fields planted earlier are not clear. The amounts and distribution of rainfall between 28 May and 24 June were excellent, thus lack of rainfall may not be the dominant factor. Indeed, it would be expected that the earlier planted crops would have developed deeper root systems, thereby enabling them to better withstand the drought that occurred between 24 June and 13 July. Although no systematic effort was made to solicit farmers' reasons, numerous farmers complained early in the season of bird and fowl damage to freshly planted fields. This would be expected

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17. As with replanting, no effort was made to obtain data on the percentage of hills affected during transplanting.

Table 16. Percent of fields in which thinning and transplanting occurred by handtool and animal traction farmers.

Crop	Handtool farmers			Animal traction farmers			Total		
	Thinning	Transpl.	No. of obs.	Thinning	Transpl.	No. of obs.	Thinning	Transpl.	No. of obs.
E35-1 sorghum	95	40	20	89	23	26	91	30	46
White sorghum, local/ improved management	70	15	20	96	17	24	84	16	44
White sorghum, local	77	15	13	69	31	13	73	23	26
Red sorghum, local	88	6	17	69	6	16	79	6	33
Millet, local	91	6	32	67	5	43	77	5	75

Table 17. Percent of fields partially replanted or transplanted by crop and date of first planting

Date of first planting	E35-1 sorghum		White sorghum, local/improved management		White sorghum, local		Red sorghum, local		Millet, local	
	%	Number of obs.	%	Number of obs.	%	Number of obs.	%%	Number of obs.	%	Number of obs.
15-18 May	-	-	-	-	-	-	50	2	52	7
25-29 May	-	-	-	-	63	8	33	12	32	25
30 May - 3 June	-	-	-	-	60	5	33	3	20	20
4-8 June	-	-	29	28	38	8	38	8	11	19
9 June +	41	46	25	16	0	5	0	8	0	4
Total	41	46	27	44	42	26	27	33	24	75

to be most severe when only a small portion of the area is sown.

THINNING

Data summarizing the incidence of thinning are also presented in Table 16. In contrast to the absence of thinning reported in several areas of Upper Volta, farmers in the study villages performed some thinning on more than three quarters of their sorghum and millet fields. Farmers indicated that although the practice was not new to them (several reported having learned the technique from their fathers) it was increasing in popularity as a result of extension efforts.

But while the practice itself is common the quality of the activity and the uniformity of field coverage appears to be highly irregular. In part this is because thinning is rarely carried out as a sole activity but rather constitutes a joint activity with first weeding. Because of the large number of persons typically involved in first weeding, including an important number of children, the number of plants left remaining per hill normally varies considerably around the ideal often stated by farmers of one to three plants for millet, and four to five for sorghum.

Table 16 shows that nearly all E35-1 fields were thinned, as per recommendations. However, this reflects in part the effect of additional advice given to farmers in late July. Field visits at that time revealed that in many cases farmers were leaving a traditional stand of up to five plants per pocket. Because station experimental results had previously demonstrated severely depressed yields for E35-1 at that density, farmers were advised once again to thin to one or two plants per pocket. This departure from "farmers' management" must be considered in interpreting yields at the end of the season, since it is clear that in the absence of additional advice, yields on perhaps 30 to 40% of the E35-1 plots would have been substantially reduced.

The somewhat lower incidence of thinning among farmers using animal traction, is due primarily to the greater additional time required to thin when the first weeding is performed with an animal-drawn weeder. This suggests that thinning would become less common and/or pose a greater labor conflict with the intensified use of animal traction equipment.

SUMMARY AND CONCLUSIONS

This report has presented a description of soil preparation, planting, replanting, and thinning operations performed by sample farmers during the 1980 season. It also examined local varieties of sorghum and millet available in the study area, and how farmers utilize crop, varietal, and soil differences in formulating their planting strategies under varying states of nature. Although these results are preliminary and must await availability of the full data set for more detailed analysis, the following observations and tentative conclusions can be made at this time.

1. Farmers distinguish among, and have access to, a range of local sorghum and millet varieties including ten varieties of white sorghum, eight red sorghum varieties, and five millet varieties. Due

to a generally positive correlation of desirable characteristics across varieties, however only half of the available materials were sown, and very little varietal diversification was observed among the fields of individual households. The latter result suggests that planting a mix of varieties does not constitute a risk-minimization management strategy in the study area. Moreover, with the possible exception of one white sorghum variety, farmers do not have access to consumer preferred materials that yield well in late planting situations. Thus during the current season, farmers did not change varieties as the planting period progressed either for first planting or for replantings.

2. Farmers acknowledge a well defined planting sequence in which they allocate sorghum and millet to different soil types as the early rains become established. The sequence can be briefly summarized as follows:

- red sorghum on bas-fond soils;
- millet and red sorghum on intermediate and upper slope sandy-loam soils, first near the compound and then in the bush;
- white sorghum on better sandy loam soils, again first near the compound followed by fields at greater distance;
- millet on shallow sandy or gravelly soils.

The sequence is generally adhered to even if the onset of rains is moderately delayed. However, with extremely late arrival (early to mid-July) patterns are substantially modified. Plantings are reduced on bas-fond and shallow soils and replaced by millet and short-cycle cowpea on deeper sandy-loam soils.

If replantings are required, early arrival first planting patterns are initially retained with no changes in variety, intercrops, or population densities. Later replantings (after mid-July) involve a reduction in sorghum and an increase in millet, again with unchanged population densities.

3. Under traditional practices, soil preparation for sorghum and millet fields is minimal. Farmers not equipped with animal-traction equipment generally sowed all sorghum and millet fields directly. Among animal-traction households nearly 60% of both sorghum and millet fields were scarified, but less than 5 percent were plowed.

The major constraint to plowing appears to be power and labor time. Preliminary estimates indicate a labor requirement of approximately 40 man-hours/ha to plow with the donkey-drawn houe-manga. Given the intermittent rains necessary to soften the soil, this operation can delay the planting of some millet and sorghum fields by as much as 3 weeks, with a consequent trade-off in yield potential for full-season materials.

Moreover, when plowing or scarification was performed, 90% occurred only 1 or 2 days before planting. That is, even farmers who prepared the soil did not take advantage of early rains to perform these tasks. Farmers explained that once plowed with the light donkey-drawn houe-manga, the dominant sandy-loam soils in the study area tend to collapse and cap with subsequent rains, quickly losing much of the benefit of early plowing.

The substantial labor requirement for plowing, combined with the need to wait for a planting rain, was found to significantly delay planting of local sorghum and millets. On the other hand, scarification, which is normally performed jointly with planting, did not have a delaying effect. Finally, because of the additional logistics involved in soil preparation with traction equipment, animal-traction farmers were significantly less able to follow periodic rains with rapid planting.

The problems observed for plowing with donkey-drawn equipment may have important implications for E35-1. In the absence of animal-traction plowing--but with hand soil preparation--E35-1 was observed to experience significant problems of seedling establishment. This suggests that despite the limited adoption of animal-drawn equipment in most areas of Upper Volta, animal traction may be a necessary element of an E35-1 "package". Moreover, even among animal-traction households, the considerabale labor requirement for plowing and need to delay the operation until immediately before planting could importantly limit the area sown to E35-1, given its relatively short (2 week) recommended planting period.

4. An analysis of germination and seedling establishment showed a strong direct correlation between earliness of planting local varieties and the need to replant and/or transplant. Although no local white sorghum fields planted after 9 June required replanting or transplanting, 40% which were planted before 9 June were at least partially replanted or required transplanting to fill empty hills.

These results reflect the risk involved in early planting of local full-season photosensitive varieties under farmers' conditions. For this reason, later planted short-duration materials should importantly reduce the risk of poor establishment related to early planting. Nevertheless among 46 E35-1 fields, all but one of which were sown after 12 June - less than 80% germination was observed on 22% of the fields; on 41% replanting and/or transplanting was required. Unless apparent establishment problems of the new later planted variety are corrected, it is not clear that its use would substantially reduce the replanting requirements associated with earlier planted locals.

5. Thinning of sorghum and millet is a technique traditionally practiced by sample farmers in the study area. During the current year thinning was reported on approximately 75% of the local sorghum and millet fields being monitored. Farmers generally recognize the advantages of thinning to reduce hill stands to objective of two to three plants per hill for millet and four to five for sorghum. (Eight to ten seeds are typically sown per hill.)

Normally conducted as a joint activity with first weeding, however, the uniformity of traditional thinning is generally poor and a considerable number of exceptions to the ideal plant stands were observed. Reluctance on the part of many farmers to thin E35-1 as recommended to one to two plants per hill was also observed. Because previous results have shown that yields for E35-1 fall significantly at high population densities this underlines the need to give greater emphasis to the thinning component in any future efforts to extend E35-1.

It is also likely that more uniform thinning at lower plant stands will require additional labor at a time which conflicts with timely and thorough first weeding. In addition, the incremental labor time required for thinning is greater among farmers weeding with animal-traction equipment than among handtool farmers. This is because when weeding with traction equipment, thinning can no longer be performed as a joint activity but requires an additional pass through the field. Thus it was observed that the incidence of thinning was consistently lower for animal traction farmers. These results suggest that thinning labor may pose an additional constraint to the area sown to E35-1 among animal-traction units and/or could be an important source of reduced yields when improperly performed. More conclusive results on this point will follow the analysis of labor and yield data that will be available latter in the season.