MANURE USE IN TWO VILLAGES OF CENTRAL UPPER VOLTA

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INTRODUCTION

In order to estimate rainfed crop production budgets under farmers' conditions in central Upper Volta, the ICRISAT West Africa Economics Program undertook a farm-management study in 1980 at Nakamtenga and Nabitenga, two villages 35 kilometers (km) northeast of Ouagadougou (see Matlon 1980a and Matlon 1980b for a description of the general objectives of the study). In the course of the study, it was observed that farmers used various types of animal manures--pig, sheep, goat, cattle, donkey, chicken--in their fields. As a management practice with potentially important effects on productivity, manure use seemed to warrant a more detailed analysis.

In this paper we undertake a description of manure use in the two sample villages. This study has three objectives:

1. To estimate the quantities of manure used by type of manure.

2. To describe the existence of a manure market in the survey villages, if indeed such a market exists. If such a market does not exist, then we need to describe how those farmers without animals are able to acquire manures and what social relations determine manure exchanges.

3. To show the allocation of manure among fields, crops, and different field emplacements. Within this objective we also describe the different methods used to place manure.

SURVEY METHODS

The Sample

The sample used in the survey contained 44 peasant households divided nearly equally between the two villages. The participating households contained about 52 percent of the total population (862) in the two villages, and were chosen from among the members of the village cooperative association (the groupement villageois). The sample farmers are probably among the more progressive in the village; whereas 31 percent of all households in the study villages employ animal traction equipment (AT), among the 44 sample members, 23 use such equipment--- the Houe Manga (a light toolbar) or the plow for cultivation, and a cart for transport. Among those sample households using AT, 21 use the

Houe Manga with donkeys, and 2 use a heavier plow with oxen.

Data Collection

The 44 heads of household (HH) participated in an input-output survey of all those fields of sorghum, millet, maize, groundnuts, and Bambara nuts which were under their direct control. To collect such input-output data, two enumerators resident in the villages visited the HH weekly between May and December of 1980. Data were collected on field labor (hours worked daily by men, women, children and hired laborers), inputs used, and total output from each field. All data were recorded on precoded forms. All fields in the sample (roughly 300) were measured with a compass and tape. Harvests were estimated by farmers' recall of the quantities of each crop in numbers of local units taken off each field during the harvest periods. Subsequently, a sample of local units was weighed to convert them into metric units.

As with harvest data (and for other types of physical inputs) farmers were asked about the quantities of manure by type applied to each field in local units. Using the average weight of each local unit (e.g., kilograms per basket) farmers' reports of the numbers of different units were converted into estimates of kilograms of manure.

It is evident that these measures probably under-estimated total applications, especially for those fields closest to the households which ordinarily receive household wastes throughout the year. We attempted to measure household wastes thrown on household fields only for the period of two or three months before and during the current rainy season by the recall method. Nevertheless, underestimates from this source are likely. In addition, we were not able to measure the amounts of manure directly contributed by night paddocking in the sample.

AVAILABILITY OF MANURE

Origins and Types of Manure

The majority of manure comes from paddocks, animal enclosures, and chicken coops as well as around the household concession. The greatest share of manure comes from animal wastes, but substantial amounts of household waste are also available from sweepings. Farmers indicated that quantities available generally varied from one season to the next.

For example, after a good rainy season, there is generally more manure available than after a drought year, simply because the animals are better nourished. Moreover, when forage is available, the animals leave more of their droppings in the paddocks where recovery is greater.

Available Manure

The quantities of manure shown in Table 1 include manure applied to the household fields of all sample farmers as well as manure used by sample farmers on test plots managed by farmers under ICRISAT staff supervision.[1] This table does not show quantities of manure used on fields not under control of the HH. We have estimated that the cereal fields of the HH occupy about 84% of the total cropped area in the sample.[2]

In the 23 households using AT the mean amount of manure used is 1 442 kilograms (kg) while hand-tool households applied 631 kg on average, a difference of roughly 56%. Mixed manures and cattle manures are the most common types among AT farmers; on the whole those two types of manure contributed about 85% of the total quantity used. Cattle manure is particularly important among AT farmers as it represents nearly 30% of the total weight of manure used by that group.

The availability of cattle manure among hand-tool households is negligible. Manure spread in fields cultivated by such households is 53% mixed manures and 39% manures of small ruminants. The remainder is donkey manure, which contributes about 8% of the quantity used by hand-tool households.

Total Use per Hectare

Farmers spread a mean quantity of 347 kg of all manure per hectare. We estimate that the mean area cropped by AT households was 3.9 hectares (ha) and that cropped by hand-tool households was 3.0 ha (Appendix I). From that base, and taking into account the manure used on the test parcels (0.10 ha per farmer) we find that the mean manure use is 419 kg/ha for households using AT and 242 kg/ha for households not using AT technology.[3] Farmers report that these quantities are insufficient to manure all their fields, an opinion which our findings tended to confirm. Given the insufficiency of quantities available to hand-tool households, how then are they able to procure more manure ?

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[1] These test plots were cropped in an improved white sorghum (E 35-1), and a local white sorghum with improved management practices. Under supervision of ICRISAT staff from the Economics, Agronomy, and Sorghum Breeding Programs. Results are reported in Matlon 1981.

[2] SAFGRAD researchers in a Mossi Plateau village found that the cereal fields of household heads were 84% of the total area cropped by sample households. See Swanson 1981 for the evidence.

[3] Assuming that household head cereal fields, excluding the trial plots, comprise 84% of the total cultivated area and that there are equal rates of manure application on the fields of the household head and those of other household members.

Table 1. Quantity of manure use by type and household (kg/household)

Type of Household		Type of Manure				Total	Number of Households
		Cattle	Small Ruminants	Donkey	Mixed*		
Animal Traction	kg	509	157	77	699	1442	23
	%	35%	11%	5%	48%	100%	
Hand	kg	-	246	50	335	631	21
	%	-	39%	8%	53%	100%	
TOTAL	kg	266	200	64	525	1055	44
	%	25%	19%	6%	49%	100%	

* Mixed manure or farmyard manure includes all household residues, goat, poultry, and cattle dungs.

MANURE EXCHANGES

To examine manure exchanges, we divided the 44 households into three groups by the total quantity of manure used per household. We constructed a subsample of 12 HH: 4 farmers having used large amounts of manure, 4 having used none, and 4 having used an average quantity. Each of these 12 farmers was interviewed individually about his manure exchanges and, more generally, about manure exchanges in the villages.

Our interviews showed that manure exchanges are quite rare. While several farmers claimed to have never heard of such exchanges, others reported that they do occur, but very infrequently. For example, in the case of close relatives, a herd of goats or sheep may belong to the entire extended family. If the animals do not pass the night in the same enclosure within the extended family compound, those households having collected greater quantities of manure from the common herd may give some to those households having collected smaller amounts.

The majority of farmers who do own cattle, apart from draft oxen, prefer to entrust them to Peulh[1] rather than to keep them on their own farms. Among the 44 sample households, less than 10 HH entrusted; numbers entrusted rarely exceeded 30 heads. Farmers who have confided their animals can collect manure from the herders' paddocks or can ask the herders to paddock the animals in their fields for a few days. In general, these farmers give nothing in exchange for the manure collected in the paddocks of the Peulh. But, in the case of night paddocking in the fields of these farmers, the farmers provide food to the herder during his stay on the field.

Farmers reported never having seen manure bartered in the region. However, they reported that it is possible to barter manure against manure but not against any other good. One can, for example, exchange a basket of chicken manure against the same quantity of goat manure, but this practice is still uncommon. Gifts of manure are as rare as barters and are done only in small quantities. Thus, a farmer may give a few baskets of manure to someone who wishes to manure a small parcel of vegetables. At harvest time, the giver of the manure might receive in return a small fraction of the harvest. Generally, the farmer will accept the gift only if the crop (e.g., lettuce) is rare in the region, but will refuse it otherwise.

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[1]Entrustment of cattle to herders of the Peulh ethnic group (sometimes known as Fulani) is common throughout West Africa. The herders are, in a sense, specialized livestock managers. For their services they usually receive milk from the cattle, grain (sometimes), and they (though apparently not in our survey villages) have exclusive right to the cattle manure.

ALLOCATION OF MANURE BY CROP

Our surveys have shown that the various types of manure are not equally allocated to all crops. Tables 2 and 3 give the mean quantities of manure used per hectare by crop according to technique (AT or hand).[1]

The results in Table 2 show that maize received the greatest quantity of manure per hectare among farmers using AT technology, and that millet and groundnuts received the smallest amount. Results also show that red sorghum received nearly twice as much manure per hectare as did white sorghum. It is important to note that the test parcels of improved white sorghum (E 35-1) and of local white sorghum/improved management were manured at a level far superior to those of the traditional crops, having received 47% of the total quantity of manure used by AT farmers.

Table 3 presents the same data for farmers cultivating with hand tools. Apart from maize, for which the quantity of manure used per ha is superior to that used on AT farms, all crops in hand-tool farms received less manure compared to AT levels. As in the case of farmers using AT technology, red sorghum was more heavily manured than white sorghum among hand-tool farmers but the difference between red and white sorghum was greater among the hand-tool farmers. The test parcels of E 35-1 and of local white sorghum/improved management received approximately the same quantities of manure. In sum, they received 33% of the total quantity of manure applied by hand-tool farmers.

Tables 2 and 3 show that for both cultivation techniques the quantity of manure applied to maize fields is substantially higher than that on all other crops. Ninety percent of the maize fields are situated close to the houses for the sample households and thus receive the majority of all the household wastes. Moreover, in view of the proximity of the houses, maize fields also receive substantial amounts of manure from small ruminants kept in the family compounds. The quantity of manure used among other crops does not vary a great deal from one crop to the next, red sorghum excepted.

Table 4 presents a test of the mean differences for manure use by crop between hand and AT farms. The t-test reveals that the mean difference between technologies is statistically different from zero only

[1] See Appendix 1 for average areas cultivated by crop.

Table 2 . Manure applied by crop for animal traction owners[a]

Crops	Animal Traction Owners									
	Cattle		Small Ruminants		Donkey		Mixed		TOTAL	
	Kg/ha	% of manured fields	Kg/ha	% of manured fields	Kg/ha	% of manured fields	Kg/ha	% of manured fields	Kg/ha	% of manured fields
White Sorghum N = 13	141	15	0	0	24	8	174	23	339	38
Red Sorghum N = 17	167	6	353	6	129	12	0	0	649	24
Millet N = 41	85	5	0	0	0	0	17	5	102	10
Maize N = 17	213	6	480	18	0	0	2947	29	3640	53
Groundnut N = 24	0	0	136	4	0	0	0	0	136	4
White Sorghum Improved (E 35-1) N = 25	1289	24	0	0	202	8	3169	28	4659	60
White Local Sorghum Improved Management N = 23	1659	22	0	0	293	9	3278	30	5229	61
TOTAL	148		46		22		203		419	

[a]The means are for all fields, i.e., both those having received manures and those not having received them.

Table 3 . Manure applied by crop for hand cultivators

Crops	Hand Cultivators									
	Cattle		Small Ruminants		Donkey		Mixed		TOTAL	
	Kg/ha	% of manured fields	Kg/ha	% of manured fields	Kg/ha	% of manured fields	Kg/ha	% of manured fields	Kg/ha	% of manured fields
White Sorghum N = 13	0	0	0	0	0	0	88	8	88	8
Red Sorghum N = 17	0	0	29	6	0	0	388	41	417	47
Millet N = 32	0	0	34	6	0	0	16	9	51	16
Maize N = 14	0	0	2211	43	901	14	663	14	3775	71
Groundnut N = 18	0	0	42	6	0	0	0	0	42	6
White Sorghum Improved (E35-1) N = 20	0	0	605	30	78	5	1074	25	1756	59
White Local Sorghum Improved Management N = 20	0	0	622	25	87	5	1282	30	1991	60
TOTAL	0		95		19		129		242	

Table 4 : Statistical t-test of the difference in manure use between AT and hand-tool farmers[a]

Crops	Value of t-statistic	Degrees of freedom
White Sorghum	1.423 [b]	22
Red Sorghum	0.472	29
Millet	0.690	40
Maize	-0.067	26
Groundnuts	0.594	39

[a] In view of the experimental nature of the test plots of E 35-1 and the local white sorghum/improved management, t-tests were not done on the mean differences in manure use between hand-tool and AT farmers for those plots.

[b] Significantly different from zero at the 10 percent level.

in the case of white sorghum (and for that crop only at the 5 percent level). Nevertheless, it is important to note that for all crops except maize the mean amount of manure used per hectare for AT farmers is substantially superior to that in hand-tool households. For example millet on AT farms received nearly twice as much manure as millet in hand-tool farming. The importance of zero observations in both techniques--farmers who used no manure at all--tends to obscure somewhat the statistical differences between the mean quantities by technique.

Plant Nutrients Contributed by Manure

The total quantities of plant nutrients--nitrogen, phosphorus, and potassium--added to the soil by manure are presented in Tables 5 and 6. These nutrient quantities were calculated by applying approximate nutrient coefficients to the weight of each type of manure used per hectare. The coefficients used were:

	N	P_2O_5	K_2O
Cattle	0.020	0.015	0.010
Small Ruminants	0.018	0.015	0.020
Donkeys, Horses	0.015	0.015	0.035
Mixed	0.018	0.015	0.030
Household wastes	0.018	0.015	0.030

These coefficients were taken from the standard French agronomic handbook for tropical countries[1] and are not based on field measurements at the survey site. In applying them to the quantities of manure used by type and by crop, we obtain the weight per hectare of nutrients added to the soil by each group of farmers. The method is clearly only an approximation and does not take into account losses caused by evaporation, leaching, or runoff.

Studies of the Mossi Plateau area[2] have shown soils of the region to be especially deficient in phosphorus and in nitrogen. The potassium content, though not negligible, may become a limiting factor when the nitrogen and phosphorus levels are increased with chemical fertilizer applications. From Tables 5 and 6 it appears that the amount of potassium returned to the soils through manure was generally higher than that for either nitrogen of phophorus.

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[1] France, Ministère de la Coopération, Memento de l'Agronome, 3rd ed., Paris, 1980.

[2] ORSTOM, Ressources en Sols : Notice Explicative, Carte à 1/500.000, Paris, 1976.

Table 5 : Nutrients added to soil by animal manure by crop for traction cultivators (kg/ha)

Crops	Elements		
	N	P_2O_5	K_2O
White Sorghum	6	5	7
Red Sorghum	12	10	17
Millet	2	2	1
Maize	66	55	105
Groundnut	2	2	4
White Sorghum Improved (E 35-1)	86	70	115
White Local Sorghum Improved Management	97	78	125
TOTAL[a]	8	6	10

[a] Weighted averages, where the weights are the shares of each crop in total area.

Table 6 : Nutrients added to soil by animal manure by crop for hand cultivators (kg/ha)

Crops	Elements		
	N	P_2O_5	K_2O
White Sorghum	2	1	3
Red Sorghum	8	7	13
Millet	1	1	2
Maize	65	56	118
Groundnut	1	1	1
White Sorghum Improved (E 35-1)	31	26	53
White Local Sorghum Improved Management	36	30	60
TOTAL[a]	4	4	7

[a] Weighted averages, where the weights are the shares of each crop in total area.

Manure Quantities According to Field Emplacement

Fields were classed in three categories according to the distances separating them from family compounds. The classification distinguishes household fields (champs de case), village fields, which are not too far from the compounds, and bush fields, which are the most distant and are often the most recently cleared. The distribution of manure use varies systematically by field emplacement, the quantity of manure diminishing as one goes from household fields to bush fields. For example, all household fields received manure, reflecting primarily ease of transport.

The proximity of maize fields to the compounds explains the particularly high use of manure in that crop, as shown above in Tables 2 and 3. Groundnut fields tend to receive manure only when they are close to the compounds. Millet and red sorghum fields tend to be manured across all locations.

The allocation of manure by field emplacement depends largely on the farmers' means of transport. Farmers possessing AT equipment frequently use carts to transport manure to village or to bush fields. This relative ease of transport explains the fact that a larger proportion of village fields of AT farmers received manures, while such fields of hand-tool farmers have to be manured by hand, or, at best, with sacs loaded onto bicycles. For both types of farms fields distant from compounds receive manure only rarely.

MEANS OF SPREADING MANURE

Given the insufficiency of manures, farmers in the study region practice several systems of manure spreading in order to facilitate absorption of nutrients by the plants. The most common method is simply to throw the manure in bulk throughout the field; mixing of manure is then done after the first rains at the time of soil preparation or seeding. This most common method also appears to be the oldest means in the villages, but there are at least three others.

The first is to heap up the manure in small piles or mounds in order to enrich those spots which will receive seed at planting time. When farmers have AT equipment the incorporation of earth and manure is done during line-tracing or plowing. The second method is to put the manure in several large piles; in this case, the manure is spread with several large baskets throughout the entire field.

Table 7 . Manure applied by field emplacement (kg/ha)

Crops	Hand				Animal Traction			
	House	Village	Bush	N	House	Village	Bush	N
White Sorghum	160 (6)[a]	0 (4)	0 (3)	13	542 (8)	265 (3)	0 (2)	13
Red Sorghum	652 (9)	272 (5)	433 (3)	17	1326 (9)	550 (4)	0 (4)	17
Millet	40 (7)	51 (4)	77 (21)	32	13 (13)	197 (13)	92 (15)	41
Maize	3756 (14)	0 (0)	0 (0)	14	3063 (15)	2101 (2)	0 (0)	17
Groundnuts	190 (4)	0 (12)	0 (2)	18	633 (0)	0 (10)	0 (6)	24
TOTAL	559	67	113		448	219	79	

[a]Number of field according to emplacement in parentheses.

Spreading of this type often follows a certain order. Donkey and cattle manure are generally spread before seeding whereas manure from small ruminants is often spread after planting along the lines traced to guide planting. Farmers asserted that animal manures thus spread along planting lines can be as effective as chemical fertilizer on all crops.

The third strategy is to divide the field into two, three, or four parts. Each year, the farmer will use one of the methods described above for spreading manures in the field part-by-part. For example, if the farmer has manured part 1 of the field in year 1, the entire quantity of manure used in the field will be put in part 2 in year 2. Year by year parts of the field are progressively manured in a rotating cycle. This method has the reported advantage of conserving residual effects of manures more intensively in sections of the field, an advantage which farmers said was augmented if animal traction is used to turn the manure under. If animal traction has not been so used, the residual effects are said to disappear more rapidly.

LABOR USE IN MANURING

Table 8 presents labor times for collecting, transporting, and spreading manure by crop. Labor time per hectare is relatively high for maize, but unimportant for millet and groundnuts. Labor devoted to manuring activities as a share of total labor use is less than 5 percent for all crops with the exception of maize for which it is 11 percent. One can say that labor does not appear to be a constraint to increased manure use especially if one considers that labor in manuring often takes place during the dry season or during intermittent slack periods of the cropping season.

Men contribute a greater share of labor in manuring activities than do women and children. Apart from collecting and transporting manure, which are often done by children, spreading is done by the men employing one of the methods described above. Women and children sometimes participate in this operation, but at lower levels. Labor in manuring activities is spread more equally among men, women, and children in the hand-tool group than in the AT group with the concentration of men's labor in manuring activities more marked among AT households.

Table 8. Labor time used in manure transport and application by crop (hours/hectare)

Crops	Hand				Animal Traction			
	Men	Women	Children	N	Men	Women	Children	N
White Sorghum	9	2	1	13	25	6	0	13
Red Sorghum	17	13	4	17	11	0	0	17
Millet	3	3	1	32	3	a		41
Maize	57	36	23	14	44	15	14	17
Groundnuts	1	0	0	18	2	0	0	24

[a] --- Less than an hour.

In considering labor times, it appears that manure use requires less effort among AT farmers than among hand-tool farmers, in spite of the fact that AT farmers use more manure. The difference is explained by the fact that AT farmers have means of animal-powered transport not available to hand-tool farmers which allow the transport of greater quantities over longer distances. Heads of household not having carts must transport manure in baskets or in sacks, on foot or on bicycle, from the enclosures to fields, means of transport which require considerably more time than cart transport.

APPENDIX I

Average areas sown to major crops by heads of household

Crops	Animal Traction	Hand
White Sorghum	0.285	0.163
Red Sorghum	0.290	0.320
Millet	2.470	1.340
Maize	0.056	0.045
Groundnuts	0.201	0.114
White Sorghum Improved (E 35-1)	0.082	0.060
White Local Sorghum Improved Management	0.056	0.053
	3.440	2.605

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