



FORESTRY PLANNING & DEVELOPMENT PROJECT
Government of Pakistan-USAID

REPORT #6

PROSPECTS FOR WOOD-DUNG FUEL REPLACEMENT
THROUGH FARM FORESTRY DEVELOPMENT:
THE PUNJAB, NWFP, BALUCHISTAN.

Michael R. Dove

Office of the Inspector General of Forests
&
Winrock International Technical Assistance Team

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SUMMARY

I. USES OF DUNG

1. 82% of households burn dung for fuel.
2. In most cases dung is burned in combination with wood, in order to conserve wood and improve combustion.
3. 88% of households use dung as fertilizer, the principal advantages of which are its beneficial impact on crops and soils, and its long-lasting effect.
4. 93% of households use chemical fertilizers, the principal advantages of which are the beneficial impact on crop yields and maturation, and the principal disadvantages of which are cost and water requirements.
5. The average household uses 60% of its dung supply for fuel and 40% for fertilizer.

II. ADEQUACY OF DUNG SUPPLY

1. Most households have adequate supplies of dung to meet their needs for fuel and, to a lesser extent, fertilizer.
2. The principal stated reason for inadequate supplies of dung is small numbers of livestock.
3. The use of dung for fuel diminishes the supply of dung for fertilizer, and the use of dung for fertilizer diminishes the supply fuel.

III. PURCHASE AND SALE OF DUNG

Very few farm households sell dung, but a minority purchase it, chiefly for use as fertilizer.

IV. FACTORS AFFECTING DUNG USE

1. Size of Landholding
 - i. The balance between the demand for and the supply of dung tends to be less favorable on small farms than on big ones.
 - ii. As a result, small farms tend to use less dung for fuel-using agricultural by-products instead - and more for fertilizer than do large farms.
 - iii. Small farms also purchase more dung than large farms.
2. Ownership Status
 - i. Because of its long-lasting impact on the soil, dung tends to be used as fertilizer only by farmers with long-term interest in the land.
 - ii. As a result, landowners: (a) use more dung for fuel and less for fertilizer than tenants, (b) are more likely to feel that their supplies of dung for fertilizer are insuf-

ficient, and (c) are more likely to buy additional dung for fertilize.

3. Source of Water for Agriculture

- i. Farmers with irrigated lands use the most dung for fuel; farmers with mixed irrigated/rainfed lands use the most dung for fertilizer; and farmers with completely rainfed lands fall in between.
- ii. Farmers with irrigated lands have the most adequate supplies of dung and purchase the least dung; farmers with mixed lands have the least adequate supplies and purchase the most; and farmers with rainfed lands fall in between.

V. RECOMMENDATIONS

1. A program to replace dung fuel with wood fuel and increase the use of dung as fertilizer is likely to be successful and should be undertaken.
2. The outreach component of this program should focus on the fact that decreasing the proportion of dung used as fuel increases the proportion that can be used as fertilizer, thereby reducing short-term outlays for purchased fertilizers, and contributing to long-term land improvement.
3. This program should focus on owner-operators with fewer than 12.5 acres of mixed rainfed/irrigated lands (or, as a second preference, completely rainfed lands).
4. The program should avoid tenant farmers, farmers with large holdings, and farmers of completely irrigated lands.

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I. USES OF DUNG

1. Use of Dung As Fuel

Among the farm households in the study sample, 82% burn dung as fuel. Among these households, 92% burn dung together with wood. The major reasons cited for mixing dung and wood are to conserve wood and improve combustion (the main problem with wood is dampness and difficulty of burning, and the main problem with dung is its tendency to smoke if burned alone):

Reason for Mixing Dung and Wood	No. of Households Citing
Conserve Wood.....	..33% of all households
Improve Combustion.....	..48% of all households
Overall.....	.....58% these households
Of the dung.....	.....25% "
Of the wood.....	.....17% "

The farmers mix wood and dung in their fires because of the shortage of wood, not the shortage of dung. If they mixed because of a shortage of dung, mixing would increase as the household supply of dung decreases, but it does not:

Number of Households That:	Adequacy of Household's Dung Supply:		
	Inadequate	Partially Adequate	Adequate
Don't Mix	9% HH	8% HH	7% HH
Do Mix	91% HH	92% HH	93% HH

Note: this association is not statistically significant. For $n = 512$ households (HH), $X^2 = .42$, $P < .75$.

2. Use of Dung as Fertilizer

Among the study households, 88% use dung as fertilizer (in the broadest sense-of the term, meaning to improve soil moisture and structure as well as fertility). The advantages and disadvantages of dung for this purpose are reported to be as follows:

Advantages of Dung as Fertilizer	No. of Households Citing
Improves Crop Growth/Yield...	...68% of all households
Improves Soil Fertility.....	...45% "
Long-Lasting Effect.....	...26% "
Good for Rice Nursery.....	...10% "
Reduces Pests.....	... 6% "

Disadvantages of Dung Fertilizer	No. of Households Citing
None.....	...90% of all households
Requires Water.....	... 4% "

3. Use of Chemical Fertilizers

Among the study households, 93% use chemical fertilizers on their land. Farmers report the advantages and disadvantages of using chemical fertilizers to be as follows:

Advantages of Chemical Fertilizer	No. of Households Citing
Improves Crop Growth/Yield...	...80% of all households
Quick-Acting/Speeds Growth...	...24% "
Improves Soil.....	...7% "

Disadvantages Chemical Fertilizer	No. of Households Citing
None.....	...43% of all households
High Cost.....	...23% "
Requires Water.....	...21% "
Increases Pests.....	...10% "
Degrades/Addicts Soil.....	...10% "
Short-Lasting.....	...5% "
Produces Unhealthy Food.....	...5% "

4. Percentage of Dung Used for Fuel Versus Fertilizer

The farmers in the study sample report using an average of 60% of their dung supply for fuel, and 40% for fertilizer, with the following distribution:

Percentage of Dung Supply Used for Fuel	Percentage of Dung Supply Used for Fertilizer	Number of Households Reporting
0-25.....	.....100-75	20% of all households
25-50.....	.....75-50	13% "
50-75.....	.....50-25	24% "
75-100.....	.....25-0	43% "
		100%

II. ADEQUACY OF DUNG SUPPLY

1. Incidence and Causes

The dung supplies of most households suffice to meet needs for fuel and, to a lesser extent, fertilizer as well:

Dung Supply Meets All Needs for	No. of Households Reporting
Neither Fuel nor Fertilizer	....21% of all households
Fuel Alone.....	....24% "
Fuel and Fertilizer.....	....55% "
Fuel - total.....	.....79% all households
Fertilizer - total....	.....55% "

Among households whose dung supplies do not suffice to meet needs, the reason most commonly cited for the insufficiency is too few animals:

Reason for Shortage of Dung	No. of Households Reporting
Few Livestock (Small dung supply).....	90% all households
Heavy Use for Fuel.....	15% "
Much Land (High demand for fertilizer)	10% "

2. Fuel-Fertilizer Competition

The supply of dung is limited, and its use for one purpose results in a scarcity for other purposes. Thus, the greater the percentage of dung that is used for fuel, the greater the likelihood that the supply for fertilizer will be inadequate, and the reverse is also true:

Supply of Dung Reported to be Adequate for Fertilizer Needs:		Proportion of Dung Used for Fuel	
		0 - 50 %	50 - 100 %
NO		32% HH	48% HH
YES		68% HH	52% HH

Note: this inverse association is statistically significant. For $n = 277$ households (HH), $X^2 = -6.3$, $P < .025$.

Supply of Dung Reported to be Adequate for Fuel Needs:		Proportion Dung Used as Fertilizer	
		0 - 50 %	50 - 100 %
NO		11% HH	22% HH
YES		89% HH	78% HH

Note: this inverse association is statistically significant. For n = 277 households (HH), $\chi^2 = -6.5$, $P < .025$.

III. PURCHASE AND SALE OF DUNG

Very few households in the study sample sell dung, but a minority buy it, usually for use as fertilizer:

		No. of Households
Sell Dung:	NO.....	97% all households
	YES.....	3% "
Purchase Dung:	NO.....	81% all households
	YES.....	19% "
Purpose:	Fuel.....	.....16% these hh
	Fertilizer....	.....84% "

The fact that most of the dung that is purchased is used for fertilizer and not fuel reflects the market and subsistence-oriented character of fertilizer and fuel use, respectively. This is also reflected in a positive association between using dung for fertilizer and buying it, and a negative association between using dung for fuel and buying it:

Number of Households that:	Household Uses Dung for Fertilizer	
	NO	YES
Don't Purchase Dung	97% HH	79% HH
Do Purchase Dung	3% HH	21% HH

Note: this association is statistically significant. For n = 602 households (HH), $\chi^2 = 14.7$, $P < .001$.

Number of Households that:	Household Uses Dung for Fuel	
	NO	YES
Don't Purchase Dung	62% HH	85% HH
Do Purchase Dung	38% HH	15% HH

Note: this inverse association is statistically significant. For n = 602 households (HH), $X^2 = -30.1$, $P < .001$.

IV. FACTORS AFFECTING USE OF DUNG

1. Size of Landholdings

The role of dung in the farm economy and ecology varies according to the size of the farm (see table on following page). Small holdings only support small numbers of livestock, hence the supply of dung is small. The demand for dung for fertilizer will be equally small, because it varies with the size of the farm. The demand for dung for fuel will not be as small, however, because it varies not with the size of the farm but with the size of the farm family, which tends to be the same whether the household farms 1 acre or 100 acres. As a result, the overall demand for dung is more likely to exceed the supply on small farms than on large ones. The small farms deal with this problem by using less dung for fuel (using in its stead the lower class fuels of crop straw, chaff, and the remains of animal feed) and more dung for fertilizer (the alternate to dung - chemical fertilizers from the market - is too costly for them). Despite these measures, the small farms are still more likely than others to have to purchase dung to meet their needs.

In project efforts to replace dung fuel with fuelwood, thereby freeing more dung for use as fertilizer, these small farms (less than 12.5 acres) should be the first priority.

Number of Households That:	Household Landholdings (Acres)					X ² Analysis
	0-2.5	2.5-5	5-12.5	12.5-25	≥25	
Burn Dung	47%	70%	85%	-	-	n = 486 X ² = 36.5
Don't Burn	53%	30%	15%	-	-	P < .001
Use Dung as Fert.	91%	97%	92%	91%	89%	n = 491 X ² = 4.3
Don't Use	9%	3%	8%	9%	11%	P < .50
Use Chemical Fert.	-	87%	93%	-	-	n = 489 X ² = 4.5
Don't Use	-	11%	7%	-	-	P < .05
Dung for Fert. >50%	59%	41%	30%	37%	34%	n = 235 X ² = 5.2
Dung for Fuel >50%	41%	59%	70%	63%	66%	P < .25
Supply Adequate for Fuel	YES	-	76%	-	80%	n = 484 X ² = 0.9
	NO	-	24%	-	20%	P < .50
Supply Adequate for Fert.	YES	-	43%	-	65%	n = 484 X ² = 22.2
	NO	-	57%	-	35%	P < .001
Purchase Dung	-	30%	21%	-	-	n = 486 X ² = 3.9
Don't Purchase	-	70%	79%	-	-	P < .05

2. Ownership Status

The role of dung in the farm household economy and ecology also varies according to ownership status (see table on following page) and the presence or lack of long-term interest in the land. Farmers say that an application of dung improves the land for 2-4 years (referring to the impact of the dung on not just soil fertility but soil structure as well). This characteristic is seen as an advantage by the land owner, but as a disadvantage by the tenant or sharecropper. As one tenant told us, 'Dung improves the soil for 3 years, but my contract with the landlord is only for 1 year'. If a tenant goes to the trouble of fertilizing the land with dung, there is no guarantee that he - and not some other tenant, or the landlord himself - will be allowed to crop the land and reap the benefits during the 2nd and 3rd years. As a result, tenants and to a lesser extent tenants cum owners tend to use more of their dung for fuel and less for fertilizer. They are less likely to feel that they have insufficient dung for fertilizer, and they are less likely to purchase dung for this purpose: (they are more likely to purchase chemical

fertilizers, whose short use-life better suits their equally short tenancies).

Accordingly, tenants are unlikely to respond favorably to outreach efforts based on the benefits of replacing dung fuel with wood and thereby freeing more dung for use as fertilizer. These efforts should target only landowners.

Number of Households That:	Landless Tenant	Tenant/Owner	Working Owner	Landlord	χ^2 Analysis
Burn Dung	90%	83%	80%	74%	n = 603 $\chi^2 = -8.5$ P < .05
Don't Burn	10%	17%	20%	26%	
Use Dung as Fert.	71%	85%	-- 94% -- --		n = 600 $\chi^2 = 41.8$ P < .001
Don't Use	29%	15%	-- 6% -- --		
Use Chemical Fert.	92%	94%	95%	87%	n = 600 $\chi^2 = 5.8$ P < .25
Don't Use	8%	6%	5%	13%	
Dung for Fert. >50%	20%	-- -- -- 36% -- -- --		n = 277 $\chi^2 = -4.4$ P < .05	
Dung for Fuel >50%	80%	-- -- -- 64% -- -- --			
Supply Adequate for Fuel	YES	82%	82%	79%	n = 598 $\chi^2 = 6.0$ P < .25
	NO	18%	18%	21%	
Supply Adequate for Fert.	YES	63%	67%	47%	n = 598 $\chi^2 = 18.5$ P < .001
	NO	37%	37%	53%	
Purchase Dung	3%	15%	-- 25% -- --		n = 602 $\chi^2 = 30.4$ P < .001
Don't Purchase	97%	85%	-- 75% -- --		

3. Source of Water for Agriculture

Finally, the economic and ecological role of dung on the farm varies according to whether the farm is irrigated or not (see table on following page). Farmers with irrigated lands use the most dung for fuel and the least for fertilizer; farmers with mixed rainfed/irrigated lands use the most for fertilizer and the least for fuel; and farmers with completely rainfed lands fall in between. The farmers with irrigated lands have the most adequate supplies of dung and do the least buying; the farmers with mixed lands have the least adequate supplies and buy the most; and farmers with rainfed lands

again fall in between. (As noted earlier in this paper, the use of dung for fuel is not associated with purchases of dung, while the use of dung for fertilizer is.) The distinction in dung use between irrigated, mixed, and rainfed farms is based on the fact that the irrigated farms require the fewest nutrient inputs (and they certainly benefit the least from the moisture content of the dung), at the same time as they have the fewest sources of non-dung fuels. The mixed farms, in contrast, have the best supplies of fuelwood and hence the least need to burn dung, freeing it for use as fertilizer. The rainfed farms have the poorest supplies of fuelwood and hence the greatest need to burn dung, and since they are cropped less intensively than the mixed farms they need less dung for fertilizer in any case.

Farmers with mixed rainfed/irrigated lands, and to a lesser extent those with completely irrigated lands, are therefore more likely than farmers with completely irrigated lands to be receptive to a program to reduce the proportion of dung used for fuel and increase the proportion used for fertilizer.

Number of Households That:		Source of Water for Agriculture			X ² Analysis
		Mixed	Rainfed	Irrigated	
Burn Dung		59%	80%	93%	n = 603 X ² = -57.5 P < .001
Don't Burn		41%	20%	7%	
Use Dung as Fert.		98%	92%	79%	n = 600 X ² = 32.3 P < .001
Don't Use		2%	8%	21%	
Use Chemical Fert.		94%	92%	94%	n = 600 X ² = 1.8 P < .50
Don't Use		6%	8%	6%	
% Dung Burned	0-50	54%	42%	18%	n = 277 X ² = 21.4 P < .001
	50-100	46%	48%	82%	
Supply Adequate for Fuel	YES	64%	80%	83%	n = 598 X ² = 16.2 P < .005
	NO	36%	20%	17%	
Supply Adequate for Fert.	YES	44%	54%	59%	n = 598 X ² = 16.2 P < .005
	NO	56%	46%	41%	
Purchase Dung		42%	18%	11%	n = 602 X ² = 45.6 P < .001
Don't Purchase		58%	82%	89%	

V. STUDY SAMPLE

The data presented here are based on interviews with 1,132 households in 58 villages in the predominantly rainfed districts of the Punjab (districts Attock, Chakwal, Rawalpindi, Khushab, Sialkot, Gujrat, Jhelum) and NWFP (districts Kohat, Karak, D.I. Khan) and in the irrigated district of Nasirabad in Baluchistan. The villages were selected, based on field observations and interviews with Forest Department and local officials, as being representative of their areas. The households were selected randomly from each village's voter's list. The researchers spent an average of 3-6 man-hours of time with each household, in the course of a minimum of 2 interviews. This investment of time produced a great quantity of data, of which only those pertaining to the analysis of prospects for replacing dung-fuel with wood-fuel are presented here.

VI. RECOMMENDATIONS

1. Prospects for Wood-Dung Fuel Replacement

- i. Since most households have a more positive opinion of dung fertilizer than chemical fertilizer, and since a sizeable minority report a shortage of dung for this purpose, farmers are likely to be receptive to a program designed to increase supplies of dung for fertilizer.
- ii. Since there are many good reasons for burning some dung, but no good reason for burning a major part of the household's supply except for the lack of fuelwood, farmers are likely to be receptive to a program to reduce dung burning by increasing supplies of wood.
- iii. Since most dung is currently used for fuel not fertilizer in Pakistan, a program that succeeded in increasing the proportion used for fertilizer could have a significant impact on the condition of Pakistan's farmlands.

2. Outreach Strategies

The outreach component of the wood-dung fuel replacement program should emphasize the following points:

- i. The use of dung for fuel is a major cause of inadequate supplies for use as fertilizer.
- ii. The aim of the program is not to eliminate the burning of dung but to reduce the proportion involved.
- iii. The replacement of dung-fuel by wood-fuel will reduce cash outlays for chemical fertilizers.
- iv. The farmers themselves already recognize the many merits of dung fertilizer and the many drawbacks of chemical fertilizer.

3. High Priority Targets

Field operations will be most successful if they focus on the households in greatest need of a wood-dung fuel replacement program, namely:

- i. Households with small landholdings (under 12.5 acres), which have the highest demand/supply ratios for dung.
- ii. Households that own the land that they work, which have the greatest interest in long-term improvement of the land.
- iii. Households with mixed rainfed/irrigated lands (and to a lesser extent those with completely rainfed lands), which both use and need the most dung for fertilizer.

4. Low Priority Targets

Field operations will not be successful if they concentrate on households that are least in need of, or least likely to be receptive to a wood-dung replacement program, namely:

- i. Households with large landholdings (over 12.5 acres).
- ii. Landless households that work land as tenants or sharecroppers, or landowners that let out their land to be worked by tenants or sharecroppers.
- iii. Households with completely irrigated lands, which burn the most dung but are least interested in increasing their use of it for fertilizer.

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Project Reports

REPORT #1 Household-level Factors Affecting Interest in Planting Trees and Operating Nurseries: The Punjab. By Michael R. Dove, 6 May 1987.

REPORT #2 Household-level Factors Affecting Interest in Planting Trees and Operating Nurseries: The NWFP. By Michael R. Dove, 6 June 1987.

REPORT #3 Household-level Factors Affecting Interest in Planting Trees and Operating Nurseries: Baluchistan. By Michael R. Dove, 6 July 1987.

REPORT #4 Village-Level Factors Affecting Interest in Farm Forestry: The Punjab, NWFP, Baluchistan. By Michael R. Dove, 13 August 1987.

REPORT #5 Prospects for Farm Forestry on Rainfed versus Irrigated Farms: The Punjab, NWFP, Baluchistan. By Michael R. Dove, 7 November 1987.

REPORT #6 Prospects for Wood-Dung Fuel Replacement Through Farm Forestry: The Punjab, NWFP, Baluchistan. By Michael R. Dove, 7 November 1987.