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COMPARATIVE ECONOMICS OF TRACTION ENERGETICS IN ARID AREAS OF WESTERN RAJASTHAN

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ABSTRACT

Economic analysis of alternative traction inputs needed for agricultural sector in the arid region of western Rajasthan revealed that supply of the total traction energy from animals as well as from machines is incommensurate with its demand in the region. In comparative terms, the annual traction would be cheaper strictly in an 'out-of-pocket' sence. Taking long range implications, mechanised traction seems to have an edge over the animal traction resources. A judicious combination of both animal and mechanical traction inputs is needed for better resource utilization and optimum agricultural production.

INTRODUCTION

The advent of green revolution and massive allocation of planned resources for rapid agricultural development have generated sizeable competition in the pattern of power use by farm sector in arid areas of western Rajasthan. In vast part of arid Rajasthan, the restrictive recource endowments tend to support livestock population more efficiently than the crop production and thus the livestock population continues to increase. The availability of ample bullock power has its own ramification, for, the ready availability of the bullock power itself imposes sizeable restriction on the choice of its subsitution by tractors. On the other hand, the unfavourable climatological resource endowments, which leave much lesser time for agricultural operations, call for increased substitution of bullock power by tractor (Goyal *et al.*, 1981). In the post-green revolution period since 1966-67, the use of tractors, pumsets and chemical tube-wells, fertilizers and plant protection materials in the arid areas of Rajasthan has increased manifolds. The demand for petroleum products has also increased simultaneously with the increased use of mechanical power and chemical fertilizers, for which there is a world wide shortage (Bhatia 1976; Mishra *et al.*, 1976; Rao and Singh 1977; and Sangi and Blase 1976).

The present study is an attempt to document and analyse availability of animal and traction energy for agricultural sector, and to estimate comparative economics of energy sources alternative to animal energy for arid areas of western Rajasthan.

MATERIAL AND METHODS

Primary data was collected from two villages, namely, Ransigaon and Haryadhana in Bilara tehsil of Jodhpur district. A total of 20 irrigated farms representing the average size of holding (3.5 ha) in the district were randomly selected. The total cultivated area of these selected cultivators were 70 hectares. Primary data for the year 1978-79 were collected from these selected farmers. The secondary data base (Anon., 1977) was employed to generate total energy requirement and the primary data were employed to generate comparative economics of the alternative source of traction energy.

RESULTS AND DISCUSSION

The availability of animal traction energy in arid areas of western Rajasthan during 1977 was worked out with the assumption that 1972-77 growth rates of different animals will also prevail in near future. The districts comprising arid areas in western Rajasthan and accounting for about 62 per cent of hot Indian arid zone, include Barmer, Bikaner, Jaisalmer, Jodhpur, Jhunjhunu, Nagaur, Pali, Sikar, Jalore, Ganganagar and Churu. The results are set out in table 1. A perusal of table 1 would reveal that from all animals the total energy available for arid areas of western Rajasthan is estimated to be 0.909 m hp., of which 0.374 m hp is contributed by bullocks and 0.535 m hp from all other working animals of the arid areas of Rajasthan.

Energy requirements in arid areas of western Rajasthan :

Cropping pattern is one of the most important determinants of energy requirement in agricultural sector. The problem is further compounded when double and multiple cropping in an year are practiced. However, the monoculture system of farming is the mainstay in context of arid region, from both crop-wise as well as from *inter se* distribution for area of principal crops in the state of Rajasthan which contains about 62 per cent of total arid region of the country. A large proportion of the area allocation is done in favour of dry land crops irrespective of size distribution (Table 1).

Table 1 : Availability of animal power in 11 districts of arid western Rajasthan (1977)

Particulars	Number	Horse power*	Total horse power
Bullocks (above 3 years)	747853	0.5	373926.5
Male Buffaloes (above 3 years)	71755	0.5	35877.5
Camels (above 4 years)	441518	1.0	441518.0
Horses and ponnies (above 3 years)	11096	0.5	5548
Mules (above 3 years)	528	0.5	264
Donkeys (above 3 years)	105095	0.5	52547.5
Total :			909681.5

* After Chamola and Rao, 1981.

It has been estimated that on marginal and small farms (< 2 ha) approximately 0.6 hp of power is needed for every hectare of cropped area in rabi crops, of which 0.5 hp is used for tillage operation and 0.1 hp is used for post harvest operations; for kharif crops 0.15 hp of power is needed. Similarly, on semi medium and medium farms (between 2 to 10 ha.), approximately 0.8 hp of power for every hectare of cropped area is needed in rabi, of which 0.6 hp is needed for tillage operations and 0.2 hp is needed for post harvest operations and for kharif crops approximately 0.15 hp is needed. Likewise, for large farms (<10 ha), approxmately 1.0 hp per hectare for rabi crops is needed, of which 0.8 hp is needed for tillage operations and 0.2 hp is needed for post harvest operations and for kharif crops 0.4 hp is needed (Chamola and Rao 1981). For estimation of energy requirement, the data pertaining to size distribution of operational holdings were worked out. The pattern emerging out of the size distribution of operational holdings is set out in table 2.

It is seen from the data presented in table 2 that medium and large holdings jointly account for above 59 per cent of the total of 1.45 million holdings in arid areas of western Rajasthan. This is followed by small farms (about 17 per cent). Marginal farms account for only about 5 per cent of the total number. Thus it can be seen that the total net cultivated area was heavily skewed in favour of large farms, followed by that of medium, semi medium, small and marginal farms. Almost similar pattern is discernible for the total area as well.

Juxtaposing the energy need coefficients on the size distribution pattern, the power needs for different size of holdings in arid areas of western Rajasthan could be worked

Table 2 : Distribution of operational holdings (ha) amongst farm sizes in arid areas of western Rajasthan (1976-77)

*Particulars	Number of Holdings	Net cultivated area	Total area
Marginal framers (0 to 0.5 ha)	73359 (5.07)	13727.91 (0.13)	16756.07 (0.13)
Small farmers (0.5 to 2 ha)	245094 (16.93)	278101.17 (2.66)	304819.52 (2.37)
Semi medium farm (2 to 4. 0 ha)	274449 (18.96)	746055.51 (7.12)	801504.21 (6.24)
Medium farmers (4 to 10. 0 ha)	447140 (30.89)	2635663.52 (25.14)	2924719.5 (22.76)
Large farmers (10 to 50 and above)	407405 (28.14)	6806627.85 (64.94)	8798996.54 (68.49)
Total	1447447 (100.00)	10480175.96 (100.00)	12846795.86 (100.00)

out (Table 3). A perusal of table 3 would reveal that in order to operate 10.84 m ha of cropped area in 1976-77, 4.038 m hp was needed. However, available energy from different working animals was only 0.909 m hp (Table 1) for arid region of western Rajasthan. The results reveal that there is an energy deficit of 3.12904 m hp in the hot arid zone when only animal energy is considered. Further, on the basis of total available area of the arid zone this gap will be increased. Thus total available animal energy will meet only a smaller portion of the arid areas needs. Under such circumstances additional energy has to be met either by existing tractors or augmenting the quantum of animal energy in the arid districts.

Tractor energy in arid areas of western Rajasthan :

The total number of tractors in this arid tract in 1977 were 698, 648 ranging between 25 to 60 hp. Assuming 20 hp as the total average available tractor energy in this tract, the total energy from tractors could be estimated to be 0.436 m hp. Thus only about 0.04 m hp/ha is available from existing tractors in arid areas of western Rajasthan. Since the total energy requirements of all the size classes are 4.038 m hp, the available tractor energy also seems to be inadequate to cover the demands. Thus even with animal and mechanical energy sources cosidered together, energy deficit under the existing circumstances would be much more.

Comparative cost effectiveness of alternative traction power resources :

It is now amply clear that bullocks, camels and tractors constitute most of traction energy resource-mix in agrarian sector of hot Indian arid zone. Irrespective of the cost concepts employed, camel turns out to be most cost-effective traction energy resource which is followed by bullock pair and tractor in that order. From amongst the four concepts namely fixed, variable, total and net costs, the relative importance of each alternative traction energy resources are found to vary considerably. For example, while fixed costs are least for bullocks and camels, the order of the same varied for the tractors. Similarly, both total and net costs rank high for all the elements of resource-mix. In terms of out-of-pocket expenses also, camel and bullock rank lower than tractors. More or less same pattern emerges for the average costs computed for average work days per annum. If returns and time constraints are not taken into account, the animal traction energy resources in arid areas will prove to be more cost-effective than the tractors. However, since the demand for total energy required for the average cultivated area far exceeds the supply, a simultaneous increment in all traction resources seems to be desirable. This axiom would, however, hold true with difficulty if the practice of fallowing induced by adverse climatological factors and mid-season abandonment of cultivation due to crop failures are taken into account.

Table 3. Power needs (hundred thousand hp) for agriculture in arid areas of western Rajasthan (1976-77)

Particulars	Net cropped* area in rabi crops	Power needed		Total power needed during rabi season	*Net cropped area in kharif seasons	Power needed		Total Power needed during kharif seasons	Total power needed kharif plus rabi season
		Tillage operations	Post-harvest operations			Tillage operations	Post-harvest operations		
Marginal farmers	.0091 (0.02)	0.00455	.00091	0.01546	0.14 (0.15)	0.014	0.007	0.021	0.0264
Small farmers	.14105 (3.1)	0.07052	.01410	.08463	2.78 (2.65)	0.3892	0.139	0.5282	0.6128
Semi medium farmers	0.7780 (17.1)	0.46683	0.15561	.62244	7.46 (7.11)	1.492	4.373	1.865	2.4874
Medium farmers	0.91000 (20.00)	0.54683	0.18200	.72800	26.36 (25.15)	5.272	1.318	6.59	7.318
Large farmers	2.71180 (56.6)	2.16944	0.54236	2.7180	68.06 (64.94)	20.418	6.806	27.224	29.9358
Total	4.5500 (100.00)			3.52233	104.80 (100.90)			36.2282	40.3804

* Hundred thousand ha.

Table : 4 Comparative cost-effectiveness of alternative traction energy resources in arid areas

[1]Particulars	Bullcoks	Camels	Tractors
Fixed costs	1254.00	869.00	15902
Variable costs	6830.00	4100.00	9062.80
Total costs	8084.00	4969.00	24964.80
Net costs	7884.00	4894.00	24964.80
Total out of pocket costs	1629.00	1019.00	23844.80
Average costs/work day/annum			
i. Net costs	43.80	34.96	356.64
ii. Out of pocket expenses	9.05	7.28	340.64

[1] Assumptions :

For bullocks and camels out of pocket expenditure consists of cost items like depreciation of 12% on their present value: Rs. 3000 for bullocks and 2200 for camels; interest of 14% on investment, repair and maintenance and depreciation on equipments; interest on investments in equipments etc. and miscallaneous expenses and 50 Pc value of concentrate feeds to the bullock/camels; for tractor, except for drivers wages, all other costs incurred from out of pocket expenses.

Fixed costs consist of items, for bullocks depreciation on bullocks/camel 12 per cent of their present value of Rs. 3000 and 2200 respectively. Interest on investment bullock/camels 14 per cent; repair maintenance and depreciation on equipments, machinery sheds etc.; interest on investment in equipment, machinery sets etc. and miscellaneous expensres, for tractor fixed costs consists of the items, depreciation on tractor and its accessries (10 per cent of its present value of Rs. 60,000, interest on tractor and its accessories 14 per cent of its value, depreciation on sheds and interest on its investments and insurance and misc. expenses.

Variable cost for bullocks consists of feed costs and roughages, concentrates, mineral mixture and labour costs and for tractor variable costs include fuel and lubricant costs, drivers wages, repair and maintenance etc.

Total costs is the summation of fixed and variable costs.

Net cost for bullock calculated by deducting dung cost from the total cost, for tractor it is same as total cost.

Average cost work day/per annum calculated on the basis of 180 days operation period per annum.

CONCLUSIONS AND POLICY IMPLICATIONS

The total energy available from animals for arid areas of Rajasthan is estimated to be 0.909 m hp of which 0.374 m hp is from bullocks and 0.535 m hp from all other working animals of this arid tract. Total available tractor energy in this tract is estimated to be 0.436 m hp.

Table 5. Crop. wise percentage of area cropped under foodgrains to total cropped area (Raj. 1977)

Holder	Rice	Sorghun	Bajra	Maize	Wheat	Barley	Others	Pigeon pea	Gram	Other pulses
Marginal	3.3	9.7	21.7	21.4	25.3	11.0	7.6	3.7	65.4	30.9
	(8.4)	(4.6)	(2.5)	(11.9)	(6.1)	(7.9)	(11.3)	(10.0)	(4.9)	(1.7)
Small	3.3	11.0	26.4	19.4	24.3	9.6	6.0	3.0	63.2	33.8
	(13.5)	(8.4)	(4.8)	(17.5)	(9.5)	(11.2)	(14.4)	(15.0)	(8.6)	(3.3)
Semi-medium	3.3	12.4	28.0	14.8	25.0	11.8	4.7	2.8	59.3	57.9
	(28.4)	(20.0)	(10.8)	(28.1)	(20.6)	(28.7)	(23.8)	(30.0)	(17.6)	(8.1)
Medium	2.5	14.0	37.4	9.4	25.6	7.6	3.5	1.3	49.9	38.8
	(37.4)	(39.6)	(25.6)	(31.4)	(37.3)	(32.7)	(31.3)	(35.0)	(36.3)	(25.6)
Large	0.7	8.0	68.0	2.7	15.0	3.8	1.8	0.2	27.7	72.1
	(12.3)	(27.4)	(56.3)	(11.1)	(26.5)	(19.5)	(19.2)	(10.0)	(32.6)	(61.3)
Total	2.0	11.0	45.6	9.3	21.4	7.2	3.5	1.1	41.4	57.5
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

For total net cultivated area of this zone 4.03804 m hp are normally needed. Thus total available energy meets out only 1/10th of the needs.

Owing to unsurmountable financial and physical constraints in relation to the size of holding, it would be unwise to wholly depend on either source of traction energy. Therefore, a judicious use of both the tractor as well as animal sources of power commensurate with existing resource structure is all that seems desirable.

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