MECHANISATION IN DRYLAND AGRICULTURE: PRESENT STATUS AND FUTURE NEEDS

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Nearly 67 per cent of India's total cultivated area of around 142 million hectares is under rainfed agriculture. This area accounts for 44 per cent of total food production. Important food crops like nutritious cereals (91%), pulses (91%), oilseeds (80%) and commercial crops like cotton (65%) are cultivated. Dryland agriculture also supports 40 per cent of human population and 60 of the total livestock.

The special weather conditions like low, erratic and highly skewed rainfall often allows a very short period for carrying out agriculture operations like sowing, fertilization, inter-culture, etc. Hence, the timeliness of the agricultural operations occupies special significance in dryland agriculture. Besides, frequent droughts resulting in migration of labour to urban areas also contribute to shortage of labour for agriculture. All these constraints / difficulties may be suitably overcome to some extent through mechanization of rainfed agriculture. Hence, an attempt is made in this article,

i) to examine the relevance of mechanization in rainfed agriculture

ii) to review the energy availability, requirements and progress of mechanization and

iii) to suggest measures for upscaling of mechanization in rainfed areas.

Relevance of mechanization in Indian Agriculture

There are two schools of thought viz. 'Substitution view' and the other 'Net contributor view' regarding the need for agricultural mechanization.

The substitution view looks at tractors (which was synonymous with mechanization) and animals as two different power sources, which technically are perfect substitutes. Under this view, it will be guided by factor prices. If the opportunity cost of labour (the wages) and maintenance cost of animals should become sufficiently high, it will make sense to shift to tractors.

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The reasons put forth in support of this view that automation is not needed in Indian agriculture are:

i) Abundant agriculture labour is available in rural areas, as 2/3 population lives the rural areas.

ii) Even according to 2001 census nearly 54 per cent of rural population is agricultural workers, out of which 26.7 per cent is agriculture labourers (Table-1).

iii) The wages are low and hence labour force at lower cost is available for agriculture, which is generally cited as the biggest advantage (strength) for our exports.

iv) There is a rampant unemployment and under employment prevalent in rural areas.

v) Most of the farms are marginal and small and hence mechanization is not feasible.

vi) The resource base of the farmers is very low and hence cannot afford machines.

The facts advanced by the "Net Contributors View" for mechanization are:

i) Power is a primary constraint to agriculture production regardless of factor prices.

ii) The cost of production of our commodities is high compared to other countries, though labour component forms a considerable portion of cost of cultivation of crops. Hence, we are not able to compete in international trade with other countries.

iii) Some of the operations cannot be efficiently performed by human/bullock labour, which result in low level of precision.

iv) Some of the operations result in too much drudgery especially for women labour and hence need to be mechanized.

v) The productivity of labour is very low and can be enhanced only through mechanization.

vi) Higher power and speed of tractors will allow more timely operations, thus contributing to higher coverage and yields.

vii) Tractors may be able to do operations like reclaiming of lands which cannot be done by bullock power.

viii) Tractor can contribute to increased production without necessarily displacing labour through higher cropping intensity etc.

The arguments for and against are advanced mainly because of the misconception that "farm mechanization means just tractorization" in agriculture, which is not quite true. Mechanization has to be taken in the broad sense and any improvement in the tools and implements used for agricultural operations irrespective of the source power i.e. human/animal or mechanical should be considered as a part of mechanization.

Starkey P. (1998) has summed up this very aptly "Agricultural mechanization involves the use of tools, implements and machines to improve the efficiency of human time and labour".

Energy availability and requirements

Livestock as a source of farm power:

Livestock was the chief source of power for the farm sector. The contribution of draught animal power to total power availability in Indian agriculture has been declining over the years. It has come down from 45.26 per cent in 1970-71) to 9.89 per cent by the year 2001-2002 and it is estimated to come down further to 8.02 by the year 2005-2006 (Table-2). This is mainly due to the decrease of drought animals for field operations. From 41.8 million animal pairs in 1971-72, it has decreased to 33.98 million pairs by the year 1996-97 i.e. by 18.7 per cent which is mainly due to high decrease in the number of male cattle used for drought purpose (Table-3). Scarcity of the fodder availability coupled with high cost of rearing of animal power are the two main reasons for it . Now a days a bullock pair is for 200-300 hours/year while the utilisation should go up to 800-1000 hours/year.

Energy needs of agricultural sector:

The draught power available at present (2001-02) is 1.231 kw/ha and the same is estimated to be 1.502 kW/ ha by the year 2005-06 (Table-2). With declining of animal power contribution in Indian Agriculture, the mechanical power source needs to be used for bridging the gap.

Progress of mechanization in agriculture:

From table-4, it can be seen that there is a good progress in farm mechanization in India. From 610 tractors per million hectare of gross cropped area in 1970, it has increased to 9860 hectares by 1993 which is nearly 1500 per cent jump. During the last ten years (1991-92 to 2000-01) about 2.05 million tractors and 16018 power tillers were sold in the country (Table-5). Similar trends were observed in case of power threshers (Table-6) and irrigation pumps (Table-7).

Impact of Farm Mechanization on Agricultural Production

The expert working group constituted by the CIAE in September, 1984, had observed that it is possible to achieve (Mishra & Srivastava, 1989):

i) Five to ten per cent improvement in yields by proper and timely seedbed preparation.

ii) Ten to twenty per cent improvement in yields by using seed cum fertilizer drills.

iii) Five to thirty per cent improvement in yields through control of weeds by use of inter-culture tools, sprayers and dusters.

iv) Four to five per cent savings through timely and efficient harvesting and threshing operations.

The group also felt that losses could also be minimized through mechanization in case of some commodities.

Scope of Mechanization in Agricultural Operations

Mechanization is possible in all stages of production of agriculture i.e. starting from land preparation to post-harvest operations and for value addition/processing of agricultural commodities. The operations which can be mechanized for different crops identified by different studies is presented in table-8.

From the table it can be seen that though the importance of mechanization identified for farm operations has differed from crop to crop, all the important operations have scope for mechanization. The most important operation identified especially for dryland crops, like sorghum, sunflower, cotton, etc. is sowing and planting followed by weeding and inter-culture.

The improved implements identified for mechanization of various agriculture operations are presented in table-9.

Besides the agricultural operations, there is also tremendous scope for mechanization of post-harvest operations like grading/sorting/ deshelving /, dehusking, packing etc. Some of the value addition machinery like mini dhal mill units, small scale processing machinery, etc. also helps mechanization of agricultural sector.

Government Policies

Agriculture being both a central and state subject, the policies followed for mechanization differs from state to state.

Electricity: Electric power at subsidised tariffs / free power as in the case of Punjab

and recently in Andhra Pradesh had tremendous effect especially in digging of bore wells and energization of pumpsets. Most of the open wells are replaced by bore wells for which diesel/electrical pump sets are used as bullocks cannot be used for these type of wells.

Subsidies: Most of the state governments are giving subsidies to the extent of 33 to 50 per cent for purchasing improved tools and implements, which may also help in rapid mechanization of agricultural operations. Similarly drip irrigation, sprinkler irrigation, equipment etc. also have subsidy to the extent of nearly 90% in some states.

Taxes: The tax policy plays an important role and always has a catalytic influence on changes. These have influence in case of mechanisation also. For example the Govt. of India in the budget for 2004-2005 announced exemption of Excise duty which was 16% previously for tractors, implements etc. This exemption enables availability at lower and affordable price. Similarly, the sales tax charged by centre and states also have an effect on prices of agricultural machinery.

Import and Export Policy: For example, the gift scheme which was in operation, which exempted import and sales tax during 1970 has resulted in import of large/huge number of tractors. Similarly, the 1991 liberalised policies of import have helped import of machinery and equipment for polyhouse, processing equipment etc.

Credit: As most of the farmers are resource poor, providing credit plays an important role in going for mechanization. As such there is no special credit provision for implements and machinery. However loan facility from Nationalised banks is available for purchasing tractors and identified machinery. In fact ease in bank loan facility in 1980's is one of the reasons for increase in sales and production of tractors in India.

Conclusions and Suggestions

i) The mechanization policy should be clearly spelt out in the overall agricultural policy, so that long term planning can be done. The present policy of giving subsidies and tax exemptions now and then should be streamlined and clear cut guidelines be laid down keeping long range perspectives in view

ii) Selective mechanization of agricultural operations needs to be encouraged to bridge the gap between energy availability and requirements.

iii) The top down approach of mechanization, which still mostly means tractorisation should be avoided and a participatory approach employed to identify and prioritize areas of mechanization. The experts are of the opinion that "The type and degree of mechanization should be decided by the producer to suit best his business and his

own particular circumstances and the choice of suitable methods will therefore be just one of a number of choices that the farmer has to make" (Clarke 1997).

iv) Upliftment of private sector for development and production of improved tools and implements should be encouraged by giving proper incentives.

v) The long term effects on environment of some policy measures should be analysed before taking steps for free power/subsidy.

vi) The role of alternatives to single-farm ownership such as partnerships and custom hiring of implements needs to be examined. In this context, custom hiring centres pioneered by CRIDA through participation of cultivators need to be upscaled.

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Table 1. Rural population and agricultural workers

(in million)

Class of workers	1961	1971	1981	1991	2001
Rural population	360.3 (82.0)	439.0 (80.1)	523.9 (76.7)	628.7 (74.3)	741.7 (72.2)
Cultivators	99.6 (52.8)	78.3 (43.4)	92.5 (37.8)	110.7 (35.2)	127.6 (31.7)
Agricultural labourers*	31.5 (16.7)	47.5 (26.3)	55.5 (22.7)	74.6 (23.8)	107.5 (26.7)
Other workers*	57.6 (30.5)	54.7 (30.3)	96.6 (39.5)	128.8 (41.0)	167.4 (41.6)
Total agricultural workers	188.7 (100)	180.5 (100)	244.6 (100)	314.1 (100)	402.5 (100)

Note : 1. * Includes marginal workers
2. Figures within parentheses indicate percentage of total population.

Source : Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.32

Table 2. Percentage contribution of different power sources to total power availability in India

Share of total power	1971-72	1981-82	1991-92	2001-02	2005-06
Agricultural worker	15.11	10.92	8.62	6.49	5.77
Draught Animal	45.26	27.23	16.55	9.89	8.02
Tractor	7.49	19.95	30.21	41.96	46.70
Power Tiller	0.26	0.33	0.40	0.54	0.60
Diesel engine	18.11	23.79	23.32	19.86	18.17
Electric motor	13.77	17.78	20.90	21.26	20.73
Total power kW/ha	0.295	0.471	0.759	1.231	1.502

Source : Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.104.

Table 3. Population of draught animals for field operations

(in million)

Livestock		1971-72	1976-77	1981-82	1986-87	1990-91	1991-92	1996-97
Cattle	Male	72.56	73.23	61.05	63.78	61.62	61.10	58.53
	Female	2.07	2.05	2.04	1.95	1.92	1.91	1.87
Buffalo	Male	7.61	7.93	7.32	6.56	6.31	6.25	5.94
	Female	0.37	0.34	0.33	0.68	0.81	0.84	1.03
Camels**(male & female)		0.49	0.47	0.41	0.36	0.33	0.32	0.29
Total animal pairs*		41.80	41.25	35.79	36.86	35.66	35.77	33.98

Note : 1.* Bovine in pair and Camels in single

2. ** Camels are mainly used in Rajasthan & Haryana for field operation and thus, 60% of its total camel population assumed for field operations.

Source: Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.34

Table 4. Progress of farm mechanization

Items	1970	1974	1980	1985	1988	1993
Gross cropped area (million ha)	165.80	170.00	169.70	176.00	177.00	183.00
Tractors						
Cumulative total (million)	0.10	0.23	0.47	0.82	1.05	1.80
Per million hectare of gross cropped area	610.00	1,320.00	2,790.00	4,660.00	5,950.00	9,860.00
Oil engines						
Cumulative total (million)	0	1.75	2.65	3.35	4,250.00	5.20
Per million hectare of gross cropped area	0	10,320.00	15,640.00	19,690.00	24,000.00	28,490.00

Irrigation pumps, electricity-operated tube wells

Cumulative total (million)	1.35	2.43	3.97	5.71	7.00	9.62
Per million hectare of gross cropped area	8,340.00	14,280.00	23,360.00	32,360.00	39,950	52,710.00
Consumption of power (kwh) for irrigation per (000'ha) of gross cropped area	23.30	37.40	79.50	116.10	196.70	350.70

Source: Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.103

Table 5. Year-wise production and sale of tractors and power tillers

(in number)

Year	Production		Sale	
	Tractors	Power tillers	Tractors	Power tillers
1986-87	80369	3325	80164	3209
1987-88	92092	3005	93157	3097
1988-89	109987	4798	110323	4678
1989-90	121624	5334	122098	5442
1990-91	139233	6228	139831	6316
1991-92	151759	7580	150582	7528
1992-93	147016	3648	144330	8642
1993-94	137352	9034	138796	9446
1994-95	164029	8334	164841	8376
1995-96	191329	10147	191329	10147
1996-97	222769	11000	222769	11000
1997-98	260815	12200	254279	12200
1998-99	261609	14480	262351	14880
1999-2000	278556	16891	173181	16891
2000-2001	255690	16018	254825	16018

Source : Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.101

Table 6. Cumulative number of agricultural tractors (4 wheel) and power threshers

Year	Four wheel tractors	Threshers
1972	1,48,200	2,05,800
1977	2,75,900	4,84,100
1982	5,18,800	10,25,000
1987	10,20,800	13,63,800
1992@	13,17,961	18,13,800
1995@	17,13,595	22,22,000
1996@	18,53,000	24,22,000
1997@	20,38,000	28,22,000
1998@	22,24,000	32,22,000
1999@	24,78,512	N.A.

Note : @ Data collected from Manufacturers Association

Source : Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.101

Table 7. Number of irrigation pumps

(in million)

Year	Diesel pumps	Electric pumps	Total
1951	83,000	26,000	1,09,000
1956	1,23,000	47,000	1,70,000
1961	2,30,000	1,60,000	3,90,000
1966	4,71,000	4,15,000	8,86,000
1972	15,46,000	16,18,000	31,64,000
1977	23,59,000	24,38,000	47,97,000
1982	31,01,000	35,68,000	66,69,000
1987	59,68,000	63,49,000	1,23,17,000
1991@	46,59,000	96,96,000	1,43,55,000
1995@	51,00,000	1,17,00,000	1,68,00,000

Note : @ Data collected from Manufacturers Association

Source : Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.100

Table 8. Crops and their farm operation requiring mechanization as identified by various centres through mechanization studies

Crops	Operation							
	Tillage & seedbed preparation	Sowing and planting	Transplanting	Weedling and interculture	Plant protection	Harvesting	Threshing	Combining
Rice	ANGRAU (PO)* BAU (AD) AAU (AD) NADUAT (PO) PDK (PO)	KAU (PO) AAU (MO)	TNAU(PO) PAU (PO) MPKV (MO) ANGRAU (MO,PO) BAU (MO) GBPUAT (PO) KAU (PO) AAU (MO) NDUAT (PO) UAS (MO,PO) RAU (PO) PDKV (PO)	TNAU (PO) BAU (MO) JNKVV(PO) AAU (MO) PDKV(PO)	PDKV (PO)	KAU (PO) PDKV(PO) UAS(PO)	MPKV (PO) BAU (MO) GBPUAT (PO) KAU(PO)	TNAU (PO) NDUAT (PO) UAS (PO)
Wheat	-	BAU(PD)	-	-	-	-	-	CIAE (PO) NDUAT (PO)
Maize	-	-	-	TNAU(PO)	-	-	-	-
Sorghum	-	UAS (PO)	-	UAS (PO)	-	TNAU(PO) MPKV(PO)	-	-
Pearl Millet	-	UAS(PO)	-	UAS(PO)	-	MPKV (PO)	-	-
Groundnut	-	IIT (AD)	-	TNAU(PO)	-	TNAU(PO) IIT(AD)	TNAU(PO) MPKV (PO)	-

							UAS(PO) IIT (AD)	
Soybean	-	-	-	CIAE (PO) JNKVV (PO)	CIAE (P0)	-	-	CIAE (PO)
Sunflowe r	-	JNKVV (AD) UAS (PO)	-	UAS (PO)	PAU (PO)	-	GBPUAT (PO)	-
Cotton	PDKV (PO)	ANGRAU PDKV (PO) UAS (PO)	-	PAU (PO) PDKV (PO)	PDKV (PO)	TNAU (PO) PAU (PO) ANGRAU (PO) PDKV (PO) UAS (PO)	-	-
Jute	-	IIT (AD)	-	-	-	-	-	-
Potato	-	PAU (PO) ANGRAU BAU (AD) GBPUAT (PO) IIT(AD) NDUAT(PO)	-	-	-	ANGRAU GBPUAT(PO) IIT (AD)	-	-
Sugarcan e	-	TNAU (PO) MPKV(PO) ANGRAU(PO) GBPUAT(PO) NEUAT(PO)	-	TNAU (PO) ANGRAU(AD) ANGRAU(PO)	-	PAU(PO) TNAU(PO) MPKV(PO) ANGRAU(PO) GBPUAT(PO)	-	-
Pulse	-	-	-	TNAU(PO)	-	TNAU (PO) MPKV(PO)	-	-
Onion	-	MPKV(PO)	-	-	-	PAU(PO) MPKV(PO)	-	-
Coconut	-	-	-	-	-	KAU(PO)	(DEHUSKING)	-

/arecanut							KAU (PO)	
Fruits	-	-	-	-	-	NEH(MO) BAU(MO)	-	-
Vegetable crops	-	PAU(PO) ANGRAU(PO) BAU(AD) JNKVV(AD) NDUAT(PO)	-	-	-	-	-	-
Rapeseed mustard	-	PAU(PO)	-	-	-	-	-	-
Fodder	-		-	-	-	PAU(PO)	-	-

Note: MO=Manually Operated, AD=Animal Drawn, PO=Power Operated

Source: *Agricultural Research Data Book, 2003*, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.96-97

Table 9. Traditional and improved implements

Items	Traditional implements	Improved implements
Seedbed preparation	- Spade	- Deshi plough
	- Disc plough	- Mould board plough
	- Bakhar	- Cultivator
		- Disc harrow
		- Rotavator
		- Roto-tiller
		- Puddler
		- Chisel plough
		- Patela harrow
		- Pulverizer roller
		- Leveler
Sowing/Fertiliser	- Broadcasting	- Rotary dibbler
application device	- Dibbling	- Mechanical
	- Transplanting	- Transplanters
	- Line sowing	- Pneumatic planter
	- Behind plough	- Planter
	- Pora/Khera	- Raised bed Planter
	- Multi seed drill	- Seed drill
		- Seed-cum-ferti drill
		- Zero till drill
		- Till planter
		- Fertiliser broadcaster
		- Ammonia applicator
		- Potato planter
		- Groundnut planter
		- Sugarcane planter
Irrigation	- Leather bag	- Centrifugal pump
	- Swing basket	- Submergible pump
	- Dhenkli	- Sprinkler
	- Chain pump	- Drip irrigation
	- Washer pump	- Propeller pump
	- Persian whell	- Axial flow pump

Interculture/Plant	- Khurpi	- Hand weeders
Protection	- Spade	-Cultivator
	- Plough	-Wheel hoe
	- Blade harrow (dora)	- Rakes
		- Rotary tiller
		- Ridger/Furrower/sweep
		- Sprayer
		- Duster
Harvesting / Digging	- Sickle	- Serrated sickle
	- Khurpi	- Reaper
	- Spade	- Combine
		- Digger
Threshing / Shelling	- Beating	- Pedal thresher
Decortication	- Rubbing	- Power thresher
	- Animal treading	- Combines
	- Olpad threshing	- Decorticator

Source: Agricultural Research Data Book, 2003, Indian Agricultural Statistics Research Institute, Indian Council of Agricultural Research, Govt. of India. Pp.95