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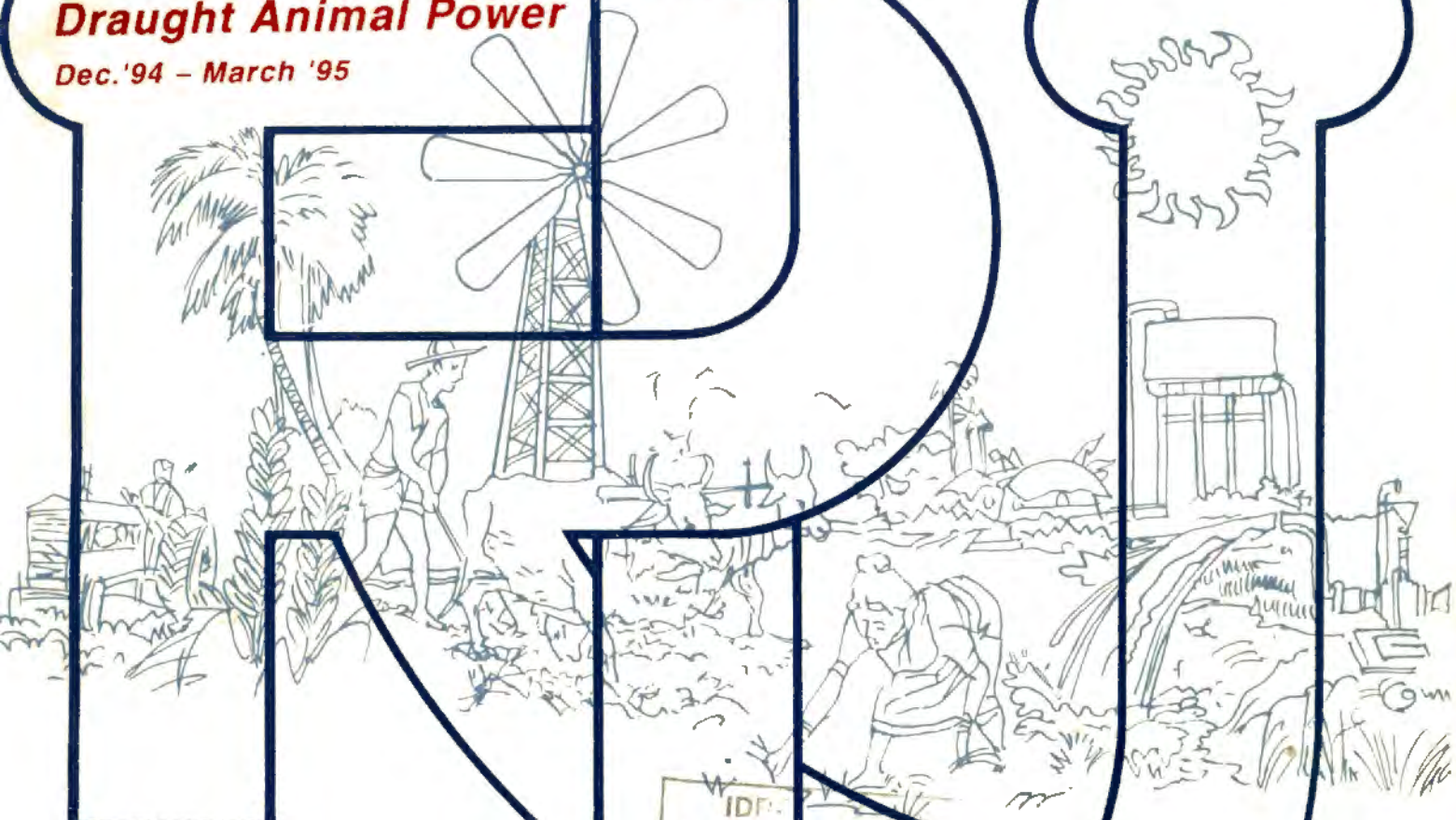

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AVAILABLE TECHNOLOGIES ON DRAUGHT ANIMAL POWER AND PROPOSED STRATEGIES FOR THEIR POPULARISATION IN U.P. AND BIHAR

N.S.L. SRIVASTAVA
Director & Project Coordinator
All India coordinated Research Project on Utilization of Animal Energy
Central Institute of Agricultural Engineering,
Bhopal -462018

A number of improved designs of animal drawn agricultural implements for land levelling, seedbed preparation, sowing, weeding and hoeing, water lifting, harvesting of root crops and threshing are commercially available. A good number of post harvest equipments like cane crushers, chaff cutter, improved oil ghani etc. are also commercially availble. Good designs of animal carts with pay load of 1 to 3 T are also commercially available. These equipments and carts are being used by a large number of progressive farmers. However in U.P. and Bihar majority of the farmers do not use these improved implements and carts.

In this paper author has discussed about the strategies to be adopted for creating awareness amongst the farmers, mass production and supply of improved animal drawn implements and carts, training of farmers, demonstration of improved machinery in farmers fields, availability of credit and subsidies, facilities for repair and maintenance and strengthening of infrastructural and support system for extension and popularisation of improved animal drawn agricultural implements and carts. The paper also emphasises the need for creating data base and a cell in the directorate of agriculture for coordination and Monitoring of programmes related to popularisation of DAP System.

In Uttar Pradesh and Bihar about 60-70% of tillage and sowing operations are still being performed by using draught animals. They are also being extensively used for rural transport of men and material. In these states as per the Agricultural Census 1985-86 the operational holdings in marginal and

small categories were about 88.2% in U.P. and 88.98% in Bihar as given in Table 1.

Table 1 Operational holdings by major size groups (1985-86)
(Nos. in 1000)

Category	U.P.	Bihar	India
Marginal	13782	8976	56147
0-0.99 ha	(72.60)	(76.65)	(57.79)
Small	2964	1327	17922
1-1.99 ha	(15.61)	(11.33)	(18.45)
Semi medium	1582	951	13252
2-3.99 ha	(8.33)	(8.12)	(13.64)
Medium	602	404	7916
4 -9.99 ha	(3.17)	(3.45)	(8.15)
Large	55	52	1918
10 ha and above	(0.29)	(0.45)	(1.97)
TOTAL	**18985**	**11711**	**97159**
	(100)	**(100)**	**(100)**

Source : Agricultural Statistics at a Glance 1994. Deptt. of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India.
Note : Figures in paranthesis are percentages.

All the farmers in marginal and small categories and atleast 50% in the semi - medium category depends on animal sources of power for their farm operations. Thus about 92.36% farmers in U.P. and 92.04% in Bihar, depends only on human beings and draught animal power. Any improvement in the design of hand tools and animal drawn implements will go in a long way to improve the efficiency and productivity of these farmers.

POPULATION OF DRAUGHT ANIMALS AND AGRICULTURAL WORKERS

The population of draught animals and agricultural workers in these two

states are given in Table 2 and 3.

Table 2 **Population of draught animals in U.P. and Bihar.**

(Nos. in '000)

Species	U.P.			BIHAR			INDIA		
	1972	1977	1982	1972	1977	1982	1972	1977	1982
Cattle	13581	13530	13018	7462	7477	7628	74636	75274	73574
Buffaloes	1595	1822	2007	760	823	799	8303	8272	6603
Camel	44	38	36	-	-	-	1109	1068	1078
Horses	230	204	217	99	110	111	942	916	900
Mules	37	37	80	01	01	04	75	89	131
Donkeys	210	200	263	31	38	28	994	978	1024

Source : Live Stock Census 1977 and 1982, Ministry of Agriculture Govt. of India

Table 3 **Population of cultivators and Agricultural workers in the total population of U.P. and Bihar during 1991.**

(No. in millions)

Population	U.P.		Bihar		India *	
	Nos.	%	Nos.	%	Nos.	%
Total	139.0	100	86.33	100	836.6	100
Urban	27.6	19.1	11.36	13.2	215.3	25.
Rural	111.4	80.9	74.97	86.8	621.3	74.3
Workers						
Total Main	41.3	100	25.6	100	285.4	100

Population	U.P. Nos.	%	Bihar Nos.	%	India * Nos.	%
Cultivators	21.8	52.7	11.1	42.9	110.6	38.7
Agricultural Labourers	08.0	19.3	09.5	37.1	074.6	26.1
Household Industry	01.8	04.3	00.7	3.3	010.4	3.6
Others	09.7	23.7	04.3	16.7	089.8	31.6

* Excludes J & K where 1991 Census was not held.

Source : Census of India 1991. Series 1, paper 3 of 1991. Ministry of Home Affairs, Govt. of India.

STATUS OF AGRICULTURE IMPLEMENTS USED BY THE FARMERS

The number of agricultural machineries owned by the farmers in the States of U.P. and Bihar as on 15th August 1982 and 1987 are given in Table No.4

Table 4 Number of Agricultural Machineries owned by farmers of U.P. and Bihar as on 15th August 198 and 1987.

(Nos. in '000)

Implement	U.P.		Bihar		India	
	1982	1987	1982	1987	1982	1987
Hand Operated Equipment						
Hand seed and ferti drill	175	299	154	163	3832	3741

Implement	U.P.		Bihar		India	
	1982	1987	1982	1987	1982	1987
Pedal operated thresher	285	930	80	134	583	2558
Winowing fan	233	616	3	11	11016	25576
Maize sheller	026	168	8	18	414	711
Chaffcutter	7907	11288	665	741	18032	29464
Hand operated sprayer	042	1049	123	95	1899	5841
Hand hoe	-	53266	-	0	-	77417
Wheel hoe	-	2290	-	-	-	3705
Blade hoe	-	3216	-	-	-	8495
Paddy weeder	-	159	-	-	4740	-
Tree prunning knives	-	6041	-	-	13310	-
Budding and grafting knives	-	510	-	-	-	4414
Garden rake	-	895	01	-	7305	-
Others	-	20905	-	24	-	49174
Animal Drawn Equipment						
Wooden plough	14494	15977	5617	5785	59679	62637
Steel plough	6127	9094	821	1053	13344	19842
Disc harrow	444	1849	111	148	10529	9239
Cultivator/ Triphali	940	2389	1	6	6847	11251
Seed cum ferti drill	55	707	86	92	6034	11183
Levelling karaha	334	1154	716	784	10519	12590
Seed planter	29	90	5	3	622	1498
Olpad thresher	82	143	4	5	367	794
Bullock cart	395	9250	1188	1152	18109	25745
Persian wheel	487	419			941	1037
Cane crusher	442	70	7	42	741	492
und former	-	1821	-	2	-	2423
Soil scoop	-	29	-	2	-	2491
Potato/groundnut digger	-	637	-	0	-	1772
Reaper	-	19430	-	1	-	25436
Others	-	1574	-	0	-	9112
Power Operated Equipment						
Diesel engine Pumpset	1058	2604	283	365	3353	5968
Electric Pumpset	361	730	171	306	39771	6349
Power tillers	43	326	28	29	273	701
Tractors	139	684	10	14	489	1590

Implement	U.P.		Bihar		India	
	1982	1987	1982	1987	1982	1987
T.D. Mould board plough	-	-	57	333	191	764
T.D. Disc harrow	89	475	1	1	333	948
T.D. Seed Drill	12	135	-	-	188	500
T.D. Planter	3	51	-	-	80	164
T.D.Leveller	17	173	-	-	188	915
T.D. Potato Digger	4	92	1	20	737	-
Thresher	280	847	72	79	768	1917
Sprayers/ Dusters	10	101	3	11	194	900
Chaff cutter	121	655	1	-	328	1466
Cane crusher	40	71	-	-	111	506
Combine harvester						
a) Trailed	-	-	7	-	0	386
b) Self propelled	-	-	4	-	0	26
Others	-	-	72	-	0	210
Miscellaneous Equipment.						
Sprinklers	-	-	12	-	0	164
Hydraulic ram	-	-	1	-	0	11
Cahin washer pump	-	-	1	-	0	9
Biogas plant	-	-	36	-	6	441
Others	-	-	91	-	49	1966

Source : Input Survey 1981-82 and 1986-87, Ministry of Agriculture, Govt. of India

IMPROVED TECHNOLOGIES AVILABLE ON DRAUGHT ANIMAL POWER

Unlike other sources of power, draught animals are very versatile. They are used as direct source of energy for various crop production and post harvest operations and for rural transport. They are used in rain and sun, under muddy and rough field conditions, on kachcha and pucca roads and

even on steep slopes and teracess. Their by-product, dung and urine are used as indirect source of energy in the farm of manure, dung cakes and biogas.

The improved technologies available on draught animals are as under.

A) To increase availability of power from them

i) Improved yokes and 3 padded collar harness have been developed which increase the draught output from the animals from 7.5 - 25% or even more.

ii) The draught power of bullocks, buffaloes, camels and donkeys have been assessed in sustained working on whole day basis, in two shifts, using local yokes/harnesses.

Bullocks : 12% of body weight in summer and 14% in winter season.
Buffaloes : 12% of body weight in all seasons.
Camels : 18% of body weight upto 7 hrs of work following 2 h work + 2h rest schedule.
Donkeys : 32% of body weight upto 6 hrs. and 36% upto 4 hrs.

iii) If improved implements matching to the power source is used, the command area from the same animal can be increased form 30-70% in comparison to the traditional system.

B) For Crop Production Operations

i)	Light levelling	:	Levelling karaha Soil scoop
ii)	Ploughing	:	10 - 25 c.m. Mould Board Plough
iii)	Harrowing/bakharing	:	4 - 6 disc harrow 50 - 70 cm bakhar

iv) Puddling	:	50 - 100 cm puddler
v) Planking	:	1.5 - 2 m planker on harrow patela
vi) Sowing / planting	:	3 - 5 rows seed drills/seed cum fertiliser drills 2-3 row planters for maize, cotton, potato, groundnut. 1 row sugarcane planter.
vii) Weeding/interculture	:	1, 2, 3 and 5 tynes sweeps and cultivators.
viii) Ridging	:	Single bottom ridger/furrower
ix) Harvesting	:	Groundnut/potato digger
x) Threshing	:	Olpad thresher
xi) Water lifting	:	Persion wheel, improved water lifts.

C) Post Harvest Operations

Using animals in rotary mode of operations.

i) Cane crushing
ii) Chaff cutting
iii) Oil extraction
iv) Grinding
v) Grain cleaning
vi) Paddy threshing
vii) Maize/groundnut shelling
viii) Flour grinding
ix) Electric generation

The above technologies are commercially available and are popular in some pockets of U.P. and Bihar.

STRATEGY FOR POPULARISATION OF ANIMAL DRAWN EQUIPMENT AND CARTS

Since a good number of technologies are commercially available a proper strategy need to be worked out for their popularisation in the States of U.P. and Bihar. For this following points should be considered.

1. Identification of improved package of implements

At the first step a Committee of experts should identify a package of improved implements for different crops and regions to be popularised. They should identify makes, model, size, cost etc.

2. Acquisition of identified machines

Once the machines to be popularised are identified. The state Govts. should either arrange to procure those machines from different places for distribution/sale amongst the farmers or should advise the farmers about the make and model and address of the manufacturers where from they can buy those items. The network of agricultural implements manufacturers available in the states of U.P. and Bihar should be involved in meeting the targets fixed for popularisation programmes. Their quality and prices should regularly be monitored. State Agro Industries Corporations, besides manufacturing agricultural implements should be given the responsibility of promoting local manufacturers and enforcing quality control.

3. Distribution of machines

Normally the farmers go for the purchase of agricultural machinery only a month or two before the season. If any subsidy is to be given it should be made available at the time of purchase.

SUPPORT SYSTEM

Any extension and popularisation programme can not succeed unless it has proper support system for different activities for which manpower and infrastructure is required.

1. For creating awareness about the machines

For creating awareness about the usefulness of new machines regular radio and T.V. programmes should be organised. Extension literatures should be distributed. Video tapes on the working of the machines should be prepared and shown to the farmers. At present this type of activity is very much lacking. Majority of the farmers do not know about the new developments and about availability of those items.

2. Supply of agricultural machineries

Normally simple agricultural implements are supplied to farmers under various promotional programmes. Supply of such implements to farmers in different parts of the State is very difficult unless advanced planning is done.

For this following steps should be taken.

i) Get the items manufactured/procured and supplied to different regions atleast 3 months in advance.

ii) Check that the material has been supplied in good condition and there are no broken or missing parts/components. any defect found should be rectified.

iii) Involve local manufactuerers in supply of equipment but ensure quality of materials supplied.

iv) Provision should be made about the availability of spare parts.

3. Demonstration of agricultural machinery

Generally farmers take decision about the purchase of any implements/ carts only when they are fully satisfied after seeing the performance of such equipments. The State Govt. of U.P. and Bihar do not have adequate infrastructure and manpower to conduct demonstration of improved implements and carts in different regions, this activity need to be substantially strengthened by trained manpower and mobile van etc. A team of trained demontrators should go from village to village and demonstrate proper working of improved implements and carts.

4. Availability of credit

State Govt. should select and list out important animal drawn implements and carts on which loans can be given to farmers by the NABARD at concessional rate of interest. At present many such implements are not in the approved list of NABARD and hence credit is not made available to farmers.

5. Training in operation and maintenance

Training of farmers, farm women and rural youth in proper operation and maintenance of agricultural implements is necessary for efficient utilisation of those implements/carts. At present adequate training facilities are not available in these states which need to be strengthened substantially.

6. Organising field and farmers days

Field and farmers days should be regularly organised during Kharif and Rabi crop seasons where farmers can be shown the actual benefit of use of agricultural machinery. Farmers from different places should be brought to those field days.

7. Exhibition and display centres

Agricultural machinery exhibitions should be organised in each region of the State every year or alternate year. This will give an opportunity to the farmers to see different types, makes and models of machines on the basis of which they can make their own choice.

In each region there should be a permanent display centre for agricultural machinery jointly run by the State Govt. and private manufacturers. In this centre different types of machines and packages of implements suitable for that region should be displayed alongwith full details. Farmers, manufacturers for them and planners can visit these centres and select machinery available for them.

8. Facility for repair and maintenance

When new machines are introduced in any area it should be ensured that there are some facilities for spare parts, repair and maintenance. Mechanics and village artisans of that area should be trained to repair newly introduced machines.

STRENGTHENING OF INFRASTRACTURE AND MANPOWER

In order to execute the extension and popularisation programmes there should be sufficient manpower and facilities in the State. For this a Directorate of Agricultural Engineering in both the States is essential. This Directorate should have sufficient trained technical manpower at block, district, region and State level for procurement, supply, demonstration, organising exhibitions and training programmes, giving assitance to farmers in selection of right type of equipment and for proper monitoring of the various programmes related to popularisation of agricultural implements.

CREATION OF DATABASE

A computerised data base can be created in each State regarding popularisation of draught animals and status of use of different types of agricultural machinery by the farmers. This will be helpful for planning purpose.

COORDINATION AND MONITORING CELL

A cell for coordination and monitoring of activities related to animal drawn implements and carts and other agricultural machinery can be created in the Directorate of Agricultural Engineering to have proper coordination between R&D organisations, manufacturers, State Govt. extension agencies, voluntary organisations, banks etc. engaged in agricultural machinery promotion programmes. the cell will also monitor the progress of various programmes for effective implementation.

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MULTI-PURPOSE ANIMAL DRAWN TOOL FRAME, ITS ADVANTAGES OVER THE CONVENTIONAL EQUIPMENT

Dr. R.S. Devnani,
Director,
Central Institute of Agricultural Engineering,
Bhopal, M.P.

Indian farmer is using animal drawn implement to perform the farm operations. These equipments are in use over the centuries and very little modification have been carried out. These are fabricated locally using the available raw materials by artisans. The major disadvantages in traditional implements are described as low output, low efficiency and the drudgery involved in performing the tasks by the farmers. The CIAE, Bhopal has developed improved animal drawn implements. CIAE Multi-purpose Tool Frame is one such device which can help in enhancing the work output from the pair of bullocks as well as reduce the drudgery of walking behind the animal.

Research conducted on the improved yokes and harnesses have indicated that the output from the pair of animal is increased by the use of Nagpuri yoke or three padded collor yokes. This enhanced output will be useful to overcome the resistance which is increased due to the riding of the operator on the tool frame. Thus with improved tool frame and yoke, the utilization efficiency of the animal powered system can be enhanced.

The mechanization of agriculture at the small farmer's level in India changed very little from the earlier times. In general, small farmers are using the animals as a source of power and a few implements which preceded the era of the hand tools. These implements have no moving parts and therefore, these are tools, but not machines. The farmers in the country has a very limited resources and, therefore, he can not make investment in the machines for the production of crops and for mechanized transport etc. Therefore, the

change to mechanized agriculture at farmer's level is to select appropriate technology based on draught animals which can be introduced among the farmers to improve the work output as well as reliability of the farm operations so as to be sustainable. To consider this, first step is to list out the activities carried out during the course of cropping season by the farmers and select the appropriate technologies which are technically superior and economically viable under local conditions.

Primary tillage, secondary tillage, fertilizer specifications, manure application, seed-bed preparation, sowing, crop thinning and weeding, weed control, chemical applications and secondary weed control with chemical weedicides. Harvesting of the crops, selective and complete crop drying, threshing, final cleaning, packing, stubble gathering, on farm transport, storage and marketing. Most of these operations are carried out by country plough, blade harrow, pata, hand tools like khurpi, sickle, roller type thresher, rake and a bullock cart. In order to mechanize the production system, the selection of appropriate technologies would involve careful assessment. The CIAE multipurpose tool frame is an appropriate technology for crop production of operation which has been described in this paper.

APPROPRIATE TECHNOLOGIES :

A large number of implements, tools and machines have been developed and reported by ICAR institutes, State Agricultural Universities and also number of farmers and other organisations. The transfer of these technologies need careful assessment. For this the simple approach is to classify them in different categories and recommend them accordingly to the requirements and needs of the farmers. The developed technologies can be classified into different categories as follows :

1. Technologies which help the farmers in performing unit field operations

timely to maximize yield. This can be done by timely sowing, eastablishment of the crop stand, weed control, harvesting, threshing etc.

2. Technologies which will increase the output of the oeprations and thus increase the output of the operator, i.e., lifting or supporting the load, carrying and their transport are the final actions.
3. Technologies that will avoid untimely work stoppages of the system elements, ie., draught animal, machine or the operator which includes providing of lifting arrangements on the implement, easy adjustment to be carried out while performing the field operations, easy picking and discharging of materials and avoidance of the cause of long rest periods.
4. Technologies which will reduce time and human energy while performing the tasks like lifting of the tools, to make small turing radius at the end of the field or to eliminate carrying of implements manually around the turns.
5. Technologies that will reduce the operator's drudgery such as eliminate walking, mechanize some of the operational controls, to make more time of the operator's available for productive activities and to improve the working life of machine by material substitution etc.
6. Technologies which would help in transport of the materials and the produce on farm and for market.

The important point in assessment of technology should be that it meets the basic operational criterion, the selected technology may not meet the above list fully but most of them to a great extent. are developed on these lines.

UPGRADATION OF ANIMAL DRAWN TOOLS :

Most of the animal drawn implements used in the country consist of long beam which is attached to the animal at the yoke and other end is fixed on the

implements. An operator's handle is provided at the tool end for steering the tools and lifting it at the time of turning. These implements are designed by the village artisans. to operate at stabilized depth for particular soil conditions. When the conditions change, the operator has little control to make adjustments and make it efficient. The mechanization of animal drawn technology can be essily improved by providing wheels and simple piece of lifting device further the operator's seat. Thus the tillage, sowing, interculture and other field operations can be carried out at a higher field efficiency.

The modifications and introduction of animal drawn technology can be introduced according to the level of technological skill developed by farmers and the stages of development of the region. The improved animal drawn implements can be introduced in two or more stages :

(i) Those implements and tools where addition of wheels are incorporated for transport and control on the depth of operation to utilize the full power of animals.

(ii) Wheels for carrying the tools, depth control and a seat for operator to ride on it. The improvements can substantially help the farmer in performing the tasks effectively and also achieve timeliness in operation.

One way of bringing the change is to incorporate the wheels on all the tools recommended for the crop production machine. This may be costly proposition. On the other hand it would be better to intoduce the implement system where the tools can be easily attached or detached as in case of other mechanized power unit. Keeping this in view the tool frame of multipurpose type was developed at CIAE, Bhopal for the farmers using animals as source of power on the farms.

CIAE MULTIPURPOSE TOOL FRAME :

The CIAE reported development of multipurpose tool frame to help the

farmers in performing the major field operation which are mostly carried out with traditional implements such as desi plough or bakhar. The tool frame is provided with a number of attachments, so that the walking of the operator behind the animal is eliminated. The wheels on the tool frame are mounted on the screw jack, therefore, depth of operations can be adjusted easily while the machine is in operation. The implement beam is connected to the yoke on the neck of the animals, this has also screw type arrangements for easy adjustment, the angle or line of pull. The tools which are to be attached on the tool frame are fitted with simple clamps and can be adjusted for effective width of operation according to the field and crop conditions. All these features are incorporated to improve the work output of the system using draught animal as a source of power and to reduce the drudgery of the farmers.

DESCRIPTION :

The tool frame consisted of a rectangular type frame which is provided with 2 ground wheels made of 400 mm dia with screw jacks for lifting and lowering the frames, a long wooden beam or pipe shaft to connect the frame with the yoke. The rectangular frame is made from 40 x 40 x 5 mm angle iron section joined together to make a hollow square section. The rear part of the frame which acts as a tool bar is made of 1000 mm in length. The implements are mounted on the tool bar using the clamps. These can be attached and detached easily. The implements provided are mould board plough, ridger bottom. sweep blades of different sizes, three row seed cum fertilizer drill, seat for the operator and a platform for transport of farm input and produce.

SPECIFICATIONS OF TOOL FRAME :

Length	:	3360 mm
Width	:	1300 mm
Height	:	1000 mm

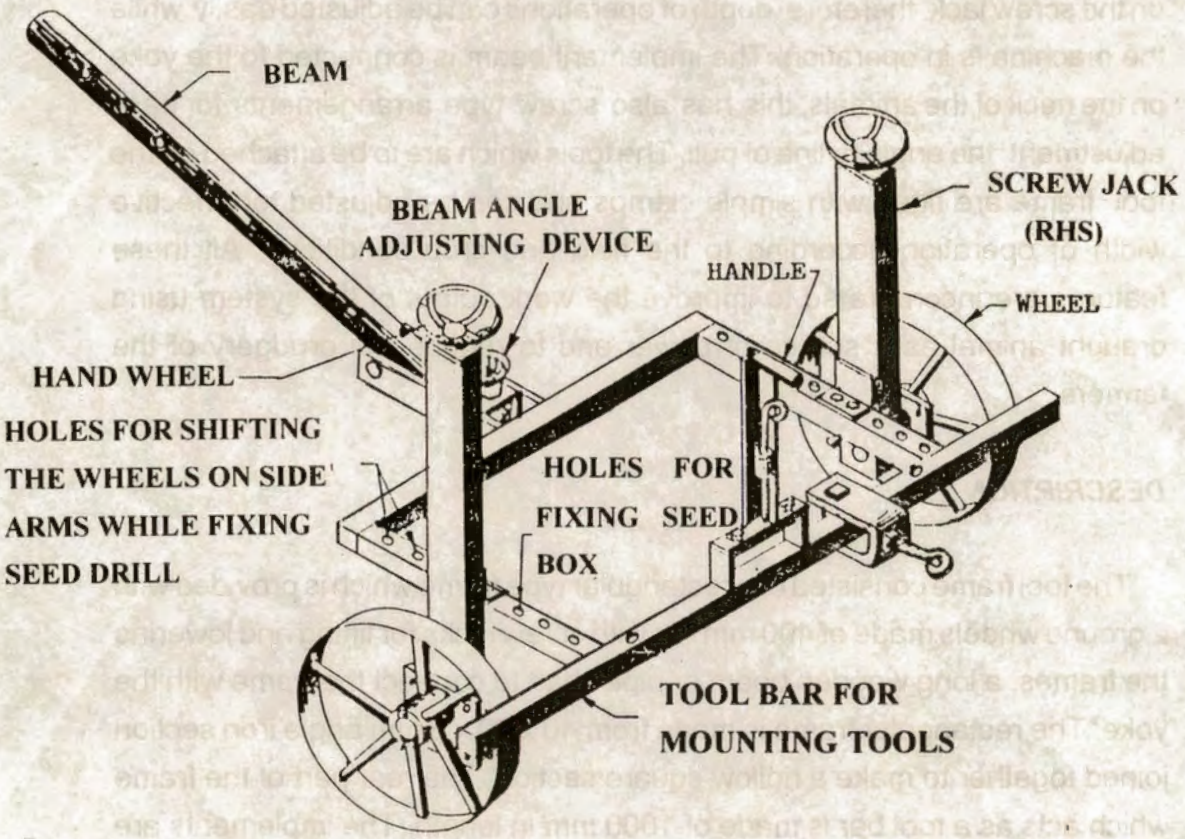

Fig.- **ANIMAL DRAWN MULTIPURPOSE TOOL FRAME**

Weight : 200 kg with all attachments
Cost of the machine : Rs. 5600/-

COST OF OPERATION :

(i)	Ploughing with MB Plough	:	Rs. 200/- Per ha
(ii)	Tillage with sweeps	:	Rs. 60/- Per ha
(iii)	Sowing of seeds and fertilizer application	:	Rs. 50/- Per ha
(iv)	Weeding & interculture	:	Rs. 40-56/ha

PERFORMANCE DATA/FIELD CAPACITY :

(i) Ploughing with MB plough for 0.6 ha/hr
(ii) Tillage with sweeps for cultivation and drilling seeds and fertilizer : 0.12 ha/hr
(iii) Weeding and interculture : 0.15 ha/hr
(iv) Labour requirements : 1-2 for different operations

SPECIAL FEATURES :

A seat for the operator and a platform for transport of input or produce. Thus the walking can be avoided. The depth of operation can be adjusted to suit the size of animals.

The studies conducted on the farmers fields as well as on the Institute farm have given the better results. From these results, it is noted that the work output capacity of performing various operations with the tool frame is at least in a times than the conventional or the tranditional tools.

Project has indicated that by using improved yokes and harness such as improved Allahabad type three padded collar harnesses and the Nagpuri yoke, the output of the animals can be enhanced by 1-12 percent. When the

The recent studies conducted under the Utilization of Animal Energy tool frame is used, and the operator is to sit and ride on it, the draft requirements are increased by 10-12% over the conditions when operator has to walk behind the animals. Thus with tool frame and improved yokes it is possible to perform the farm operations on the small fields using animals draught power technology.

CONCLUSION :

The improved implements such as tool frame with various attachments is the appropriate technology for introduction on the farmers fields for raising the upland food crops in many parts of the country and can be used to give advantage to the farmers of enhanced work capacity and also reduce the drudgery. The only decision to be taken by the policy makers is regarding the funds for technology multiplication and quick absorption by the farmers. This needs much greater attention because this type of technology involves more capital, munufacturing technology, quality control as well as dedicated technical manpower to popularise them in the rural areas spread throughout the country.

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SHARED RESPONSIBILITIES

The provision of water supply and sanitation facilities imply a two-way partnership between project executors and project beneficiaries. However, the intended partnership and division of responsibilities are not always achieved ..... what is important is that the right balancin responsibility sharing should be maintained.

WHO

STATUS OF BULLOCK POWER AND ITS UTILIZATION IN EASTARN UTTAR PRADESH

M.R. VERMA
Prof. of Agril. Engg.
Narendra Dev University of Agricultural
& Technology (NDUAT), Faizabad.

Bullocks are major draft animals (DA'S) in Eastern Uttar Pradesh. The study based on sample survey of eastern U.P. indicated that mostly bullocks of local non descript (60%), Gangatiri (15%), Hariana (13%) and kherigarh (12%), breeds are used as DAS in this region. The annual use of bullocks was found to be quite low (186 to 598 h/yr) and it was maximum during the periods of 15th June to 31st July and 15th October to 30th December of the year. The bullocks are mostly utilized for tillage (76.7%) and crop sowing (133.4%). The study reveals that the bullock power contributes about 0.276 hp/ha which is about 31% of total power (0.89 hp/ha excluding irrigation) available for crop production. In this region about 30-40% farmers are still dependant on bullock power for their crop production inspite of major thrust given on introduction of mechanical sources of farm power during last one decade. The nutrient availability to working bullocks is below the desired level and is more alarming during summer season.

The farmers of this region are still using the age old bullock drawn implements (country plough and wooden planker) of about same size irrespective of breed and size of bullocks with very poor system efficiency. The use of some of the promising bullock drown improved matching equipment has also been suggested in the paper to enhance animal machine system.

Bullocks are being used in Indian Agriculture since ages as draught animals (DA'S). In this age of mechanization they still have an important place in Indian agriculture and will continue to have the same for many more years to come particuarly in under-developed and developing regions of the

country like eastern Uttar Pradesh. It is felt that the use of bullocks will never be completely displaced in eastern UP due to tractorization because of large number of small holdings and socio-economic disparities among the farmers of this region. Increasing trends in fossil fuels prices and their limited reserves have led to the search and use of new and renewable energy resources. A large investments are being made in developing technologies for harnessing the potential of solar,wind, geo-thermal,bio-mass and other renewable energy resources for the service of man and to use them in agriculture. Among the various non-conventional and renewable sources of energy, bullocks as draught animals constitute a very high proportion specially in agriculture sector and are easy to develop and harness.

The bullock power saves considerable amont of non-renewable fossil fuels required for agriculture-forming. It is well within the reach of marginal and small farmers and is technically feasible and economically viable. It is also more equitably distributed than any other energy resources and is intimately associated with rural life. Bullocks are unique source of renewable energy, converting solar energy through plant life into useful products and services. They also help in restoration and maintenance of ecological balance. Thus, there is a strong symbiotic relationship and interdependence among Land-Plant-Draught Animal-Man system (Ramaswamy, 1983).

It is estimated that there are about 3.80 million bullocks as DAS in eastern U.P. About 47.2% farmers have bullocks as tractive source of power of which about 50% also hire tractor power (NDUAT 1989). Farmers of this region are still using the primitive type implement (country plough and wooden planker) of same size irrespective of breed and size with very poor work out put (0.03 to 0.04 ha/h field capacity) and system efficiency. Thus in order to use bullock power fully and efficiently, improvement in traditional animal-machine systems and their testing under actual field conditions seems to be necessary.

METHODOLOGY

The study is based on the data collected during field survey conducted by the author and his team under the ICAR Adhoc scheme on "Study on Local draught animals and adoption of improved implements for eastern UP". For this case study the eastern Uttar Pradesh which comprises of three agro-climatic zones namely:

(a) North Eastern Plain Zone (Zone No. VIII)
(b) Eastern Plain Zone (Zone No. IX) and
(c) Vindhyan Zone (Zone No. X) has been taken as project study area because of typical socio-economic conditions, land holding sizes, bullock types, local needs etc. of the farmers of this region.

The farmers were also contacted personally and interviewed to know the constraints in DA'S utilization and to get their suggestions in improving this system.

RESULTS AND DISCUSSIONS :

Bullocks and their availability :

The bullocks are major draught animals used for agriculture work in eastern work in eastern Uttar Pradesh. The major bullock breeds used for draught purposes are local non-descript (60%),Gangatiri (15%), Haryana (13%), and Kherigarh (12%). In general bullocks are ready for use in agriculture and allied works after the age of about three years and their useful service life is about 10 years. The survey conducted by the author and his team (NDUAT 1989) during the year 1988-89 reveals (table 1) that draught bullocks population has declined drastically (46.06% decrease from 1982 to 1988-89) during the last few years due to increased use of electro-mechanical

sources of power in agriculture as well as poor output of the traditional bullock power system and drudgery involved in their use. Inspite of decrease in bullocks population on an average 47.2% farmars in eastern UP have draught animals as tractive source of power and about 30-40% farmars mostly (most of the) small and marginal farmers are fully dependant on them for various farm operations. The tractor owner farmers also use bullocks for some operations like interculture,fodder transport, etc.

The farm power received from bullocks in eastern UP is about 0.276 hp/ ha (Table 2) which contributes about 31% of the total farm power available (0.891 hp/ha excluding irrigation) for agriculture (NDUAT 1989).The table 2 indicates that on an average total farm power availability per unit area (1.51 hp/ha) based on sample survey seems to be satisfactory, but the crop production and productivity of this region are still lower than other developed regions of the country. One of the main reasons of poor crop production and productivity is poor and improper use of available farm power. Thus it involves a detailed and systematic study on utilization pattern,system efficiency, quality of work performed etc., by various sources of farm power including bullock power to boost the agriculture production and productivity with reduced cost of production.

UTILIZATION OF BULLOCKS :

Bullocks are employed for a variety of farm operations in eastern UP. They are capable of doing work under varying field terrain and climatic conditions. They can develop 4-5 times more power than their normal capacity for short duration. They may be used for following farm operations.

(A) Crop Production Operations:

i) Tillage

ii) Sowing and fertilizer application

*ploughing	iii)	Weeding and interculture.
*Harrowing	iv)	Water lifting
*Planking	v)	Threshing

(B) Post Harvest Operations:

i) Chaff cutting
ii) Oil extraction
iii) Cane crushing
iv) Grinding etc.

(C) Rural Transport:

Earlier, bullocks and other DA'S were being used for most of the above operations have now been modernized through non animate power sources and use of bullocks in rural transports is also being reduced to some extent.

The avarage utilization of bullocks in Kharif,Rabi and Zaid crop seasons in eastern UP was 171, 244 and 21 hours respectively (Table 3). The annual average utilization was 436 hours varying from 186 to 598 hours. The operation wise average annual utilization of Bullocks was 334.5 hours (76.76%) in tillage, 58.6 hours (13.43%) in sowing, 9.0 hours (2.07%) in threshing and 33.7 hrs(7.74%) in other miscellaneous works like transport, irrigation, post harvest operations etc.

This indicates that annual utilization of bullocks in this region is quite low (186-598 hrs/yr) where as ideally it should be about 2500 hrs/yr (Srivastava 1987). Thus keeping in view the above facts, there is a need to develop new and diversified areas where bullocks may be utilized efficiently and regularly to make this power source economically viable in comparison to other mechanical sources of power.

STATUS OF BULLOCK DRAWN IMPLEMENTS:

The number of bullock operated improved implements equipment like mould board plough, disk harrow, cultivator, seed drill, ridger, puddler etc.,per 1000 ha of cultivated area in different agro-climatic zones of eastern (Table 4) indicates that present status of improved bullock drawn implements and equipment use is very dismal in all the three zones of eastern UP (Singh et. al. 1988). Still at present almost every bullock owner farmers use age-old primitive country plough and wooden planker for seed bed preparation, sowing and interculture operations. The use of country plough involves drudgery and gives low work output (0.03 to 0.04 ha/hr). Ploughing of one hectare field with a country plough of 10-12 cm size involves walking of animals and operator of about 80-100 km per operation and normally it requires 4-5 operations for satisfactory seed bed preparation. The country plough being smaller in size under utilizes the power available with the average size of a pair of bullocks, thus, it increases drudgery and reduced efficiency of bullock power system. By use of matching and improved implements/equipment as per bullocks capabilities the animal-machine system efficiency, field capacity may be improved and the drudgery can also be reduced.

Although a number of bullock drawn implements/equipment have been developed during last three decades but most of them still have not reached and became popular among the farmers due to several reasons. One of the major reasons is non-availability of good quality implements, matching to bullock power, the table 5 gives the traditional and improved animal drawn implements machinery for various operations. This table only indicates the name of improved equipment but before adopting them there is need to specify and know the detailed specification of these equipment considering the bullock capacity, soil type, annual use and other socio-economic aspects. During the present study it has been observed that almost same size of

implement is being used with all sizes of bullocks. Thus, there is an inefficient utilization of animal-machine system.

The average command area with 20% cropping intensity by a pair of bullocks of different sizes with traditional implements, at farmers level in eastern UP is (Table 6) 0.633, 1.106 and 2.175 ha/bullock pair of small, medium and large size bullocks respectively, whereas with the use of improved matching implements, 1.5 to 2 times area can be commanded with the same pair of animals (Verma & Verma 1987).

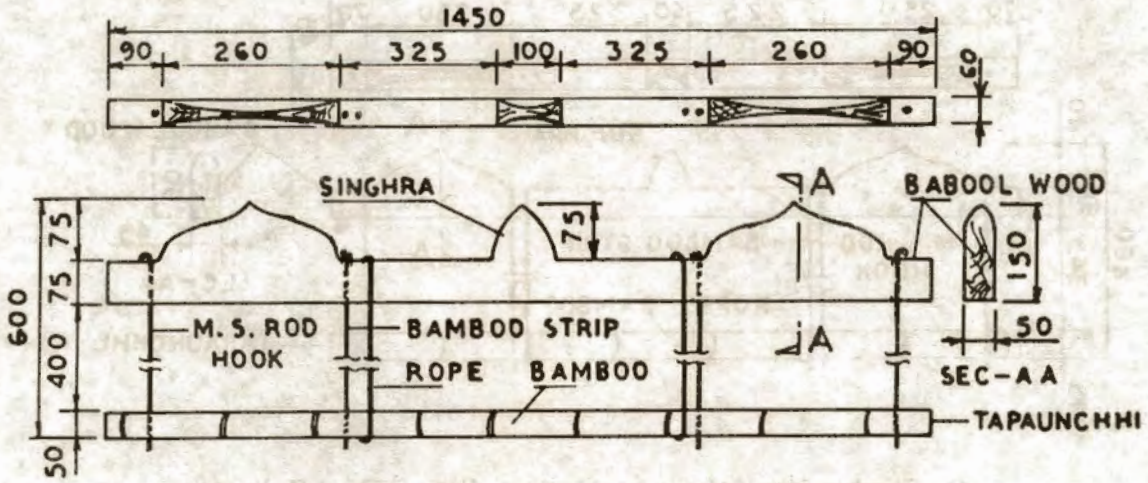
STATUS OF HARNESSESS AND YOKES:

In eastern Uttar Pradesh, a simple rigid double neck wooden yoke of different sizes is commonly used for hitching a pair of bullocks with implements by using a beam (made of wooden or GI pipe) or rope. These yokes differ in sizes according to size of animals and most of them are closed from bottom side while few are opened from bottom (fig.1). It was observed that there is uneven distribution of load when different sizes of animals are used in a pair to pull on implement using this type of yoke. Sometimes it also creates injuries on animals neck and develop neck gall which reduces the draught capacity of the animals. Thus there is need to design, adopt and popularize improved harnesses to improve draught capacity of the animals and provide comfort to the DA'S (Devnani 1987).

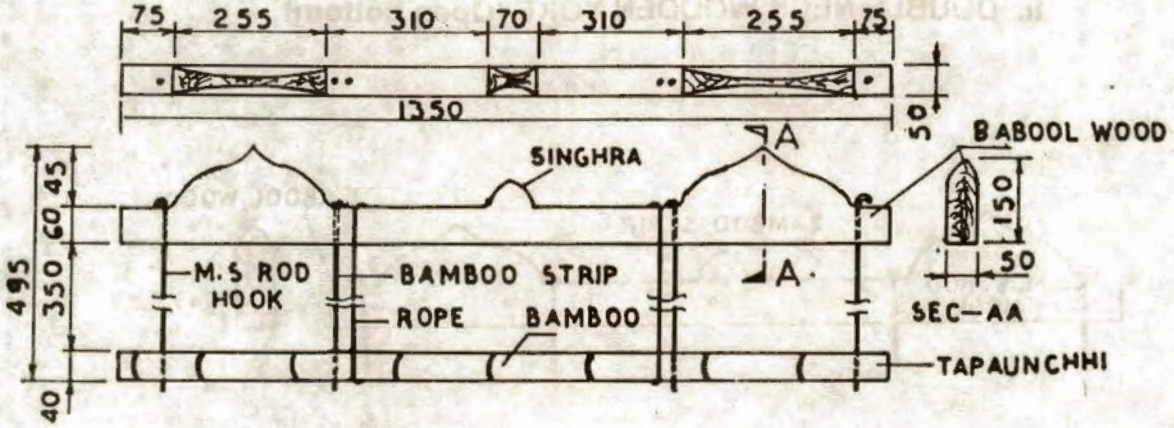
FEED AND NUTRIENT MANAGEMENT :

In eastern U.P. bullocks are reared mostly on crop residues. Only few farmers (34%) feed green fodder and concentrates regularly. The study showed that nutrient availability to bullocks in this region was below desired level and was more alarming in summer season (Table 7). It was also observed that nutrient intake and its utilization was effected by quality of feed

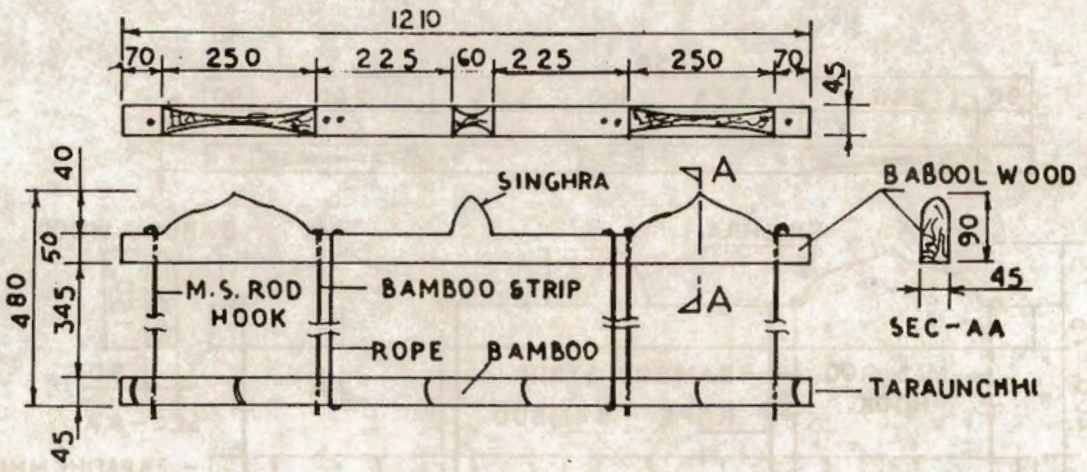
I. DOUBLE NECK WOODEN YOKE (Closed Bottom)



A. Double Neck Yoke for Heavy Size Pair of Bullock

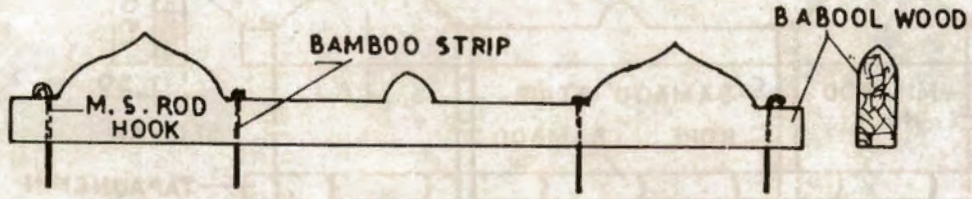


B. Double Neck Yoke for Medium Size Pair of Bullock



C. Double Neck Yoke for Medium Size Pair of Bullock

II. DOUBLE NECK WOODEN YOKE (Open bottom)



(Fig.-1)

and changes in environmental conditions.

Hence, there is need to develop suitable fodder production package and have strong R&D programme in nutrition management of bullocks to increase their work output keeping in view of the local condition.

CONSTRAINTS IN BULLOCK POWER UTILIZATION :

A number of farmers were contacted with a view to have their opinion for lesser and declining trend of bullock power utilization. Although the farmers of different districts of eastern U P have been contacted but opinion of most of the farmers were same. Some of the major issues raised by them in this regard are given as under :

* A great deal of drudgery is involved in various farm operations specifically when performed with traditional implements using bullock power. New generation does not want to walk behind bullock.
* Work output and bullock power system efficiency is poor and hence it is difficult to finish the critical farm operations in time.
* Non-availability of labour at cheaper wage rate for operating the animals.
* The care and maintenances of bullocks is year around and cumbersome
* Increase in electro-mechnical power sources through mechanization and their availability for custom hire at reasonable rates has reduced the bullock power use.
* Risk of sickness.
* Problem of fodder due to decrease in grazing land (only in very few areas).
* Non-popularization and availability of improved and reliable, matching implements/equipment for different farm operations.

RESEARCH NEEDS FOR IMPROVING BULLOCK POWER SYSTEM :

It is now beyond doubt that bullock power plays an important role in Indian

Agriculture particularly in those areas where most of the farmers land holdings are small and their socio-economic conditions are poor (like eastern Uttar Pradesh, Bihar, Orissa etc.). Bullock power system saves consumption of fossil fuels, provides manure in agriculture and is renewable in nature. On the basis of foregoing analysis and discussions on various issues of bullock power system made in this study, it may be said that bullock power system efficiency and utilization is very poor in eastern U.P. Thus, there is a great need and scope to have strong research and development (R&D) back up in the following major areas to improve this system.

A. Draft Bullock Improvement:

* Breeding
* Feed and nutrition management
* Health cars.

B. Enhancing the efficiency and utilization of animal-machine system:

* Adopting improved harnessing devices.
* Development and use of matching implements.
* Assessment of Draught capacity of different breeds of bullocks.
* Fatique assessment and working out suitable workrest cycle for bullocks.

Table 1 : Changing trend in DA'S population in Eastern Uttar Pradesh (1972-1989).

Category of DA'S	DA'S population per 1000 ha cultivated area *			%Change from 1982 to 1988-89.
	1972 **	1982 **	1988-89 ***	
1. Male cattle over 3 years	*1043.5 (5877)*	*1242.9 (7000)*	*670.7 (3777)*	*(-) 46.03*
2. Male buffaloes over 3 years	*5.9 (33)*	*38.9 (219)*	*20.7 (116.6)*	*(-) 46.78*
Total	**1049.4**	**1281.8**	**691.4**	**(-) 46.06**

* *Cultivated area of eastern UP 5.632 m / ha.*

** *As per live stock census 1982 of U.P., India*

*** *As per sample survey data (NDUAT,1989).*

Figures in parenthesis indicate total number of DA'S in thousand.

Table 2 : Farm power availability in eastern UP from different sources (As per sample survey)

Source	No sample survey village	Unit hp	Total power hp(%)	Power per unit area hp/ha .	Power per unit area excl. irrigation hp/ha
Human	*5607 **	*00.07*	*392.49(8.36)*	*0.126*	*0.126*
Animal	*2145*	*00.40*	*858.40 (18.27)*	*0.276*	*0.276*
Tractor	*81*	*25.00*	*1417.50** (30.17)*	*0.457*	*0.457*
Engine	*236*	*07.75*	*1829.00 (38.94)*	*0.589*	*0.029****
Electric Motor	*40*	*05.00*	*200.00 (04.26)*	*0.064*	*0.003****
		4697.39		*1.513*	*0.891*

* Cultivated area 3104.07 ha

** About 70% tractor power is used for agriculture.

*** About 95% engines and motor power is used for irrigation.

Figures in parenthesis are in percent of total power.

Table - 3 Operation and crop season wise annual use of DAS in eastern UP (Based on sample survey NDUAT:1989)

Operations	No. of Bullock Pairs surveyed	Av. utilization hrs. Crop seasons Kharif	Rabi	Zaid	Av. annual use (hrs)
Tillage	42 Bullock pairs	151.38	172.25	10.86	334.49 (76.76%)
Sowing	-do-	15.00	40.67	2.89	58.56 (13.43%)
Threshing	14 pairs from each of three zone of the region	—	7.52	1.48	9.00 (2.07%)
Other		4.55	23.61	5.57	33.73 (7.74%)
Total	-	170.93	244.05	20.80	435.78

Table 4: Status of animal drawn implements/equipment in different zones of Eastern UP *

Sl.No.	Name of Implement	No. of equipment per 1000 ha cultiveted area zone [No.VIII]	zone [No. IX]	zone [No.X]	Eastern UP Av.
1.	M.B.Plough	_	_	168.0	089.5
2.	Disk harrow	66.8	102**	-	22.6***
3.	Cultivator	97.0	61.8	-	40.6
4.	Seed drill	-	-	0.4**	0.1***
5.	Olpad Thresher	-	-	0.4**	0.1***
6.	Sugarcane crusher	27.5	71.0	22.9	31.2
7.	Chaff cutter	-	-	-	-
8.	Dunlop/local cart	55.0	55.0	25.4	36.1
9.	Ridger	-	-	-	-
10.	Puddler	-	-	-	-
11.	Persian wheel	-	06.80	-	01.0

** *Based on survey reports of NDUAT,Faizabad,Status of agricultural implements use in Uttar Pradesh(Singh et-al 1988).*

*** *Estimated*

* *Based on Ist Annual Report 1988-89 of ICAR Adhoc scheme on "Study on Local Draught etc." NDUAT,Faizabad,Centre (NDUAT 1988).*

Table 5: Indigenous and improved animal drawn implements/ equipments for different farm operations.

	Operation	*Indigenous Implement*	*Improved Implements*
1.	Ploughing	Country Plough	M.B.Plough
	Harrowing	Country plough with miniature mould board	Disk Harrow
	Puddling	-	Puddler
	Cultivating	-	Cultivator
2.	Planking	Wooden planker	Patela Harrow
3.	Sowing	Boardcasting Mixing with contry Plough,country plough with tube	2-5 row seed cum ferti drill & 2-3 row planter
4.	Weeding and Interculture	Country plough (very limited use)	3-5 time cultivator, Dore,3-5 time sweep.
5.	Spraying & Dusting	-	Animal drawn engine operated Sprayer and duster.
6.	Irrigation (water Lifting)	Mhote	Persion wheel,Animal drawn duplex pump.
7.	Making ridges furrows,bunds.	Country plough with some attachement	Ridger/furrower,bund former
8.	Harvesting	Country Plough(for root crops)	Potato digger,Ground-nut digger
9.	Threshing	Bullock treading	Olpad thresher,Hold on type paddy thresher
10.	Trasport	Local cart	Pneumatic carts
11.	Post Harvest Operations	Local oil ghani,Cane crusher	Improved ghani,Cane crushers,flour grinder

Table 6 : Average command area per bullock pair (bp) in eastern U.P. as per sample survey.

Sl. No.	Size of bullock pair	Command area (ha/hp)	Cropping intensity(%)
1.	Small	0.633 (0.20 - 0.93)	190 (180 - 220)
2.	Medium	1.106 (0.60 - 2.04)	203 (185 - 236)
3.	Large	2.175 (1.74 - 2.7)	189 (184 - 195)

Note:
1. Figures in parenthesis in Table 6. indicate range. of command area and cropping intensity.
2. *Only bullock operated farms were taken for study (as shown in Table 6. of last page).*

Table 7 : Excess and shortage of nutrient availability to working bullocks in different seasons of the year in eastern UP.

Sl.No.	Season / Nutrient	Excess (+) Light wt 350 Kg	Shortage (-) Medium wt. 350-450 Kg.	Kg. Heavy wt. Above 450 Kg
A.	**Winter :**			
	DM	+0.23	+0.43	+0.37
	DCP W_L	-0.09	-0.11	-0.18
	DCP W_H	-0.13	-0.21	-0.33
	TDN W_L	+0.49	+0.68	+0.47
	TDN W_H	-0.39	-0.23	-0.96
B.	**Summer :**			
	DM	-0.40	-0.45	-1.11
	DCP W_L	-0.17	-0.20	-0.30
	DCP W_H	-0.20	-0.31	-0.45
	TDN W_L	+0.19	+0.30	+0.10
	TDN W_H	-0.59	-0.61	-1.33
C.	**Rainy :**			
	DM	+0.04	+0.15	-0.03
	DCP W_L	-0.10	-0.14	-0.24
	DCP W_H	-0.13	-0.24	-0.39
	TDN W_L	+0.45	+0.86	+0.77
	TDN W_H	-0.33	-0.05	-0.66

W_L : Light work
W_H : Heavy work

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HARNESSES OF DEVELOPING COUNTRIES

A.K. Singhal
Agricultural Engineering Department
C.S. Azad University of Agril. & Technology, Kanpur-208002

A number of developing countries, particularly in Asia and Africa are today faced with food crises. Agricultural production is unable to keep pace with a food crises and spiralling population growth. The only means of remedying famine situations between now and the end of the century is to increase agricultural production. This in turn will call for parellel increase in the supply of energy to Indian Villages. Draught animal power seems to be inevitable because India has over 15 million small holdings with less than one hectare area where the use of tractors and tillers are uneconomical and has the largest live stock in the world. The replacement of draught animal power by mechanisation may need an investment of over 10,000 crores of rupees. As per F.A.O. estimate it will be necessary to double the present supply of energy for agricultural traction. This will clearly call for renewed efforts to improve the efficiency of draught animal energy-problem to which little or no attention has been paid, as ineficient harnesses in variably infilict on the unfortunate creatures a life of torture due to which only part of their power potential is ever exploited. Usually, they work under cruel yokes. As a consequence their working lives are considerably reduced and they produce little meat. milk or manure. A large number of related problem need to be tackled without delay if the situation is to be improved for example- breeding of live stock, improving food stuff supplies, vaterinary services and work of increasing the efficiency of animal-drawn agricultural implements and vehicles. The present paper review the work done in this area and discusses to one problem only, namely the efficient harnessing of draught animals of different species.

CHARACTERISTICS OF GOOD HARNESSES

The angle of pull :

Loads are pulled by means of two straps, chains or ropes that connect the

load to the animal. The angle between the traces and the horizontal line at the point of attachment to the load (fig. -1) is called the angle of pull. This angle should be as narrow as possible so as to use the power of the animal to a maximum.

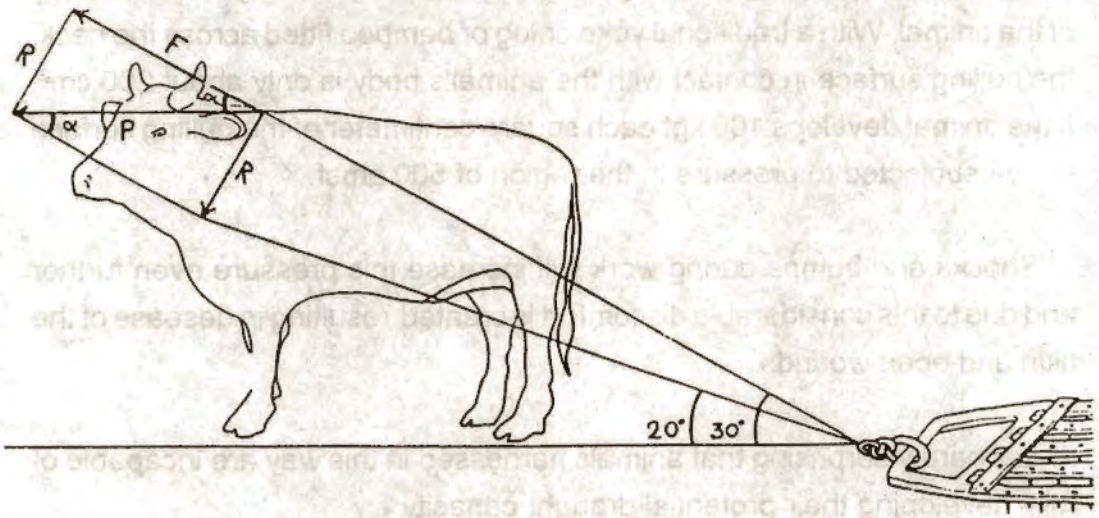

Fig. 1 The angle between the trace and the horizontal should be as small as possible

Ideally, there should be no angle at all which occures for example, when animals are attached to the relatively high carts and when the traces are parallel to the ground as the angle increases. the pulling force is split at the point of attachment to the animal part of the force (R) is wasted for the pulling proceses and instead exerts pressure and added discomfort on the animal.

By way of example if a bullock is harnessed to a yoke and the angle of pull is 30°, the downward pressure on the animal could amount to as much as 50 kgf. This calculation does not take into account the weight of the yoke itself. Which may amount to about 10 kg per animal.

SURFACE PRESSURE :

The efficiency of a harness is greatly influenced by the way it fits the body of the animal. With a traditional yoke or log or bamboo fitted across the neck, the pulling surface in contact with the animal's body is only about 200 cm^2. If the animal develops 100 kgf each square centimeter of the pulling surface will be subjected to pressure in the region of 500 gmsf.

Shocks and bumps during work will increase this pressure even further and due to this considerable discomfort is created resulting in desease of the skin and open wounds.

It is hardly surprising that animals harnessed in this way are incapable of fully developing their protential draught capacity.

With a well designed and properly padded collar for bullocks, the pulling surface on each shoulder may easily be increased to 600 cm^2 giving a total of 1200 cm^2 over the two shoulders.

The pressure on each cm^2 of the animal's back may thus be reduced by a factor of six. This, together with the provisions of padding, allows the animal to work more efficiently and without suffering.

WORKING POSITION :

An efficient harness must be designed so that the animal can use its body

in a natural way. Placing a yoke on the head or neck obliges the animal to alter its normal stance and also forces it to curve its spine in order to hold the yoke in place. Often adult animals are incapable of doing this and can not be worked. As soon as the animals are put to work they resent yoking. They jump about with the yoke. In this stage usually generalised inflammation on neck is seen with local swelling. Apart from considerations of posture, attaching animals by the neck or head is cruel in that its exposes them considerable unnecessary suffering when loads are pulled over rough grounds. The continual shocks that occur during such work are transmitted directly to very vulnerable parts of the body.

WEIGHT OF THE HARNESS :

Ideally, harnesses should be as light as possible. This being said, the horse collar perfected over the centuries in, for example, Europe and North America were relatively heavy. Those designed for heavy work weighted about 20 Kg. However, if given the benefits of modern materials it is now possible to reduce this figure considerably.

Some research has indicated that the weight of the harness carried by a horse at walking pace is of direct relevance to the useful load it can pull (excluding the weight of the vehicle) thus, to increase the weight of the harness by 10 kg could reduce the useful load by 200 kg or a proportion of 1 to 20.

HORSE COLLARS :

It is generally accepted that the best harness ever applied to animals is the horse collar. In most areas the collar harness was employed exclusively with horses. Which assumed an increasingly important role as saddle and draught animals.

Horse collars meet all the criteria of a good harness described above.

THE SWISS OXEN COLLAR & CONVENTIONAL YOKE :

Yokes are primarily designed to facilitate the control of the animal they are also in expensive and relatively easy to manufacture as most of the serviceable yoke consists off a smooth round pole of 1.3 meters in length, with a diameter of atleast 9 cm. It is fitted at the centre with bolt to which the shaft of the cart can be attached. It is securely bound with a strong rope, 40 cm on either side off this rod, a very smooth wood of 2.5 cm. diameter being fitted to prevent the yoke pole moving at right angles and extended below by 30 cm. -25 cm. beyond each of these, aflat headed rod of iron about 1.5 cm thick or of tougher wood is inserted parallel to the first one through the yoke in a manner which allows the rod to be moved up and down. The neck rods come down at each side of the neck. When the yoke is carried and kept in position, maintaining the proper distance between the pair of bullocks. Bearing surface between the neck rods is slightly levelled, so as to form a shallow arch which adapts it self more closely to the neck and increases its area of contact. Edges are rounded off. Regrettably, efficient utilisation of draught power and comfort of the animal are hardly ever taken into account.

A notable exception to this rule is found in Switzerland where farmers dis-adopt the horse collar to bovines. This not only enabled them to increse the draught efficiency of the animals but also to harness horses and bovines together in the same team, an important advantage for those farmers who could only afford one horse. These collars are usually referred to as "Bern" collars. The design was greatly influenced by that of the horse collar and notably provided padding around the animal's body. Contrary to popular belief, perpetuated by the use of yokes, bovines do not pull best from the head or neck. Rather their pulling force, like that of horses and indeed of human beings comes from the shoulders. (fig.- 2 and fig.- 3)

Some double neck yoke was designed by Senor Cespedes of Bolivia

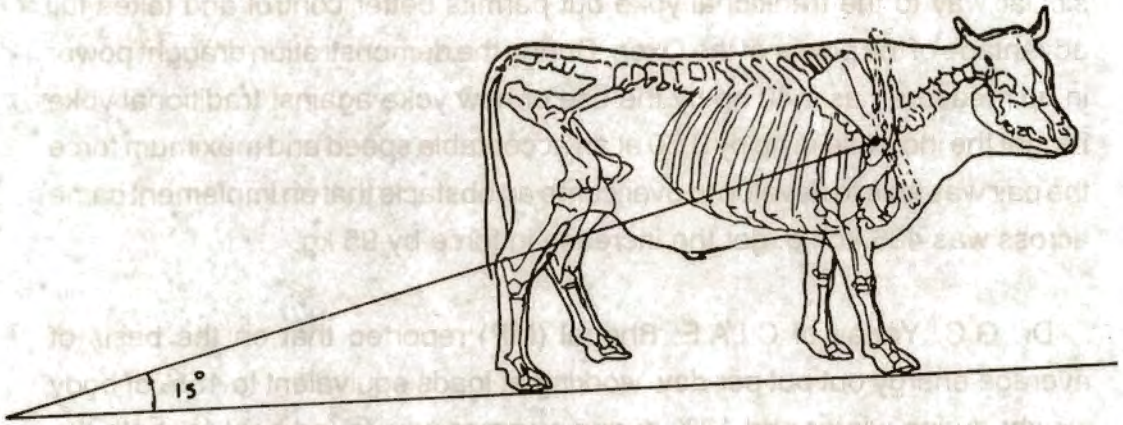

Fig. - 2

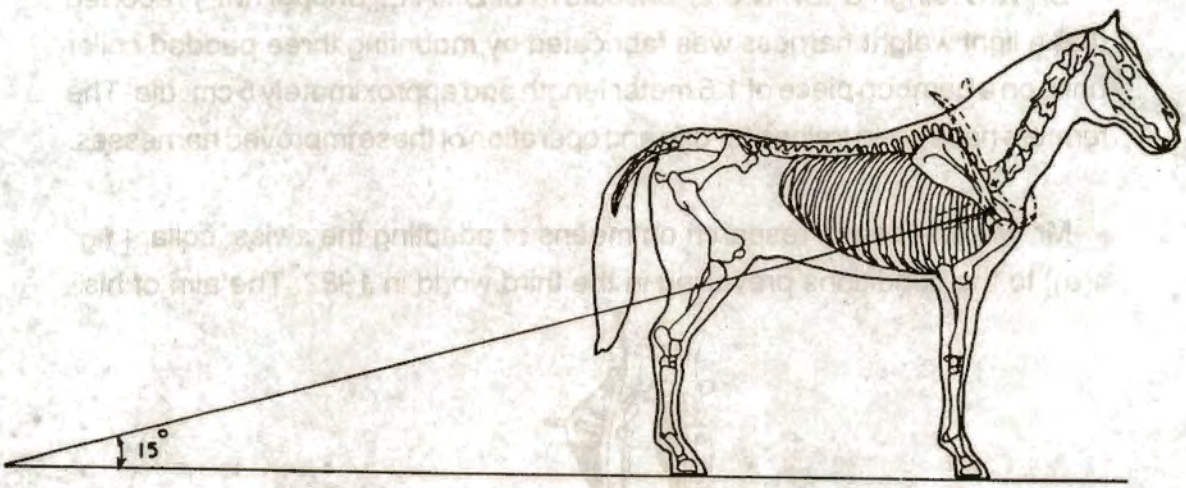

Fig. 3 - The angle of pull is the same

(South America). This was made of wood similar to the traditional yoke. But this is simple, lighter and cheaper. This yoke is fastened to the Oxen in a similar way to the traditional yoke but permits better control and takes full advantage of the power of the Oxen. During the demonstration draught power in hp measured as 1.40 hp by the use of new yoke against traditional yoke i.e. got the increase in hp by 0.60 at an acceptable speed and maximum force the pair was able to develop to over come an obstacle that an implement came across was 436 kg i.e. got the increase in force by 95 kg.

Dr. G.C. Yadav of C.I.A.E. Bhopal (MP) reported that on the basis of average energy out put per day working at loads equivalent to 15% of body weight during winter and 13% during summer was found best for both the Malvi and local breads of bullocks using improved Allahabad double animal harness. With local yokes the energy output per day was best at draft load of 10% of body weight for both the breeds under both the seasons i.e. the padding system increases the efficiency of the bullocks considerably.

Dr. R.C. singh & Dr. N.S.L. Srivastava of C.I.A.E. Bhopal (MP) reported that a light weight harness was fabricated by mounting three padded collar units on a bamboo piece of 1.6 meter length and approximately 5 cm. dia. The farmers have been trained for use and operation of these improved harnesses.

Mr. Micutta began research on means of adapting the swiss collar [fig.-4(a)] to the conditions prevailing in the third world in 1982. The aim of his

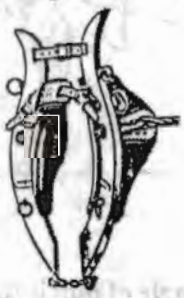

Fig. 4 (a) - A bovie collar developed in Switzerland.

investigations was to preserve the functional value of the swiss collar but the simplify the design and reduce production cost so as to render it accessible to the world's poorest communities.

BRIEF DESCRIPTION OF THE COLLAR :

The basic components of the collar are the hames and the pads-both of which may be readily produced from materials available locally. The hames are formed from two pieces of wood shaped to fit the contours of the animal [fig.-4(b)]. They should be made from hard, yet resilient wood such as that used locally for the manufacture of handles for agriculture tools like axes or hoes. It is important that the grain of the wood runs along the curve as this strengthens the hames. If good quality wood is employed the thickness of the hames need not exceed 3 cm for bovines or 2 cm for donkeys. It is essential that the hames should fit the animal well in order to ensure the maximum of comfort. For bovines, which rarely trot, the hames are placed wider apart at the bottom. For animals which do occasionally trot, such as donkeys, the hames may be closed slightly more around the breast so as to provide increased stability.

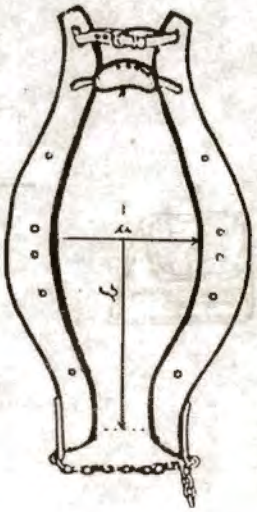

Fig. 4(b) - The hames

PADS :

The shoulders of draught animals must be well protected against the pressure of the hames-hence the improtance of pads inceased. Traditionally, pads were manufactured from leather but there is no reason why they should not be made from any available cloth for example, jute bags (particularly flour sacks) available in all developing countries offer a good solution (fig.- 5) and also number of vegetable matters that will serve the purpose of suitable stuffing material.

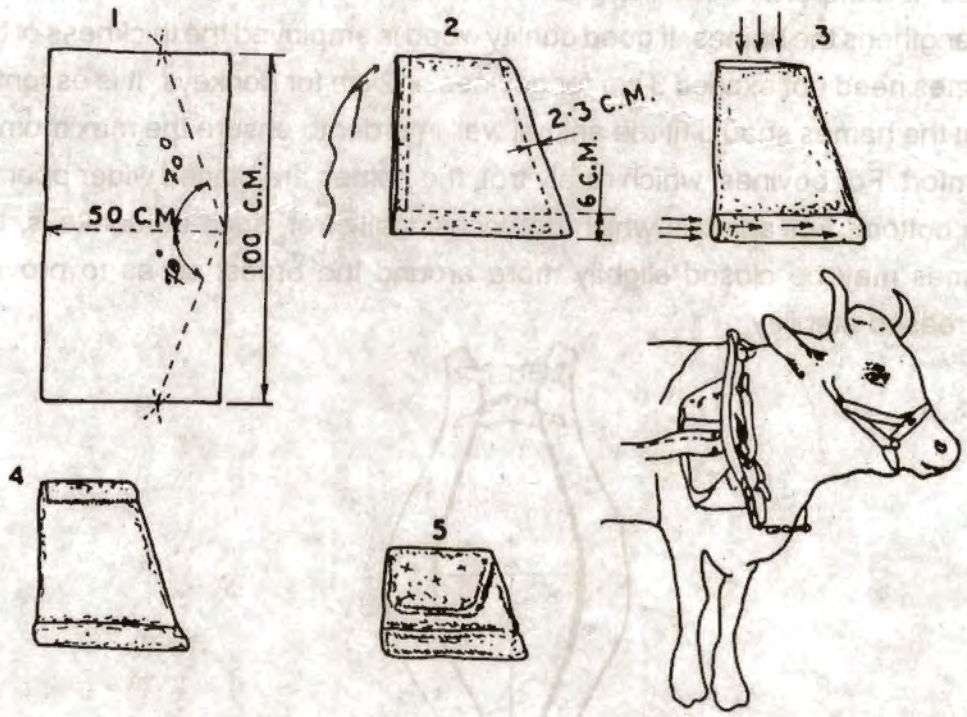

Fig.- 5

TESTING THE NEW COLLAR :

The new collar as produced by Dr. Micuta was given to some swiss farmers who continue to use bovines for daily agricultural work. They have been using the collar daily for the last three years and as per their report it has given entire satisfaction. This collar was made locally and fitted to a donkey and cart used to deliver completed cookstoves to outlying households in KENYA. As per Dr. Micuta report it was immediately accepted and liked by the local population of KENYA.

EVALUATION :

The significant advantages of using a collar harness rather than a yoke are universally recognised. In 1920 Ringelmann, France, established that an Oxen equipped with a collar could accomplish the same amount of work as two oxen attached a yoke. Similarly in 1950, Mr. Jean Garnier demonstrated in South Asia that a collar harness increased the pulling force of buffaloes by 50%.

Mr. Henk Dibbits found that two donkeys harnessed with the swiss collar could plough on light soil as well as two oxen working under yoke.

As per Dr. Micuta quite apart from providing increased pull, it should not be over looked that the new harness also eliminates the suffering caused by the inefficient harnessing techniques prevalent in developing countries. The useful working lives of draught animals are thus prolonged and they produce more and better meat, milk and manure. Farmers need to treat their animal as friends - almost members of the family. Man and animal must form a team - especially as with the swiss collar the animal's head and neck are free and he is able to defend himself against cruel treatment.

Above all, the natural fibre reinforced polyster composite material for the

production of hames of this swiss collar may be used to reduce further the weight of this harness. As some work on the fabrication and properties of natural fibre-reinforced polyster composites was already taken up by Dr. K.G. Satyanarayana and others and they reported that the mixure of coir, banana, cotton, fibres (length dia ratio of individual cell in the range of 35, 150 and 1300 respectively) of lesser strength properties than GRP although they posses comparable specific stiffness and the component made by this mixture when exposed to outdoor weathering have been in satisfactory use for more than four years. This may further decrease the weight of the harness which may result in increase comfort to the animal. This swiss collar should consequently only be introduced among the people who are willing to understand, respect and cherish their animal.

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There are few ways in which a man can be more innocently employed than in getting money

NEED FOR DIVERSIFICATION OF USE OF DRAUGHT ANIMALS & THEIR ENERGY

Dr. R.N. PANDEY
Dy. Director General
U.P. Council of Agricultural Research, Lucknow

The draught animal are integral part of our farm and rural transport sector, but due to their limited use (only 60-75 days per year) they do not seem to be economocially viable for the small and marginal farmers. Author in the present paper has suggested some possible additional areas for the use of draught animal's energy.

Since ancient time animals have been an integral part of our society. Till recent past, animal power has been the only source used in Indian farming sector. Even today animal power is the major source for meeting the demand of agriculture. However, it has been observed that animal population has been on continuous decline. The basic reason for this decline is due to abondoning the use of draught animal power by a sector of farmers who find its upkeep and maintenance uneconomical. Draught animals in India are most commonly used for field preparation and transport. They are also used for sowing, interculture and threshing of some crops. In some areas their use can also be seen in cane-crushing and irrigation.

Due to this limited use of draught animals only in agriculture and rural transport sector these animals are hardly used for 60-75 days in a year and for remaining period they remain idle. During these idle days they need to be fed and maintained which makes their use uneconomical. Therefore, it is essential to use the draught animal energy during idle days in other than commonly used areas.

ENERGY POTENTIALS OF DRAUGHT ANIMALS OF U.P. :

Innovative use of draught animal energy can meet our energy demands.

Energy equivalence of a pair of bullocks working 10hrs/day in terms of other energy sources are shown in table 1. The animals which have potential to be used as draught animals are given in table 2. Considering, the population of only bullocks and male buffaloes which are commonly used for draught purpose. These animals together can generate energy equivalent to 32291.22 million KWH during their idle period (265 days/annum) (Table-3). This energy is around 1.5 times the total electrical energy consumed by the State annually (Table -4). There are 5.353 million heads of dry milk animals (Cows & buffaloes only) in the state. If these animals are also used for draught purpose during their dry periods (around 200 days/annum) they can gennerate additional energy equivalent to 3627.2 million KWH. This is enough to meet the energy demands of all sectors except industrial power, domestic uses and demands of agriculture (Table -4).

In addition to bullocks, cows & buffaloes the state has around 23 million other animals (Sheep, Goats, Pigs & Dogs) which have potentials to be used for draught purposes with proper training. This potential need to be exploited for beneficial use.

DIVERSIFICATION OF DRAUGHT ANIMAL ENERGY USE :

Use of draught animal power is limited to a few conventional areas, Viz. field preparation, Sowing, interculture & threshing of some crops and transport. There is a strong need to extend their use in other non conventional areas. Not only that it is also essential that draught potential of all animals other than conventionally used should also be exploited, for beneficial use.

Thus there is need to diversify not only the draught animal energy use areas but also to diversify the animals for draught purpose. Some of the possible additional areas where draught animal energy should be used are listed in table 5. which need to be exploited.

CONSTRAINTS & NEED FOR FUTURE RESEARCH :

The main constraint in use of draught animal power in other than conventionally used areas seem to be our mental block. This has restricted the development of energy efficient, cheap and dependable approrpriate machinery/equipment for most of the uses listed in table 5. The other factor responsible is the lack of proper extension and popularization services and proper training of village artisians. These areas need to be seriously looked into by our scientific community for future use. For diversification of animals for draught purpose our conventional thinking need to be made unconventional. Well planned, time targeted problem oriented studies need to conducted to make available the design data to develop appropriate matching machinery for different areas of application and different kinds of animals.

Table-1 : Energy equivalence of a pair of bullock with some energy sources.

Energy Sources		Equivalent Amount.
Diesel		11.79 litre.
Kerosene		02.44 litre.
Electricity		08.47 KWH.
Man		51.50 Hrs.
Woman		64.3 Hrs.
Food grains:	Paddy Wheat Gram Pear Soyabean	06.87 Kg.

Table -2 Potential of Draught Animals in U.P. (1988)

Animals.	Population (million)
Bullocks	19.493

Animals.	Population (million)
He-buffaloes.	09.280
Bullocks + Buffaloes	28.773
Dry Cows	02.584
Dry Buffaloes	02.769
Dry Cows + Dry Buffaloes	05.353
Sheeps	02.180
Goats	11.320
Pigs	09.320
Dogs	00.050

Table-3: Energy Potentials of Common Draught Animals of U.P.

Source	Energy Equivalent (million KWH/Rs)
Bullocks & male Buffaloes	3,2291.22
(14.386 million pairs)	Rs. 57,200.25 *
Dry milk animals	3627.20
(2.676 pairs)	Rs. 8,028.00*
Total	35918.42 / Rs.65,228.25 *

* @ Rs. 15/- per day.

Table - 4: Electricity Consumption in various sectors in U.P. (1991-92)

Particulars.	Million KWH (Annual)
Total Generation	18184.00
Total Consumption	21348.00
a) Street lighting	00209.00
b) Industrial lighting & Small Industries	01420.00
c) Public Water Supply	00394.00
d) Railway	00680.00
e) Domestic uses.	04051.00
f) Industrial Power	05833.00

Particulars.	Million KWH (Annual)
g) Agriculture	08194.00
h) Others	00567.00

Table - 5 : Additional Areas of Draught Animal Power Utilization.

Particulars	Utilization
Domestic Sector :	Grain grinding. Dal milling Rice milling Chaff Cutting Cream Seperation. Primary Processing of fruits & Vegetable.
Agricultural Sector :	Inter-culture Plant Protection Irrigation Pumps Sprinklers. Drips Others Harvesting. Shelling & decertifation Winnowing. Fruits & Vegetable Processing.
Industrial Uses :	Some primary process operation Transport. Power generation.

ASSESSING WORK-REST CYCLE OF DRAUGHT BUFFALOES UNDER SUSTAINED WORKING

M.P.Singh
Associate Professor
Department of Farm Machinery & Power Engineering
College of Technology, Pantnagar-263145

The work rest cycle in linear mode has been determined in order to access the work capacity of buffaloes without undue fatigue. A loading car developed by Central Institute of Agricultural Engineering, Bhopal was used. Two male murrah buffaloes were harnessed with Allahabad harness and local yoke respectively. A draft equivalent to 12% of body weight was maintained and six levels of work-rest cycle were used;

All the physiological responses and distress symptoms were recorded to develop the fatigue - score - card. The reduction in speed of the buffaloes with duration of work were also noted. The comparison made on the basis of physiological responses of animals and fatigue score showed that schedule of 4h(W)-7h(R)-4h(W) i.e. 4h work in morning (5-9AM) with an intermittent rest of 7h and 4h work in post rest session is the best as compared to other schedules of work rest. However, at places where working in morning and evening is not possible due to managerial constraints, the schedule of 2h(W)-1h(R)-2h(W)-1h(R)-2h(W)-1h(R)-2h(W) could be opted as an alternative option.

Animal and Plants are gift of nature. The ancient man domesticated equines and cattle to work as draught animal. Animals played a significant role in Man's life for search of food and work as well as his fight against fellow man to attain supremacy. Draught animals have been making significant contribution to agricultural production system. The asset value of draught animal power system can be gauged from the fact that nearly 300 million people in India depend upon draught animal power for ploughing and adjunct

farming operations, hauling carts, carrying goods, logging in forest etc. Draft animal power is appropriate for small holding of less than four hectares. The pace of mechanization of agriculture in India is relatively slow mainly because of size of holdings is very small. Mechanization of agriculture operations will become economical only in large and to some extent medium size holding whose number is only 2 million and 8 million respectively out of over 60 million farmers. Draught animal power is part of the life stock system, which itself contributes perhaps 10% of gross national product. India has largest livestock population of world. Eighty four million draught animals provide 40 million horse power. Draught animals provide energy for cultivation of 100 million hectares which works out to two-third of the entire area sown in the country. They haul 25,000 million tonne kms of freight per year in 15 million animal drawn carts. Estimates show that work animals is save at least six million tonnes of petroleum fuel valued at Rs. 4,000 Crores per year. Replacement by Petroleum based mechanical power will take several years which will need an investment of over Rs. 25,000 Crores an amount clearly beyond the reach of Country's economy.

The annual utilization of animals in India is very low to the extent of 100 days in a year. A recent survey conducted in tarai region showed that the annual utilization of the animals. The utilization of animals for draught purpose depend upon how they are tamed, trained and harnessed. It is desired that animals should not be made to work continuously for a long time so that they are not fatigued. Further, the work-rest period should be long enough to bring the animals close to initial conditions before the work commences again. The buffaloes are utilized mainly in linear mode along with other work animals for varying conditions of load, speed and environmental conditions using different work rest cycle schedule (Marya,1987, Thakur etal, 1989; and kumar 1989.)

Keeping this in view, a study was undertaken for assessing work-rest cycle

for buffaloes while working in linear mode of operation for obtaining maximum work efficiency without undue fatigue at draught equivalent to 12 percent of body weight.

MATERIALS AND METHODS :

Schedule of different work rest cycle during winter seasons of the yearly mode of operation of buffaloes under sustained working was studied. The experiments were conducted using a loading car operated by he-buffaloes on a standard last track.

The loading car consisted of a three wheeled carrier (cart) on which different components were mounted. The main structure was clamped on standard Mahindra Jeep (MM-540) rear wheel assembly. The loading car consisted of various components such as fuel tank (45 litres capacity), hydraulic pump (Displacement 12.5 cubic cm. per revolution), relief valve (5-140 Kg/sq. cm.), Pressure gauge (0-200 kgf/sq. cm.) and drive system. The drive from round wheel was through chain and sprocket assembly with an over all wheel to pump ratio of 1:25.7 . A pair of male murrah buffaloes in the age group 9-10 years were used during experiment. The buffaloes were harnessed/yoked using Allahabad harness and local Tarai yoke. A draught of 145 Kgf (12% of body weight of buffaloes) was used during the experiment. The pull during the experiment was measured using load cell (0-500 Kg.) and load cell indicator. The work was performed on whole day basis using 6 different work rest cycles as mentioned below.

1-WR1	:	4h(W) -7h(R)	- 4h(W)
2-WR2	:	4h(W) -2h(R)	- 4h(W)
3-WR3	:	4h(W) -1h(R)	- 4h(W)
4-WR4	:	4h(W) -1/2h(R)	-4h(W)
5-WR5	:	2h(W) -1/2h(R)	-2h(W)-1/2(R)-2h(W)-1/2h(R)-2h(W)
6-WR6	:	2h(W) -1h(R)	-2h(W)-1h(R)-2h(W)-1h(R)-2h(W)

The physiological parameters along with frothing, leg incoordination, excitement, inhibition of progressive movement and tongue protusion were recorded. The speed of operation was also noted. The fatigue Score card was prepared to know the state of fatigue of buffaloes.

The data of physiological responses were analysed statistically using 2 factor completely Randomized Design (CRD).

RESULTS AND DISCUSSIONS :

The comparative performance of he-buffaloes in different work rest cycles in linear mode of operation were evaluated for obtaining maximum work efficiency without undue fatigue at draught values of 145 kgf (equivalent to 12% body weight). The tests were carried out on a standard test track with six different pause of rests. The performance evaluation of six different work rest cycles in winter season are described below:

1. Variation in Respiration Rate :

The relationship between change in respiration rate of buffalo with duration work at 6 different work-rest cycles has been shown in Fig.-1 to 3.

The figure showed substantial increase in respiration rate with the duration of work. It was observed that increase in respiration was at increasing rate up to first two hours of work and thereafter it increased at decreasing rate in pre and post rest sessions.

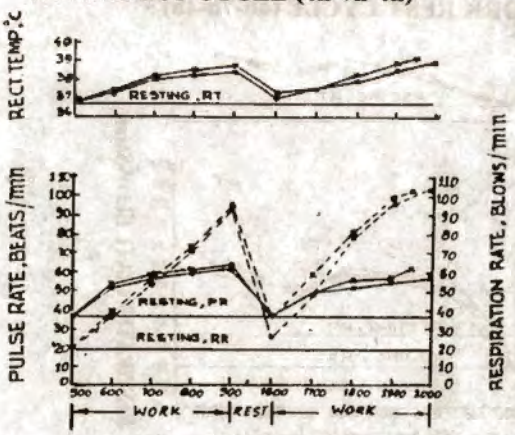
For the two harnesses/yokes namely Allahabad harness and Local yoke, the work was performed in 4h work - 7h rest - 4h work - cycle, the work-rest cycle commonly being followed by the Tarai farmers. The respiration rate values increased by 75.00, 51.42, 33.96 and 33.57% in pre rest session and

PERIOD OF WORK,h	500-W-900-R-	1600-W -	2000
TEMP , °C	159	23	21	175
RH , %	69	40	36	62

PULSE RATE - ALLAHABAD YOKE *

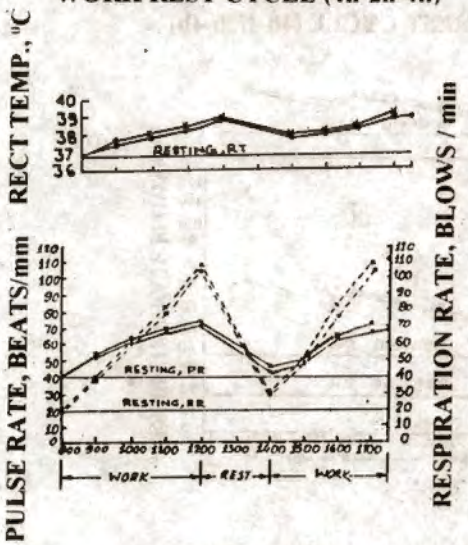
RESPIRATION RATE - LOCAL YOKE x

WORK REST CYCLE (4h-7h-4h)



PERIOD OF WORK, h	800-W-1200-R-	1400-W-	1730
TEMP °C	19.8	25.2	23	21.4
R.H., %	53	40 38		50

WORK REST CYCLE (4h-2h-4h)



PERIOD OF WORK REST, h

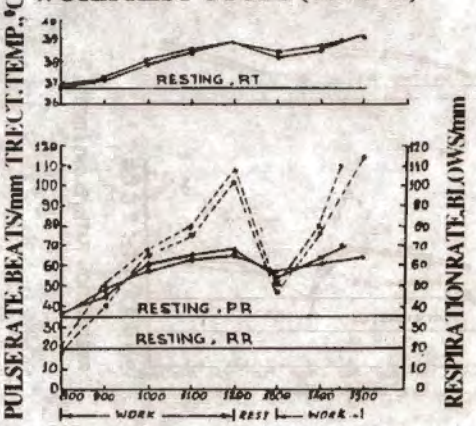
FIG.-1 RESPONSES OF BUFFALOES WITH ALLAHABAD HARNESS AND LOCAL YOKE WORKING ON WHOLE DAY BASIS AT 145 kgf DRAFT AT 2 kmph SPEED

PERIOD OF WORK,h		**800-W-1200-R-**	**1300-W -**	**1500**
TEMP ,	**°C**	**18.25**	**27**	**23.2**
RH ,	**%**	**45**	**52**	**38**

PULSE RATE - ALLAHABAD YOKE *

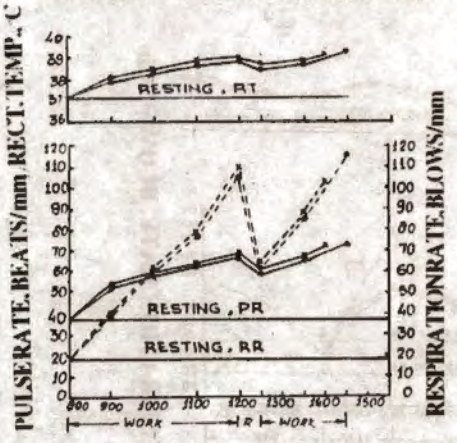
RESPIRATION RATE - LOCAL YOKE x

WORK REST CYCLE (4h-7h-4h)



PERIOD OF WORK, h		**800-W-1200-R-1230-W-1430**		
TEMP	**°C**	**18.8**	**23**	**23.3**	**24.2**
R.H.,	**%**	**58**	**42**	**40**	**38**

WORK REST CYCLE (4h-1/2h-4h)

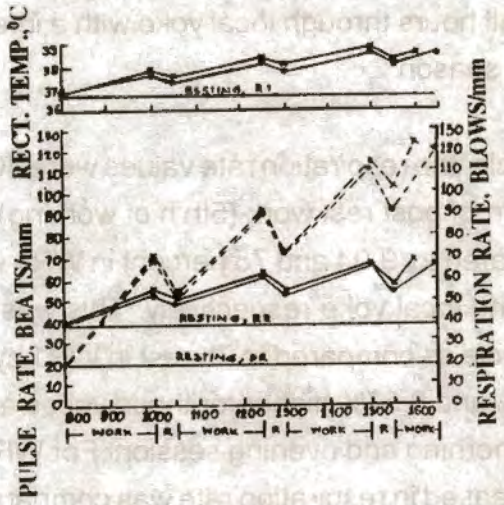


PERIOD OF WORK REST, h

FIG.-2 **RESPONSES OF BUFFALOES WITH ALLAHABAD HARNESS AND LOCAL YOKE WORKING ON WHOLE DAY BASIS AT 145 kgf DRAFT AT 2 kmph SPEED IN WINTER SEASON**

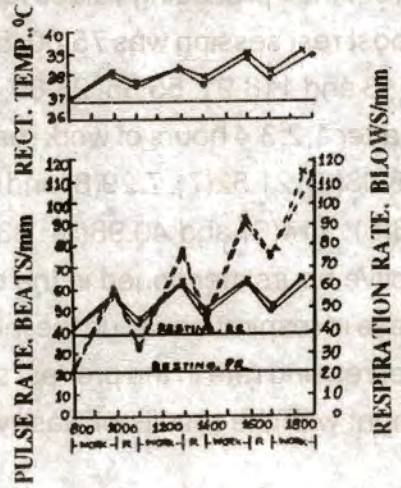
PERIOD OF WORK, h	800 -	1630
TEMP., °C	19.8 -	18.8
R.H., %	52 -	53
PULSE RATE	-	ALLAHABAD YOKE *
RESPIRATION RATE	-	LOCAL YOKE

WORK REST CYCLE (2h-½/2h-2h)



PERIOD OF WORK, h	800–W-1000-R-1100-W-1300-R-1400-W-1600					
TEMP., °C	18.8	21	23	24	22	19
R.H., %	56	52	50	48	52	56

WORK REST CYCLE (2h-1h-2h)



PERIOD OF WORK REST, h

FIG.- 3 RESPONSES OF BUFFALOES WITH ALLAHABAD HARNESS AND LOCAL YOKE WORKING ON WHOLE DAY BASIS AT 145 kgf DRAFT AT 2 kmph SPEED IN WINTER SEASON

88.0, 68.08,21.52 and 7.29% in post rest session for Allahabad harness from its preceding values whereas these values were 90.00, 44.73, 32.72, 30.13 and 62.85, 40.35, 9.09, 19.31 percent respectively for local yoke. The total work performed by using Allahabad double neck harness was 8 hours as compared to Seven & half hours through local yoke with a intermittent break of 7 hours during winter season.

For WR2 work rest cycle, the respiration rate values were 40.00 and 80.95 percent higher at the start of post rest work (5th h of working) with the initial respiration rate as compared to '9.04 and 75 percent in WR1 work rest cycle for Allahabad harness and local yoke respectively. This was mainly due to only 2h of rest in WR2 cycle as compared to 7h rest in WR1 cycle. However, these values were 12.5% and 8.57% higher for these yokes as compared to values while working in morning and evening session. For WR2, WR3, WR4 work rest cycles, the increased in respiration rate was comparatively steeper and was much rapid in initial two hours of work (A similar trend was reported by Devdattam and Maurya et. al., 1978; Thakur and singh; 1990). The percent increase in respiration rate from their preceding values for WR1, WR2, WR3 and WR4 work rest cycle in post rest session was 75.00, 51.42, 33.90, 33.57 and 90.00, 44.73, 32.72, 30.13 and 118.91, 55.55, 23.80, 29.48 and 105.40, 52.63, 36.20, 31.64 percent after 1,2,3,4 hours of work respectively whereas these values were 88.0(5), 68.08(6), 21.52(7), 7.29(8) and 67.85(5), 61.70(6), 38.15(7), 6.66(7 $\frac{1}{2}$) and 76(5), 114(6) and 40.98(5), 33.72(6) in post rest session of working in respective hours mentioned in the brackets. The data indicated a substantial increase in respiration rate in the initial 2 hours of work thereafter it increased at a decreasing rate in the pre rest session of working. These results are in agreement with the results of Sastry et al. 1970.

In post rest session also, the respiration rate values increased with elasped time. The variation in values of respiration rate in the 5th hour during different work rest cycles was mainly due to varying environmental conditions

and rest hour duration. These values were minimum (47) for WR1 compared to 47, 76 and 86 in WR2, WR3, and WR4 work rest cycles respectively indicating sufficient rest (7h) in WR1 work rest cycle brought the respiration rate near resting level compared to 2h, 1h and 1/2h rest in other three cycles.

The percentage increase in respiration rate values from their initial for WR5 and WR6 work rest cycle in the 2,4,6,2h of work was 265.0, 114.28, 72.50, 61.70 and 305.26, 40, 23.91, 20.38 for Allahabad harness where as there values were 252.38, 111.11, 63.66, 47.43 and 305.26, 40, 23.91, 20.38 respectively for local yoke. The respiration rate values increased in the initial 2h and their after decreased steadily. The higher values of percentage increase in initial 2h for WR6 cycle compared to WR5 was attributed to lower initial values of respiration rate due to changed environmental conditions. The respiration rate values in 6½ th hour were 103.5 and 111 for Allahabad harness whereas these values were 108 and 114 for local yoke respectively. The statistical analysis of data of the respiration rate of 5 and 6 hours of work for both yokes / harnesses showed a significant difference at 5% level of significance.

2. Variation in Pulse Rate :

The relationship between change in pulse rate of buffalo with duration of work at 6 different work-rest cycles has been shown in Fig. 1 to 3. The figures showed substantial increase in pulse rate. It was at increasing rate in initial 1 to 1.5 hours of work and thereafter it increased at decreasing rate in pre and post rest sessions. In case of buffaloes the pulse rate reached steady state (A state when the physiological load on the animal is maintained constant) after two hours of work.

For WR1 cycle, the pulse rate values increased by 26.73, 8.91, 5.45 and 5.17% in pre rest session for Allahabad harness from its preceding values

whereas these values were 39.47, 3.44, 3.57, 5.17 and 20.00, 14.58, 1.81, 8.91 percent respectively for local yoke. The total work performed by using Allahabad double neck harness was 8 hour as compared to Seven & half hour with local yoke with a intermittent break of 7 hours during winter season.

For WR2, WR3, WR4 work rest cycle the increase in pulse rate was comparatively steeper and was much rapid in initial hours of work. (A similar trend has been reported by Agrawal et al. 1982; Maurya, 1982. Since blood is the carrier of oxygen to the active muscles and the oxygen demand increases with exercise (increase in work load) the pulse rate which represent cardiac efficiency increases. The percentage increase in pulse rate from their preceding values for WR1, WR2, WR3 and WR4 work rest cycle in post rest session were 26.73, 8.91, 5.45, 5.17 and 21.42, 15.68, 11.01, 6.10 and 18.42, 24.44, 10.71, 4.83 and 33.76, 13.59, 7.69, 6.34 percent after 1, 2, 3, 4 hours of work respectively whereas these values were 28(5), 6.25(6), 5.88(7), 4.62(8), 10.58(5), 32.97(6), 32.97(7), 8.80(7 1/2) and 9.9(5), 4.91(6) and 10.16(5) 12.30(6) in post rest session of working in respective hours mentioned in the brackets for Allahabad harness. Similar trend were also observed in local yoke. The data indicated a substantial increase in pulse rate in the initial 1 to 1.5 hours of work thereafter it increased at a decreasing rate in the pre rest session of working. These results are in agreement with the results of Sastry et al. 1970 and thakur et al. 1987. In post rest session also, the pulse rate values increased with elapsed time.

The percentage increase in pulse rate values from their initial for WR5 and WR6 work rest cycles in the 2, 4, 6, 8th of work were 41.02, 32.25, 27.41, 34.73 and 35.00, 17.3, 34.7, 35.4 for Allahabad harness whereas these values were 44.73, 28.57, 20.63, 32.29 and 40.00, 43.18, 26.00, 24.50 respectively for local yoke. The pulse rate values increased in the initial 2h and their after decreased steadily. The statistical analysis of data of the pulse rate of 5 and 6 hours should significant difference at 5% level of significance.

3 Body Temperature :

The variation in body temperature of buffaloes during various work-rest cycle is presented along with other physiological responses from Fig.- 1 to 3. The resting level rectal temperature for both the buffaloes was approximate 36.2°c . For 4h(W)-7h(R)-4h(W) cycle increase in rectal temperature was 0.55, 1.09, 3.84, 4.41 in pre rest session and 0.54, 1.64, 2.35, 3.29 percent in post rest session after 1, 2, 3, 4h from their initial rectal temperature respectively while working with the Allahabad double neck harness. A similar trend was also observed in case of local yoke with this work rest cycle.

For 2h(W) - 1h(R) - 2h(W) - 1h(R) - 2h(W) - 1h(R) - $1\frac{1}{2}$ (W) cycle, the increase in rectal temperature was lower as compared to values of 2h(W) - 1/2h(R) - 2h(W) - 1/2h(R) - 1/2h(R) - 2h(W) cycle. An increasing trend of rectal temperature similar to 4h(W) - 7h(R) - 4h(W) cycle was also observed in case of 4h(W) - 2h(R) - 4h(W), 4h(W) - 1h(R) - 4h(W), 4h(W) - 1h(R) - 4h(W), 4h(W) - 1/2h(R) - 4h(W) cycle.

An observation on the rectal temperature of buffaloes during pause revealed that there was a steep drop in temperature and its percentage decrease could be said more close to the respiration rate than the pulse rate.

4 Relationship of speed and power output with period of work :

The relationship of speed and power output with different work rest cycles has been shown in fig.- 4 to 6. In all cases the initial data of speed and power output was recorded after 10 minutes of work thereafter for every hour till the end of work- rest period. For 7h(W) - 4h(R) - 7h(W) cycle, in pre rest session the variation of speed and power in 1,2,3,4 hours of operation were 9.45, 7.69, 10.44, 14.42 and +3.84, -1.28, -3.89, -6.40% while in post rest session these values were 5.47, 6.46, 10.44, 12.93 and 7.40, 8.02, 8.64 and 9.25

percent respectively when buffaloes were harnessed with Allahabad harness. The variation in power and speed was more pronounced in case of local yoke as compared to Allahabad harness.

In case of 2h(W) - 1h(R) - 2h(W) - 1h(R) - 2h(W) - 1h(R) - 1$\frac{1}{2}$ h(W) cycle, the decrease in power output and speed in 1,2,3,4 session of work was 20.00, 3.46, 7.69, 5.8 and 16.52, 15.10, 10.75, 10.87 percent from there preceeding values in each session for Allahabad harness. More variation in these values were obtained in case of local yoke.

A similar trend was observed in case of 2h(W) - 1/2(R) - 2h(W) - 1/2(R) - 2h(W) - 1/2h(R) - $1\frac{1}{2}$ (W) - 4h(W) cycle.

5. Fatigue Score Point :

The combination of draft, speed and duration of work causes fatigue to buffaloes. The fatigue score card was prepared and presented in Fig.- 7 to 8 for different work - rest cycles respectively. The distress symptoms were identified and necessary score points were given to calculate state of fatigue of each cycle.

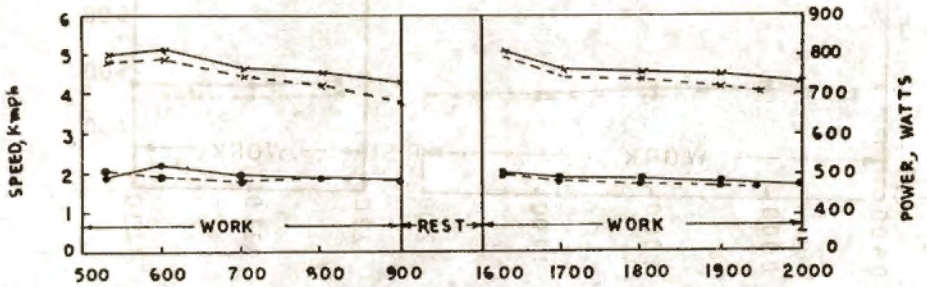
On the basis of fatigue score points secured amongst different work-rest cycles the performance of WR1, cycle was best followed by WR5, WR6, WR2, WR3, and WR4 cycle. The best performance of WR1 cycle was attributed to the long rest in between the two working sessions of morning and evening.

CONCLUSIONS :

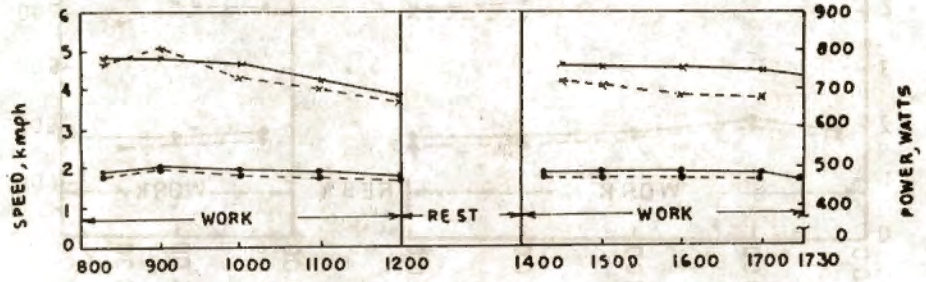
On the basis of experimental results, the following conclusions were drawn :

— ALLAHABAD YOKE
– LOCAL YOKE
x POWER OUTPUT
O SPEED

SEASON WINTER



– ALLAHABAD YOKE
– LOCAL YOKE
x POWER OUTPUT
O SPEED



TIME IN HOURS
[4h (W) - 2h (R) - 4h (W)] CYCLE

FIG.- 4 VARIATION IN SPEED AND POWER AT DIFFERENT HOURS OF WORK AT 12% OF LOAD IN WINTER USING ALL ALLAHABAD HARNESS AND LOCAL YOKE FOR VARIOUS WORK REST CYCLE.

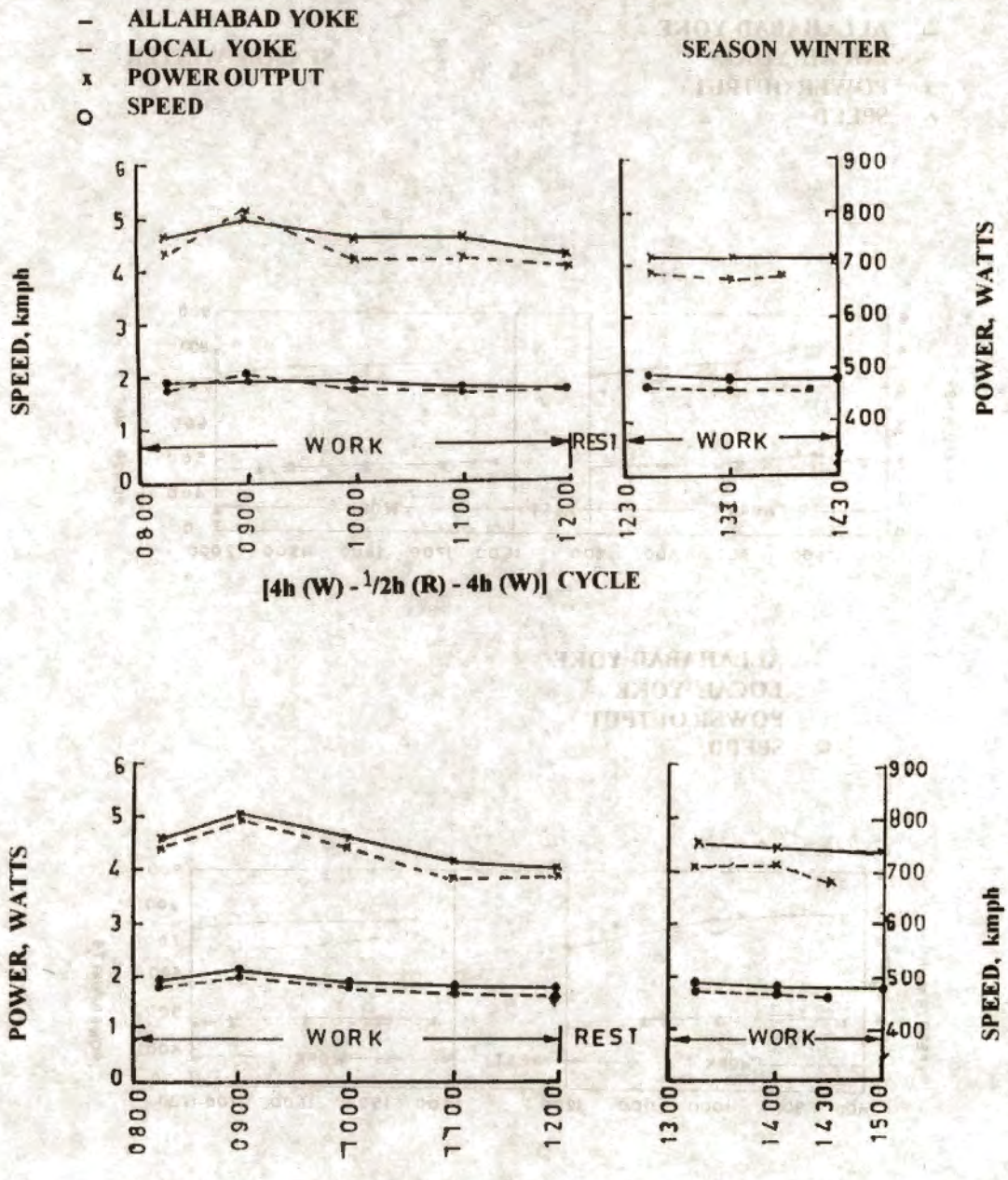
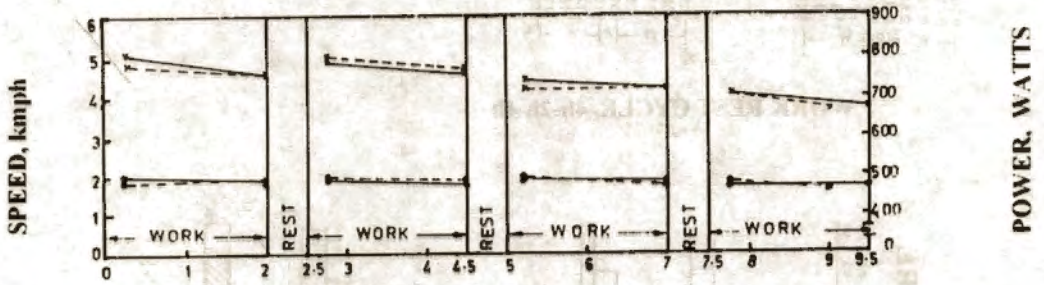


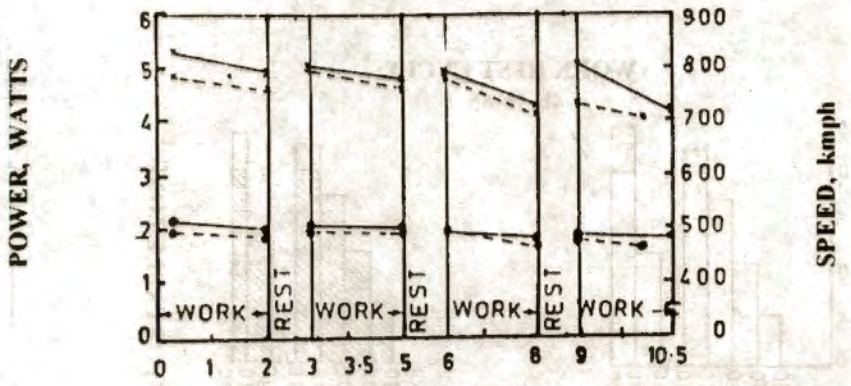
FIG.- 5 VARIATION IN SPEED AND POWER AT DIFFERENT HOURS OF WORK AT 12% OF LOAD IN WINTER USING ALL ALLAHABAD HARNESS AND LOCAL YOKE FOR VARIOUS WORK REST CYCLE.

ALLAHABAD YOKE
– LOCAL YOKE
x POWER OUTPUT
SPEED

SEASON WINTER



[4h (W) - 1/2h (R) - 4h (W)] CYCLE



TIME IN HOURS
[4h (W) - 1h (R) - 2h (W)] CYCLE

FIG.- 6 VARIATION IN SPEED AND POWER AT DIFFERENT HOURS OF WORK AT 12% OF LOAD IN WINTER USING ALL ALLAHABAD HARNESS AND LOCAL YOKE FOR VARIOUS WORK REST CYCLE.

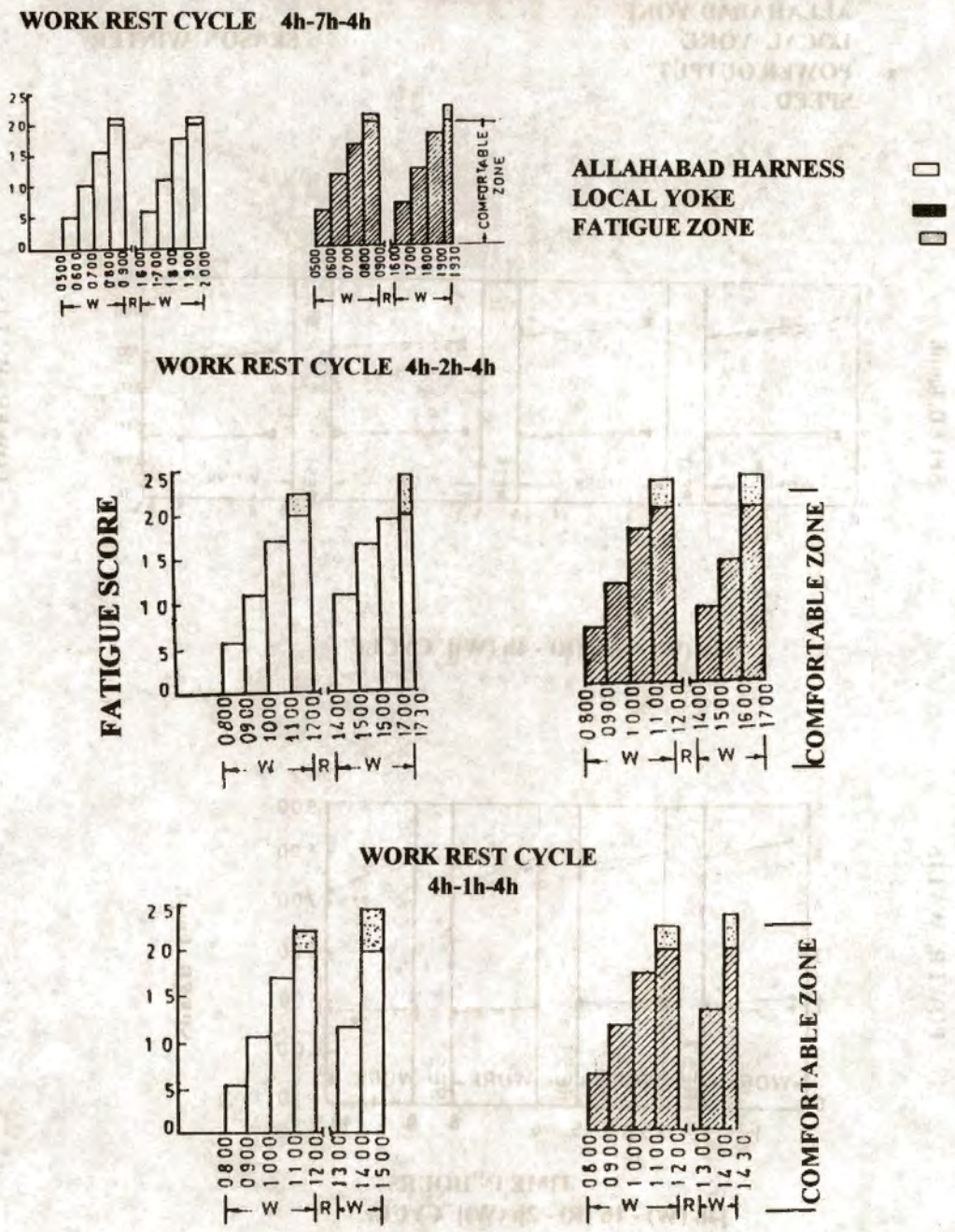
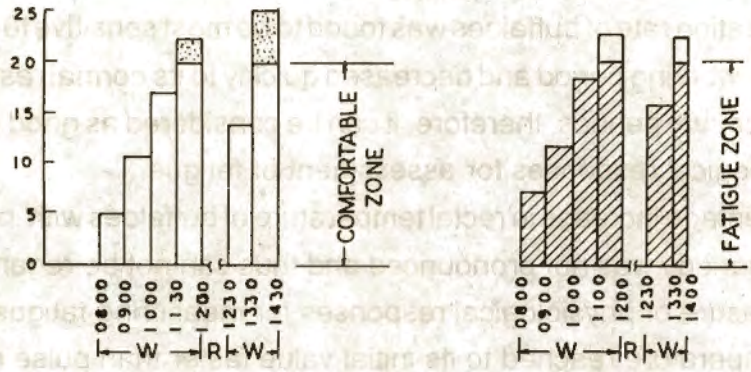
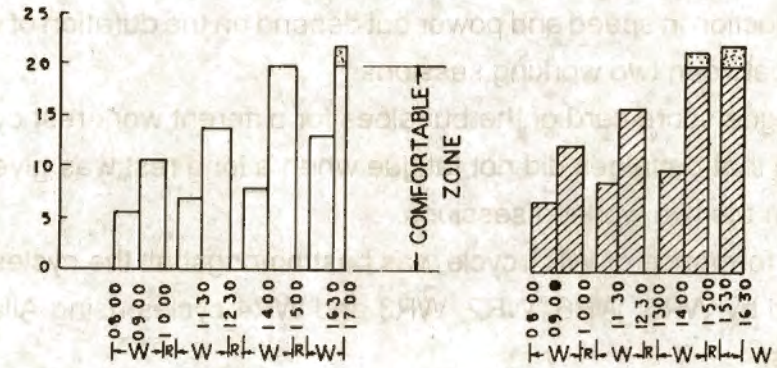


FIG.- 7 FATIGUE SCORE OF BUFFALO AT 145 kg (12% OF BODY WEIGHT) DRAUGHT WITH DIFFERENT WORK REST CYCLE IN WINTER SEASON.

WORK REST CYCLE : 4h -1/2h - 4h



WORK REST CYCLE : 2h -1/2h - 2h



WORK REST CYCLE : 2h - 1h - 2h

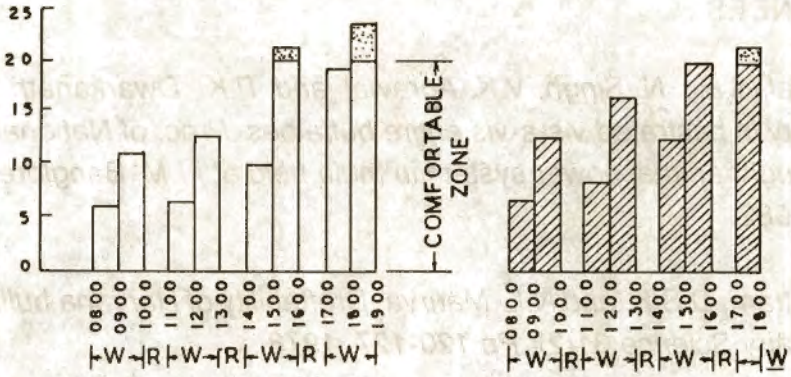


FIG.- 8 FATIGUE SCORE OF BUFFALO AT 145 kg (12% OF BODY WEIGHT) DRAUGHT WITH DIFFERENT WORK REST CYCLE IN WINTER SEASON.

1. All the physiological responses increased significantly with the increase in duration of work from its resting level.
2. The respiration rate of buffaloes was found to be most sensitive to increase during the working period and decreased quickly to its normal resting level during recovery periods, therefore, it can be considered as good measure of physiological responses for assessment of fatigue.
3. The percentage increase in rectal temperature of buffaloes with increasing working periods was not pronounced and thus can not be regarded as a good measure of physiological responses for measuring fatigue. The rectal temperature reached to its initial value faster than pulse rate.
4. During recovery period, the pulse rate dropped slowly than respiration and rectal temperature.
5. The reduction in speed and power out depend on the duration of work and rest in between two working sessions.
6. The fatigue score card of the buffaloes for different work rest cycles showed that buffaloes did not fatigue when a long rest was given in between the two working sessions.
7. The performance of WR1 cycle was best amongst all the cycles tested followed by WR5, WR6, WR2, WR3 and WR4 cycles using Allahabad harness.

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DRAUGHT ANIMAL POWER UTILISATION PATTERN IN BIHAR PLATEAU

*M.K. SINGH *, S.TIWARI ** & ANIL KUMAR****
Birsa Agricultural University,
Ranchi, Bihar

Draught Animals are as important as agricultural lands for the developing world. Recognising the importance of draught animal power (DAP) as an appropriate renewable energy source, now it is the right time to explore the possibility of raising this DAP system to a feasible, desirable and economically viable level. There is a considerable variation in the input-output ratio of DAP within the country due to improper planning and lack of technical know-how. Positive effects of improved devices have also been elaborated in the present paper.

There is strong relationship among man, animal, plant and land use systems since ages. This relationship tended to be neglected through the science and technological development over last few decades in India. This development arrived at reducing the use of bio-energy sources with that of electro-mechanical and fossil sources of energy. However, it has been realised in recent years that these sources of energies are neither cheap nor unlimited and whatever reserve exits are deplating fast all over the world. Thus it has led to a serious thinking and giving more and more attention on renewable and alternate source of energy. Draught animals (D.A.) are an important source of renewable energy for crop production in India. The National Commission on Agriculture has indicated that rural dependance on draught animal power (D.A.P.) for multiple uses will be substantial at least

* I/C, Cropping System Research
** Additional Director (RES)
*** Associate Prof. (Agricultural Engineering)

upto the end of the current century. The commission has also indicated that to meet the demand of increasing foodgrain production one has to double the energy input to agriculture by 2000 A.D. Thus to meet this demand D.A.P. is one of the most important sources of farm power which may be exploited in more efficient and systanable manner.

It has been realised that D.A. are unque form of renewable source of energy converting sun's energy through plant life into useful products and services.

It has been pointed out that D.A.s are competing with man for source land. The situation is true only in certain conditions but in Bihar plateau there is no such condition in most of the district. There are plenty of wastelands and forests which could not be put under cultivation, may be used for grazing grassing and fooder growing. At the same time it may be pointed out that DAs live largely on crop residuece, grasses and agro-industrial by products. Majority of plateau farmers are marginal and small having an average land holding size of 0.63 ha (Table 1).

D.A.P. is an ideal source of farm power. Such a group of farmers for variety of reasons, they may have to continue to depend on D.A.P. for many more years to come. Inspite of great importance of D.A.P. in Bihar plateau a little has been done to upgrade this ancient system for providing energy on farms.

D.A.P. is complimentary to mechanization, while mechanization can continue at a pace technically feasible and economically viable. D.A.P. needs to be used only where it is inevitable or appropriate.

D.A.s such as bullocks and male baffaloes are the major source of farm power in Bihar plateau. They are used to pulling the implements, to thresh crops, haul carts, water lifting devices, sugarcane crushers, oil ghanis etc.

It is estimated that there are 2.8 million D.A. in Bihar Planteau against 7.2 million in Bihar and 80 million in the country as per 1982 live stock census. The bullocks of this region are mostly small and weak.

TABLE - 1 : Agricultural Land Holding in Bihar Plateu (1985-1986)

S.N.	HOLDING SIZE ha	NUMBER OF HOLDING Nos. Million	percent (%) %	AREA Million ha	Percent %	AVERAGE SIZE OF HOLDING ha.
1.	Upto 1	1.268	58.22	0.536	13.59	00.42
2.	1 to 2	0.328	15.06	0.474	12.01	01.44
3.	2 to 4	0.322	14.78	0.908	23.02	02.82
4.	4 to 10	0.216	09.92	1.294	32.80	05.99
5.	Above 10	0.044	02.02	0.733	18.58	16.66
	TOTAL :	2.178	100.00	3.945	100.00	27.33

POWER AVAILABILITY :

The agricultural labourers in the region comprises of landless and the cultivators possessing smaller holdings, total number being about 3.8 million, Bihar plateu.

TABLE - 2 : Availability of Power for Agriculture in Bihar Plateu Estimated

S.N.	SOURCE	KW PER UNIT	NUMBER (MILLION)	TOTAL KW (MILLION)	% OF TOTAL	% OF SUB-TOTAL.
A.	**ANIMATE**					
1.	Human	00.045	3.800	0.17	09.02	21.25
2.	Animal	00.224	2.800	0.63	33.42	78.75

S.N.	SOURCE	KW PER UNIT	NUMBER (MILLION)	TOTAL KW (MILLION)	% OF TOTAL	% OF SUB-TOTAL.
B.	COMMERCIAL					
1.	Tractor	18.650	0.020	0.37	19.63	34.10
2.	Power tiller	05.222	0.001	0.005	00.26	06.46
3.	Diesel engine	05.222	0.100	0.52	27.59	47.93
4.	Electric motor	03.730	0.050	0.19	10.08	17.51
	TOTAL (A + B)	-	-	**1.885**	**100.00**	-

Bihar Plateau has about 2.8 million heads of draught animals, 20 thousand tractors, 5 hundred power tillers. Other power sources consisted of 1 lakh diesel engines and 50 thousand electric motors. An estimate of the power available for farming including all known sources is 1.885 million kw out of which from mechanical and electrical sources is 1.085 million kw and rest from human and animal. Assuming an average draught developed by a cattle of this region 0.224 kw, the total D.A.P. is 0.63 million kw which is about 33.42 percent to total available power and 78.75 percent to animate sources. Thus it is avident that inspite of great emphasis on mechanization during recent years, D.A.P. remains a major source of farm power in this region. The average power availability in the plateau agriculture through all sources is 0.27 hp/ha while only through mechanical and electrical sources it is 0.48 hp/ha. Hence, it is difficult to reach the level of 0.8 to 1.0 hp/ha even after taking into account all sources of power in coming years. Therefore, to increase the productivity, it is required to increase the utilization and efficiency of D.A.s to meet the requirement in plateau's agriculture,because in the present circumstances it is not possible to replace draught animals.

D.A.P. UTILIZATION :

The draught animals in this region are based for ploughing, planking, puddling, sowing, threshing, haulage, oil extraction (on limited scale), cane

crashing and water lifting. They are generally used in pairs. The work output per bullock pair with country plough is approximately 0.025 to 0.03 hp/ha depending on the size of bullocks. The annual use of these bullocks are about 300 to 350 hrs. with about 4 to 5 hrs. work/day in Bihar Plateau. However, in the peak season it may be as high as 8-10 hour a day. The estimated working days of D.A.s in a year are about 60 to 80 days. Due to low annual use the cost of operation of a pair of bullocks is as high as shown in table - 3. Since, it is a monocropped area, the animals are under except in kharif season. This makes animal power more expensive and under utilized. By some modification in cropping pattern and alternate application of D.A.s, the situation can be improved. On one hand there is shortage of farm power and on the other, the available power is not properly utilized. The reason for this are varied; poor health of animals due to improper care and feeding, large number of small size animals, use of improper harness that causes losses in power and fatigue of animals, use of traditional equipment and carts, lack of suitable draught animal breeding programme, lack of awareness and facilities about alternate uses of DAs, etc.

USE OF EFFICIENT IMPLEMENTS :

It is through implements that the power from animals is converted into useful work. The efficiency and output of draught animals, therefore, greatly depend upon the efficiency of implements to be used with them. Most of the traditional implements are smaller in size and under utilises the available draft of animals and increase dredgery of both, animals and the operators.

It has been observed that the dredgery involved in operation with most of the local implements is tremendous due to their crudness and low capacity. Ploughing 1 ha. field with a country plough of 10-15 cm size involves walking of animals and operator equivalent to 67.5 - 100 km per operation and normally with country plough it takes 4-5 operation before a field is ready for

seeding. With wider improved implements, walking is proportionately reduced. The draft availability from a pair of animals in sustained working ranges between 10-12% of their body weight. Thus even from a pair of local animals weighing 500-600 kg, draft force of 50 to 60 kg can easily be obtained. The draft requirement of indigenous and many improved implements is below the available draft capacity of a pair of bullocks of this region.

Thus there is a great scope of popularising improved implements and thereby increasing draught animal power utilisation in this region.

ASSUMPTIONS :

1. Initial cost of animals : Rs. 6000 per pair
2. Resale Value : Rs. 200 per pair
3. Working life : 10 years
4. Weight : 500 Kg. per pair

Unit cost of operation, Rs./hr.

$Cu = [(Fc + Mc - Dc) / X] + Oc$

Fc - Annual fixed cost Rs/hr.
Mc - Annual maintenance cost Rs./hr.
Dc - Annual dung cost Rs./yr.
Oc - Operating cost Rs./hr.
x - Annual use
Fc - (5000 - 200) / 10 = Rs. 480/-

Assuming [(6000 + 200) / 2] x (12 / 100) = Rs.372/-
Assuming @ 50/- per month (Rs. 50 x 12 months = Rs. 600/-).
Total annual fixed cost = Rs.1,400/-
*** No one insures their animals.**
Mc - Rs.4,000/-
Annual dung cost - Rs.400/-
Operating cost - Rs.4/- per hour

$Cu = [(Fc + Mc - Dc) / X] + Oc$
$= [(1400 + 4000 - 400) / X] + 4.00$
$= (5,000 / X) + 4.00$

TABLE - 3 : Annual use vs unit cost of operation of a pair of bullocks

S.NO.	ANNUAL USE	Cu = [(5000 / X)] + Rs.4/- per hour
1.	100	54.00
2.	200	29.00
3.	300	20.67
4.	400	16.50
5.	500	14.00
6.	600	12.33
7.	700	11.14
8.	800	10.25
9.	900	09.55
10.	1000	09.00
11.	1100	08.54
12.	1200	08.16
13.	1300	07.85
14.	1400	07.57
15.	1500	07.33
16.	1600	07.12
17.	1700	06.94
18.	1800	06.78
19.	1900	06.63
20.	2000	06.50

STATUS OF DRAFT BUFFALO RESEARCH IN NORTHERN INDIA

M.P.Singh
Associate Professor,
Department of Farm Machinery and Power Engineering,
College of Technology, G.B.Pant University of Agriculture and Technology,
Pantnagar ,Distt.Nainital (U.P.)

Draft animals are making significant contribution to agricultural production system. India posseses about 83 million of animals out of which 8 million are draft buffaloes. Most of the time, the draft animals remain idle and are used hardly 100 days in a year. A sizable amount of work has been done for increasing the utilization of these draft buffaloes efficiently and effectively. This paper reviews the status of work done on various aspects of the research carried out on draft buffaloes.

In India, 360 million people depend on draft animal power for ploughing and adjunct farming operations. Draft animal power is appropriate for small holding of less than four hectares. Bullocks and buffaloes are the main sources of draft power in India with a population of about 75 and 8 million respectively, out of the total draft animals population of 85 million. Considering the importance of draft animals in Indian Agriculture, the ICAR has given attention in two major areas which include (a) conservation and improvement of different breeds of animals and (b) utilization of animal energy more efficiently and economically through better understanding of draft ability of different animals, development of appropriate matching implement for major breeds and management techniques,increasing annual use so as to make them economic competitive source of farm power. This paper, therefore, high lights the present status of research work conducted on various aspects of buffalo power utilization.

ANIMAL POWER UTILIZATION IN TARAI REGION OF U.P :

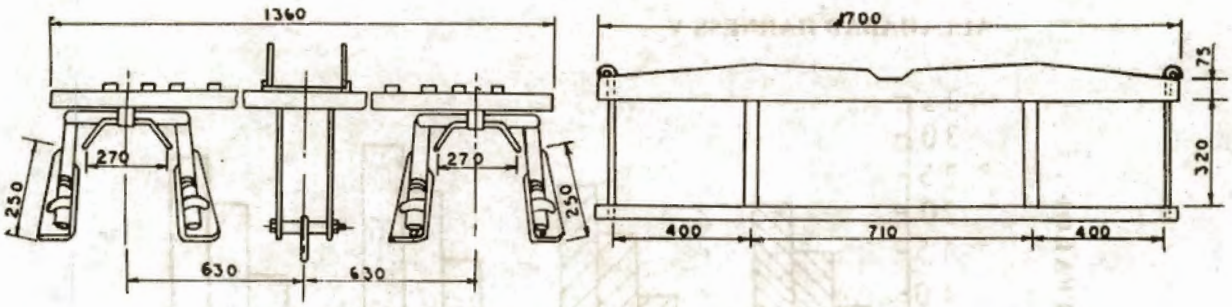
In India DAP is used for about 100 days a year only against 300 days in

China. The utilization pattern annually of few villages of Tarai Region should point out the problems/bottlenecks to analyse the reasons for reduced utilization. The information were collected from two selected villages regarding utilization in Rabi and Kharif for the year 1987-88 and 1992-93. The farmers using bullocks/buffalo as draft animal only were selected. A total of 89 and 29 families were interviewed. The total average annual utilization of Shantipuri-2 village was 472 pair-hr approximately in the year 1987-88 and 784 in the year 1992-93. The total average annual utilization of Shantipuri-3 village was 494 and 764 pair hours approximately during above period. The overall average annual utilization of both the village was 483 and 774 pair hours for these period respectively which shows a very low trend of annual utilization and hence some alternate job should be encouraged during idle period.

HARNESSING DEVICES DEVELOPED FOR BUFFALOES :

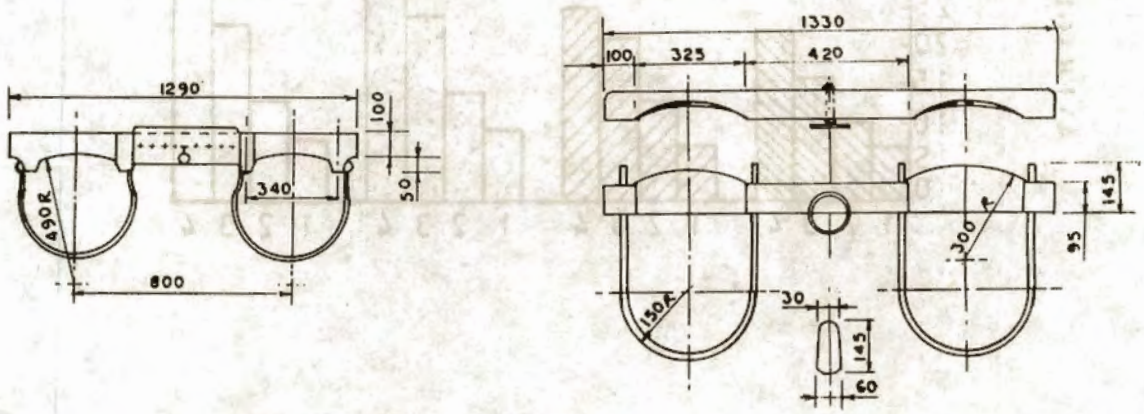
(a) Yokes and harnesses for a pair of buffaloes :

The power developed by a draft animal depends on many factors which includes the use of correct harness/yoke. A poorly designed yoke/harness causes poor transfer of power to the implement. Four types of yokes/ harnesses namely Allahabad harness, local, Nagpuri and Pantnagar yokes (Fig. -1) were evaluated at drafts varying from 8 to 14% of body weight which was equivalent to 95-170 kg. of load, used for a pair of buffaloes. The animals were allowed to work for four hours continuously at constant speed of 2 km/ hr. The experiment was also conducted at draft equal to 20% of body weight. The data was analysed on the basis of changes in ohysiological responses and fatigue score. The results showed minimum fatigue score (Fig. - 2), in case of Allahabad harness. A comparison between yokes and harness showed best performance with Allahabd harness because of application of pull through. Three different positions of the body which utilized the amximum body weight of the animal more comfortably foilowed by local yoke under sustained loading. With Allahabad harness the work was performed for a maximum duration of 7 hours were as it was only 6 hours with local yoke.



ALLAHABAD HARNESS (Y_1) **LOCAL (TARAI) HARNESS (Y_2)**

NOTE : ALL DIMENSION IN M.M.



PANTNAGAR ADJUSTABLE YOKE (Y_3) **NAGPUR YOKE (Y_4)**

NOTE : ALL DIMENSION IN M.M.

FIG. - 1 DIFFERENT TYPE OF YOKES AND HARNESS (PAIR OF ANIMALS)

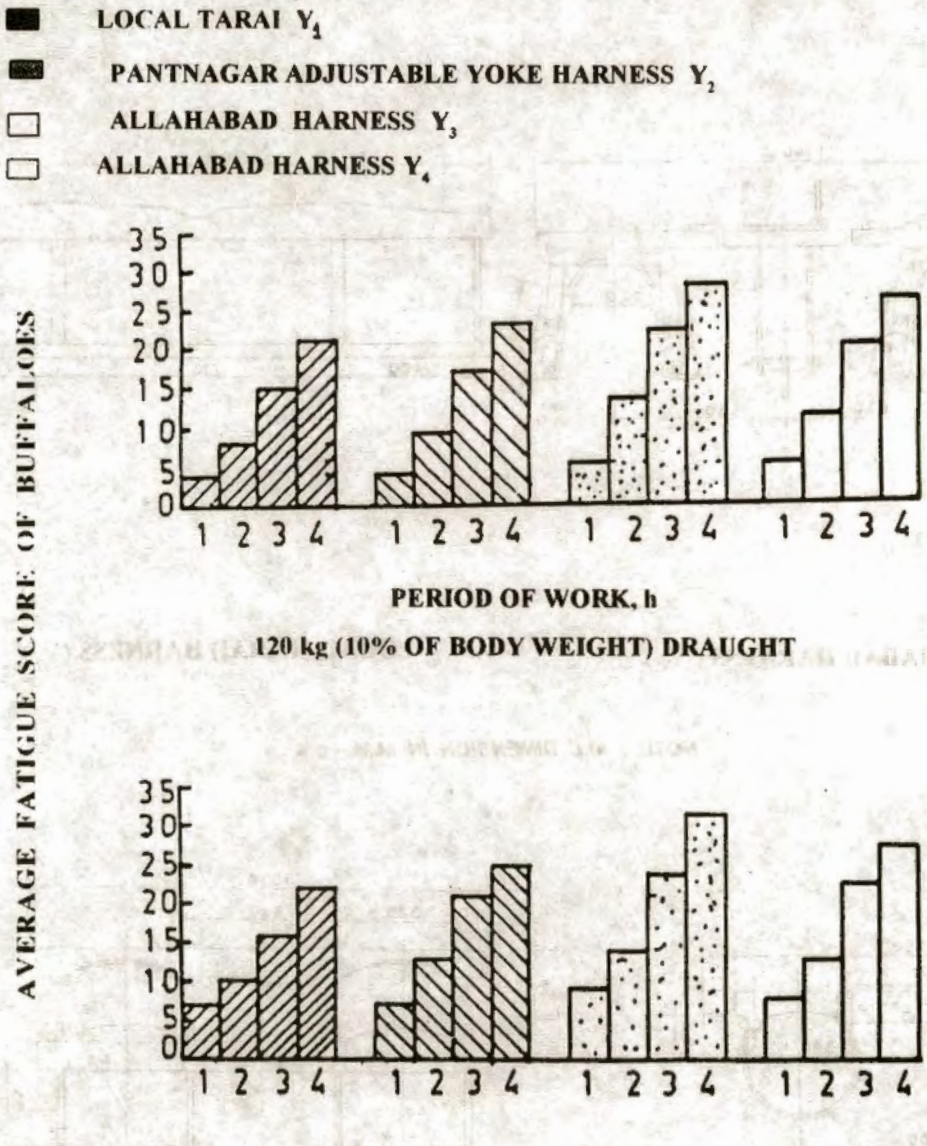


FIG. - 2 FATIGUE SCORE OF BUFFALO AT 120 kg. AND 144 kg. DRAUGHT WITH DIFFERENT YOKES HARNESS FOR PAIR OF ANIMALS

(b) Yokes and harnesses for single buffalo :

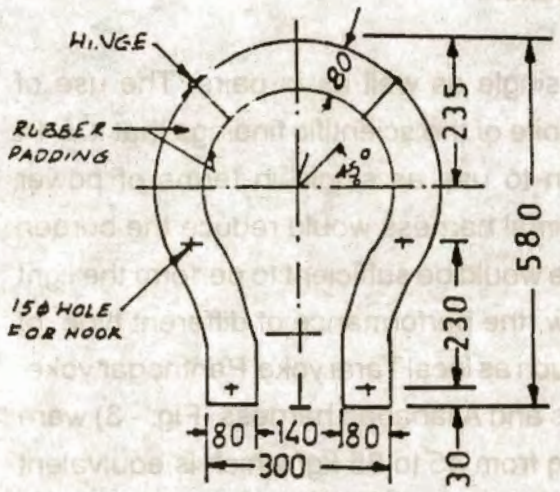
Animals are being used both in single as well as in pairs. The use of animals in pairs is more common inspite of the scientific findings that it is 14 to 20% less efficient in comparision to use as single in terms of power conversion efficiency. The single animal harness would reduce the burden of maintaining two animals where one would be sufficient to perform the light draft tasks. Keeping this point in view, the performance of different type of single animal yokes and harnesses such as local Tarai yoke, Pantnagar yoke, Pantnagar adjustable colloar harness and Allahabad harness (Fig. - 3) were assessed at five level of draft varying from 45 to 85 kgf which is equivalent to 8-18% of body weight. A male murrah buffalo was hitched with the yoke/ harness and allowed to work for four hours continuously at a constant speed of 2 km/h. The relationships between physiological responses and period of work were established. The Pantnagar adjustable collar harness was found best among various yokes/harnesses tested followed by Allahabad harness.The results indicated that the fatigue - score was for various yokes prepared harness give minimum value with Pantnagar adjustable collar harness (Y3) (Fig. - 4) followed by Allahabad harness (Y4), Pantnagar Yoke (Y2) and local Tarai Yoke (Y1). There was significant effect of draft, types of yoke-harness and duration of work on fatigue-score of buffalow. The fatigue-score was significantly lower in case of (Y3) in comparision to (Y4) during the whole day of work at all the speeds tested.

Based on above findings the Pantnagar adjustable collar harness for single animal was recommended for its utilization amongst the farmers.

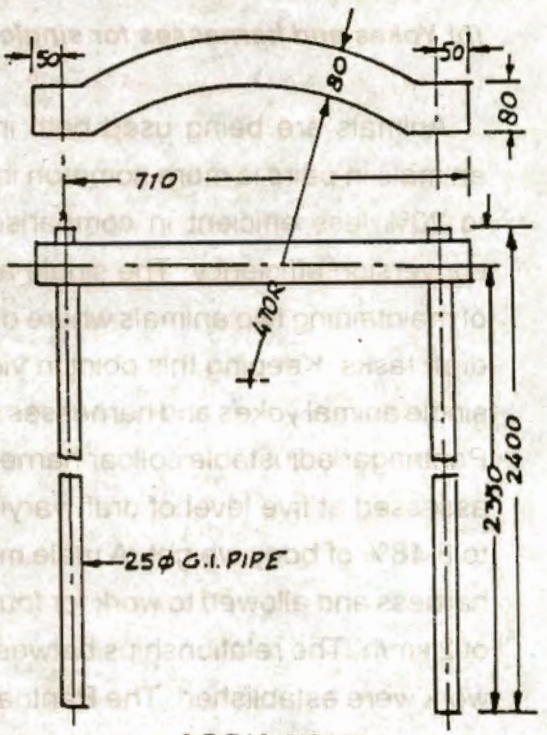
SCHEDULING OF WORK - REST CYCLE FOR BUFFALOES :

(a) Work-rest in linear mode of work :

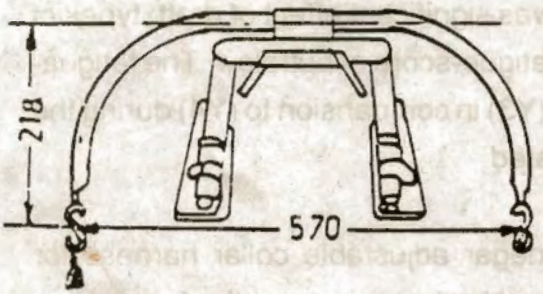
The work rest cycle in linear mode was determined in order to access the



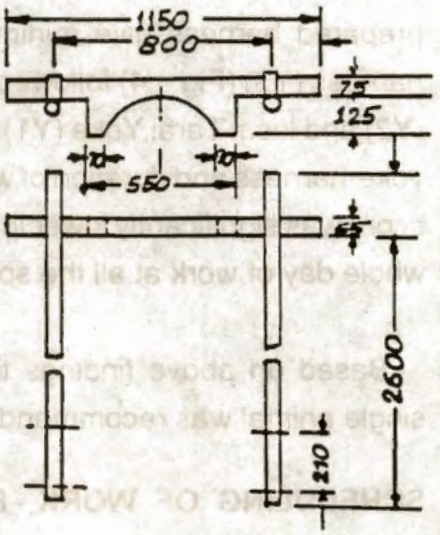
PANTNAGAR COLLER HARNESS



LOCAL YOKE



ALLAHABAD HARNESS



PANTNAGAR YOKE

FIG. - 3 SINGLE ANIMAL YOKE-HARNESS

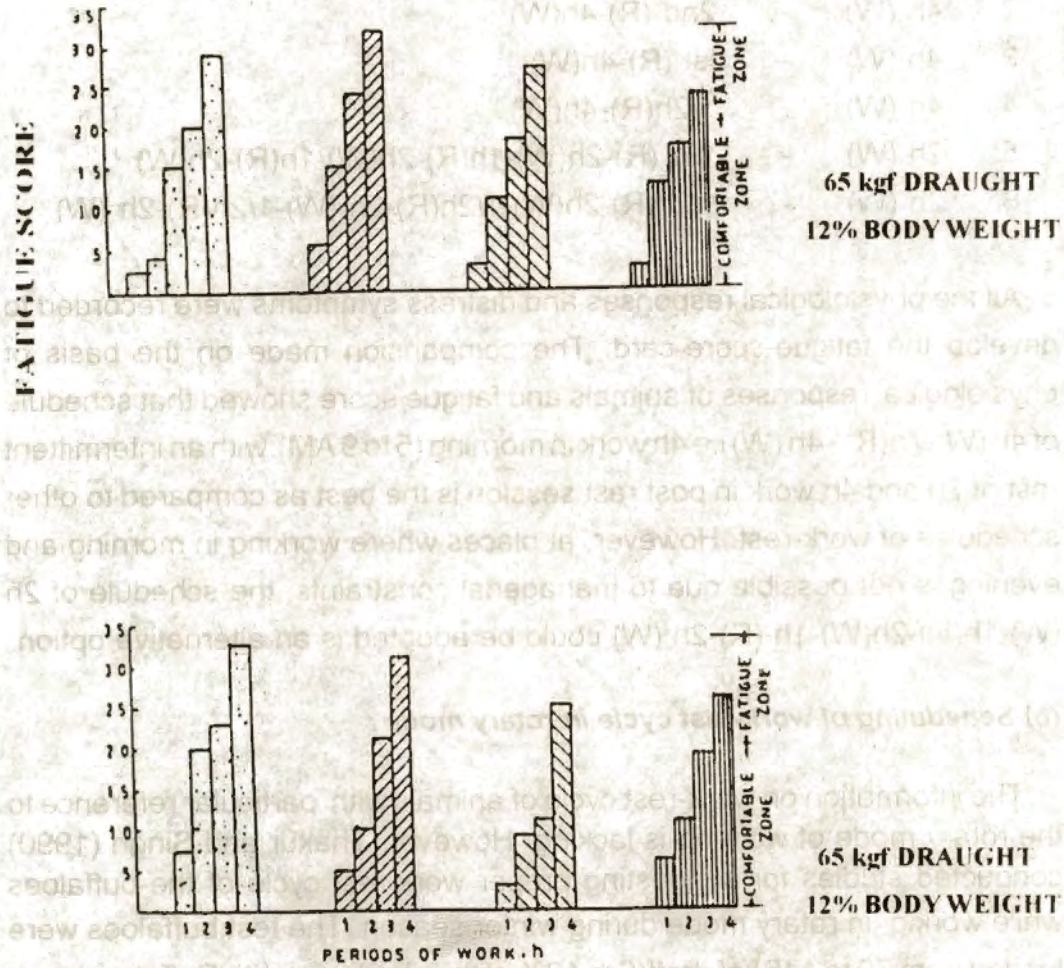


FIG. - 4 FATIGUE SCORE OF BUFFALO AT 65 AND 75 kgf DRAUGHT WITH DIFFERENT YOKES (SINGLE ANIMAL)

work capacity of buffaloes without undue fatigue. A loading car developed by CIAE Bhopal was used. Two male murrah buffaloes were harnessed with Allahabad harness and local yoke respectively. A draft equivalent to 12% of body weight was maintained and six levels of work-rest cycle as given below were used.

1. 4h (W) - 7th (R)-4h(W)
2. 4h (W) - 2nd (R)-4h(W)
3. 4h (W) - Ist (R)-4h(W)
4. 4h (W) - 1/2h(R)-4h(W)
5. 2h (W) - 1/h (R)-2h(W)-1h(R)-2h(W)-1h(R)-2h(W)
6. 2h (W) - 1/2h(R)-2h(W)-1/2h(R)-2h (W)-1/2h(R)-2h (W)

All the physiological responses and distress symptoms were recorded to develop the fatigue-score-card. The comparision made on the basis of physiological responses of animals and fatigue score showed that schedule of 4h (W)-7h(R) - 4h (W) i.e 4h work in morning (5 to 9 AM) with an intermittent rest of 7h and 4h work in post rest session is the best as compared to other schedules of work-rest. However, at places where working in morning and evening is not possible due to managerial constraints, the schedule of 2h (W)-1h(R)-2h(W)-1h (R)-2h (W) could be adopted is an alternative option.

(b) Scheduling of work-rest cycle in rotary mode :

The information on work-rest cycle of animals with particular reference to the rotary mode of working is lacking. However, Thakur and Singh (1990) conducted studies for suggesting proper work-rest cycle of the-buffaloes while workig in rotary mode during winter season. The test buffaloes were loaded from 70 to 145 kgf draft(6 to 12% of their body weight), Buffaloes were allowed to work at different loads in three cycles of 1 h work -1/2h rest, 2h work-1/2h rest and 2h work-1h rest upto a total period of 4 hours. The optimum paper output was found to be 0.87 hp at their hitching point which was equai to 0.55 hp at the end of the output shaft of gear unit while working

at a speed of about 2km/h and developing approximately 120 kgf draft equivalent to 10% of the body weight of buffaloes. It was recommended that for draft upto 95 kgf, 2h work-1/2h rest cycle should be adopted to perform the work comfortably during winter season. However, for higher draft of upto 145 kgf (12% of body weight of buffaloes), for higher draft of upto 145 kgf (12% of body weight of buffaloes), 1h work-1/2h rest should be followed upto second period of work and thereafter, a longer duration of 1h or more should be given to keep down the physiological responses of buffaloes. In case the physical dimensions and weight of the animals were similar, they should be interchanged during the third period of the schedule for equal distribution of the work load. But if the animals were of different body weight, the stronger one should be hitched at the outer periphery.

The work capacity of he-buffaloes at different draft varying from 60 to 200 kgf i.e 5 to 17% of body weight was studies. The results of this study are illustrated in Fig. - 5 . This figure reveals that at lowest draft of 60 kgf (5% of their body weight) the speed of buffaloes remained constant for working period of 3 hours but for higher draft 90 to 200 kgf (7.5 to 17% of body weight) there was cyclic variation. The power output was constant for 60 and 90 kgf draft but for 120, 150 and 200 kgf draft, the power output decreased steadily by approximately 15,12 and 9% after 2.5, 2 and 1 hour of continuous work

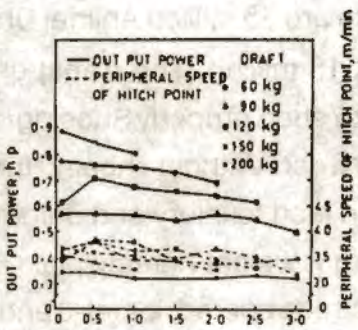


FIG. - 5 VARIATION IN PERIPHERAL SPEED OF HIGH POINT AND POWER OUTPUT OF BUFFALOES AT VARIOUS DRAFT DURING WORK

respectively. The work after 2 hours for 150 kgf and 1 hour for 200 kgf draft could not be performed due to willingness to stop frequently even after simulation. This study shall help in deciding the size of gear reduction unit and also the periods of work for most efficient utilization of animal-machine system.

SCOPE OF ANIMAL POWER UTILIZATION ON ROTARY GEAR :

Driven Agro-products processing machines :

The draft animal power in India either remains unutilized or underutilized for most of the periods. Their increased utilization round the year would reduce the unit cost of animal energy. To harvest this energy, an animal power complex was developed for operating various rotary powered machines such as loop type paddy thresher, ground-nut decorticator maize sheller, flour mill, seed cleaner-cum grader, chaffcutter and electric generator. The heart of the complex is a mechanical gear reduction unit which increase the output shaft speed by 65.5 times and is driven by the pair of buffaloes. The test conducted while operating these machines give an encouraging results. The performance and economics of above machines is given in Table -1.

Hoof shoeing and hoof care :

It is estimated that there are 35 million Animal Drawn Vehicles (ADVS) out of which India's share is 15 million. The transporation by animals is only possible when animals are shod properly Shoeing is done to provide traction and to prevent excessive wear. Without shoeing the hemorrhage in the hoof wall occurs and may even lead to injury and deformity of the hoof. Different type of hoof shoes of 90 gm weight namely plain, quenched, ordinary mild steel, weld deposited electrode coated, lomet-3 and Modi-600 hard surfacing weld deposited electrode coated were shod randomly on 5 buffaloes having average weight of 500 kg. The Brinell Hardness Number of shoes varied from 220 to 540. The Buffaloes were operated on a tarmacdum road at a draft

equivalent of 12% of body weight. The weight loss of shoes were measured after 25, 50, 75, 100 and 125 hours of operation (Fig. - 6 & 7). The average

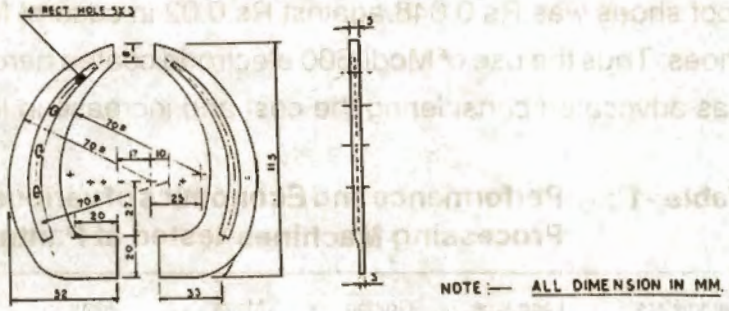


FIG. - 6 DETAILS OF HOOF SHOE OF BUFFALO

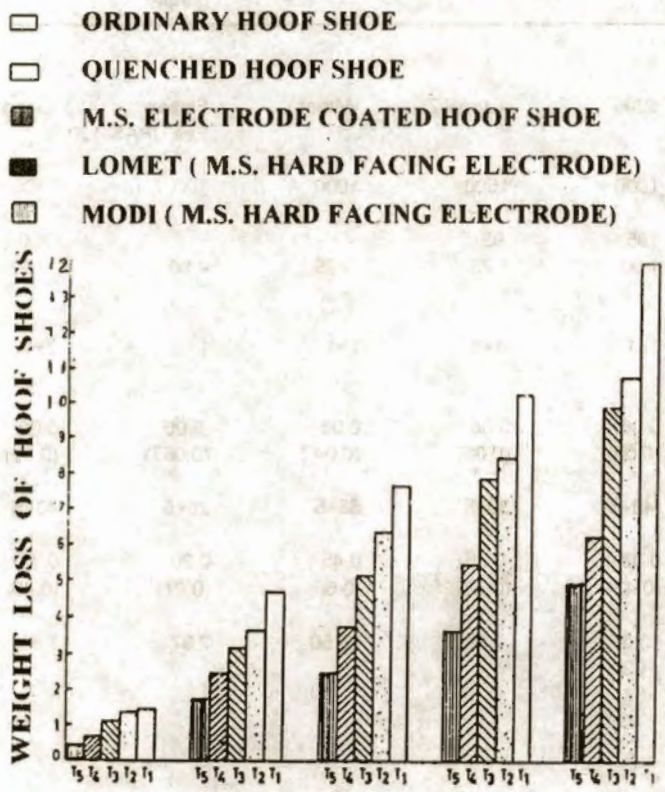


FIG. - 7 AVERAGE WEIGHT LOSS OF HOOF SHOES DUE TO WEAR AT 25, 50, 75, 100 AND 125 HOURS OF OPERATION.

expected life of Modi-600 coated hoof shoes was found to be approximately 60% higher than plain hoof shoes. The cost of operation per hour for ordinary hoof shoes was Rs.0.048 against Rs.0.02 in case of Modi-600 coated hoof shoes. Thus the use of Modi-600 electrode coated hard surfaced hoof shoes was advocated considering the cost and increase in life expectancy.

Table -1 : Performance and Economics of various Animal Gear Driven Processing Machines tested at Pantnagar.

Test parameters	Loop type paddy thresher	Ground Nut decorticator	Maize Sheller	Flour mill	Seed cleaner cum grinder	Chaff cutter	Electric Gen.
Crop/Grain Parameters							
i) Variety	Jaya	6206	Langa-2	Wheat	Pigeon Pea UPAS-120	Ganga-2	
Machine parameters							
a. i) Approximate cost	Rs. 1250	1000	1500	1000	100	1100	5000
ii) Peripherial speed. m/min	126	195	93	-	-	250	1400
iii) Output, g / h	2.38	1.00	1.73	0.25	4.50	8.60	0.8 KVA
iv) Persons needed for operation machine gear unit	2+1	1+1	1+1	1+1	1+1	2+1	1
b. Animal Gear Unit							
i) Power required at no load, hp kw	0.17 (0.227)	0.06 (0.08)	0.06 (0.08)	0.03 (0.04]	0.05 (0.067)	0.09 (0.12)	0.21 (1.17)
ii) Draft at hitching point kgf	80.5	40+5	30+5	55+5	25+5	40+5	90+5
iii) Power required at load, hp (KW)	0.46 (0.61)	0.33 (0.43)	0.25 (0.33)	0.45 (0.60)	0.20 (0.27)	0.35 (0.49]	
Cost of operation	8.96	13.37	7.15	53.50	2.97	1.81	8.717 / KW
i) Animal driven unit including hiring charges of a pair of animal and operator, Rs/q	-	-	-	-	-	-	-
Cost of operation Manual (Hand beating)							
i) Output, g/h	0.325	0.083	0.35	-	-	3.8	-
ii) Cost, Rs/q	7.69	30.12	8.39	-	-	(Hand operated chaff cutter)	-

COMMAND AREA CONTROLLED BY A PAIR OF BUFFALO :

The command area controlled by a pair of draft buffaloes in paddy-wheat, paddy-potato-sugarcane, maize-lahi-sugarcane and maize pigeon pea, wheat-sugarcane was assessed in Tarai region of U.P. The command area was based on maximum area covered for operation within a specified time limit. The command area was assessed with using normal size implements and increased size implements (Table - 2). The increased size of implements was decided on the basis of draftability of pair of buffaloes usually assumed to be equivalent to 10% of their body weight. The improved implements for seedbed preparation such as M.P. plough disk harrow rotary puddler and planker were selected. An approximate increased of 22-40% in the command area could be achieved with the use of increased size implements with out undue fatigue to buffaloes (Table - 3).

Table 2: Specifications of implements used for tillage evaluation.

Name of implement	Type	Draft Kg.	Width of cut, mm	Approx. Cost Rs.
Normal size				
M.S Plough.	Single botton	75+5	150	150
Cultivator	Three Tyne Adjustable	50+5	600	600
Disk Harrow	Offset	75+5	700	1000
Country plough	Local	75+5	100	100
Rotary puddler	Blade	75+5	700	200
Planker	Wooden - flat	70+5	2000	250
Increased size				
M.B. Plough	Single botton	95+5	230	200
Cultivator	Five tyne	65+5	100	200
Disk Harrow	Offset	95+5	900	1200
Country Plough	Local	85+5	150	150
Rotary puddler	Blade	85+5	900	250
Planker	Wooden - flat	85+5	2000	300

Table - 3 : Command Area under different crop rotation

S.N.	Crop Rotation	Command Area (ha), normal size implements used	Increased size implements used	% Increase
1.	Paddy-wheat	2.83	3.46	22.26
2.	Paddy-Potato-sugarcane	3.04	3.73	22.69
3.	Maize-Lahi-sugarcane	3.02	3.90	29.13
4.	Maize-pigeonpea-wheat	3.07	4.31	40.39

Further research on Draugh Buffaloes :

In order to have efficient and increased utilization of DAP following research thrust should be given :

1. To study seasonal changes in pysiological parameters and skin morphology.
2. To study the power availability from draft animals scheduling proper work-rest cycle.
3. To enhance output from draft animals by adoption or package of matching implements (tillage to transport) for different cropping systems and agro-climate zones.
4. To determine the nutrient requirement of animals with reference to draft capacity.
5. To assess the effect of energy and protein variable on draft capacity.
6. Management of DAP for increased employment and income generation.
7. Technoeconomic studies on custom hiring of DAP for increased utilization and self employment.
8. Proper utilization of DAP.
9. Developing excellance in animal energy research,organising training programmes and improving information and communication systems related to efficient utilisation of DAP.

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STATUS OF D.A.P. IN BIHAR

Prof. K.K. Sinha
Project Engineer
Community Polytechnic
Government Polytechnic, Barauni.

Draught Animal Power in India has great potential as a source of energy in agricultural and transport sector, but it has been under exploited because of poor socio-economic condition of the rural areas. DAP can play a vital role especially in the states having acute power problem. In the present paper, author discussed the various options for proper utilisation of draught animal power in the remote areas of our country with a special reference to the Bihar state.

Animals have always played an important role in the economy of our country. Among animals, draught animals were important source of renewable energy before middle of 20th Century, catering the needs of domestic, agriculture, transportation and other motive power related works and contributing subsequently in our national income, is presently a neglected sphare and out of sight of our scientists and planners.

The industrial revolution coupled with Mechanisation of even farm sector has yielded good results, no doubt, particularly in developed countries however for country like ours where more than 80% of its population live in rural areas and contribute more than 70% of the national income, this mechanisation of farm sector as well as, rural trasport system is now badly affecting the rural ecomony particularly of backward and populous states like Bihar where energy problem is accute, specifically power generation situations is worsening day by day. People has to depend upon fossil fuel like Diesel, Petrol, Kerosene which is too costly to afford by the common rural mass for domestic, agriculture, cottage industry and trasport purposes.

This resulted in higher production cost of farm, as well as, small industrial products, since the remunerative prices of agriculture products are not competative with their production cost, hence marginal and small farmers, are desperate and even not in a position to cultivate the lands properly, effectively and efficiently. The per-capita income of the rural people who are depending mainly upon agriculture is decreasing day by day. The result can be seen apprantly the small farmers are looking for alternative livelyhood. They are preferring to do low category outside or open small retail Thus it is abundently obvious that due to acute power shortage in village, rising cost of farm equipments, rapid increase in fuel cost, fragmentation of cultivable lands, deteriorating road condition in villages, villagers are finding themselves helpless in present circumstances.

PRESENT SATUS OF D.A.P. :

Energy-related studies are being taken up to develop more precise understanding of the present energy problems and build future scenerios. But one of the relatively weak area has been the lack of studies on the actual energy use pattern specifically of energy power obtained from D.A. and its use. The industrial sector and urban areas have been studied better as compared to the agricultural sector and rural areas. Even survey of living stock including draught animals has not been carried out since 1982 in Bihar so it is not possible to provide the exact and upto date status of D.A. and D.A.P. as per 1982 survey, is given total draught animal 1,40,93043 which is 18% of the total D.A. in India.

Bullocks	Buffallows	Horses	Camels	Elephants	Donkeys	Mules
94,12,636	*46,41,109*	*1,10502*	*98*	*N.A.*	*26913*	*1785*

Status of Draught animal driven carts, farm equipments :

1. Bullock carts : 07,55,215

2.	Wooden plough	:	44,44,713
3.	Sugar cane pressure Machine	:	36,296
4.	Bullock driven lift for irrigation	:	30,000
5.	Horse carts	:	92,000
6.	Tractor	:	14,644

But during the last decade although we have no exact survey reports, but there is a drastic reduction in number of D.A. and D.A. driven carts and farm equipments due to mechanisation of farm sector, availability of electric power in villages, road facility and not the least acute shortage of traditional labourers in villages and their migration to other states like Punjab & Delhi. But again during the present decade due to acute power shortage in villages, rising cost of farms equipments, rapid increase in fuel cost, fragmentation of cultivable lands, deteriorating road condition in village, villagers are finding themselves helpless in present circumstances and again looking back hesitantly to these traditional animal source of power.

STATUS OF D.A.P. USE IN AGRICULTURE :

The direct energy sources used in agriculture are man power, animal power and electrical & Mechanical power. The energy input in agriculture differs among various categories of farmers and degree of mechanisation. Traditionally, before partial mechanisation of the agriculture sector, the source of power in agriculture were men and draught animals. But now the situation has almost changed. Use of tractors for tillage, transport and threashing are very common now. Only animal power in ploughing is used to some extent. Even small & marginal farmers are using tractors on hire basis. The lift irrigation is fully mechanised now. Bullock driven lifts have virtually been replaced by electric pumpsets and diesel engine pumpsets. The non-availability of power in rural area has forced the people to depend upon Diesel engine pumpsets whose operation & maintenance cost is too much to be borne by the common rural mass particularly small & marginal farmers.

STATUS OF DAP USE IN TRANSPORTATION OF FAMILY & AGRICULTURAL PRODUCTS IN RURAL AREAS :

Before 1980, the mode of transport for family for visit to local market, local bus stand was bullock cart & Horse driven carts. Large scale construction of rural roads and liberalisation in issuing road permits during 1980-90, changed the mode of transport in the rural areas. More than 75% bullock carts, 50% horse driven carts became inoperative. Small vehicles became operational even in the rural areas and tractor trailor were extensively used for transportation of goods from village to local market. But now again the situation is changing fast due to poor maintenance of these rural roads, Vehicles operators are finding hard to ply vehicle on these rural roads and people are returning to use horse - driven carts for family and agriculture transport to a large extent. However, bullock carts are still less in use.

STATUS OF D.A.P. IN A TYPICAL VILLAGE OF BIHAR :

As stated above there is no upto date-relevent data regarding the D.A. animal and D.A. driven carts and farm equipments, however I am presenting a data in this regard of a typical village in Bihar. The data so obtained will clearly speek about the trend of present status of D.A.P. in comparison with 1971 & 1982.

Comparative indices of land / man & land / live stock ratio :

Name of the village - Pyarepur,
District - Nalanda (Bihar)

S.No.	Particulars	1971	1982	1994
1.	Human - Live stock Live stock per 100 of Population	55	48	44

S.No.	Particulars	1971	1982	1994
2.	Human - D.A.P. Bullock pairs per 100 of Population	10	07	03
3.	D.A.P. - Density Bullock pairs per ha of area	0.25	0.18	0.08

Comparative indices of D.A. driven cart, farm equipments, tractors, electric motor, diesel engine:

S.No.	Particulars	1971	1982	1994
1.	Draught Animal			
1.1.	Bullock & Buffalow	300	200	155
1.2.	Horses	6	4	6
2.	Bullock Cart	4	2	-
3.	Horse Cart.	2	2	5
4.	Plough	200	100	50
5.	Sugar cane crushing machines.	1	1	-
6.	Lift irrigation			
6.1.	Bullock driven lift	2	-	-
6.2.	Electric pumpset	12	22	4
6.3.	Diesel engine Pumpset	4	9	25
7.	Tractor	1	2	4

CONCLUSION :

From above facts & figures it is quite obvious that the farm sector where the D.A.P. mostly used, has been gradaully mechanised as a consequence of which this sector too is gradually transforming from labour intensive to capital intensive. But in view of the accute power shortage in states like Bihar

is facing presently a unemployment due to rising population and crunch of resources, dependence on renewable sources of energy like D.A.P. and its optimal utilisation is becoming more and more necessary. It is high time now to think it over and revive interest in our lost animal power which in the event of a serious energy crisis can provide decentralise and ecologically sound means of power and energy in rural areas and has tremendous potential to argument the rural economy.

Tobacco can damage human life at every stage of development, from embryo to old stage. At the same time, however, smoking is probably the most preventable of all major health hazards.

IMPORTANCE OF DRAUGHT ANIMAL POWER SYSTEMS IN PRESENT SCENARIO AND AN OVERVIEW OF MNES' DAP PROGRAMME

R.P.Sharma
Senior Scientific Officer
Ministry of Non-Conventional Energy Sources, Govt. of India
New Delhi.

Among the third world countries, India is the largest user of draught animals. Inspite of this, the country losses much of its cattle wealth and DAP because of bad working conditions, starvation diet, infliction of cruelity, death due to strain of over work, natural calamities etc. To day, the whole world is in the midst of an energy crisis, in this situation draught animals are the only alternative to support the agricultural and transport sectors of the economy and also to maintain the self-sufficiency. The efforts made by the Ministry of Non-Conventional Energy Sources, Govt. of India in this direction has been elaborated in the present paper.

There has been a close relationship between man and animal from their very existance on the earth. In real terms domestication of equines and cattle as draught animals has laid a mojor mile stone in the long march of man from his nomadic existence to civilised life. From the very beginning the animals have not only played a significant role in making man's job easy but also helped him utilising of nature for food and fighting against fellow men. The invention of the wheel accelerated utilisation of animals for ploughing, carting, and many other operations which revolutionised man's concept of agriculture and transport. In the commercial era, which began in 15th centuries the Draught Animals were deployed to clear jungles for preparing land for man's habitation. Thus throughout man's existence, the Draught Animals have been playing a key role in the way of his progress. Strangely the contribution of Draught Animals to man's well-being continues to be as significant today as it was 5000 years ago, particulary in developing

countries, including India.

DRAUGHT ANIMAL POWER SYSTEM (DAPS) :

Draught Animal Power (DAP) is the muscle power of Drught Animals (DAs)such as bullocks and buffaloes which are extensively used for pulling ploughs and other Animal Drawn Implements (ADIs), and hauling Animal Drawn Carts (ADCs). Horses and Camels are used for hauling carts and donkeys as pack animals. The system which comprises Draught Animals as well as the equipments/devices that are pulled or drawn by them for carrying out various agricultural operations and transporting rural goods is called Draught Animal Power System (DAP's).

POWER UTILISATION IN AGRICULTURAL SECTOR :

Prior to independence agriculture sector used negligible amount of commercial energy and depended on animate (human and animal) energy. The green revolution that started in mid sixties has completely transformed the old system of Indian agriculture into a modernised system of agriculture. This has resulted in meeting country's total requirement of foodgrains without depending on any other country. Adoption of high yielding varieties of crops coupled with multiple cropping scheme, expansion of irrigation facilities and farm mechanisation have encouraged the farmers to use higher commercial inputs. Before modernisation of agriculture many traditional jobs like water lifting, oil extraction threshing, chaff cutting etc. were done with the help of draught animals. But after modernisation/mechanisation of agriculture most of these process are now being done by using electric motors or disels engines. Thus with the increase of productivity levels and cropping intensity more energy is required for production, processing, and handling of crops. In this regard a time series analysis of power availability for Indian farms 1961 to 1991 has been carried out which is given in table 1. on the next page.

Table 1 : Power availability for Indian farms :

Year	Total Power availability Indian Farms(KW/ha)	Contribution of DAP (KW/ha)	Availability of Commercial Power (KW/ha)
1961	0.31	0.222 (17.6%)	0.088
1971	0.36	0.230 (60.5%)	0.130
1981	0.63	0.225 (35.8%)	0,405
1991	0.92	0.226 (24.6%)	0.694

FACTS OF RELEVENCE OF DRAUGHT ANIMAL POWER SYSTEM :

From the table 1 it may be seen that although the contribution of DAP did not go down and was stagnant between 0.222to 0.234KW/ha while the use of conventional power (electrical and mechanical) increased many folds. According to a survey report the power availability, in particular, for agriculture in Panjab, Haryana and Western U.P is, however, of the order of 3KW/ha. Thus there is a large gap in terms of power requirment to match to the level of production in these states which could only be bridged over by increasing utilisation of DAP system. The draught animal power will therefore be relevant in future also for many decades to come.

There are about 100 million operational farm holdings in our country with average size of 1.65 ha. These farm holdings are categorised as given in table 2. on the next page.

Table 2 : Catagories of farm holdings.

Category	Area	% Farm Holdings
Marginal	0-1 ha	59%
Small	1-2 ha	18%
Semi-medium	2-4 ha	13%
Medium	4-10 ha	08%
Large	above 10 ha	02%

Thus under such situation where about 90% of the farm holdings are below 4 ha, draught animals would be the most appropriate and reliable source of power on Indian farms.

India is endowed with 84 million Draught Animal which are capable of generating about 42 million horse power of 30000MW of equivalent electric power. The total energy available there from is equivalent to about 54000 million units per year at an average daily working hours of 6 for 300 days in a year. The DAP system is really the back bone of rural transport as most of the rural goods are handled by it. According to an estimate about 25000 MT kilometers of goods are transported by about 15 million animal drawn carts existing in the country.

At an optimal replacement rate of 10 bullocks/buffaloes per tractor the present population of Draught Animals is equalto about 8 million tractors saving the nation about 26 million tonnes of diesel annually, almost equal to the total production of petroleum in the country; worth about Rs.22,000 crores annually at the prevailing prices of disel oil. The market value of draught animals is estimated as Rs. 34,500 crores and implements approx. Rs. 24,000 crores and their replacement in terms of 8 million tractors and equipment will require approx. Rs.160,000 crores additional amount. In addition to the above, the draught animals also provide about 100 million tonnes of dry dung and raw material for about 1.5 million biogas plants, thus saving valuable fire wood.

FACTS AT A GLANCE SHOWING IMPORTANCE OF DAP SYSTEMS :

In order to understand importance of DAP systems a typical analysis of Tractors Vs DAP system has been carried out which is given in table 3. From this analysis it may be seen that DAP system are over advantageous not only interm of economy but also protecting from environmental pollution.

Table 3: Typical analysis of tractor Vs. DAP systems :

Particular	Tractors	DAP Systems
Cost	Rs.1,50,000	Rs.30,00
Implements	Rs. 50,000	Rs 15,000
Total	Rs.2,00,000	Rs.45,000
Overheads		
(10%depreciation	Rs.70,000	Rs.15,750
10% Repair	After 10 years	Scrap
15% interest)		
Run by	Fossil fuel	Agro waste, oil cakes
Effluent	Pollution	Dung+urine (Biogas, dung cake manure, antiseptic coating of dung in mud houses)
Status of Rural Resources	Transferred	Conserved
After 10 years	Scrap	Automatic addition

Keeping all the factors in view it may be concluded that DAP systems have their great significance in the present scenario because of the following reasons :

i) They are self renewing
ii) They are non polluting
iii) Management is known to rural people
iv) They are available at point of use and whenever required
v) Animal systems are cheapest

vi) Animal systems are product of rural areas
vii) They genérate employment in rural areas
viii) They check transfer of resources from rural areas
ix) They eliminates use of fossil fuels
x) They provide extra bonus in the form of dung and urine
xi) No commercial energy is required to run them.

AN OVERVIEW OF MNES' ANIMAL ENERGY PROGRAMME :

The programme on "Draught Animal Power" (DAP) was started in 1984 with limited funding support.As aresult of R&D efforts following have been developed:

- Animal Power Generating System, 150 W capacity; through NITIE Bombay.
- FRP; Carts; 1-2.5 MT capacity through GFTC; CEAT Hyderabad.
- 16 different designs of improved bullock carts; capacity 1-3.00 MT through CARTMAN Bangalore.
- Cycle Trailers; capacity 150-200 kg through IERT Allahabad.
- Improved Bullock Cart; capacity 1 tonne through REC Trichy.
- Animal drawn Ambulance - through CARTMAN Bangalore.

Popularisation of the following was also taken up :

- Tropiculators developed by ICRISAT Pattencheru (A.P) in the State of U.P, T.N. & Maharashtra.
- Sulabh pumps, leaves cup & plate making M/Cs etc in Orissa by OREDA.
- FRP Carts.
- Improved Bullock Carts in A.P.
- Cycle Trailers in adjoining areas of Allahabad.

In addition following activities have also been completed.

- An expert Committee set up by the Ministry has prepared a report on "policies and programmes on Draught Animal Power (DAP).

- A National Conference on "Programmes and policies on DAP was held on 4-5th March, 1994 in New Delhi.
- Seven Regional Conferences on DAP have been planned of which 4 have been held during 1994-95. One batch at Allahabad, Bhopal, Bangalore, and Shillong. The objective of the conferences is to identify improved field worthy animal drawn devices and develop State spefific Energy Programmes for demonstration training and publicity for DAP Devices.

Reference :

CARTMAN Journal (October 1994) or Table - 2.

Every 100 minutes the earth receives as much energy from the sun as mankind uses in a year.

DRAUGHT ANIMAL POWERED - IMPLIMENTS

Development of civilization is unique outcome of man animal and machine system. Animals are serving to human beings since the inception of the civilization and it will continue to work in future also. Because it is an established fact that the DAP items can not be replaced by any other item which is depend upon the Conventional Energy because of it's limited availability and increasing cost. Therefore, stress is being put to develop / modify DAP items in such a way so that the total productivity of the system may be increased as well as better confort to animals and their life may be increased (purhaps which is a big question in traditional systems). In this article the description of few improved harnessing systems are given which fulfills the above objectives which are:

1. Hauling Harness.
2. Cinch.
3. Light Animal Collar 1.
4. Light Animal Collar 2.
5. Travois.

1. HAULING HARNESS:

A simple harness for pulling heavier loads about the farm or the home garden. (see fig.-1).

A. Material Required :

1. One long leather strap which will fit around your animal from flank to flank. Two shorter leather straps which will fit over the withers and the croup to the long strap. One short length of leather.
2. Three large metal rings and 4 smaller metal rings.
3. Needle and heavy thread.

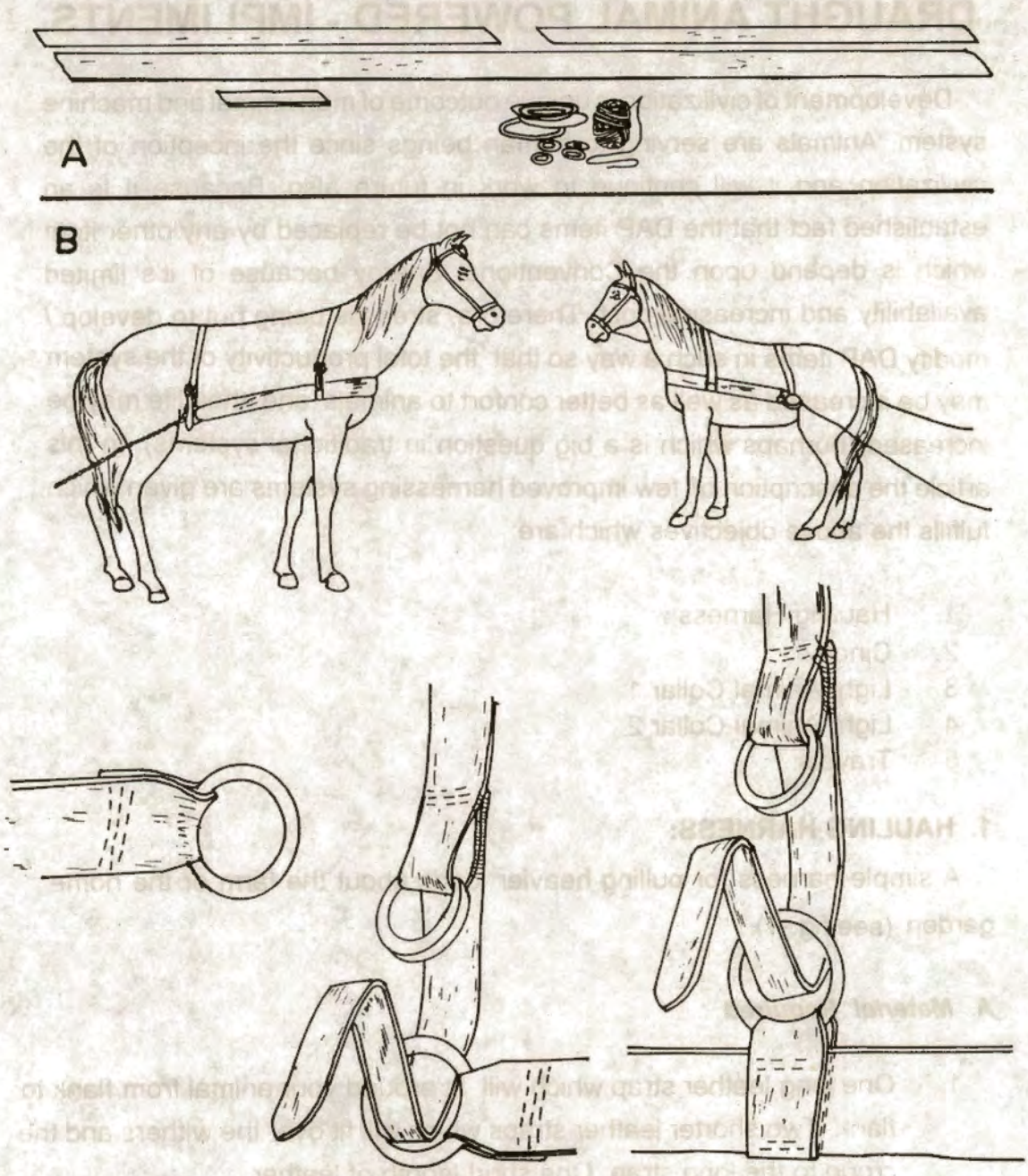

Fig. - 1

B. Instructions

1. Sew large metal rings to each end of the long leather chest-flank strap.
2. On one side of the chest-flank strap attach the shorter leather straps, one for the croup through the end ring and the other for the withers near the front.
3. Detail of croup strap on opposite side showing attachment of two small rings.
4. Detail of withers straps on opposite side showing attachment of two small rings

2. CINCH :

An easily constructed belly cinch to be used with either of the light animal collars included in this tool box. This harnessing method is suitable when a rigid connection between animal and load is required. (See fig.-2).

A. Material Required :

1. One long piece of leather and 4 short pieces of leather.
2. Two large metal rings, 4 small metal rings, heavy thread or twine and needle.
3. An animal collar.

B. Instruction :

1. Attach the large metal rings to one end of the long piece of leather to form the belly cinch. Attach the short pieces of leather and the small metal rings to the cinch for belting of rigid connecting member. To ensure the correct positioning of these short straps put the cinch on the animal to be used and, using the rigid connection, mark the exact position for these straps.
2. Put the collar to be used and the completed belly cinch on the animal. Insert the rigid member into the loops on the collar and belt the short straps. Attach a lenght of chain to the rigid member and hook in place to the collar as illustrated.

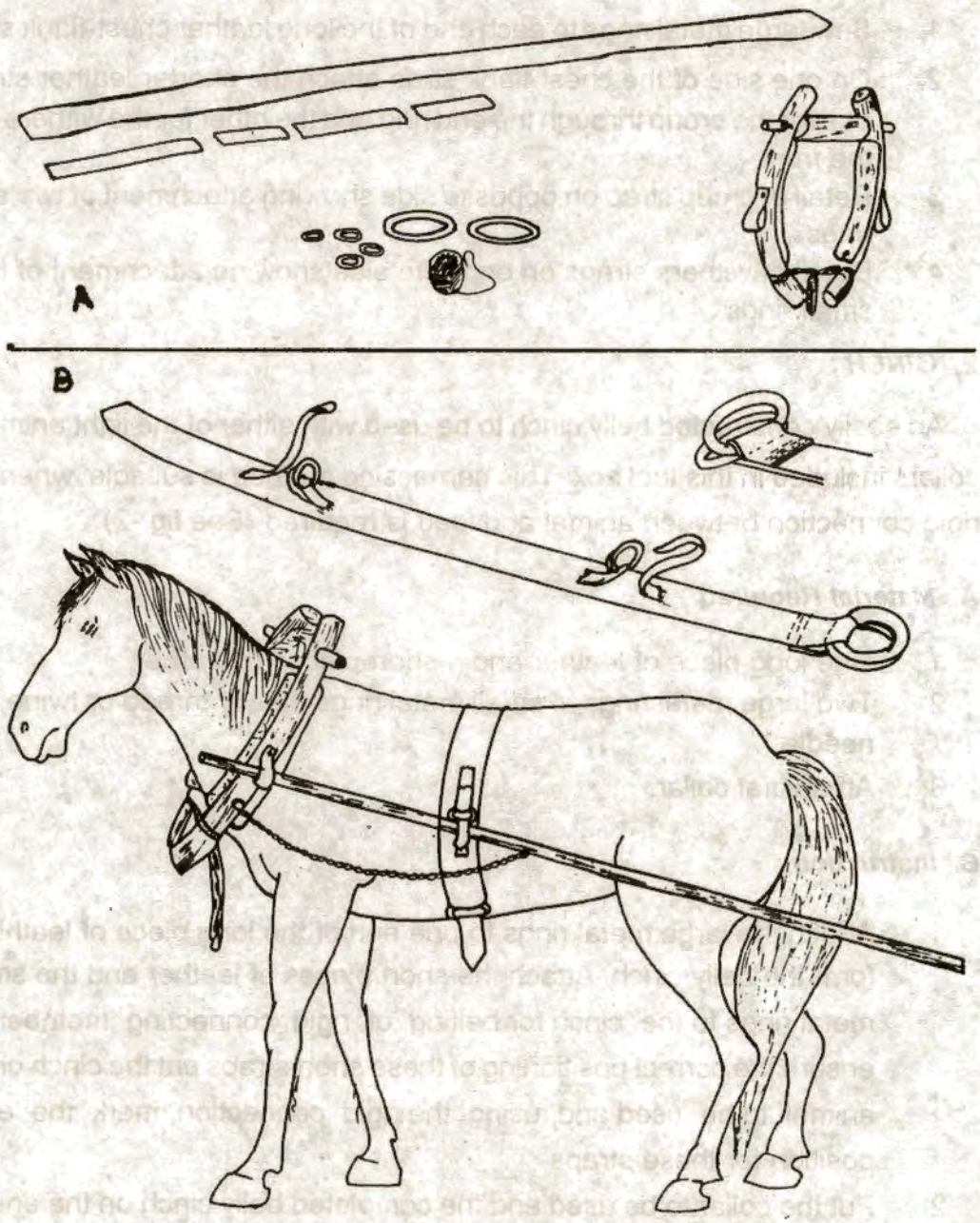

Fig. - 2

3. LIGHT ANIMAL COLLAR 1 :

Heavier work about the farm and home may be performed using a light animal such as a horse, pony or donkey. Here is a light animal collar which can be carved from scrap lumber (See fig.-3).

A. Material Required :

1. Two longer pieces of wood, 1 shorter piece of wood, 2 wooden pins.
2. A leather belt and 2 leather straps.
3. A wood carving knife, hammer and nails.
4. Blanket cloth or straw for padding (not shown).

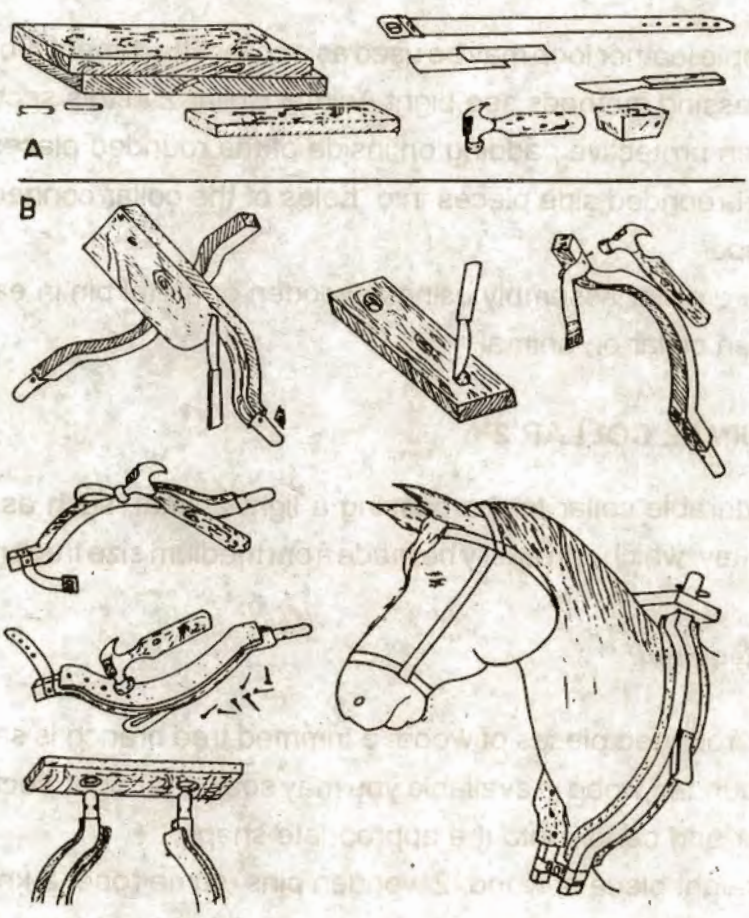

Fig. - 3

B. Instructions :

1. Carve the longer pieces of wood into rounded sections for each side of the collar. Take care that the inside rounded surface fits the base of the neck of the animal to be used. The top of each piece should be shaped to receive the collar connecting member. Drill a hole through the top of each piece for wooden pin.
2. Carve two holes through the shorter piece of wood to form the collar connecting member.
3. Cut the leather belt in two and nail securely one piece to each shaped side.
4. A simple leather loop may be used as a collar attachment. For alternative harnessing methods see Light Animal Collar 2 in this section.
5. Fasten protective padding on inside of the rounded pieces.
6. Insert rounded side pieces into holes of the collar connecting member.
7. Secure collar assembly using a wooden or metal pin in each side. Fasten collar on animal.

4. LIGHT ANIMAL COLLAR 2 :

A simple durable collar for harnessing a light animal, such as a horse, poney or donkey, which can easily be made from medium size tree limbs (See fig.-4).

A. Material Required :

1. Two rounded pieces of wood; a trimmed tree branch is satisfactory. If no rounded wood is available you may soak a straight section in warm water and bend it into the appropriate shape.
2. A straight piece of wood, 2 wooden pins, some rope, a knife, hammer and nails some leather strips, cleats and rings for the harness and blanket, cloth or straw for padding.

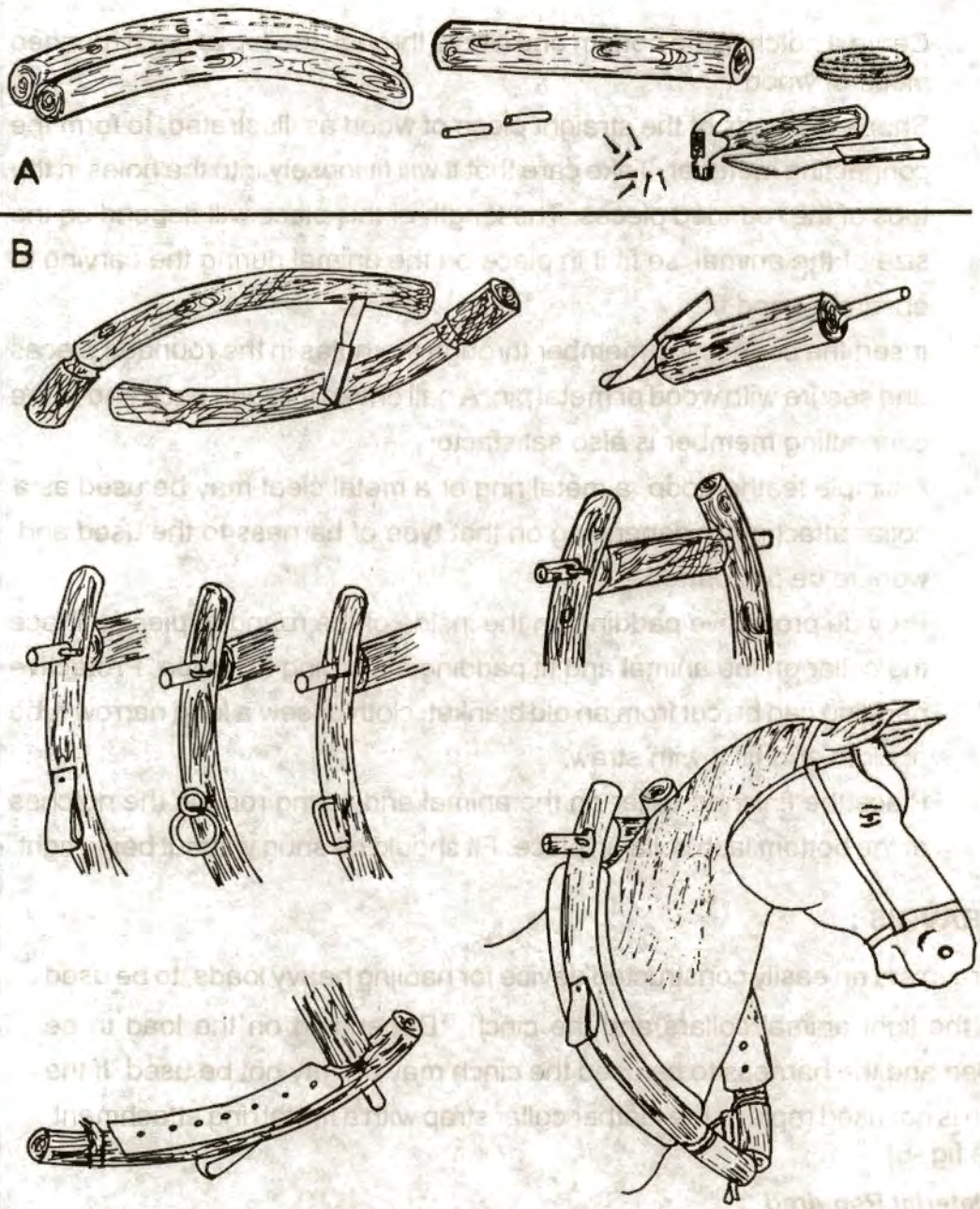

Fig. - 4

B. Instructions :

1. Carve a notch at the bottom and a hole through the top of each rounded piece of wood.
2. Shape the ends of the straight piece of wood as illustrated, to form the connecting member. Take care that it will fit loosely into the holes in the tops of the rounded pieces. The length of this piece will depend on the size of the animal, so fit it in place on the animal during the carving to ensure a good fit.
3. Insert the connecting member through the holes in the rounded pieces and secure with wood or metal pin. A nail driven through each end of the connecting member is also satisfactory.
4. A simple leather loop, a metal ring or a metal cleat may be used as a collar attachment depending on that type of harness to the used and work to be performed.
5. Provide protective padding on the inside of the rounded pieces. Place the collar on the animal and fit padding according to shape. Protective padding can be cut from an old blanket, cloth or sew a long narrow tube of cloth and fill it with straw.
6. Place the finished collar on the animal and, using rope in the notches at the bottom lash collar in place. Fit should be snug without being tight.

5. TRAVOIS :

Travois is an easily constructed device for hauling heavy loads, to be used with the light animal collars and the cinch. Depending on the load to be hauled and the harness to be used the cinch may or my not be used. If the cinch is not used replace the leather collar strap with a metal ring attachment (See fig.-5).

A. Material Required :

1. Two long straight pieces of wood, 2 shorter pieces of wood, rough straight tree members are satisfactory. 2 shorter pieces may be lashed together to form a long piece.

2. Rope.
3. A cinch (optional).
4. An animal collar.
5. Length of chain, hooks, small metal rings, other available attachments (not shown).

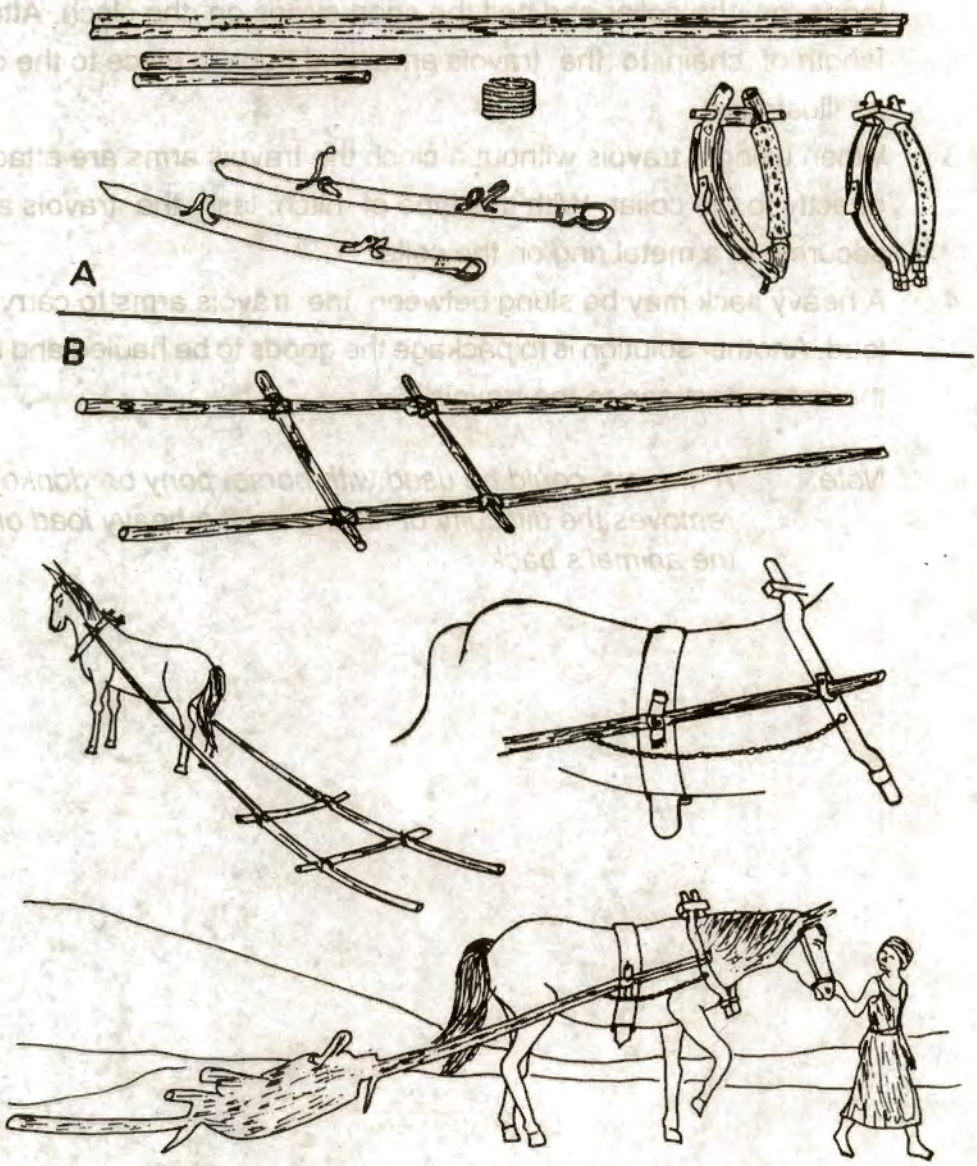

Fig. - 5

B. Instructions :

1. Lash the two shorter pieces of wood on top of the two longer pieces to make the travois.
2. Put the collar and the cinch on the animal. Insert the travois into the loops on the collar and belt the short straps on the cinch. Attach a length of chain to the travois arms and hook in place to the collar as illustrated.
3 When using a travois without a cinch the travois arms are attached directly to the collar. With this type of hitch, lash the travois arms securely to a metal ring on the collar.
4. A heavy sack may be slung between the travois arms to carry the load. Another solution is to package the goods to be hauled and lash the entire package to the travois.

Note: A travois could be used with horse, pony or donkey. It removes the difficulty of having to lift a heavy load on to the animal's back.

MOVES TO HARNESS WIND FOR POWER

Sri Lanka took her first positive steps towards harnessing yet another untapped energy source, wind, for the generation of electricity.

A report of a World Bank team has been most optimistic about the potential after a study in sourthern Sri Lanka. They did not go to the North for security reasons but it is sure the potential there is similar or even greater.

The team has told the CEB chief that 200 Megawatts of electricity could be generated by wind power in a southern location. The CEB has requested that a pilot project for a 3 MW wind energy powered plant to study potential and environmental repercussions should be undertaken by the team.

It is very likely that the World Bank would commission a pilot project by 1996 to study all the required parameters. The Bank team has said that the end result of this research would be to identify the most favourable spots in the south of Sri Lanka.

The chairman of the team added that the Water Resources Board will review a project launched some years ago to use wind to lift water. There were over 150 wind mills in different parts of the country which were neglected due to a variety of reasons.

The CEB also made a specific request to the World Bank team to assess the feasibility of 'stand alone' systems of wind and thermal combinations to serve remote areas where the national grid would take a long time coming, and wind by itself may not be adequate.

The Board which is concentrating its efforts on taking all precautionary measures to meet a major energy crisis predicted for 1996, predicted as a bad year for rain, has also requested a grant of US$ 40 million from the Global Environment Fund for research into non-traditional sources such as wind, solar, agricultural waste and mini-hydro to produce electricity in the more remote areas. Private sector participation will be invited to undertake the

projects in line with current government policy.

Sri Lanka's current requirement of power is in the region of 12.99 GWH or nearly 13 million units of electricity. The demand has been increasing by ten percent every year.

METHANE HYDRATE- A FUTURE ENERGY SOURCE

An ice-like material that occurs in underground deposits all over the world and is composed largely of water and methane may become a promising future energy source-if scientists can exploit it viably.

Global deposits of this material, known as methane (or gas) hydrate, are estimated to contain twice as much as corbon as all other fossil fuels on earth.

Methane hydrate is a molecule of methane trapped inside a spherical cluster of water molecules held together by hydrogen bonding. It forms from natural gas and water in sediments and permafrost, where temperatures are below 20 degrees celsius and pressures are very high.

Gas hydrates contain small amounts of other gases such as ethane or hydrogen sulphide. The hydrates typically are found beneath the ocean floor on continental margins and regions north of the Arctic Circle.

But tapping this enormous potential energy resource may not be as easy as drilling for oil or natural gas.

Nevertheless, scientists and engineers are now beginning to develop strategies to exploit methane hydrate. The main problem with methane hydrate is it is a solid that is not amenable to conventional gas and oil recovery techniques.

Professor of chemical petroleum engineering at the University of Pittsburgh have identified two potential recovery techniques for gas hydrates. One

involves injecting a warmer fluid, such as seawater, into the hydrate deposits, causing the hydrate to dissociate into water and gas, which can then be recovered conventionally.

Another technique involves reducing the pressure in the hydrate deposit by drilling into it to remove free gas that has been encaged by the deposit. This also leads to the breakdown of the hydrate.

An analysis of each technique indicates that pressure reduction may be superior. But the best choice for any deposit will depend on its location and the nature of the surrounding environment.

However, the environmental effects of such drilling are uncertain. Some scientists have expressed concern that the release of methane from hydrates into the atmosphere could affect earth's climate since methane is an even more potent greenhouse gas than corbon dioxide. Methane release from hydrate deposits is believed to occur naturally, but large-scale drilling could significantly increase the amount of gas entering the atmosphere.

NARI GASIFIERS FOR THERMAL APPLICATIONS

An automatic gasifier that can run on waste sugarcane leaves and grasses to produce thermal power, developed by the Nimbkar Agricultural Research Insitute (NARI) in Maharastra, has been awarded a grant by the Rockefeller Foundation in New York to commercialise the technology.

It can replace light diesel oil (LDO) burners in furnaces and pre-heating operations in metallurgical units.

The gasifier can produce 300-400 kilowatts thermal power, using a wide range of biomass such as sugarcane leaves, bagasse, sweet sorghum stalks wheat husk, grasses and safflower residues as fuel.

It gives combustible producer gas containing carbon monoxide and hydrogen, which burns with an intense bluish-white flame whose temperature exceeds 1200 degrees celsius.

The unit can be retrofitted to existing oil-fired furnaces, or can be used directly to produce heat for bakeries, brick kilns, and met allurgical furnaces, to make jaggery, or to dry seeds and other farm produce.

About 24 per cent of the fuel is converted into char, a value-added by-product which can be briquetted to form excellent fuel for wood stoves or can be used as a soil conditioner.

The unit neither needs any water for operation nor generates any waste water. It also requires minimum maintenance as toxic tars and other condensed materials do not accumulate in pipelines and equipment, and can quickly start up or shut down. It has gone through the necessary testing and will be installed shortly in a metallurgical company near Pune.

The fixed cost of the system varies from Rs. 1200-2000 per kilowatt depending on the capacity, the materials used, the degree of mechanisation of the systems that handle fuel and ash, and the extent of automation of the system.

For a 300-KW manually-operated gasifier using biomass at a cost of Rs 500 per tonne (dry weight), the payback period is two or three years.

DDT USE ENDORSED

Research indicates that there is still a place for that much maligned pesticide DDT, in controlling the Tse-tse fly, a vector in the debilitating disease trypanosomiasis- the dreaded sleeping sickness.

Scientists from Britain's Natural Resources Institute, who studies the impact of DDT in Zimbabwe, found that the pesticide had a severe impact on a largescale on four bird species, particularly the blackchat and the wood-hoopoe, and one lizard species. It was found to have little effect on fish and on soil fertility.

Sleeping sickness leads to a drop in energy and a gradual wasting away

and even death, if left untreated. It has the same effect on livestock and is particularly several in cattle.

FUEL FROM COCONUTS

The coconut may soon yield engine fuel- the result of a simple technology being perfected by Australian scientists. This technology provides coconut oil of such purity that it can be used to power diesel engines. At the base of this technology is a device invented by Dr. Dan Etherington of the Australian National University. A vital factor in the success of this technique is the moisture content and temperature of the coconut shavings. To preserve copra, all but five per cent of the moisture is removed and high pressure is needed to squeeze out the oil. But Dr Etherington's experiments showed that retaining between 9 and 13% of the moisture made oil extraction relatively simpler and lifted the yield dramatically to about 60%. Oil extracted by ten of Dr Etherington's devices has been tested in truck engines, outboard motors, and power generators in the Western Pacific nation of the Solomon Islands and Vanuatu. Little engine modification was needed. A low-cost oil extraction kit has been produced which includes a pedal-powered rotary grater, a solar drier, solar oven, and charcoal and sand filter.

LAND DEGRADATION

The billion acres of land - and area the size of China and India combined - have been seriously degraded in the world since the Second World War. If current land-degradation patterns continue, farmars will be hard-pressed to grow enough food, fuel and fibre and fodder for a population that will swell by one billion every decade. This is the conclusion drawn by the World Resources Institute, a Washington based centre for policy research and technical assistance on issues of poverty, development natural resources and environmental quality.

The report points out that agricultural policies around the world encourage

farmers in industrial and developing countries to make choices that injure both the environment and their own long-term economic interests. If Government provides the right incentives, sustainable agriculture could be as profitable as conventional farming methods.

POWER FROM CANE LEAVES

Sugarcane leaves, millions of tonnes of which go waste in India can be used to generate power, save diesel and produce enough heat to run jaggery units. Report scientists from the Nimbkar Agricultural Research Institute (NARI), at Phaltan in Maharastra. Loose sugarcane leaves generate electricity in the 10-15 kilo watts (KW) range. Tests on a 15-kilo-volt-Ampere diesel genset powered by a sugarcane leaves gasifier showed that 70-90 per cent diesel substitution could be achieved with 5 kilo Watts load. the NARI gasifier, also produces char which is 15-28 per cent of the fuel. The char boosts the overall efficiency of the system to 80-85 per cent and when mixed with a suitable binder it forms an excellent briquetting fuel for cooking purposes.

In India alone, about 430 million tonnes of crop residues and produced every year, out of which 330 million tonnes are used as feed or fodder and the remaining 100 million tonnes simply disposed of by burning in open fields.

BAN ON TIMBER USE

There is a ban on the use of solid timber by the Union Government's Central Public works Department (CPWD) following the identification of as many as 15 substitutes ushering in what may well be an environment friendly era in construction work.

The materials identified after much research and field studies, some of which are already in use are: PVC, medium density fibre board, glass fibre reinforced plastic, cement based particle board, bagasse board, straw board, rubber wood, Eucalyptus wood, expanded polystorone, red mud

polymer, interpenetrating polymer network, ferrocement and glass fibre reinforced gypsum.

SOIL NUTRIENTS

Every soil different nutrients-there are 13 basic nutrients, Carbon, hydrogen and oxygen are available from air and water. The secondary elements-nitrogen, phosphorous and potassium, are available from fertilisers. Only limited quantities of the 7 remaining elements iron, zinc, copper, sulphur, magnesium, manganese and molybdenum - are needed. However, a deficiency in any of these nutrients can drastically reduce yield.

Gypsum from Rajasthan contains 20% sulphur and with the 90% subsidy given by the government, it cost as little as Rs. 4 a bag. Thanks to this single measure, Haryana's per hectare oil seeds productivity is the highest in India. In mustard production is about 1,300 Kg. per ha. compard to the National average of about 1,000 Kg per ha.

DEVICES TO CHECK VEHICLE POLLUTION

Scientist at the National Environmental Engineering Research Institute (NEERI), Nagpur, have developed a new device for reduction pollution from petrol-driven vehicles. The device called a catalytic converter to reduce carbon mono oxide from the exhaust of vehicles. Carbon monoxide (CO) forms nearly 70% of the emissions and hydrocarbons (HC) about 30% of fuel left unburnt in engines is emitted from the exhausts. Carbon monoxide is highly dangerous as it mixes with air and reduces human intake of oxygen during broathing. The NEERI-developed device will make it harmless by converting (CO) into carbon dioxide found in abundance in the atmosphere and useful for the survival of plants.

The key component of the device is a special material prepared from some rare metals. The material is called a catalyst (a substance which does not

change during a chemical reaction) and helps in chemical reaction. When the carbon monoxide is passed over the catalyst placed in the vehicle's exhausts pipe, it is converted into harmless carbon dioxide. 50 to 60% of CO in the exhaust will get converted into carbon dioxide during this purpose.

The device will cost approximately Rs. 1,200 for Two-wheelers and Rs. 2800/- for cars and other vehicles with four stooke engines. The cost may decrease further after mass production starts.

The catalyst will be effective for 15,000 to 25,000 kilometres depending on the quality of fuel (rate of adulteration). After that only the catalyst will have to be replaced and not the entire assembly. This will cost about Rs. 300.

BRITISH MAKE IMPORTANT BREAK THROUGH IN FUEL CELLS

A team of British scientists have made considerable advances in their search for a cleaner, more efficient source of power when they overcame some of the difficulties that have frustrated previous research and development of fuel cells which could power the electric cars of tomorrow.

The direct methanol fuel cells, developed by the scientists at Newcastle University in northeast England, have several advantages over the petrol engine: they are efficient at all speeds; fuel consumption is the same whether driving on the open road or in congested urban areas; and there are no noxious exhaust fumes such as nitrous and sulphurous oxides.

Fuel cells are electrochemical systems that convert the chemical energy of a fuel cell and oxidant into electricity. Methanol and steam are deliverted to the cell's positive electrode (the anode) while air is fed in at the negative electrode (the cathode), producing electricity, and waste in the form of water and carbon dioxide.

Fuel cells themselves are not a new idea. But research and development of an ideal cell was hindered by several obstacles. The Newcastle university scientists were able to surmount several of them in the new fuel cell. For

instance, using a solid electrolyte made from Nafton, an acidic plastic, they have solved the problem of chemicals passing to wrong electrodes while simultaneously ensuring that the cells can run efficiently at their optimum operating temperature of 100 degrees celcius of above.

They have also developed more efficient electrodes using complex layers of ruthenium, carbon and small amounts of platinum.

Targets for the fuel cells performance set by the European Union are already being exceeded with further development, the Newcastle research team hopes to produce cells with a constant efficiency rating of 30 per cent compared with the internal combustion engine's 20 to 25 per cent on the open road, and only eight per cent in town traffic. Although some unsolved engineering problems remain, the researchers expect experimental cell-powered vehicles to be on the roads within the next five years.

SOLAR ENERGY WILL COSTS LESS

On her recent visit to India US Energy Secretary Hazel O'Leary said that it will be as cheap to produce electricity from sunlight by the turn of the century as it is from the more common sources of today. Recent breakthroughts in the technology of producing solar energy will dramatically lower its costs and further technical developments will continue this trend.

She mentioned the technical break through that is thin-film photovoltaic cells, which are expected to halve the cost of solar energy. Sunlight causes a chemical reaction within such cells that produces electricity. The thin-film technology is expected to be incorporated in glass panels that could be set up in commercial building exterior walls or in the roofing of a house. Photovoltaic technology could be used in rural areas of the developing world. They do not need a central generating plant and a power-line system for their operation.

RICE STRAW HELPS BOOST BIOGAS OUTPUT

Studies conducted by TERI (Tata Energy Research Institute) show that biogas production actually doubles by the addition of rice straw to the dung slurry. Wheat straw too increases methane production, through not to the same extent as rice straw.The Microbiology and Molecular Genetics Unit of TERI has spear headed the biomethanization experiments. The unit has established the advantages of using the new methods-increased potential for production of biogas and manure, and less pollution when families turn to biogas instead of burning dung. Two young scientists working on the project, have clearly established the potential of agricultural by-products like rice and wheat straw for biogas production. This offers new scope for the development of alternate feed materials for biogas generation when the supply of cattle dung is limited. Not only was methane production enhanced by adding crop residues but a greater biodegradability of organic matter (contained in the straw) was achieved. The experiments have been going on for the last six months at the Institute's farm on the Delhi-Haryana border and the slurry left behind after production of biogas has been found to be a very good fertilizer. In other words, the new technology will greatly benefit the farmers economically. The Institute has designed a biogas digester design, through it has already conducted over 20 workshops on the technology in different parts of the country. According to present indications, the technology will go a long way in changing the face of rural India by solving the problems of energy and manure at one stroke.

INCENTIVES FOR MINI HYDRO IN SLOVENIA

The construction of new mini hydro schemes in Slovenia, to be connected to the national grid, is to be encouraged in the future through higher buying prices and favourable loans.

The Ministry for Industry has recently announced approximaty US$ 1.5 million in financial support for such schemes. This should allow for about 40

new schemes to be constructed, provided that the concerns of the Ministry for the Environment can be answered.

At present approximately 30 per cent of the hydropower potential in Slovenia has been exploited. There are about 290 privately instigated and 30 industrial mini hydro schemes, which together generate about 33 GWH/year. It is estimated that the number of installations could easily double in the coming years.

CFRI TECHNOLOGY FOR CHULHAS RELEASED FOR RURAL PEOPLE

The CFRI (Central Fuel Ressearch Institute), Dhanbad, has developed two models of coal/coke fired improved domestic ovens (chulhas), 'Angarmitra' and 'Angarbandhu', under the National Programme of Improved Chulhas. These chulhas have the provision of optimum pre-heated secondary air and low-cost clay insulation. The thermal efficiencies of these chulhas are around 40%, as compared to 25% for the conventional market chulhas. Nearly 100 chulhas of each model fabricated at CFRI have been handed over to the MADA (Mineral Area Development Authority) free of cost for popularization among the rural people.

FUNDING MINI HYDRO : MIXING THE FINANCIAL COCKTAIL THAT WORKS

New mini hydro proposals often generate rather more enthusiasm among engineers and developers than they do in the offices of banks and funding institutions. There are many reasons for this: the capital instensive nature of the technology, inflexible electricity tariff structures, the lack of industrial customers in areas with good potential, the expense of conventional distribution, revenue collection in under developed regions, and the fact that individual schemes may be too small to attract the interest of the financial sector.

There are, however, many imaginative initiatives which can inform and inspire the funding of new schemes. In many latest edition of the journals there are articles addressing many of the constraints just mentioned, and some reminders of bankable advantages, such as the socio-economic benefits of a remote oil mill and the reduction in CO_2 emissions that the hydro alternative brings, both of which can attract non-commercial support and push some more proposals into reality.

KALINA CYCLE FOR THERMAL POWER GENERATION

The Kalina cycle is claimed to improve the operating efficiency of thermal power plants by 15-25%, lower production (fuel and operating) cost and reduce environmental emissions. The Kalina cycle uses a mixture of ammonia and water as the working fluid. In the conventional Ranking Cycle, steam at high pressure is used to spin the turbines to generate electricity. The Ranking cycle constitutes the majority of thermal power plants in operation today. Since ammonia and water boil at different temperatures, cotinuous boiling occurs over a range of temperature. This enhances heat transfer, and hence efficiency.

ELECTRIC AND HYDROGEN VEHICLES

In a study by World Resources Institute New Yark, James Mackenzie challenges conventional wisdom on such alternative fuels as methanol, ethanol, and compressed natural gas and concludes that none of them solve the problems linked to our heavy reliance on petroleum. They would result in higher levels of ozone and would not reduce global warming. A wide spread switch to gasonol is no solution. He states that developing carbon based alternative transportation fuels that are only marginally better for the environment than gasoline. The nation should focus instead on electric and hydrogen vehicles, the most promising long term means of curbing pollution

and green house gas emission. He also emphasizes the need for realistic thinking about future transportation modes. Why overhaul the nation's energy transporation? We'd much better off concentration on getting electric vehicles on the road.

INTERNATIONAL ENVIRONMENTAL EDUCATION

The North American Association for Environmental Education (NAAEE) is organising an International Environmental Education Course.

The North American Association for Environmental Education (NAAEE) in collaboration with the Smithsonian Institute's Conservation and Research Centre in Virginia, U.S.A. will organise an International Environmental Education Course from 17th October to 5th November'95.

The course is intended for people working for NGO's or Government Agencies in Developing Nations who are interested in developing their Environmental Education (EE) programmes. The main focus of the course will:

- What is EE and what role can it play in solving environmental problems?
- How to use social marketing to enhance an EE strategy.
- Choosing and designing effective communication tools.
- Creating and using EE activities.
- Monitoring and evaluating EE programmes.
- Fund raising for EE initiatives.

For more information contact :
NAAEE Environmental Education Training Institute
1255, 23rd street
NW
Washington DC 20037, USA

WATER SANITATION AND HEALTH

The Development and Project Planning Centre of the University of Bradford is offering a new course in the area of developnment management in 1995. The course entitled "Community Mangement of Development Projects: Water, Sanitation and Health; from 7th May to 14th July'95

The course is intended for practitioners in projects or programmes in

water, sanitation and health, which include community management.It will focus on the interaction of Government NGOs and private organisation with the community and how problems arising at this interface can be overcome. Modules will include management skills, planning techniques, policy issues, appropriate technologies, computing and project planning.

For more information Contact :
Professional Development and Training
Programme Secretary (ATW)
Development and Project Planning Centre
University of Bradford, Bradford BD7 1 DP, England

IMA's RURAL DEVELOPMENT TRAINING PROGRAMMES

IMA offers the following Rural Development Training Programmes to be held in Brighton, UK from 10th July - 23rd September 1995

- Management and Extension
- Management for Women in Rural Development
- Training of Trainers
- Media Producers
- Women in Environmental Management
- Managing Sustainable Development

IMA's ASIAN RURAL TRAINING PROGRAMME

IMA offers the following Asian Rural Development Training Programmes to be held in Chiang Mai, Thailand from 6th November -16th December 95.

- Asian Horticulture: Production, Processing and Market Development
- Technology & Rural Women: An Asian Perspective
- Developing skills in Asian Seed Technologies & Management
- Management for Rural Development in Asia

For more details contact :
The Course Administrator, IMA

36, Robertson Road,
Brighton, BN1 5NL, U.K.

ECOLOGY AND SUSTAINABILITY

Schumacher College, UK will organise a course on "Ecology and Sustainability in the New World Order" at Totnes, UK from 3-20 July'95.

For more information contact :
Ms Vandana Shiva
Schumacher College
Dartington Hall
Totnes, Devon, UK

ENERGY AFRICA

Water Africa Ltd, will hold a seminar "Energy Africa 95" from 20th October to 3rd November'95 at Ghana, West Africa.

The seminar aimed at energy producers in Western Africa, and helath and education services, emergency services, the civil services, and manufacture industry.

For more details contact :
Tracey Nolan, Water Africa Ltd.,
37 Upper Duke Street, Liverpool L1 9DY, U.K.

ENERGY' 96

The sixth international energy forum will be hosted by the China Association for Science & Technology in collaboration with International Energy Foundation with support from 50 organisations in 28 Countries. The conference, with the theme: "Energy Strategies in Developing Countries in the 21st Century Challenges and Opportunities",will be held from June 3 to 7 1996.

Specialized workshops such as Active Solar Energy; Passive Low Energy

Architecture, Global Climate Change, Energy Sustainability, Photovoltaics, Science and Technology Management: The challenges of the Market Economy and the Commercilization of Technology headed by world leading scientists and engineers, will also be hold prior to the forum:

For further information contact :
Mr.Lui Feng
Energex '96'
Conference Manager, China International Conference
Centre for Science & Technology, 44 Kexueyuen Road
Shuangyushu, Beijing
China - 1100086.

MICRO HYDRO POWER

Intermediate Technology, UK, will organize a "Training Course on Micro-Hydro ower" at Cebu, Philippines, from 3rd September to 23rd September'95.

The main topics include: Comparative energy studies, survey techniques, feasibility studies, scheme design, financing, subsidy policy, credit, local manufacture of components, and maintenance of schemes between 03 KW and 300 KW, participative planning, local management and ownership.

The course is for rural development planners, engineers, technicians, etc.

For more details contact :
Mr Adam Harvey
Coordinator
Micro-Hydro Internation Course, Intermediate Technology,
Myson House, Railway Terrace
Rugby CV 21 3 HT, U.K.

AGRICULTURE GROWTH RURAL POVERTY AND ENVIRONMENTAL DEGRADATION IN INDIA

Agricultural growth, rural poverty, environmental degradation and participatory processes are highly interrelated. Yet each of them is usually studied in isolation and the strategies adopted for the different sectors are seldom informed by the interrelationship between them. A major point of current relevance in this book is that it also examines the implications for development strategy and policy in the context of the ongoing economic reforms in the country.

There seems to be some improvement in the growth rate of agricultural output in the last decade when compared to the first decade of the green revolution. There are indications that the inter-crop and inter regional disparities in growth witnessed in the early years of the green revolution are getting redressed to some extent in the recent period.

Environmental degradation is attributed to the slow rate of land augmenting technological change and the inequitable distribution of gains resulting in pressure on the environment from the poor as well as the affluent.

On the basis of his study, the author recommends stepping up public investment in agriculture, especially in irrigation and research, as essential to raise the growth rate, and to realize the possible gains from trade as well as to ensure the equitable sharing of such gains.

The book has been divided into five chapters viz; Agricultural Growth, Rural Poverty, Environmental Degradation, Participatory Rural Development, Economic Reforms and Agriculture, its also includes Bibliography, Index and Figures.

"Agricultural Growth - Rural Poverty and Environmental Degradation in India" by C.H. Hanumantha Rao, Published by Oxford University Press, Delhi, Rs. 340/-, Pp 274, English 1994.

INDIA'S EUCALYPTUS CRAZE

Eucalyptus planting on farm lands in India has attracted a great deal of controversy. Faced with rapidly dwindling timber resources, the Indian government launched a concerted farm forestry programme in the late seventies. The objective was to persuade farmers to grow fuelwood and fodder for their own use. In actual practice , however, farmers preferred to plant trees which had commercial use, the most widely favoured tree in this context was encalyptus, which was planted primarily for sale as timber, for poles or as pulpwood. By the mid eighties (after 1986) most Indian farmers seemed to have lost their enthusiasm for eucalyptus. Little research has been done on the pattern of adoption, diffusion and rejection of this innovation for any part of India.

This book propose to fill this gap for one fertile region, western u.p. It analyses three issues: what were the socio-economic characteristics of eucalyptus planters, why was eucalyptus planted more, in the western than in the eastern or southern region of u.p. and why was its planting given up after 1986.

The book is organised in ten chapters. First is for the introduction of Eucalyptus and about the book. The experience of introduction of high yielding varities of seeds (called MVs) is reviewed in chapter two. Chapter three discusses the similarities and differences between eucalyptus and MVs. Chapter four reviewed the literature on agricultural innovation discusses the individual characteristics of farmers according to the physical size of holdings treating farm size as on index of economic status, chapter five describes the methodology of field work. Next three chapters (6 to 8) describe the results of the field work. Chapter 6 test the hypothesis regarding the characteristics and the regional dispersal of tree planters. Chapter seven presents an approximate financial analysis of eucalyptus planting done by 28 farmers in the four western u.p. villages with a view to understanding the reasons for the decline in eucalyptus planting after 1986. Chapter 8 discusses

aspects of marketing from eucalyptus, and chapter 9 integrates the findings on the hypothesis and presents a summary of the book. The last chapter assesses the trends in the farm forestry programme, and discusses the policy implications arising out of the findings of this research.

"India's Eucalyptus Craze-The God that Failed" by N.C. Saxena, Published by, Sage Publications, New Delhi, Pp 264, 1994, Rs.275/-, English.

CAPTURING COMPLEXITY

While there is a considerable and growing body of literature concerning the role of women in social and economic development, appropriate research method have yet to be developed to fully encompass the multiple dimensions of women's productive and reproductive activities as individuals and as members of house holds.

How does one obtain information needed for educational or policy purposes? The first resort is to search out and utilize published data. In the case of information on the role of women in social and economic development, major gaps will remain, however, which need to be filled out of new research. If approprite methods of research are not readily available, they need to be searched out or developed. This book is a product of the collaborative efforts of two universities (University of Illinois at urbana-champaign, USA and the Maharaja Sayajirao University of Baroda, India) to fill, or lay a foundation for filling gaps in information about women in development. Another outcome of this collaboration was the recognition of a mutual interest in improving methods for obtaining policy relevant data on women.

Arguing that concrete development problems know no disciplinary boundaries, the paper in this volume promote an integrated, interdisciplinary and problem centered approach to development research. The papers included in this book are practically-oriented collection designed to give the reader an understanding of current theoretical and methodological

appproaches being used to examine gender as a development issue in a number of different disciplinary and topical areas. The individual chapters discuss why a specific focus on women is necessary, why it has been difficult using conventional approaches and methods, and how household level research may contribute to improving the quality of policy relevant data.

The book is divided into seven chapters-dealing with Introduction, Approaches to the Study of Household and Household Production, Women Agricultural Production and Rural Supports, Chapter fourth and fifth deals with Balancing Economic Needs and Care Giving, Fertility Behavior, child Care and Development. Last two chapters illustrates Nutrition and Health and Methodological concepts and issues.

"Capturing complexity-An interdisciplinary look at women, households and development", by Romy Borooah et.al. published by Sage Publications, New-Delhi, 1994, Pp 324, Rs.295/- English.

PRESPRCTIVES ON DEVELOPMENT COMMUNICATION

The current thinking in development communication has shifted from the 'dominant paradigm' of the diffusion of innovation to a less 'top-down' approach which acknowledge the importance of a micro level focous and coherent linkages to the micro-level It is an era where there is an increased willingness on the part of the development planners and scholars to carefully consider the 'felt needs' of the rural population. Development process in the third world context requires full participation of the people if there is to be commitment to development decisions sharing power through joint decision-making, blending and integrating indigenous and expert knowledge through dialogue are now viewed as more effective ways to seek solutions for micro level problems. The focus on people's participation and thinking about how development communication process support that focus, is the current challange for development planners, and development communication scholars.

The collection of eighteen original papers in this volume was presented at a 'Seminar on Development Communication Research' at the University of Poona, Pune India. These papers presents diverse viewpoints regarding the need for rethinking the effectiveness of existing development models and processes. The new model of communication presented by the editors of this volume addresses the transition from the 'top-down' approach to one which involves people at the grass-roots in development decisions. The paper are divided into three parts under the heading ,Part 1-Perspectives and Paradigms, Part 2-Issues, Approaches and Strategies and Part 3-Message Media and New Technology. Among the issues explored by the contributors are inequality, dependency development indicators, participatory approaches, message effectiveness and the use of traditional media and modern communication technologies.

The book combines theoretical concerns with practical considerations relevant to development communication. Emphasis has been given on Information strategies for Rural Development in part II. In part III two paper presents the importance on Traditional Folk Media for Rural Development and using Video in Rural Development.

"Prespective on Development Communication" by K.S. Nair & S.A. White (Ed.) Published by Sage Publications, New Delhi, Pp 256, Rs. 250/- , English.

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There is no limit to the length of contribution, but it is suggested that a maximum of 6,000 words or equivalent be used as a guide (approximately 6 to 7 pages).

1. The complete manuscript should be written in English and the desired order contents of Title, Abstract, List of Symbols, Main Text, Acknowledgement, Reference and Appendices. The Standard International System of Units (SI) should be used.
2. The manuscript should be typed on one side of the paper only (preferably 8"×11" bond paper) with double spacing between lines and 1.1/2, margin on the left.
3. Two copies of the manuscript and illustrations (one set original) should be sent to the Editor.
4. The title should be brief (maximum of 150 characters including blank in between words or other non-alphabetical characters) and followed by the author's name, affiliation and address.
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