The Management of Animal Energy Resources and the Modernization of the Bullock Cart System

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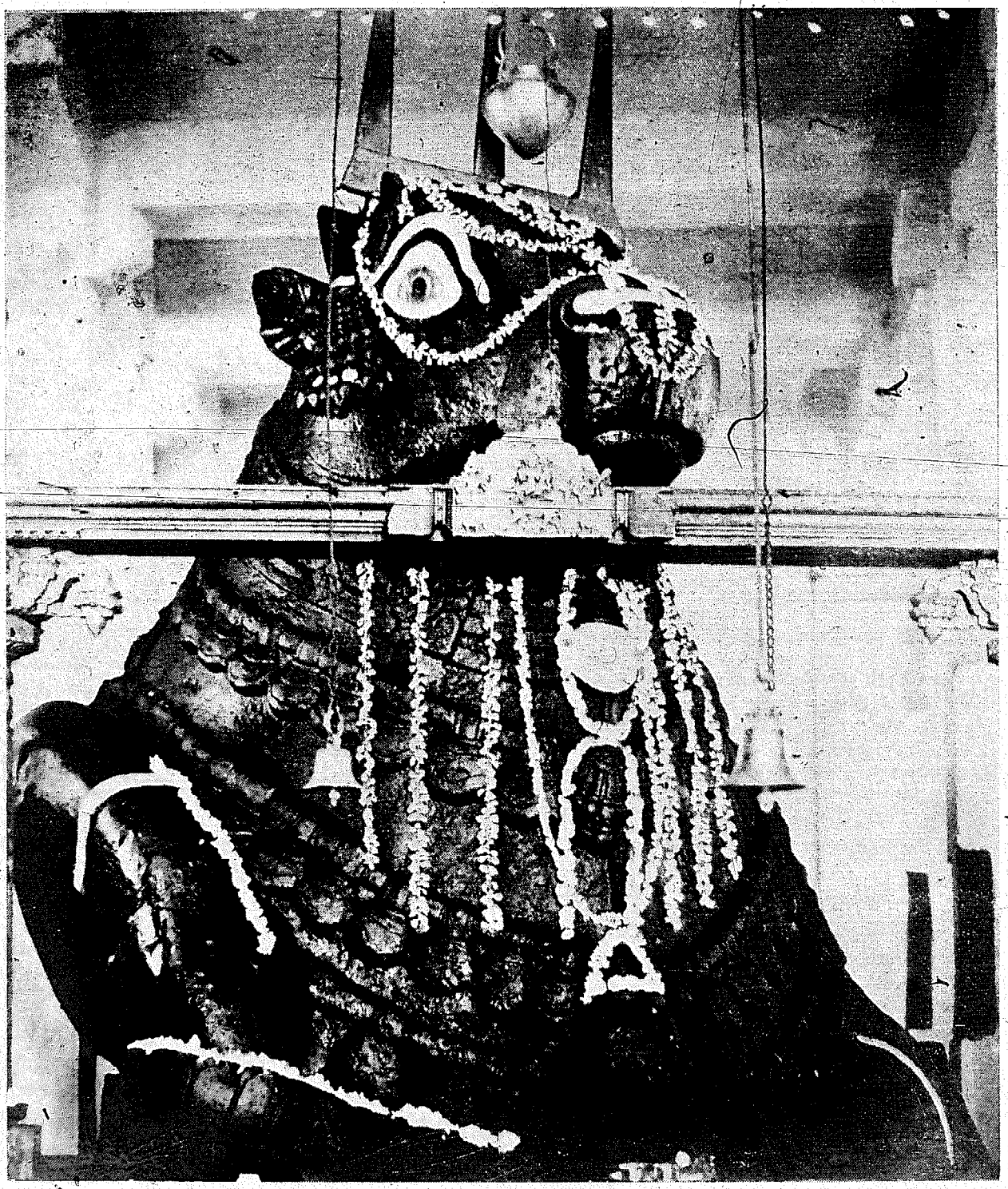

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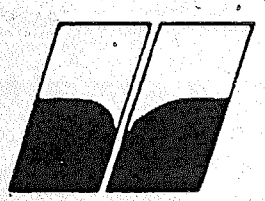

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FOREWORD

I have been working on the Modernization of the Bullock-cart Transportation System and the Management of Animal Energy Use during the last few years. A number of papers were prepared on various aspects of the system—for publication, for presentation at seminars as background material, or project proposals submitted to funding authorities. Selected papers have been assembled in this volume. There is a certain amount of obvious overlapping as between the papers; this became inevitable in the process of making each paper self-contained. Taken together, the papers cover most of the salient points which would be of interest to professionals and to the public at large. In this volume of papers, however, it is animal energy, which constitutes the principal interest, the bullock-drawn cart being cited as a case study of an important mode of utilization.

A number of my faculty colleagues have helped me in evolving ideas and in the preparation of these papers. Prof. C. L. Narasimhan has worked with me throughout on the preparation of these papers; I am deeply indebted to him. Dr. P. V. George, Dr. V. Radhakrishnan and Dr. T. P. Gopalaswamy helped in the preparation of the *Modernization of the Bullock-cart System: Techno-Economic Aspects*. Dr. J. Bandyopadhyay helped with the Animal Energy paper. The first paper on the antecedents of the animal-cart in tradition and in history and the last section on *Recommendations* for action are taken from the project report entitled *Modernization of the Bullock-cart Transportation System* submitted to the Department of Science and Technology in September 1978. This report on the Modernization of the Bullock-cart project funded by the Department of Science and Technology in January 1976 was drafted by Shri N. A. Sirsi and by Prof. C. L. Narasimhan. I take this opportunity of thanking all of them.

The Indian Institute of Management, Bangalore, has since taken up Animal Energy Management as one of its major interests. My first thanks are due to my esteemed colleagues in the Institute. A number of faculty have been assisting me in this inter-disciplinary project, each in a specific aspect, area or sector. The ideas contained in these papers are the product of my interaction with faculty—some working intensively and full time, and others part time. This acknowledgement is intended to be a token of the appreciation of their interest and contribution in what IIM-B regards as a vital project.

Professor	*Principal Area of Contribution*
C. L. Narasimhan*	Socio-economic Survey; Redesign of Carts; Cruelty to Animals; Documentation Manual; Visual Aids; Editing; Inter-disciplinary Studies

P. Bhaskaran*	Socio-economic Survey; Extension
V.A.P. Naik*	Redesign of Carts and Agricultural Implements
J. Bandyopadhyay*	Appropriate Technology & Social Involvement Projects
K.L.K. Rao	Socio-economic Survey; Use of Steel in Rural Areas
A. V. Shanmugam	Rural Communication; Exhibition
T. P. Gopalaswamy, P. V. George, V. Radhakrishnan	Socio-economics of Bullock-cart Transportation and Rural Development
R. N. Warriar	Rural Marketing
K. S. Pillai	Rural Roads
O. K. Govindarajan	Value Engineering; Rural Industries
V. Ranganathan	Cost-benefit Study
M. R. Rao, S. Subba Rao	Operations Research; Energy Management
G. K. Nayar	Productivity Studies and Measurement; Editing

*These faculty have devoted a major share of their time to the Institute's animal energy and bullock-cart projects. Others have worked part time. Shri N. A. Sirsi and Dr. G. Venkatachalam, Officers on Special Duty, worked on the Redesign and Animal Energy components of this project.

Dr. K. A. Damodaran, IIT, Madras, and Dr. Venkataraman, PSG Institute of Technology, Coimbatore, helped in the earlier stages. The Indian Roads Congress and Dunlops were the pioneers in the upgrading of bullock-cart technology. Dunlops have evinced renewed interest. In particular, I should like to record our debt to Sarvasri R. M. Bhandari, V. Kumaraswami, and J. A. Fernandez. When scientific and bullock-cart technology ruled low, the modest work of CRRI served to focus attention on unsolved problems. I should also here like to acknowledge the devoted interest of fellow-workers on the bullock-cart: Shri S. S. Venkataramanan, Value Engineer from SAIL, Dr. Ojha, IIT, Kharagpur, Dr. Reddy, Warangal and Dr. H. S. Nagabhushaniah, Rourekela, — both from Regional Engineering Colleges.

The Board of Governors of IIM, Bangalore and the Ministry of Education have always encouraged socially relevant activities of the Institute generally, and this project particularly. Special mention must be made of Dr. P. C. Chunder, Minister, Mr. P. Sabhanayagam, Secretary in the Ministry of Education, Sri T. A. Pai, Shri G.V.K. Rao, and Shri B. Sivaraman, all former Chairmen of the Institute. Shri Govind Narain, the present Chairman of the Board of Governors, has evinced deep interest in the bullock-cart and animal energy programmes. I must record the sympathy and encouragement that I have unfailingly received from Board Chairmen and members.

Besides my colleagues, several friends, well-wishers and professionals in industry, in Government, in foreign Universities and international organizations have encouraged

me and supported the project in a variety of ways. My thanks are due to all of them, and the success of the project will continue to depend on them. But for them, this project would not perhaps have got off the ground at all.

Dr. A. Ramachandran, formerly Secretary in the Department of Science and Technology, and now the Executive Director of the UN Centre for Human Settlements, Nairobi, sanctioned the first funds for the project at a time when the Institute needed encouragement. He also approved the Documentation Manual Project, work on which is now in progress. IIM-B's gratitude to Shri M. G. K. Menon, his successor, must also be recorded. His colleagues, Dr. J. Dhar, Dr. Deshpande, Dr. J. Gururaja, Dr. Manju Sharma, Mr. Ramanujam, and others in the Department of Science and Technology have unfailingly given of their time and supported the project at every turn. Dr. S. R. Valluri, head of the Technical Committee, and Director, NAL, recommended the redesign project for funding in the first instance.

The major breakthrough in obtaining acceptance for the project at Government level came with the initiative of Shri M. Ramakrishnayya, IAS, formerly Secretary in the Ministry of Shipping and Transport and currently Deputy Governor, Reserve Bank of India. An inter-ministerial effort was launched by the constitution of a Steering Committee composed of interested departments, with J. S. Marya, Additional Secretary, Ministry of Shipping and Transport and Director-General, Roads Wing, as Chairman. He and his colleagues in the Ministry of Shipping and Transport, particularly Brig. Gobindar Singh, Sarvashri Shivaguru, R. P. Sikka, D. P. Gupta, K. Arunachalam, and Dr. Swaminathan, Director, CRRI, all evinced much interest, and they deserve the gratitude of the Institute. In the Ministry of Agriculture, Dr. M. S. Swaminathan, now Secretary, and formerly Director-General, ICAR, Mr. G.V.K. Rao, Secretary, and now Member, Planning Commission, K. P. A. Menon, Additional Secretary, Dr. B. K. Soni, and Sri C. S. Sridharan, now in the UNDP, have all been helpful. A conference of ICAR and Agriculture Ministry officials was convened in Krishi Bhavan, New Delhi, on February 8, 1979 at the conclusion of which IIM-B was formally called upon to formulate proposals for an autonomous Animal Energy Development Board.

Dr. S. R. Valluri of NAL, Air Marshal S. J. Dastur of HAL, Dr. S. M. Patil of HMT, Mr. K. C. Mohan of MECON, Mr. Suri of Suri and Nayar, Mr. Raj Bhandari and Mr. G. S. Krishna of Dunlop, Mr. C. R. Dasgupta of IOC, Mr. Ravi Bhatnagar of Bharat Petroleum, Mr. M. V. Arunachalam of Tube Investments, Prof. G. R. Damodaran, Vice Chancellor of Madras University, Prof. M. Subbayyan of the PSG College of Technology, Coimbatore, Dr. S. Dhawan of the Institute of Science, Dr. Pandalai of IIT Madras and numerous others persuaded the engineer-colleagues in their organization to help in the redesign of the bullock-cart.

During a recent trip abroad, I discussed this project with the UN Agencies, Universities, R & D Institutions, funding organizations and with professional groups working on Appropriate Technology. I hope they will continue their co-operation and contribution, as the long march towards fulfilment of the goals of this project

is not only beset with complex problems but is hazardous as well. It evoked tremendous enthusiasm among all. Though those interested are far too numerous to be acknowledged individually here, I should like to make a special mention of the following:

Dr. A. Ramachandran, U.N. Centre for Human Settlements, Nairobi
Dr. Ralph W. Phillips, Deputy Director-General, FAO, Rome
Dr. M. L. Dewan, Chief, Regional Bureau, FAO, Rome
Dr. H. Huest, Chief, Agricultural Engineering Service, FAO, Rome
Dr. Harry C. Mossman, FAO
Dr. G. C. Juneja, FAO
Dr. Van Gilst, FAO, Rome
Dr. G. S. Gauri, UNIDO, Vienna
Dr. A. A. Swamy Rao, UNIDO, Vienna
Mr. S. K. Jain, Deputy Director-General, ILO, Geneva
Dr. Ajit Bhalla, Chief, Technology and Employment, ILO, Geneva
Dr. A. R. Khan, ILO, Geneva
Dr. Dharam Ghai, ILO, Geneva
Dr. P. N. Dhar, Assistant Secretary-General, UN, New York
Mr. B. P. Menon, UN Information Department, New York
Mr. Naush Adib, Chief, Energy Section, UNDP, New York
Dr. G. C. Subba Rao, CNERT, New York
Mr. M. Kulessa, UNDP, Chief Regional Projects, Asia, Pacific & New York
Mr. A. Joseph, UNDP, New York
Mr. K. Tsien, UNDP, New York
Dr. Martin Lees, UNDP, New York
Mr. N. Brown, UNDP, New York
Mr. Abid Hussain, ESCAP, Bangkok
Dr. H.G.R. Reddy, ESCAP, Bangkok
Dr. David Hopper, Vice-President, World Bank, Washington
Mr. Purviz N. Damry, Vice-President, World Bank, Washington
Dr. Charles Weiss, Science and Technology Adviser, World Bank, Washington
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Dr. Michael Radnor, North-western University, Chicago
Dr. Robert Nathans, Institute of Energy Research, Stonybrook
Dr. Warren F. Ilchman, Ford Foundation, New York
Prof. Georges Heuse, Ligue International du Droit de l'Animal, Paris
Dr. Ian Barwell, Intermediate Technology Group, London
Dr. Kamla Chowdhury, Ford Foundation, New Delhi
Mr. Eugene S. Staples, Ford Foundation, New Delhi

Dr. A.T.R. Rahman, International Development Research Centre, Canada
Dr. T. R. Laxman, Boston University
Dr. L. J. Ervin, Alternate Director, Al Diriyyah Institute, Washington.

Several days have been spent by the following colleagues in my Secretariat. They have been with me ungrudgingly preparing a number of reports, papers and project proposals and answering (only some of the) literally hundreds of enquiries and suggestions about the project originating in all parts of the country: Sarvasri S. Subramaniam, Lt. Col. S. Nagasundaram, S. Gilbert, C. S. Jaya Prakash, P. Srinivasa Murthy, M.R. Suryanarayana Shastry, Tarakram, T. K. Sivaraman, A. Srinivasan, Sirajuddin, R. Gopal, K. P. Sebastian, S. Wilson, M. Palani, A. Kurian, Miss J. K. Vedamatha and others whose help I might have overlooked. Without their enthusiasm, encouragement and solidarity, work on this project would have been impossible.

The concern for work-animals which have served us so well and the concept of the systematic development of animal energy resources form an integral part of a new set of values which are being proposed in, and fostered through, these studies. The problem is so formidable and appears so intractable that, to make any palpable impression on it at all, would necessarily call for phenomenal effort within an imposing frame. Thus the bullock-cart redesign project and the management of animal energy utilization are much more than management, engineering, or applied socio-economic research. In keeping with its potentialities for economic benefits, for value fostering and for attitudinal change, this programme has been conceived in revolutionary dimensions. It will promote participative research in technology and management in hundreds of research centres spread over the country and bring cheer to millions of rural homes. Literally thousands of people would participate in operationalizing and executing this project if it materializes in the form visualized. Let there be no mistake however. While modernizing technology for the use of animal energy and designating its place and role in the rural economy, it is not the intention to perpetuate its use for all time to come.

N. S. RAMASWAMY

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ERRATA

	FOR	*READ*
1 Page 68, Test Data for Carts, Col. 5	For Parking Cart	For *pulling* cart
2 Page 87, para 4, line 13	1000 crores of beatings	10,000 crores of beatings
3 Page 98, graph at the top	in thousands of megawatts	in thousands of *kilowatts*
	30 million megawatts	30 million *kilowatts*
	26 million megawatts	26 million *kilowatts*
4 Page 110, II. Output, row 8	Hicks	*Hides*
5 Page 123 photo	Kindly note that the wooden dummy wheel is not of Dunlop design.	
6 Page 124 all photos	Acknowledged to Rajan Poduval *Mathrubhumi* weekly, Trivandrum.	

SUMMARY DATA ON

INDIA'S ANIMAL ENERGY RESOURCES

Faced with a worldwide energy crisis, scientists are searching for new sources of energy —from the sun, wind, tides, biomass and so on.

Meanwhile, work-animals are used extensively in many third-world countries for ploughing, the hauling of carts, water-lifting, chaff-cutting and in oil extraction. Animal energy is appropriate and essential in these contexts.

Indeed, they will have so to depend on animal energy for many decades to come. Nevertheless animal energy has suffered neglect at the hands of policy-makers, scientists and professionals. Besides, animals are ill-treated throughout their working life and in death.

Animal energy is significant

(a) to countries of the Indian sub-continent, such as Pakistan, Nepal, Bangla Desh, India, Sri Lanka and Burma.

(b) to Indo-China—Laos, Cambodia, and Vietnam,

(c) to Malaysia and Indonesia,

(d) to China, and

(e) to a few countries in Africa, South America and West Asia.

The combined population of these countries is about two billions. Their work-animals may number around 200 millions.

The draught capacity of a work-animal depends on its breed, size, feed, its quality and nutritive content, etc. In India, it ranges from 0.4 h.p. to one h.p. and indeed, an animal is capable of putting forth bursts of energy up to 1.5 h.p. For purposes of calculation of energy availability, a low average of 0.5 h.p. is assumed. This is based on an animal exerting about 50 kg. or 100 to 110 lb. of draught and walking at the rate of two miles per hour over a sustained period of time.

On this basis, the energy made available by work-animals in the third-world countries with their estimated work-animal population of 200 millions may be around 100 million horse-power. The investment in work-animals and the associated components of the system may be around Rs. 200 billions.

Some data regarding work-animals in India are readily available. It seems that the situation in other countries may be more or less similar to that of India. There are about 80 million work-animals in India—70 million bullocks, eight million buffaloes, one million camels and one million horses. Besides these, mules, donkeys and elephants are also used as pack animals.

The price of a work-animal varies between Rs. 500 to Rs. 2,000 and an average figure of Rs. 1,000 has been taken for purposes of calculation.

Energy available from 80 million work-animals is of the order of 40 million h.p. which is roughly equal to 30,000 megawatts. Investment in the animal energy system, including implements and carts, may be of the order of Rs. 10,000 crores. Assuming that the cost of one kilowatt of electrical energy at the point of application is Rs. 10,000, the replacement of animals would call for an investment of anywhere between Rs. 200 to 300 billion.

A draught animal can start work at the age of three years, and work up to 10 or 15 years, depending on the intensity of use, health care and feeding.

Work-animals are principally used for ploughing. The next important use of work-animals

is for drawing carts. Horses are mainly used for transporting passengers in urban areas. Buffaloes are coming into use in certain parts of India. Not nearly so common as bullocks, they are great feeders, and certain breeds can do more work than bullocks. They are used for ploughing and carting and are used mostly singly. Hitched to a cart, buffaloes can haul heavier loads, but can only walk slowly. Camels are used both for hauling carts and ploughing and as pack animals as well.

Out of 80 million work-animals, 74 millions are assumed to lie in the rural areas and about six millions in the urban areas.

Two-thirds of the energy input going into the farming enterprise excluding carting, originates in work-animals—from bullocks for the most part. About 23 per cent is contributed by human labour and only ten per cent by hydel and fossil fuels.

For optimum output of farm produce, the present energy input to the farms has to be doubled. Such a vast quantity of ready energy can come only from animals. Even if the output of energy from fossil fuels and hydel energy were doubled, the proportion of animal energy to the total would remain the same for a number of years.

Seventy per cent of the total number of holdings covering only about 20 per cent of the area under cultivation are less than two hectares in extent. Even power-tillers are economical only for holdings of three hectares and more. Tractors are optimally used on farms of five acres—that only in places like the Punjab where a three-crop regimen can be assumed. Normally, a 15-h.p. tractor is useful for diversified activity on a 10-acre farm. It has been found, however, that the ownership of an animal emerges only at the level of a three-acre farm.

Animals cannot therefore be replaced by tillers and tractors, unless the size of the holdings increases. Alternatively, tillers and tractors should be hired out to farmers as most cannot afford their own. U.N. reports suggest that mechanization of agriculture has not been overly successful in Pakistan and Tanzania.

The high cost and worldwide shortage of petroleum fuels, the uneconomic size of small and marginal farmers' holdings and their poverty preclude the use of fertilizers and tractors. For the above reasons, animal energy will continue to be used for years to come.

Haryana, Punjab and Kerala are switching over to tillers and tractors, since tractor rental services are being established. Also, there is pressure on land, and pasture is shrinking in every village because of competing claims on land.

Elsewhere, work-cattle are increasing because of multiple cropping, higher yields per hectare, fresh land brought under cultivation, etc. In single-crop areas, farm animals are underutilized and carting serves to reduce idle time but not every farmer who has animals owns a cart.

Animal utilization in rural areas can be increased if:

- the area under second and third crops and under scientific agriculture generally can be increased;
- implements and machinery used for threshing, oil extraction, water lifting, etc., are improved and powered by animals. Ploughs, carts and harnesses have to be improved so that they utlize animal energy optimally without application and transmission losses;
- new implements and machinery are designed;
- animal power can be used to generate electricity.

Improved animal-using implements developed so far have not been utilized on a large scale.

CARTING:

The most popular among carts, countless in number and variety, is the traditional wooden-wheeled and iron-rimmed bullock-drawn cart.

Its capacity drawn by a pair of average-sized bullocks varies from about half to one tonne.

The two-wheeled, double-harness Dunlop cart equipped with a mild steel axle, smooth roller bearings and pneumatic tyres, and hauling two to three tonnes of cargo, can be designated as improved. Four-wheeled carts put together from discarded axles, wheels and pneumatic tyres of obsolescent trucks are found in increasing humbers in Tamil Nadu, Delhi, Punjab and Rajasthan.

The price of a traditional cart varies between Rs. 500 and Rs. 800 in parts of Orissa and Maharashtra and from Rs. 1.500 to Rs. 1,800 in Karnataka and Tamil Nadu. The cost of the improved pneumatic tyred carts varies from Rs. 2,000 to Rs. 3,000

Most animal-drawn carts are used for hauling freight and for carrying passengers. In some parts of India, they are the only means of transportation. There are 15 million carts, approximately 12 millions in the rural areas and three millions in the urban areas, out of which 14 millions are of the traditional variety specific to the region. One million carts have been improved in one form or another. It is observed that the number of carts has been increasing over the years.

When villages become affluent, the number of carts tends to increase. Also, as small towns increase in extent and population and become large ones, cart numbers increase. It is at the size of a metropolis that any large-scale substitution of carts with trucks begins to take place. Also, carts are being modernized at a fairly rapid rate.

Since animals are used only seasonally in farming, and even less occasionally for carting in small villages, the cart is not in these cases self-supporting. The bulk of the cost of animal use has to be imputed to ploughing. In the cities, however, carts work for five to six days in a week and the returns from professional carting at Rs. 20 a day on an average compare very favourably with incomes in other non-organized activity. On the other hand, traditional carts leave little surplus for the carter.

The traditional cart is defective in design. The draught power of the animal is wasted due to friction resulting from rough bearings and crude and inefficient harnessing, etc. The wobbling rim cuts into the road surface and damages it. Tare-weights run high. Traditional carts can be easily improved by

- smooth bearings;
- lower tare-weight;
- the introduction of a log-brake;
- better harnessing, and
- the use of pneumatic tyres on paved roads.

With the above improvements, capacity can be doubled. Even if no additional freight is forthcoming for the fresh capacity generated, the animals can pull normal loads with greater comfort. This would increase an animal's life and reduce feed levels.

The harnessing device is perhaps the most difficult to improve. In the existing design, the animal's neck is being constantly injured, and it becomes unserviceable much ahead of its time. Four-wheeled designs with pneumatic tyres reduce the vertical weight incident on the animal's neck. But these can be used only on smooth paved surfaces. Freight moved by carts is estimated at between 15 to 18 billion tonne-km. per year. As against this, railways carry 200 billion tonne-km. and road transport 100 billion tonne-km.

Investment in the animal-drawn vehicle system may be around Rs. 30,000 million while investment in railways is Rs. 40,000 million.

For short distances, over small roads and where loading and unloading time is high compared to travel time, carts are most economical and the appropriate form of transportation.

Trucks become economical only when the distance moved per day is 100 miles or over. Thus, in urban areas, carts are appropriate for numerous odd jobs where trucks are not competitive.

In 50 per cent of India's villages which have no roads, bullock-carts constitute the only means of transport.

Carts will remain on India's roads for a number of years to come. We must learn to live with them but they must be technically improved.

For field tracks and **kutcha** roads which are uneven, the bearings must be such that they do not break; hard rubber bushes have been suggested for this purpose. For all paved roads and for city traffic, hard rubber or pneumatic tyred carts-must be introduced in order to avoid road damage.

The improved carts will result in

- higher income to the carter
- additional employment
- increased transport capability
- reduced damage to roads
- longer life for the animal
- even better treatment for it if one may dare to hope.

Veterinary services are inadequate in India, particularly in the villages.

- The crushing of animal testes for castration and the branding of animals with hot iron should be prohibited by law.
- Shoeing practices should also be made more humane and hoof-shoes should be manufacturned in a range of sizes.
- Devices for protecting the hooves and legs of animals yoked to the plough should be designed.
- Fortified feed should be manufactured at village-industry level and its consumption by small and marginal farmers should be subsidized.
- Better draught breeds of cattle should be evolved.
- Slaughter-houses have to be modernized.
- Stunning before slaughter should be made compulsory in law.
- Whipping and the inhumane punishing of animals should be banned.
- Overloading, overworking and the use of sick animals for work should also be prohibited.
- The machinery for the enforcement of law should be strengthened.
- The SPCA should be invested with enabling powers and its resources and staff augmented. Persuasion should be tried to the utmost before resort is had to law and its enforcement.
- Citizens should be enrolled for enforcing laws regarding work-animals.
- Public consciousness should be created to ensure a better deal for the work-animal and non-formal programmes of education structured for the benefit of personnel dealing with animals.
- Credit for the purchase of carts of improved designs should be arranged through co-operatives and the banking system.
- Massive R & D efforts should be mounted on a regional basis to improve carts, ploughs and farming implements generally.
- An Animal Energy Development Board must be set up for funding research studies and the implementation of new designs.

THE MODERN ANIMAL-DRAWN CART: ITS ANTECEDENTS IN TRADITION AND HISTORY

Bullock-carts have survived into modern times from a roadless era. Yet roads were in existence on the Indian sub-continent during the times of the *Rig Veda* — the earliest extant literary evidence for archaeology and social anthropology. Since then, however, great developments have taken place in science and technology. The pity of it is that these have passed the technology of the bullock-cart by which has stagnated over the centuries without reforming attention.

A number of astute observers, both Indian and foreign, have commented on the co-existence of the bullock-cart and subsonic and supersonic jet aeroplanes in India's twentieth century. The co-existence of a traditional technology with a mechanized or modernized segment is not peculiar to the bullock-cart transportation sector alone. Every society has means of caring for its improvident, its halting and its poor; it also develops means of catering for the demands of the indigent and the marginal in society. These arrangements may not always be extant in their ideal or pristine condition and may not fulfil the contemporary economic criterion; they may not even be manifestly viable; but they do satisfy demand that will remain unmet otherwise. Here considerations of social and economic efficiency point to rival and even mutually opposed arrangements, and the two sets of arrangements subsist in society in a state of tension. The welfare requirement imposes a further burden on an activity that is not economically sound. Buses and the far-reaching railway network have thus wrested passenger traffic from bullock-carts. Yet the latter have maintained their absolute share of the tonne-kilometers of freight carried in relation to other road-carriers; there is indubitable evidence to suggest that animal-drawn carts have in fact improved on their past share of the traffic. Thus, the number of carts is increasing in the smaller urban settlements, and farmers who graduate into the ownership of a tractor still think it fit and necessary to retain work-animals and even a cart.

The capability of the bullock-cart system to sway the economics of transportation in the country derives from its socio-cultural foundations. It is indeed the symbol and an intimation of the social basis of a culture which planners and officials may only disregard at their peril.

The national economy has need of such efficiency for its continued progress while the gains of the past are also consolidated. In the long run, planning in our country must take this transportation capacity provided by the bullock-cart system into account and its spontaneous and unaided growth. Probably because bullock-cart operations in farming are not monetized and much transporting is done on the farmer's own account with the cart which is held by the farmer as balancing equipment to the animal-driven plough, the goods carried by the bullock-cart do not figure

in national statistics. It was in fact not until the Sixth Plan that pre-planning exercises sought definitively and authoritatively to quantify the frieght carried by carts and the employment that this vital sector of rural transportation provided. Without special sectoral attention and reform, it is difficult to envision how the rural transportation sector, which helps to diversify rural activity, can be reformed and made viable. The foregoing is the rationale of the decision of the Government of India to improve current designs of the animal-drawn carts and generate the necessary infrastructure for its modernization. In the accomplishment of this task, planning would doubtless also draw on the potential provided by growing rural incomes and prosperity made possible by the use of better seeds under the green revolution, the use of fertilizers and the growth of facilities for assured irrigation in large tracts of land.

The design of the traditional bullock-cart has changed little in centuries. The wonder is that it still remains viable while gradually approaching a state of ingenious simplicity. Its simplicity is testimony to the immemorial wisdom it embodies — the barest of hypothesis adapted to function. Yet the defects must be explained. Somewhere along the line in recent times, the growing process of adaptation came to an end. The appropriate technology policies of today seek to conserve this received wisdom and persist with the exploitation of local skills and materials in the non-organized sector that co-exists with the modern sector using contemporary technology.

While commending the virtues of this venerable artefact from archaeological time, due regard must be paid to the technical and infrastructural defects and disadvantages that the bullock-cart system suffers from. Policy should take advantage of the natural and unaided growth that is taking place—both in the matter of cart numbers and the extension of the system to new uses and sectors. With this end in view, these papers have suggested piecemeal policies of social engineering by which invidual cart components can be improved, existing carts upgraded in easy stages that the cartman can afford while wholly new designs are developed to meet the undoubted demand that arises for new carts and others on account of replacement. Animal energy which provides the motive power for the cart system should also be concurrently upgraded by a variety of measures outlined in the papers subjoined below in this volume. Modernization, then, involves the input of scientific thought and reasoning, the redesign of sub-assemblies as well as of the total cart system in the light of subsequent ideas developed in papers that follow.

Finally, the performance of the carts must be assessed in the laboratory and on the field, and the experience of the cart-owners must be fed back into the modernization exercise. This has evolved as the minimum procedure necessary for proving improved carts and components—in the course of extended consultations held between IIM-B project personnel and funding authorities, such as the Ministry of Shipping and Transport of the Inter-Ministerial Steering Group on the Bullock-cart or the Department of Science and Technology. Above all, the projected reform entails the crucial organization and management inputs. The overall objective is to

preserve an existing contrivance and technology that is serviceable and remains appropriate to demand and to stages of growth, and to maximize its benefits. The role of the bullock-cart in the total transportation system of India must be measured, legitimated and put on a sound foundation. If carts are going to be with us for many decades to come, this is the least that can be done. It is important to recognize that what is being attempted is not a retrograde exercise intended to prop up an anachronistic or antique device in a revivalistic self-regard for our tradition.

Those who refer derisively to the bullock-cart age as outmoded ignore the ubiquitousness of this form of transport in India. Also the opening up of the West in the United States to large-scale immigration from the Eastern seaboard and from Europe and the epic-like colonization that followed was based on the four-wheeled stage-coach drawn by six or eight mules, and on the horse. There were no roads — only trails blazed by the pioneers. The culture of these Social Contract states of the South (as they have been referred to) was based on the raising of beef on hooves, later on sheep-farming and thence on the art of "the sod-busting dirt-farmer". The railroad, law and order, automobiles, and highways came after the pioneering task had been largely fulfilled through the vision and enterprise of the early immigrants.

Animals are still used the world over in farming and for hauling carts, The relation between man and beast is a time-honoured one and can beeome intimate as in the case of man, dog, and horse. In times of shared danger and privation as in a desert or the wilderness, such intimacy has been known to be poignant. Valmiki, a fowler and a hunter of birds, brought to bear sublime devotion and a poetry that partook of the music of singing birds upon the natural instincts he appeared to take over from them. Apart from horses with fancy riding gear and fed on sugar, the intimacy berween man and animal has been celebrated in myth, legend and literature. Even today a farm-bred animal is cherished like no bought-out animal can be, Animals have been property since the time Job lamented the loss of his chattel (the origin of the word 'cattle) encompassed through Satan's strategm to test Job's devotion to God. As against holocausts and the sacrificial offerings of valued animals to propitiate Gods, which may offend against tender susceptibilities, there is St. Francis' delectable sermon to the birds, Early man believed that he could acquire the valour and cunning of fierce animals by eating their flesh. Animals with superadded features like the unicorn and a horned horse form part of the heraldic devices of European nobility.

India possesses an astounding number and variety of work-animals perhaps like no other country in the world. This relation between man and beast has subsisted since historical times and the technologies based on animal energy have changed little since those days; but would admit of great improvement. Intensively used animal-powered devices and components thereof have, however. been perfected in the light of contemporaneous knowledge and skills, *e.g.*, the war chariot, the horse harness in cavalry, the use of mules in the stage-coach and as draught animals for armour. Two-thirds of energy expended in farming derives from animals, and recently developed procedures for the utilization of animal dung in the village eco-

nomy have put the economics of the mechanical utilization of animal energy on a somewhat sounder footing. At any rate, on 50 per cent of India's farms, which are known to be less than two hectares in extent, there can therefore be no question of replacing them. In fact, the many small and marginal farmers who would like to own animals of their own cannot afford them. On the other hand, through carefully thought out breeding and feeding, farm animals must be upgraded purposefully.

It is a testimony to the place of animal energy in farming that the plough and the cart have not changed substantially since Homer sang of the ploughing of Greek fields by oxen in his epic poems. It is not an accident that, on the 50 million small farms which cover 90 per cent of the holdings and 20 per cent of the cultivated area in the country, draught animals are the farmer's only capital apart from the land itself and of course, the seed grain saved from the previous year's harvest.

To illustrate the antiquity of the cart from literary allusions in the *Upanishads* and the Old Testament. The wheels are older than the cart, although both are well preceded in time by the institutions of domesticated animals and the special relationship subsisting between man and these animals. If the wheel is earlier, it must surely be contemporaneous with the wooden log-roller rather than the potter's wheel which probably belongs to later times. Timber must have then come into widespread use as construction material. The animal-cart belongs to the arts of peace just as the horse-drawn war chariot belongs to the arts of war since the pre-historic days of the *Ramayana, Mahabharata* and the Old Testament. *Bhagavad Gita* was vouchsafed to Arjuna aboard a war chariot drawn by a team of splendid horses. In the Book of Judges (ch.l.v.20), Judah and Simeon smote the Canaanites and others and swept all before them because "God was with them," but they could not prevail over the tribes of the plains as the latter had the use of an iron chariot. In later historical times, the Roman gladiators and warriors used the perfected war chariot to devastating purpose. The horse and the bull were probably the first animals to be hitched to the cart just as the camel, the donkey and again, the horse were the first pack-animals to be used on the desert. Remains of pre-Mongol warriors excluded by the Great Wall of China and ranging over 1800 miles of wilderness over Eurasia have been found by Russian archaeologists, together with the bodies of their mounts in the permafrost of Siberia in a fine state of preservation. Under varying conditions of climate and soil, the horse, the camel, the mule, the buffalo, the donkey, reindeer and dogs have been tethered to the cart. In Arctic snow, however, dogs are used to draw sledges without wheels. In wilderness and desolation, man has sought and favoured the company of animals and trusted himself to their instinct for safety in adversity.

The cart of ancient times was referred to by means of such diverse Sanskrit appellations as *anas, śakata, chakri,* or *karatha.* The word cart is possibly derived from *karatha* meaning a contrivance. In olden times, *anas, śakata,* and *chakri* were used by common people for the conveyance of men and materials. *Anas* was a cart which made a shrieking sound caused possibly by moving parts not lubricated or well fitted to one another. *Sakata* could convey groups of persons and/or heavy baggage

Chakri, as the name suggests, was equipped with *chakras* or wheels. Another highly ornate form of the cart, which royalty and the affluent used, was called a *rath*. The *Praśnopanishad* mentions that the wheel (the pre-eminent *Prana*) had six spokes, each of which is likened to *udana, apana* and the other vital airs that animate and ennoble the human body. The Indian *raths* were four-wheeled, unlike other chariots which had two rollers. In the *kavyas*, the shape of the Saptarishi Mandala is likened to a topsyturvy cart. By an extension of the similie, Sanskrit literature goes on boldly to suggest that the bull-drawn cart derives its energy from the sun. It is day when Aruna, the lamed charioteer of Surya, emerges on the horizon in his *rath* drawn by many horses.

In this contrivance, powered by animal energy, the wheel has always been the most important component. It is important in that it has been used independently as a roller, and as a wheel by the potter; it is indeed so used to this day. If purposefully employed, the wheel can be used to gain a mechanical advantage. In history, man has used it to multiply the work input of his arms, legs, the muscles of his glistening and sweating back or in this century of computers, even that of his brain.

In ancient Buddhism, the wheel signifies *dharma*, and it forms part of the architrave surmounted by three lions. This device taken from the Saranath pillar is emblematic of the State in India. In darker contexts, the wheel has betokened inexorable justice ("the wheel of fire") and in the roulette, it symbolizes the vagaries of fickle fortune. The large-diameter, intricately carved stone-wheel in the Sun Temple at Konarak is conceived as a paradigm of all wheels and intended to make them all beautiful.

The undercarriage of the cart is elaborately carved in wood — with figurines of gods, godesses and of Nandi, Lord Siva's *vahana* — in stepped tiers and ascending hierarchy. The art of the wood-carver, akin at once to those of the sculptor, the master-builder, and the architect is used to depict the stories of the Hindu epics, as well as the exploits and the claim to divinity of the deity to whom the temple is consecrated. In South India, every major temple has such a car, and many of them are kept in an excellent state of repair, the wood-carver and carpenter always being ready at hand. These chariots attest to an important stage in the evolution of vehicles used in ancient India. Many temples in India possess temple-cars. On festive occasions, which is usually once in a year, the deity is taken out in a procession on one of these cars, which is invariably temple property. These chariots are generally four wheeled and massively built. The wheels are often of solid wood, the segments bolted and riveted together into place. On the day of the procession, literally hundreds of devotees lend a hand in pulling the cart, tethered to massive ropes, along a processional route. It is preceded by a choir or a group of priests who chant Vedic hymns or specially composed praise for the local deity. The figures of Gods carved in metal are decked up in miles of garlands strung together with flowers. The car flies the local temple flag and its top half is decorated with exquisite tapestry which is made to do service also as loose covers for the pillars. The temple-car, as indeed the culture of the Hindu temple, has always heavily relied on the skills

of local artisans and craftsmen and the temple and the congregation, reflecting its values and aspirations "both for here and hereafter" and those of society at large. The evolution of cart morphology and structure has been rather more fanctional. In the days of the affluent Vijayanagara empire, a chariot was built out of locally occurring granite. Elephants were used to haul such massive carriages. It is not an accident that the temples of Khajuraho, Mahabalipuram and the single-cell precursor of the Hindu temple, which writers on architecture such as O.C. Ganguly have identified, are modelled on the *ratha* or chariot of Hindu tradition — apart from the fact of course that the architect, sculptor, master builder, and the wood-worker were influenced by the same ideals, structures and motifs. The wooden temple-cars, remarkably stable for their height, hold many lessons for cart technologists even of our own day. The Moguls generally, and following them, the Rajputs and Tippu Sultan in Mysore, successfully used the animal-drawn cart for purposes of war. The cavalry horse and the mule and bullock-drawn cannons formed an integral part of the armour of the Indian army.

Carts have been made of durable materials, such as hard wood, iron or mild steel. Two large-sized wheels are attached to either end of an axle which is usually enclosed in a wooden box. The axle was made of different kinds of wood or steel or of combinations of the two. The width of the wheel rim, the diameter of the wheel, the number of wheel segments, and above all, the weight of the cart were prescribed in Sanskrit manuals and by guilds of master craftsmen in ancient and mediaeval India. Two draw-bars or pull-beams connected the yoke to the platform or in some cases, directly to the axle. The carts are hauled by a single animal or by a pair, but the double-harness cart appears to have been the more favoured in India for prescriptive, traditional reasons. In waggons or coaches drawn sometimes by as many as six mules or horses, in Europe and the USA, both the laden weight and the width of the rim were prescribed by law. Stage-coach owners and coachmen objected to this, as, contrary to Vagh's supposition, the number of mules had to be increased as a result of the road-saving reform thanks to the increased friction between the enlarged wheel surface and the track. The law was eventually observed in the breach before it was revoked altogether. It is important to note here that the Indian bullock-cart goes where there are no roads. Indeed, the stage-coach of nineteenth-century U.S.A. blazed all the trails that became the major highways of the twentieth century. In the history of land locomotion, the animal-drawn cart has indeed earned pride of place.

Early in the 1930s, Dunlop Rubber and Tyre Company Limited introduced pneumatic tyres and tubes for animal-drawn vehicles. Although structurally adapted to higher loads and greater speeds for animal-drawn vehicles, the objective was really to avoid road damage caused by the cutting action of the iron rim holding together the segments of the traditional wooden wheel. As the pressurized tyres and tubes required to be held firmly, special dish-shaped hubs and concave metal rims were also introduced. Steel axles which soon followed completed the sub-assembly. The pneumatic wheels were smaller in diameter and wider in rim width than the conventional wooden wheel. The latter was rigid and offered no cushioning effect.

The Dunlop promotional campaign was instructive and designed to secure consumer acceptance.

About this time, the Council of the Indian Roads Congress (IRC) also instituted annual prizes for the best designs of the tyrized cart, and these were awarded at local cattle fairs. According to a recent Dunlop estimate, there now exist 6,00,000 carts spread over the country which are so tyrized. The need for cost reduction in cart assemblies and components has always been a felt need. For the introduction of ADV (animal-drawn vehicle) tyres soon brought in their wake the use of second-hand equipment and improvised devices. Thus, the rejected wheel-and-axle sub-assemblies of obsolescent trucks came to be employed in wooden carts. Such carts too form a sizable proportion of vehicles which can claim to have been improved; they compare favourably with formally upgraded ADV carts which constitute about 4.6 per cent of the total.

Factory-manufactured axles for animal-drawn vehicles are now produced for track widths of 1320 mm, 1370 mm and 1525 mm. Axles of special widths are also custom made on request. The sub-assemblies were also additionally equipped with hubs and ball or roller bearings, and carts operating on undulating terrain were furnished with brakes. The body atop the chassis was also custom built and adjusted to the nature of the freight carried. The foregoing features formed part of the first package of improvements.

As noticed elsewhere in this volume, production research on cart equipment continues to this day and the future may well yield interesting variations on the present-day pneumatic tyre as heralded by the Firestone hard-rubber tyre designed for the large-diameter wooden wheel. It is easily maintained, is certainly a more versatile traction device and calls for a much smaller initial outlay. The pneumatic tyrization of carts, however, received an early set-back. At the 1941 session of the Indian Roads Congress held in Delhi, Mr. K. G. Mitchell, then President, referred to this in his address and added: "...and we have an analogous proposal to consider whether anything can be done to evolve a wheel less damaging to roads than our steel-tyred enemy that could be made in the village". In pursuance of Mr. Mitchell's proposal, a Sub-committee of the IRC on Bullock-cart Transportation was set up in April 1944 with Sri B. V. Vagh as leader. He submitted his final report on his investigations in April 1950 following six years of testing and experiments.

The wheel came in for detailed investigation at his hands. In his report, Vagh mentioned two types of wheels commonly met with in India: (1) the arm-type in which three pairs of arms pass through the hub and also through one another; and (2) the spoke-type in which 12 spokes are secured to a hub. In addition, he cited two other types which were known if not as common: (i) a solid wooden wheel of small diameter; and (ii) a combination of the spoke and the arm-types.

Parameters of the variant rigid wooden wheel reported by Sri Vagh are tabulated in the Statements I & II below which are taken from a preliminary report

entitled "Tests on Dunlop Pneumatic Equipment for Farm Carts" by Wynne Sayer, B.A., Dip. Agri. (Cantab.) from the *Imperial Agriculturist*: 1933–34. The trials were conducted at the Imperial Institute of Agricultural Research at Pusa in New Delhi. The report estimated the number of arm-type carts at 26.5 lakhs and that of the spoked type at 52 lakhs out of a total cart population of little over 80 lakh animal-drawn vehicles in the country at that time.

Sri Vagh recorded his views on the variant wheel sizes in the following passage. "In the case of an automobile, it is possible to design the body to carry a certain load and then provide an engine powered suitably to pull it. In the case of a cart, the bullock-cart and the chassis were there, and the only item which can be adjusted to the work is the wheel. What the carter is concerned with is the cost and tractive effort of his wheels and not any particular wheel diameter." So he concluded that variations in wheel-diameter were fortuitous and unavoidable. Sri Vagh further found that larger diameters were necessary in zone I (Tamil Nadu & Karnataka) to carry average loads of 199 maunds per cart while zone II (Maharashtra and Andhra Pradesh) could afford to have smaller diameters for an average load of 148 maunds available per cart. The wheel diameter decreased further in zone III (Madhya Pradesh for the most part) with an average load of 93 maunds. Sri Vagh was thus able to establish a correlation between the average load and the diameter of the wheel. In zone IV (Rajasthan) due to the aridity of the soil, commodity output was low and an average cart-load of agricultural produce weighed much less than in zones I, II and III, wheel-diameters also declined. Vagh's findings from zones V and VI were, however, recalcitrant where the load customarily carried was found to be the highest for any zone while wheel diameters were the smallest. Vagh himself put down his deviation as due to the regional practice of using two bullocks and to the broader platform over which the load stress was spread more widely.

The following five more important among Vagh's many recommendations were considered by the Bullock-cart Sub-committee of the Indian Roads Congress.

(1) There was no need whatever to replace the traditional wheel of his time which was structurally sound, had stood the test of time and could be manufactured in villages with locally available materials and skills. (The truth of this finding is now being rediscovered.)

(2) The tyre should be 3.5 in. wide with a steel section of 3.5×0.375 square inches; diameters might be varied from 3 to 5.25 ft. Even 2 in. tyres would avoid road damage. While computing damage caused to roads by the traditional bullock-cart, Vagh estimated that about 20 per cent of the total carts were, on an average, out on the roads at any one time.

(3) The axle should have lathe-turned ends and should be fitted with a single bearing covering the entire width of the hub or the axle journal instead of a pair of bearings. Such fitment makes for flexibility and self-alignment.

(4) The States would find it reasonable and worth while to spend the whole or a major part of the money saved through the avoidance of road damage to the improving of animal-drawn cart designs.

(5) New materials for cart components should be tried out.

Vagh's study was conducted for, and under the leadership of, the IRC. As such, these recommendations were not addressed to any specific implementing agency. In the result, they have awaited implementation to this day. Although agriculture and the kind of roads relevant to bullock-cart transportation were placed in the State schedule of the Constitution inaugurated in 1951, the Central Road Research Institute (CRRI), set up as one of the national laboratories under the administrative control of the Ministry of Shipping and Transport, has been continuously engaged in research on road damage caused by a number of agencies including animal-drawn vehicles. Although the CRRI is concerned primarily with soil or traction surface and load relationships, they did design a camel cart with improved draft capability for use in the arid Rajasthan desert, to which water for cultivation is being brought from the Rajasthan, the Bhakra and Gung canal systems. These carts are now being used extensively for transporting construction materials by the State Public Works Department and so to extending the water channels up to Jaisalmar.

Under the first five year plan, the Planning Commission had recommended the setting up in every State of a separate section in the Department of Agriculture with facilities for whole-time research on agricultural implements and farm tools of indigenous origin. Evidently, the Commission had in mind the devices that use animal energy for rotary power as well as for traction. During the second plan, the Planning Commission renewed its call to the State Agricultural Departments to devote increased attention to the evolving of improved farm machinery and implements. A conference of agricultural engineers from the States convened by ICAR in 1953 recommended that a countrywide survey of agricultural implements be conducted in the first instance—their variety, design, modes of manufacture, metallurgical quality and performance. A survey was sanctioned in 1954 by ICAR in pursuance of the above recommendation and was completed by the middle of 1957. But the bullock-cart did not come in for attention until a second stage in the survey.

In the second phase, Sri C. S. Sridharan, until recently Assistant Director-General (Agricultural Engineering), brought cane-crushers, chaff-cutters, paddy-hullers, threshers, decorticators, water-lifting equipment etc., and the bullock-cart within the purview of his study which covered the period 1958–60. A tabulated synopsis of quantified particulars about the structure and performance of two to four bullock-cart types from each State are set forth in the ICAR Report. The socio-economic basis of cart operations and their contribution to the rural and urban economies and income were not studied. Also the limited terms of reference precluded an investigation of the defects of existing carts or any argument for redesign.

Statement II shows that the widened rim for the cart wheel prescribed by Sri Vagh did not find favour with cart manufacturers and therefore cart-users. As the wheel diameter reached a maximum of 6.5 feet, the rim width narrowed to 1.5 in. The report showed that the axle continued to be hand made for the most part. The occasional use of bearings and the use of new materials for components was also remarked on by the surveyors. A detailed study of the filled questionnaires brings out the need for the support of financial agencies and banks for spearheading any movement for the redesign of bullock-carts. Importantly, the report showed that there had been no fall in the number of carts since Vagh's time. Despite the noticeable increases in motorized transport, cart numbers, too, had significantly increased. For the first time, thought had been given to the manoeuvrability of carts, and to the vertical load incident on the animal-neck, detailed reference to which subject is made in subsequent papers.

A word must be said about the plan strategy for increasing food production and the stepping up of productivity in agriculture. The latter became a serious concern under the second and subsequent plans. For some time between the second and third plans, it was seriously hoped that the mechanization of farming and allied operations through labour-saving devices, such as tractors, threshers and harvester-combines, would not only increase food production but make extensive and intensive farming possible. In the main, river valley projects sought to extend the area under irrigation while conferring other area benefits, such as flood control, power generation and integrated development of whole river valleys. It must be admitted in retrospect that the high hopes vested in mechanization did not bear fruit. The return to an emphasis on chemical and labour-intensive methods of increasing land yields, became abundantly evident in revised statements of policy. Since then, the accumulation of capital in agriculture is not now stressed as the surpluses available from farming are still low. The development of agriculture in the five-year plans has instead rested on infrastructural development, fertilizer and water inputs and improved seeds.

Gradually, in fufilment of modest plan targets, the length of surfaced roads has increased, and new railway routes, which were previously thought uneconomic and which connect centres of production and consumption, have come up. Against this backdrop of all-round mechanization and upgrading of technologies, the animal-drawn vehicle, however, continued to hold its own in the rural areas against alternative modes of transport. Where machines failed to make man and his worldly goods more mobile in consonance with fresh demand, the work-animal stepped out and stood in the breach. And the design of the cart from antiquity continued to serve man well.

Mixed farming, the white revolution, poultry-keeping and piggery were emphasized as subsidiary occupations in order to reduce seasonal unemployment in the countryside.

In the changing rural scene, work-animals lost some of their pre-eminence and a fine pair of draught bulls (never in the old days tethered to a common plough) and

the cart were no longer a symbol of social status. The performance efficiency of bullocks, too, fell steeply due to a let-up in genetic upgrading, poor feeding and the non-castration of scrub and non-descript cattle. The work and life-span of farm animals had suffered a steady and severe reduction over the generations. This decline was compounded by the defective mechanics of motion in the implements joined to the work-animal. The carts and farm animals began to be perceived as an anachronism on the national scene. The area under pasture and common grazing rights shrank in area, and there was no organized raising or sale of cattle-feed to make good the shortage. The yield of hay from improved non-lodging varieties of grain crops also decreased significantly. There was, and still is, a marked lack of intensity in the raising of fodder grasses as second and third crops. The Key Village Scheme and subsidies paid by State Governments for the raising of green fodder touched only the fringe of the problem. The exploitation of animal energy could only gain in efficiency as part of the overall rural development process; so it appears.

In 1963, the Programme Evaluation Organization of the Planning Commission undertook case-studies of the relative roles of the bullock-cart and the truck in rural transportation. The survey was conducted in five *mundis:* Tindivanam (in Tamil Nadu), Lasagoan (in Maharashtra), Sirhind (in Punjab), Gorakhpur (in Uttar Pradesh), and Sainthia (in West Bengal), and it showed that average loads ranged from 300 to 1,200 kg. While reports of freight loads brought to these *mundis* varied from about 430 kg., to 860 kg., the average distance from the village, where the produce originated, to the *mundi* ranged from about 15 to 20 km. The width of the iron-rim on the traditional wheel varied from 40 mm to 100 mm. The *mundi* respondents estimated that the number of bullock-carts had increased by 5 per cent annually. That is to say, the natural growth rate in this form of transportation was able to take the growth of agricultural production in its stride. Finally, bullocks were the most popular draught animals in use, buffaloes and camels also coming into increasing use in certain parts of north India. The survey undoubtedly served to establish the vital role of animal-drawn vehicles in the rural transportation of the country.

The relation between road development and the growth of bullock-cart traffic is a complex one. The number of bullock-carts in the rural areas has much do with the absence of roads in them. The fifth five-year plan postulated the highest rate of growth ever for road transport; the objective was to ensure that the remotest village in the countryside did not lie farther than eight km. from a surfaced road. The supply of electrical energy for farming in the rural areas is subsidized, and the effective demand for energization in the villages did not still justify the extension of distribution lines to far-flung farming outposts in the villages, which greatly added to transmission and distribution costs. In operational terms, therefore, animal energy still enjoys an economic advantage to which sufficient attention has not been drawn in State and district-level plans. For small farms and a variety of ancillary uses, therefore, there is often no alternative to the use of animal energy. Among village people, the reliance on the plough, the bullock-cart and animal-based implements continued to be as great as before. For short hauls, small loads, versatile movement over any available surface and low freight charges, the cart has no peer

either in the rural areas, or, for that matter, in the towns and cities. It is still cheap, readily available and safe.

The official project awarded to IIM-B in 1976 by the Department of Science and Technology was funded only modestly in relation to the wide-ranging objectives implicit in any programme for bullock-cart redesign. That it was an undifferentiated project is also borne out by subsequent developments; the IIM-B is now conducting a socio-economic survey of cart operations, a mechanical redesign project and another project bearing on work-animals and animal energy. An attempt is being made to retrieve bullock-cart technology from neglect and desuetude. In 1975, the Prime Minister of India called upon scientists and engineers to work on simple problems of society that required immediate attention, and illustrated her exhortation by referring to the bullock-cart as an example of a technology which scientists should reform in order to contribute their mite to the development process.

At present, the cart-owners and operators depend on money-lenders for their financial needs, paying interest ranging from 40 to 100 per cent per year. With the abolition of usurious money-lending in the villages, co-operative societies, lead banks, the State Bank of India and rural banks are expected to step in and finance the purchase of carts and animals. The survey showed that, for the most part, farmers effected these purchases with owned funds. For most farmers, the plough on the one side and the cart and animal on the other (if they could afford them at all) were the only capital they had. The high servicing charges payable for debts further reduced their disposable incomes.

In conclusion, the bullock-cart system is essential, but, in the rural areas, it is not yet viable economically. This introduction has helped to state the problem and detail earlier attempts made to redesign and improve the animal-cart. It is hoped that it affords a background against which subsequent papers can become meaningful.

STATEMENT I

COMPARATIVE PERFORMANCE OR IMPROVED AND TRADITIONAL CART TYPES

(One Maund = $82\frac{2}{7}$ lb.)

Serial No.	Description of Cart	Weight of Empty Cart in mds.	Cane-load in mds.	Total Weight in mds.	Draw-bar Pull in lb.	Draw-bar pull per md. in lb.	Comparative Draught in lb.
I.	*Ploughed Land:*						
	Dunlop Wooden Cart	9.75	25	34.75	112	3.46	100
	Dunlop Iron Cart	13.25	50	63.25	308	4.87	141
	Farm Cart with Iron Tyre	10.00	25	35.00	392	11.20	324
	Country Cart without Iron Tyre	6.75	16	22.75	280	12.30	355
II.	*Country Cart Track:*						
	Dunlop Wooden Cart	9.75	25	34.75	48	1.38	100
	Dunlop Iron Cart	13.25	50	63.25	100	1.58	115
	Farm Cart with Iron Tyre	10.00	25	35.00	60	1.72	125
	Country Cart without Iron Tyre	6.75	16	22.75	80	3.52	255
III.	*Dunlop vs. Country Cart Track:*						
	Dunlop Iron Cart on Dunlop Track (made-up road)	13.25	50	63.25	75	1.19	100
	Dunlop Iron Cart on Country Track	13.25	50	63.25	100	1.59	133

STATEMENT II

VILLAGE-MADE ANIMAL-DRAWN VEHICLE WITH RIGID WOODEN WHEEL: PARAMETERS

Sl. No.	Region of Use	Wheel Diameter (average)	Wheel Type	Height of Animal	Axle Section	Maximum Gross Load per Axle	Size of Hub Used in Wheel	Average Axle Height	Approximate Weight of Complete Assembly	Remarks
	Zone	in inches		in inches	in inches	in lb.	Length × dia. centre in inches	inches	in lb.	
1.	Comprising Kerala, Tamil Nadu, Karnataka & Goa	61.2	Spoke $1\frac{1}{2} \times 3\frac{1}{2}$	43	M.S. through $1\frac{3}{4}$	2500	$13\frac{1}{2} \times 11$	30	675	
2.	Comprising Maharashtra and Andhra Pradesh	53.2	Spoke $1\frac{1}{2} \times 3$	44	2	3000	12×11	26	485	
3.	Comprising Vidarbha, Orissa and South-east Rajasthan	45.3$\frac{1}{4}$	Spoke $1\frac{1}{4} \times 3$	45	$1\frac{3}{4}$	2500	11×10	22	430	Arm type in parts of Orissa
4.	Comprising Gujarat and rest or Rajasthan	37.4	Armed and spoke solid $3\frac{1}{2}$" wide	53	$1\frac{1}{2}$	2250	13×14	18	405	Combination wheel. Sandy desert tracts of Rajasthan
5.	Comprising Punjab, Jammu & Kashmir and North-west Uttar Pradesh	54.2$\frac{1}{2}$	Arm	52	2	3000	12×13	25	520	Solid wheels. Stone from quarry to road
6.	Comprising rest of U.P., Bihar & West Bengal	54.2$\frac{1}{4}$	Arm	45	$1\frac{3}{4}$	2500	12×13	25	460	
7.	Comprising NEFA, Meghalaya, Assam, Arunachal Pradesh	48.3	Arm	50	$1\frac{1}{2}$	2258	12×12	23	452	

STATEMENT III

TRACTIVE EFFORT WITH 2" TYRIZED WHEELS IN ALL RANGES OF WHEEL DIAMETERS

Zone	Average Diameter in inches	Tractive Effort Incident on Wheel in lb/ton
1	66	70
	61	72
2	54	76.5
	53	78
3	50	81
	45	86
4	48	84.5
	42	95
5	39	102
	30	144

STATEMENT III-A

TRACTIVE EFFORT OF WHEELS WITH 3.5" TYRE

Zone	Average Diameter in inches	Tractive Effort Incident on Wheel in lb/ton
1	61	60
2	57	57
	50	70
3	45	69
4	39	76.5
5	36	82

THE BULLOCK-CART: A CASE OF APPROPRIATE TECHNOLOGY

1. In discussions on economic development of under-developed countries, the choice of an appropriate technology is always a crucial determinant and in any given sector, a measurable constraint as well. Published literature on the subject has centred round the idea of choosing technologies relevant and appropriate to the production processes and to the demand situation in the under-developed world. A great deal of work has naturally been done on these subjects already following debates, in national and international conferences. The problem of an appropriate technology had to be solved before any useful recommendations could be made. Technological requirements are a function of the availability of productive resources, skills and other needs peculiar to an environment or culture. Critics have, however, pointed out that, for the most part, these discussions, although often based on feed-back, turn out to be theoretical exercises intended to satisfy remote and speculative minds and to obtain a consensus. The deliberations of social scientists, where they are not purposefully orientated to action or where they lack a management component, have tended to be like that. Their aridity notwithstanding, there has been a marked preoccupation with a trade-off between human (labour) and physical resources (capital) in order gainfully to utilize the abundant human resources available in the developing world and the need to modernize prevalent technologies. This approach has been necessary in order to quantify and increase the per-unit yield of capital as well as of the other factors of production. To repeat, little of the literature has led to practical action, and it has not been concerned, as one might expect, with applying proven technologies to known situations that cry out for rationalization or reform. In this paper, the intention is accordingly not to theorize on choice of technology *per se*. Rather it seeks to approach the problem from a practical point of view. In other words, this paper presents a genuine case for appropriate technology, which permits widespread implementation. The bullock-cart in the rural transport sector is a case in point *par excellence*. The choice of a technology and its transfer to the rural areas of Asia and Africa is an issue which is supremely important to the growth of these countries. Often, they can make the difference between the success and failure of their projects, programmes and plans.

2. Simply, technology is the application of the principles of science to the problems of production. In many sectors, different technologies could be worked out to produce the same end-goods and services. In the western world, large-scale mechanization involving heavy investment of capital contributed much to their economic growth. During such periods of growth, the demand for human-resource participation was not so insistently political nor so concerted. All countries aiming at the rapid transformation of their economies have vied with one another to transplant

these technologies which have been so successful in other contexts of time and place, whether or not these were appropriate to the new situations of an abundant supply of idle and unskilled labour, low levels of skill formation and to consumer attitudes. Again criticism has rightly fastened on the fact that the stress has been on technical improvement rather than on attitudinal change or even on purposive education for skill formation. Admittedly, capital-intensive technology may be the best where population and availability of skilled labour are both constraints or where the production process itself demands it as in the case of steel manufacture. Lower level technology, which entails greater outlays on labour and smaller investment on producer goods, would perhaps be better in a large number of other cases. A country has to choose a mix of technology for its various sectors depending on the size and skill equipment of its labour force. This fact is on occasion lost sight of by planners and policy-makers in contemporary developing societies, excessively preoccupied as they are with economies of scale. Often, even where applicable, these have not been realized in practice.

3. In countries like India, the socio-economic environment and the stages of development have not conduced to a repetitive re-application of western models of development. In such countries, capital is a scarce factor, and it is unskilled labour that is abundant. Many of them depend on the export of one or two primary commodities for the bulk of their foreign exchange needs. Foreign exchange availability is in the result inadequate and often fortuitous as well since it is based on spurts of non-traditional exports to markets which have not yet become settled buyers. For, it is a repeat order that makes a client. It is, therefore, only prudent that, wherever possible, these countries adopt techniques of production which call forth the large reservoirs of unskilled and semi-skilled labour usually available in them while being economical of capital and foreign exchange.

4. In the transportation services that India is planning to generate, then, labour-intensive technologies should receive adequate emphasis. There is no doubt that, for some long-distance transportation of goods, capital-intensive technology is unavoidable. But for intra-sectoral transportation on a small scale in the villages, there is a strong case for the retention of carts which use bio-energy as the prime motive power and are economical of capital into the bargain. There are 70 million bullocks on the active list out of a total population of 80 million work-animals, and assuming an energy output of 0.5 horse power per animal, the draught animals supply 35 million h.p. which is besides 64 per cent of all the energy input that goes into the farming enterprise in India; human labour accounts for 23 per cent of the total energy used and a residual 10 per cent comes from mechanical and electrical sources.

5. Bio-energy from animals, then, is the principal source of motive power in Indian farming. Animal-drawn ploughs and vehicles are part of the Indian scene and are several generations older than its oldest trees. In ploughing, threshing operations, and in inter-culture, where sowing for the crops takes place at different times, bio-energy supplies the motive power. Animal power is also used for lifting water

from irrigation wells or from canals where these lie at lower than ground level. Apart from these, the other major use for animal power is in the transportation of materials and men. There is no alternative to animal-drawn vehicles in certain remote areas and on trails which bypass the small towns or the national and state highways and connect one small village to another. There exists a colourful variety of animal-drawn carts in the country, such as the bullock-cart, the horse-cart, the buffalo-cart, the camel-cart, etc. On a nationwide scale, the bullock-cart symbolizes and subsumes all these other carts. In most parts, bullock-carts and buffalo-carts are the predominant types in use. In sandy terrain, where the drag or the rolling friction is great, the camel-drawn cart has been preferred even to the four-wheel-drive jeep which consumes much more petrol than normally.

6. The majority of an estimated 15 million animal-drawn vehicles in the country are powered by bullocks and the balance by horses, camels and buffaloes. Authentic responses to queries pertaining to the economics of animal-drawn vehicles on a nationwide scale are not readily available. The aggregate investment in the system could (including the cost of animals) be of the order of Rs. 30,000 million. This figure overwhelmingly represents decentralized private investment by several millions of poor people. What makes norms so variable and information-garnering so hazardous is that more than 99 per cent of these carts lie in the non-organized sector so called. Again authentic data which enables one to quantify the employment that the system provides is unavailable. One may tentatively say that 20 million people are involved in the system, part time or full time. Some eke out a livelihood from it; others use it to augment low incomes derived from other inefficient sources. Some of this is valuable indirect employment: the maintenance and upkeep of animals, associated veterinary services, the raising of forage and fodder crops and the processing of dry feed. The list is impressive but when these operations are performed by a single individual as they often are on a small farm, they make for underemployment in terms of income if not in terms of time. Most other employment would also be part time as that of the village blacksmith or the carpenter who have to collaborate both in building a cart or in effecting major repairs to the modern wheel thereof. On the basis of preliminary estimates made in the course of sample surveys conducted in certain selected districts in the country, it is estimated that over 60 per cent of the transportation needs of the agricultural sector is met by bullock-carts. Ninety per cent of all intra-village goods transport is accounted for by animal-drawn vehicles. All the cattle-feed, fuel, the farm-yard manure, and drinking water are carried in animal-drawn vehcicles.

7. And this is the kind of freight which accounts for greater mileage than the harvest which has at best to be carried only twice or thrice in a year. Even in the case of cash crops, if the sugar-cane or *sarsum* is used for *gur*-making or for oil extaction in village expellers, motorized carriers are useless. Fuel is an important cargo in the villages of the north Indian plains during the winter, and cattle feed like *berseem* in Haryana or lucerne in the Kheda District of Gujarat is significant in quantitative terms particularly as with progressive farmers who perhaps care more for their animals than the city cart-drivers and are taking to dairying and mixed farming

increasingly. This discussion encompasses transportation of all agricultural produce, inputs and commodities of rural consumption carried from the villages to the markets and *vice versa*.

8. Most of the above estimates are statistical rather than scientific; but they do seek to establish a mode of quantifying highly disparate categories of services performed by bullocks and carts. They err, if at all, on the side of caution rather than otherwise. It may, therefore, be asserted confidently that the animal-drawn transportation system is vital to the country's economy on all counts; in terms of the investment involved, employment generated and the goods transported. As against the underestimate, the task of "monetizing" these operations or services and basing them on money transactions and on imputed and realized costs must remain a basic task of rural development and not only of rural transportation.

A Neglected System

9. The absence of authentic information in animal-drawn transportation in forms from which meaningful conclusions can be derived must be commented upon at this stage. Planners have not cared enough to conserve while they generate afresh. Thus, the bullock-cart and carts drawn by other animals have hardly undergone any change in design over the past several decades. This despite the fact that the spread of science and technology among economic sectors, levels and classes of population has been particularly impressive during the past two decades. There has been no systematic effort — because of a fatalistic belief in the inexorable passing away of the carts—to transmit the benefits of modern science and technology to the bullock-cart, the rural transportation and communication systems as a whole. It is anomalous in particular that, while rural communications are being upgraded and extended, the bullock-cart which is the kingpin of the user systems has not had a look into at the councils of designers. For, in the transportation technology being adopted for the country, the bullock-cart has found no place. It is true that some sporadic efforts were made at improving the cart in the past, particularly during and after 'thirties. One may not ignore the painstaking and creditable work done by the late Mr. B. V. Vaugh for bullock-cart technology. Principally, these efforts owed, however, to a concern for roads which the bullock-cart damaged. Mention may also be made of the eminently practical and useful work done by the Dunlop Company which introduced pneumatic tyres for the first time during the 'forties. The Dunlop reform increased the load capacity of carts significantly and augmented earning while reducing overall road damage. It was not then time yet to direct attention on the bullock-cart in itself and improve it as a more efficient means of rural transport. Yet, to-day in 1979, there are no more than 800,000 improved carts on the road. But even the fruits of such efforts have not been spread widely enough due to the communication gap; the absence of a relevant authority of State interested in the problems of this non-organized and voluntary sector which lies astride the purview of many authorities; due to the absence of adequate effort in social or infra-structure marketing; and in essaying new designs and so on. An immediate procedural recommendation proposes that the bullock-cart be declared an "agricultural implement" so that rural development funds

could be diverted to bullock-cart modernization in small but recurrent quantities pending a major programmed effort at redesign.

10. The neglect of the system in the past was due partly to the feeling that bullock-carts were outmoded and on their way out. It was assumed that they ought to yield place to motorized vehicles. The complementarity of the motorized and the bio-energy systems was (and is still) either not understood or ignored deliberately. The demise of the cart system appears to be more wishful thinking rather than based on any realistic assessment of the situation. For a number of reasons, the bullock-carts are bound to remain with us for another 50 years and more. Long-distance rail transport is cheaper than truck freighting by road, and official policy has recognized this complementarity between the medium-haul truck and long-distance capacity of the railway system by allocating mutually exclusive spheres of operation to the two systems. There is no reason why this logic cannot be extended to cover the counterpart roles of the bullock-cart (short haul) and the truck (medium haul).

11. The cart apart, the bullocks, to which the cart is balancing equipment, are used for a variety of non-monetized farm operations such as the Persian Wheel, for lift irrigation from wells, for cutting green fodder, and for threshing. It is tethered to the *ghani* for oil or cane-juice extraction. Fossil energy in the form of cheap diesel oil has vitiated the economics of the small farm in the following manner: a hired tractor can plough small farms more cheaply and more quickly than a pair of bullocks, and it can perform a variety of other farm operations: *e.g.*, provide power for lift irrigation and carry inputs from the market. It has moreover a harvester, a seed-drill, and fertilizer application equipment attached to it. Tractor operations other than ploughing, however, are more expensive, and the small or marginal farmer cannot afford these. Of the majority of the villagers surveyed by the Indian Institute of Management, Bangalore, many were without bullocks of their own, and they were certainly the worse off for it. Three facts must be asserted tellingly to counter this false equilibrium established through an overhasty mechanization of farm operations at present being performed with the help of tractors: (1) the rising costs of crude which can rise, as has been predicted, to anything up to $ 20 a barrel; (2) the social costs of displacement of unskilled labour that tractorization brings in its wake, which is uneconomical even in a State like the Punjab for farms smaller than five acres; (3) the over-monetization in operations in a small family farm, which can be wasteful of cheap labour, can be counter-productive and render the process of rural development unduly inflationary. Tractorization attempted by Pakistan, Tanzania and other Third World countries has failed to produce the hoped for results. An official reversal of policy has set in in these countries.

12. There are also social and cultural factors associated with the neglect of this system, comparable to a similar neglect of other elements in our received culture. Some of these latter are cited below:

(i) in public policy, the organized urban sector has claimed far greater attention than the decentralized and often non-organized rural sector because of the

urban bias and background of those in charge of policy. The bullock-cart is thus one among many other elements of our rural culture the identity of which is being slowly eroded without good cause.

(ii) As profit rates — either for manufacturing bullock-carts or in operating them — do not compare with returns in other sectors, it has not attracted private operators who can run a whole fleet of them. At present, the bullock-cart is mainly made (rather custom built) by village craftsmen in response to specific demand. It is not for instance made in anticipation of demand.

(iii) The education system is not alive enough to those technological needs of society which have a low science content. It has tended to be imitative of the patterns prevalent in the West, and of the needs of technological development arising in that region.

(iv) A related issue is our dependence on these technologies of Western provenance. Much of the technological development in our country has been frankly imitative and dependent on the initiative of, and work done by, scientists in the West who deal of necessity with their own problems — problems of their times and their environment. In cases like the bullock-cart, therefore, where the West has nothing to offer, we remain and stagnate where we were centuries ago; and

(v) scientific personnel find that working on apparently common-place things like the bullock-cart does not evoke adequate social recognition, and work satisfaction is detracted from as a result. Social attitudes are such that, wherever innovation involves a break with the earlier technology, the work and the project become prestigious and attractive. Where the work involves the preservation and continuity of tradition, it loses interest and importance. The traditional bullock-cart has stood the test of time even if it is not yet viable in the modern world. It embodies the common-sense of many generations. Improvements to make it more serviceable would help to retain it as a functional but integral part of the rural economy.

Inefficiencies of Existing Bullock-cart Designs

13. The bullock-carts in existing designs can be grouped into two broad categories, *viz.*, conventional wooden-wheeled and tyrized carts. The traditional cart consists of a basic structure of wood and steel-rimmed wheels of large diameter. The improved carts are fitted with special axles together with ball-bearings and pneumatic tyres. Carts with solid rubber tyres provide a variation on the latter design element but are not met with too often. A further overlapping of categories arises from the fact that there exist single– as well as double-bullock carts. In certain urban areas, such as Delhi, there exist rubberized four-wheeled carts as well. The size and disposition of the tyres resemble the arrangement obtaining in a tractor or in a stage-coach used so successfully in the opening up of western United States in the last quarter of the past century. The extra wheels make for stability and better distribution of load, relieving the animal of some of the vertical load. Save for these aberrations, most of the carts in the country are two-wheeled. For all this reform, tyrized carts are, as noted before, numerically still insignificant. There are important

exceptions to this statement however: in areas like Ganganagar District in Rajasthan, where because of the recently available water from the Rajasthan, the Bhakra Nangal and the Gung canal systems, a beginning has been made with improved carts. In fact, a camel cart specially designed by the Indian Road Research Institute is used extensively in the carrying of building materials for the Rajasthan Canal system which is being extended up to Jaisalmer. In those rural areas where the proceeds of cash crops justify and pay off the costs of the improvements, and in suburban and city traffic, tyrization and other innovations have found favour. Improvement, it is important to note here, therefore, is not only a matter of technical design effort, motivation or extension work: but it has also to be supported by the economics of animal-cart operations in each case. That is how bullock-cart improvement is integrally a part of rural development. For the rest, the problem is one of reducing the cost of improvement and improving the profitability of operations, taking advantage of the growth of productive activity in the countryside. In a recent seminar on bullock-cart modernization held in New Delhi at the Agri Expo 77, I argued that improvements in efficiency following redesign should lead, in the rural areas, predominantly towards a conversion of double-bullock into single-draft carts rather than to an augmentation of freight-capacity which can only be obtained in the larger towns and cities.

14. The conventional bullock-cart is technically defective in several ways, leading to operational inefficiency. It also damages the road unduly. In carts with pneumatic tyres, road damage is reduced substantially. The pulling effort necessary for a given load is reduced and the overall carrying capacity considerably enlarged. All types of bullock-cart operations do entail varying degrees of cruelty to the animals. Some of it is, therefore, avoidable. Defective designs have added afresh to the cruelty resulting from the collapse of sensibility and that arising from human ignorance.

Technological Deficiencies of Conventional Carts

15. To repeat, the conventional bullock-cart (with a pair of wooden wheels enclosed in rims of forged steel and drawn by one bullock or a pair of bullocks) is inefficient in many ways. Its net loading capacity, even with two bullocks, is less than one tonne, and its weight itself is about one half of the pay-load. Its pulling capacity is low and the drag on the cart retards the animal and thus slows down the system. The neck of the bullock acts in effect as the third resting point for the combined weight of the cart and the load, the other two being the two wheels. Though the cart might appear to be well balanced in a stationary position, this is seldom true in dynamic situations, and the vertical load on the neck increases, a goodly proportion of it being avoidable. Thus, though theoretically the bullocks are required only to haul the load, in practice, they have both to carry as well as pull it. The stress, vertically incident on the animal's neck reduces its ability to haul. In most parts of the country, the bullock-carts have no braking device, and slowing down or stopping the carts is effected by bringing to bear an unbearable strain on the neck or on the snout of the animals which are strung through with a rein or halter of abrasive rope.

Uneconomic Nature of Operations

16. The cost of a cart with a pair of bullocks is around Rs. 1,000 to 2,500, and if the average carrying capacity of the conventional cart is less than a tonne, the returns are bound to be poor. Apart from the high cost of capital, expenditure has to be incurred on the maintenance of the animals as well as on the cart. Studies suggest that the internal rate of return is just 7 per cent which is much less than the general rates of interest as measured by yields of equity and bank loans. No economic justification can be adduced for the conventional cart in the form in which it is extant. Yet it has survived into the modern age because, as in the case of ploughs, threshers, the Persian Wheel, which have not changed in centuries, the farmers cannot afford anything better. And Indian technology has so far done little for all these.

Damage to Roads

17. In the village, the conventional iron-rimmed carts are driven over the soft terrain of the cultivated field and other rough tracks compacted and rutted through use. Most cart-drivers prefer the rutted track which is safer in wet weather and which also serves to guide the animal. They use it rather like a locomotive uses the permanent way or the rail-road. Yet, in the course of their operations, they have also to travel over the prepared *kutcha* and *pucca* roads. This was perhaps not the case when the cart originally came into use mostly for farm work (it must be contemporaneous with the war chariot) and in consequence, road development in the country, particularly in the rural areas, is a matter of recent and contemporary history. The steel rims of cart-wheels cut the road surface, particularly as they begin to wobble after constant use. The lack of maintenance for road and cart progressively increases the damage. Most cart-drivers require re-orientation of attitudes for the use of national and State highways and district roads as the latter may not be rutted the way dirt roads are. The cost to the exchequer in terms of road damage as due to bullock-cart operations has been estimated at various points of time in the course of this century. It was by the damage caused to roads by bullock-carts that the Roads Congress was exercised during the 'forties; for them it was the best and only reason for improving the bullock-cart. Authorities were therefore satisfied with the pneumatic tyre. During the 'forties, the Madras Government is reported to have estimated that they were spending — on road maintenance — an average of Rs. 100 per cart operating in and around urban areas. The scope of the present project of the Indian Institute of Management is, however, rather larger; it seeks to eliminate avoidable cruelty to the animals and improve the technology of the cart so that the combination could play a vital and enhanced role in the integrated development of rural areas.

The Alternatives

18. Clearly, then, the conventional bullock-cart is a drain on the country's resources as well as on the meagre resources of the owners thanks to road damage, inadequate returns on investment, premature cattle mortality, etc. Agriculture having already received considerable boost under the five year plans, it would at this stage be wiser to diversify effort and confer more attention on the secondary and

tertiary sectors of the rural economy. It would be perhaps wiser accordingly to retain and improve the system so as to make it more efficient both for the economy and for the individual operator. To do so would be pragmatic. For the mechanization of rural transportation would remain beyond the means of this country for many years to come.

19. The development of mechanical transport technology in the West which replaced animal-hauled vehicles came about at a time when fuel resources were growingly abundant in relation to demand and unimaginably cheap. The situation has changed beyond recognition since then. During the past quarter century, the dependence of transportation services on oil as fuel has steadily increased, and it is now the only fuel used in the transport of goods by road. Oil is now neither abundant nor cheap. Secondly, rural India today is quite different from the rural areas of the West at the time when the automobile was discovered and pioneered as a wonder vehicle. The major use for the bullocks as well as the bullock-carts is on the farm in the transportation of the harvest from the farms to the barn and thence to the market but then this forms only a small proportion of the total work done both by bullock and the cart in the service of farm activity. The average size of the farm in India is very low and hence load availability is yet too uneconomical for the full utilization of improved capacity. Conditions are not yet ripe for the centralized professionalization of farm produce collection by bullock-carts. Apart from this, roads do not exist in many parts of rural India and where they exist, they do so only in name. Bullock-carts bound for *mundis* have to traverse fields and *kutcha* roads before they can reach paved surfaces. In a study conducted in Coimbatore District, it was found that, typically, almost two-thirds of the distances involved was made up of fields and *kutcha* roads. No vehicle other than the bullock-cart can negotiate such terrain. Thirdly, the average distance from villages to *mundis* is not long enough to facilitate movement by motorized vehicles. Over short distances and for small pay-loads, the truck is not economical. The cost of ancillary services, such as loading and unloading and the compensation payable for an empty truck on the return trip, rule out truck services for farm activity. Also the idle time involved in loading and unloading would be disproportionately high as compared to running time.

20. Finally, as indicated earlier, the bullock-cart is an adjunct to animal-drawn agricultural equipment. There is no reason to believe that the importance of bullock power in agricultural operations will decrease in the near future. According to an estimate of the NRDC, energy input has to be doubled to get optimum farm output. If it is not possible to replace animal power for agricultural operations, where they are not fully employed, it should certainly be persisted with for carting operations as well.

21. High absolute levels of population, a disproportionate predominance in it of working age-groups and a lack of skill endowment in older age-groups owing to low levels of education warrant the current emphasis on labour-intensive technology. In rural transportation, it is only appropriate then that we reserve short-distance loads entirely to animal-drawn carts and, in cities, to a similar use of bio-energy

as motive power for the transportation of goods. The combination of carts and trucks in the latter case should be persisted with, the mix being determined by market forces. The technical inefficiencies of bullock-carts should be remedied expeditiously so that the misapprehension is cleared that the bullock-cart is obsolescent and due for replacement. An official of the Department of Science and Technology noted in the course of an inter-Ministerial meeting on the bullock-cart that the absence of a specialized wheel-wright in our villages denoted the unmerited decline of the bullock-cart and a growing lack of concern for it among their peoples. Bullock-cart transportation is even more labour intensive than road transportation and forestry — two sectors selectively mentioned by the Reserve Bank as suitable for investment under policies directed at augmenting employment.

22. Apart from cart-drivers engaged full time, loading and unloading operations, which can be regarded as activity directly resulting from carting, also provide employment for a number of persons in *mundis* and in the construction industry. Apart from this, at least one carpenter-*cum*-blacksmith who does service for a wheel-wright is to be found in district towns, and repair and maintenance personnel are available in almost every village. Enquiries made from representative craftsmen reveal that, on an average, 70 man-days of skilled labour go into the manufacture of a conventional bullock-cart. Even in this neglected state of theirs, more than 100,000 new carts are manufactured per year in the country. The total employment available in cart-manufacturing would thus work out to seven million man-days. On an average not less than seven man-days of maintenance and repair work are required for each cart, and the total man-days of work expended on this activity alone would be around 90 millions. Approximately 100 million man-days are spent, then, on the manufacture of new carts and on the maintenance of existing ones. Although, on the basis of a norm-year of 200 working days, the number of people involved in this activity would work out to over 500,000, the actual number would be far larger as quite a few are under-employed. One interesting feature of this mode of employment is that, since most craftsmen work with simple tools, the capital required is negligible.

23. What are the technological implications of replacing bullock-carts by other modes of transport? This *reductio ad absurdum* exercitation must be gone through to its conclusion in order to give the lie to the argument that the bullock-cart is on its way out. If bullock-carts were to be replaced, it would be entirely or partly by trucks in the urban areas or and by tractor-trailers and trucks in the rural areas. Both these modes of transport are highly capital-intensive. The earlier assumption that bullock-carts carry about 100,000 million tonne-km per year is based on the further proviso that the carts are able to obtain freight only for the outward journey.

24. Whereas the bullocks live mainly off the farm on the by-products of agriculture like straw and grass from pasture, which have few alternative uses, trucks and tractors need fuel and lubricating oils, which are scarce and have to be imported at heavy cost in foreign exchange. Fuel required to run trucks and tractors in order to carry the traffic presently handled by bullock-carts would be very high. The total

cost of displacing the bullock-cart from the country's transportation scene would therefore be heavy in terms of capital and foreign exchange and cannot be carried through in the foreseeable future. If the social cost in terms of reduced employment were added to that of the increased use of scarce resources, the figure would be even higher.

25. It is not only on grounds of adverse results to employment and fuel consumption that the replacement of the bullock-cart in the near future must be ruled out. Of course, the resultant unemployment in the rural areas would be nothing short of tragic. The elasticity of supply of draught animals is low as it is at present dependent on the breeding of cattle for milk; the male-female proportion being fixed, their number is not, therefore, controllable. No attempt is being made in this country at present so to breed animals selectively as to reinforce draft characteristics, because breeding policies have in the short run to concentrate on limiting the numbers of the stock while simultaneously upgrading individual animals for milk yields. The representative from the Animal Husbandry Department in the Union Ministry of Agriculture claimed that indigenous breeds were better suited to draft purposes than cattle elsewhere in the world and that milch cattle gave rise to bullocks which had adequate draft capability. If male calves were not required for hauling purposes, they would be sent to the slaughter-house for their skins and their tender meat, or they would be left uncared for which would again defeat the objectives of the even limited breeding policies. Mixed farming, which is being purposefully extended over large parts of the country, is based for its rationale on the close association between animal husbandry and farming. Without the animals, the loss to the farm economy by way of manure and cheap fuel foregone would be too colossal even to contemplate. And the thoroughbred draft stock are probably being priced out of the market — a loss that can be ill afforded.

26. It is not practical or feasible to replace the bullock-cart and if we have to live with it, official policy should concentrate on the only feasible course of action; improve cart and animal technically and genetically as well as economically, so as to increase earnings, reduce cruelty to the animals and eliminate road damage. That this is possible has been conclusively demonstrated by sporadic efforts in the past and again by recent but more comprehensive redesign attempts. When the carts are improved, a net-work of bullock-cart stations, operated with ancillary and supporting services, will have a pre-emptive share, as they should, in the carrying of freight originating from, or bound for, the rural areas. Such professionally organized services could impart stability to the entire bullock-cart system as well as to the service sector in the rural areas. In certain areas where improved carts are in operation, the earnings of carters have increased two and threefold.

27. Design improvement is only one aspect of the total task. Another important aspect is extension work which must demonstrate to the cart-owners the possible benefits from better carts. Here the mass media have a significant role to play. Improved carts are bound to cost more than the traditional ones. Accordingly, redesign is being directed so that it is disaggregated ad so that chosnen segments of

cart structure could be improved at small cost and could all be incorporated separately into existing designs. An over-integrated improvement of the entire system which bears no relation to designs in use will put the cart beyond the means of the farmer. In order to enable small and marginal farmers to modernize their carts, it would be necessary to extend financial assistance through banks for the purchase of improved carts. It is a heartening feature of the situation that financial institutions and banks have come forward on their own to assist, and a few of them have done even more.

28. A study of the geometrics of carts in various parts of the country is in progress. Simultaneously the task of developing sets of design improvements to suit various types of carts, incomes, terrain and use have been taken in hand. The proto-types of the redesigned elements are being experimented with in the laboratories and under field conditions.

MODERNIZING THE BULLOCK-CART

TECHNO-ECONOMIC ASPECTS

Of Non-organized Segments of Activity

1. One of the striking "dualities" about our country is the co-existence of small but well-organized segments of the economy with vast and sprawling non-organized ones. As is only to be expected, the conditions of work and living in the non-organized segments compare unfavourably with those in the modern or the "international" sectors; but the bulk of the goods produced and services rendered originate in the non-organized sector.

2. There is perhaps nothing unusual about this for, even in the free-market economies of the West, the differences between one firm and another in the same industry can be considerable — in the matter of profits earned, wages paid, or the average and marginal costs of the products. But such variations are subtended within a predictable range, and the whole system is in a state of dynamic equilibrium where the less efficient firms tend and aspire to the conditions of the most competitive. In India, the corresponding range is greater and the non-organized sector is larger and often based on antiquated but extant and viable technologies. The tacit and facile assumption is made that the non-organized sector is bound in the foreseeable future to be superseded, totally and at some point of time, by modern variants. "What cannot be cured must be endured": this need not be true of technology. We must make better what we must live with. A great deal of this paper is about the bullock-cart. Some of it is also about the non-organized sector, and isolated observations relate to modernization and to problems related to the transfer of an appropriate technology to the rural areas in developing countries. Though the unorganized segments account for the bulk of the activities in the national life, they receive far less attention — than does the diminutive organized sector — from policy-makers, entrepreneurs, the mass media, the opinion-makers and all those, in short, who matter. Thus — organized industry, organized transport, organized trade, organized labour — all capture the public imagination; they are always in the news and few bother about the problems of the corresponding non-organized segments of activity. Yet, part of the object of upgrading the status of the non-organized segments of activity is to make them viable through the induction of organization and systems. As a pre-condition, it is essential to achieve a proper understanding of the working of these non-organized segments of activity so that one may know how to change piecemeal so as to improve rather than to distrub. Since its inception, the Indian Institute of Management, Bangalore, has bestowed pointed attention on this vital task, and the animal-drawn vehicles in rural and city transportation have accordingly come in for a great deal of attention and study at its hands.

The Bullock-cart as Appropriate Technology

3. There are several types of animal-drawn carts in use in the country: bullock-carts, buffalo-carts, horse-carts, camel-carts and mule-carts. The bullock and buffalo carts are by far the predominant types of animal-drawn carts in use. Horse and mule-carts are found mainly in urban areas. Camel-carts are localized mainly in Rajasthan, north Gujarat and parts of Haryana and Delhi. There is little distinction between the carts hauled by bullocks and those hauled by buffaloes. The term bullock-cart used in this paper signifies both these types of carts. The bullock-cart is used in our country for the transport of men and materials. Its role in passenger transport has been considerably attenuated over the years with the advent of the passenger bus services over routes not covered by the railways. Although motorized traction appears to have made considerable inroads into the goods transport sector, the bullock-cart still plays a major role in the transport of farm produce, fodder, fuel, agricultural inputs, vegetables, construction materials and retail goods in the rural areas. Bullock-carts are used in the cities for freighting vegetables, garbage, dry grocery, general merchandise for the retailers and construction materials. The number of animal-drawn carts in use in the country has been increasing over the years; from 110 lakhs in 1956, it rose to 127 lakhs in 1966, and now the figure is believed to have crossed the 150 lakh mark. In fact, the number of carts has been steadily increasing in all the States except perhaps Haryana, Punjab and Kerala.

4. The aggregate investment in the system, including the cost of the animals, may well be of the order of Rs. 3,000 crores. This is comparable to the outlay on the Indian Railways estimated at over Rs. 4,000 crores and on public goods transport (automotive) vehicles (by road) estimated at Rs. 2,500 crores. The bullock-cart is, at present, the principal means of goods transportation as between villages and towns, and for use in traffic between village and village, it is still irreplacable. And it still is the only vehicle which goes where there are no roads. According to a study conducted in 1959–60 by the Planning Commission[1], bullock-carts carried 58 to 96 per cent of the produce arrivals in five of the country's regional markets. On the basis of information gathered by IIM-B from over 40 districts, it was found that, at present, an average of over 60 per cent of all goods sent from farm to market, presumably including those for intermediate destinations, was carried by bullock-carts. There are, however, no data to be had on the quantum of goods so carried.

Freight Moved by Carts

5. The latest livestock census estimates the number of carts in the country at about 15 millions and suggested that their number was increasing. The census, however, offers no data about the type and design of cart; the number of improved carts; the number of days on which they are used profitably in the towns and in the villages; income derived from carting in the villages; the pattern of ownership; the cost and life of carts; the nature of the freight they carry in the towns and villages, etc. For

[1] *Role of Bullock-carts and Trucks in Rural Transport: Case Studies*; Programme Evalution Organization, Planning Commission, Government of India; 1973

that matter, no figures are at all available regarding the sectorwise use of animal energy: in ploughing, carting, and a number of operations ancillary to farming. In January 1978, the Ministry of Shipping and Transport sponsored a socio-economic survey of bullock-cart opertations, to be conducted by the National Council of Applied Economic Research in north India and by the Indian Institute of Management, Bangalore, in the south. Results are expected to be available by the end of 1979. A similar proposal to conduct a comprehensive socio-economic survey of animal energy is being submitted to the Department of Science and Technology, and this background paper to the proposals details the kind of data necessary for redesigning the cart and improving the utilization of animal energy in all those segments where it provides the motive power for operations. Meanwhile, during the last two years, pilot studies were conducted in Trichy and Coimbatore, in Chingleput District, in Muradnagar in UP, and in Ganganagar in Rajasthan with funds made available by the Department of Science and Technology for a limited but undifferentiated study which, as a first-stage project, covered design, the socio-economic bases of cart operations and even work-animals.

6. Though not serviceable for scientific projection, observations made during pilot studies, and perceptions generally, afford a feel of the situation resulting in the estimation of orders of magnitude; strictly, these are in the nature of assumptions. Based on these, an *ad hoc* attempt is made below to assess the total freight carried by carts in the rural and urban areas.

Particulars	In predominantly	
	Rural Areas	Urban Areas
I. Carts (in millions)	12	3
II Average freight (in tonnes)	$\frac{1}{2}$	$\frac{3}{4}$
III. Average distance over which freight moved (km./day)	10	20
IV. Average number of days of use in year	52 (one day per week)	260 (five days per week)

Notes: 3. This distribution of the total number of carts between rural and urban areas is based on the urbanization index. The exact figure is crucial to our studies and is yet to be determined precisely.

4. The figures of average freight are drawn from district-level pilot studies.

7. From the above, the total freight carried by carts is calculated as under:

I. Freight carried by carts in rural areas	$12 \times \frac{1}{2} \times 10 \times 52$	=	3120
II. Freight carried by carts in urban areas	$3 \times \frac{3}{4} \times 20 \times 260$	=	11,700
			14,820 million tonne-km.
III. Total (in million tonne-km.)			15,000 (approx.)

8. It is assumed in I above that the village carts, 12 millions in number, carry 0.5 tonne of freight over an average distance of 10 km. over 52 days in the year, the rural utilization index being one day of carting in the week. In II above, it is assumed that city carts, three millions in number, carry 0.75 tonne of freight over a distance of 20 km. for 260 days in the year, the urban utilization index being five days of carting in the week.

9. As against this, motorized trucks and the Indian Railways carry 100,000 and 200,000 million tonne-km. of freight respectively each year. The investment in the bullock-cart system, including the cost of animals, may be of the order of Rs. 30,000 million as against Rs. 45,000 million invested in the Railways. This citing of orders of magnitude is sufficient to assert the importance of animal-drawn carts in India's transportation system and the appropriateness of animal-powered technology to the Indian economy.

10. A fair proportion of the carts are owned and used by farmers to carry, between farm and barn, their varied outputs—mostly agricultural produce and inputs, such as manure, fuel, fertilizers and dry fodder. Such carts are also, on rare occasion, hired out to fellow-farmers and other users although quantified evidence of this has so far been difficult to collect; but professional carting for a money hire is a long way off yet in many villages. Non-farming uses of the cart may be significant but most village carts do not yet report paid for freighting between second and third villages. The commercial cartmen, who constitute another category altogether and the economics of whose operations are regulated by other criteria, abound in the cities; but their numbers in the rural areas are as yet small. The exact proportion between farm and commercial carts has not been established; but the latter may not exceed a liberal 20 per cent. The total number of people employed in the bullock-cart transportation system — directly or indirectly, part time and full time — may be of the order of 200 lakhs. The Union Planning Commission have accepted these prototypical figures based also on empirical pilot studies for estimating the employment potential of the animal-drawn cart system in the Sixth Plan. Apart from the direct employment of operators and drivers, whose numbers will equal that of the carts, the system also provides sustenance for those engaged in loading and unloading. Those indirectly employed include the manufacturers of carts and components, as well as others who mend them. The maintenance and upkeep of animals also keep a large number of people busy a part of the time everyday the year round, but the recompense, if it can be identified at all, must be imputed, meagre or even non-existent.

11. Although trucks have been replacing animal-drawn carts in certain areas, bullock-carts are bound to remain with us for many decades to come. In the villages, it is the truck and the tractor-trailer that play a complementary role to the bullock-cart in the transport of goods over short distances. Motorized vehicles cannot replace animal-drawn vehicles easily or completely for several reasons. In the first place, trucks are not competitive over short distances, such as 5 or 10 km., which is the optimum range of the bullock-cart. Secondly, adequate loads are not available for economicaly truck operations in farming. Thirdly, trucks cannot be operated without

well-paved roads which simply do not exist in rural India. Finally, if it were possible to replace all bullock-carts by motor vehicles in rural transportation, it would not be desirable because at the present rate of exploitation, the proven world reserves of petroleum may not last very long. The initial investment in motorized road transport which will replace the animal-drawn cart systems will be a prohibitive multiple of the money invested in the latter. And India must economize.

12. Animals are a necessary part of farming operations, and farmers will therefore continue to own animals. The National Commission on Agriculture has estimated that agriculture alone would still require 800 lakh animals by the year 2000 A.D. As farming operations are seasonal, a good deal of idle time from ploughing is used in carting; either the animals are hired out, or the owner uses them himself. According to a study conducted in Coimbatore and Trichy districts recently, 53 per cent of bullock-time in the former district and, 70 per cent in the latter were taken up by the cart. The transport input in the sugar industry is intensive and carting time reflects this bias. Otherwise one-third of the time is taken up in ploughing which appears to be the national average. The proportion of bullock-time to the total of other forms of energy use—the Persian Wheel, in *gur*-making and for oil extraction by the *ghani* on the north Indian plains must be comparable. In other words, the bullock represents a multi-purpose source of energy — and scarce energy at that. As early as 1956, the Planning Commission wanted multi-purpose farm animals to be bred specifically to their tasks. In order to ensure optimal utilization of animal energy, it is essential that bullocks and other work-animals from the farm be yoked to the cart a part of the time.

13. It should therefore be clear that bullocks and carts are going to remain with us for many years to come. They simply cannot be wished away.

Bullock-cart Types in Use

14. There are several varieties of bullock-carts in use in the country, and it is not strictly correct to talk about *the* bullock-cart. Bullock-carts can, however, be grouped into two types, *viz.*, passenger carts and goods carts on the basis of what they carry. Although the two functions of the cart are interchangeable, carts meant exclusively for passengers would form only an insignificant proportion of the total. More relevantly for the purposes of this paper, carts can also be grouped into two other kinds, *viz.*, conventional carts and improved ones, depending mainly on the type of wheels, axles, platforms and other structurals and components. While conventional carts have wheels and a body made of wood, improved carts have pneumatic tyres or hard-rubber wheels and steel or steel-*cum*-wooden body. The dimensions of the wheels as well as the platforms vary from region to region and from one use to another. Wheel diameter varies from three to over six feet in many regions of the country. Wheel structure also varies correspondingly. Spokeless vehicles are found in Rajasthan; some wheels are of solid wood segments and studded with bolts and rawl plugs. In fact, they look like the wheel of a temple car. The shape and arrangement of the spokes too vary. There are paired spokes proceeding from one point of the wheel circumference to a corresponding point at the other end, passing through

the hub *en route*. There are other wheel types in which the spokes radiate from the hub to the wheel-frame. Wooden wheels are generally enclosed in iron rims which bind the wheel together. At the contact point on the road surface, along the "tread" that is, iron rims also protect the wooden wheels from wear and tear. The thickness of the iron-wheel rim (which is presumably made by the blacksmith or district-level re-rolling industries) also varies from area to area, ranging from 1.5 to three inches. The width of the rim is a parameter that is germane to the problem of road damage. It was thought at one time, the damage could be reduced through the increase of rim width. This was the solution proposed by Vagh (together with increases in wheel diameter as necessary). For a given tare-weight of the cart and a corresponding load capacity, it cannot, however, be reduced below a minimum. But then, increase in rim-width also increases friction.

15. The common tyrized cart is fitted with a steel axle and animal-drawn vehicle (ADV) tyres especially manufactured by the tyre companies. Carts made from old truck axles, wheels and tyres which have outlived their usefulness are found mainly in a few urban centres. Unclad iron tyres are met with in the environs of the city of Delhi and in parts of Haryana. Hard-rubber tyres are all too few, but found occasionally in urban areas. Firestone India have come out with a hard rubber cap-tyre for a wheel of traditional diameter, fabricated, however, from steel angles. A number of design experts have argued that this tyre, or its variations, is to be preferred to pneumatic tyres in the case of village carts which traverse un-prepared surfaces.

16. All the cart-types discussed in the last two paras are generally drawn by a pair of bullocks. Single-bullock carts, too, are quite common in our country. In certain States like Rajasthan, Uttar Pradesh and Haryana, single buffaloes are used extensively to draw carts. No different from the bullock-drawn cart in essential respects, the buffalo-cart can, however, haul heavier loads. Delhi and Coimbatore have a small number of four-wheeled carts with pneumatic tyres, the front wheels being smaller than the rear ones. The table below compares the costs of four different types of carts, the samples for the cost survey being drawn from Bangalore and Coimbatore districts for the year 1974. (See page 35.)

17. The carrying capacity of a conventional bullock-cart is only about one tonne, if that. Two-wheeled carts with pneumatic tyres can haul a load of around 2.5 tonnes. Pneumatic-tyre carts with four wheels are equipped to carry around three tonnes. In the Meerut and Muzaffarnagar districts of Uttar Pradesh, in Mandya in Karnataka and in Trichy and Coimbatore Districts of Tamil Nadu, where cash crops (principally sugar-cane) are raised, there is cargo enough to justify the harnessing of a single buffalo to a cart with two pneumatic tyres, and this combination can carry a maximum load of three tonnes.

A Neglected System

18. In this country, adequate attention has not so far been paid to bullocks as a source of motive power and to bullock-carts as a means of transportation. This

TABLE 1

CART, TYRES AND COMPONENT COSTS

Cart with Conventional Components	Cart with old truck axle and tyres	Cart with new axle and ADV tyres	4-wheel cart with new axles and 4 new ADV tyres
Rs.	Rs.	Rs.	Rs.
1. Materials Cost (Wood, axle & steel rims) .. 1,200	1. Old truck axle .. 500	1. New axle .. 1,250	1. New axle: 2 numbers .. 2,500
2. Labour for making the cart .. 300	2. Two old tyres + tubes .. 250	2. Two tyres + tubes .. 500	2. Four tyres + tubes .. 1,000
	3. Labour + Materials + Painting .. 750	3. Labour + fabrication + materials .. 1,250	3. Labour + fabrication + materials .. 1,250
Total Cost: Rs. 1,500	Rs. 1,500	Rs. 3,000	Rs. 4,750

neglect is mainly to be ascribed to the wishful thinking that animals as a source of draft power will soon be replaced by mechanical contrivances like power-tillers, tractors, havester-combines, fertilizer-and-seed drills and trucks. It is high time that a more realistic appraisal of the situation was made. We may have to live with animal-power for use in a variety of farm and off-the-farm operations since a poor country cannot afford altogether to do away with use of bio-energy as motive power. At one of its recent meetings in Delhi (September 20, 1978), a UNIDO working group on energy for the rural areas agreed that the contribution of animal energy to farming operations must remain at the present level of two-thirds of the total just as firewood will continue to contribute more than a half to the total energy output in the developed economy of the USA.

19. As the bullock-cart was considered a passing phase in the development of the transport sector, hardly any effort was made to improve the design of the cart, which, in its present form, has remained substantially unchanged over several centuries. Again, no significant effort to improve the cattle wealth of the country so as to augment their draft power was made. Through a proper manipulation of nature and nurture, (*a*) it should be possible to reinforce draught characteristics of male calves instead of sending them to slaughter-houses at birth and instead of concentrating on the milch-characteristics of female calves. Until recently, farmers preferred male cattle as these would make good work-animals about the farm. With two years' maintenance, their value would appreciate to Rs. 1,500 to Rs. 2,000 a piece instead of which they are now sold off for a pittance at birth only because farmers cannot afford to maintain the animals without returns for two years. Admittedly, some thought was devoted to developing dual-purpose breeds of cattle during the Second-Plan

period. But the emphasis has, of late, shifted to the optimization of yields from dairying, thanks to the claims of mixed farming and Operation Flood. The development of milch cattle is indeed a crying need in this underfed country; but the development of animal power is important no less. The importance of black cattle for draught purposes (buffaloes yoked to the cart and now to the ploughs as well on the north Indian plains are growing in number) cannot here be over-emphasized. The male buffalo has a proven and much higher draft capability than the bullock. In respect of its capacity to assimilate food and convert it into energy, too, it is more efficient and, therefore, more economical. The price of a male buffalo is almost one-half of that of a bullock. A Murrah buffalo, which can haul a 1.5-ton load on an unimproved cart, is much more expensive; but it is still cheaper than the female of the species which is valued for its high milk yields as well as for the larger fat content in that milk.

Defects in Existing Designs and Their Consequences

20. The conventional bullock-cart is inefficient in several ways. As noted earlier, the salient features of the conventional cart are: two large-diameter (ranging from three to six feet) wooden wheels enclosed in iron rims, together with a wooden axle-block and a platform. As the cart is not properly balanced fore and aft even under static conditions, the neck of the bullocks, where the yoke-beam rests, has now to act as the third and fourth resting points for the combined stress resulting from the tare-weight of the cart and the load—the first two points being the two wheels. The four or eight hooves are also stress points, and the argument for eliminating or reducing the vertical weight incident on the animal's neck is designed to ensure that the animal legs move forward and backward rather than up and down. A certain avoidable component of this load, which has been estimated at 80 to 100 kg., has now to be borne by the animals even when the cart is not in motion. Under dynamic conditions, this weight would be a deal more. Ideally, the function of the bullocks should be to pull the load and not to carry it. However, this does not happen in the best of the existing designs. There thus exists considerable scope for further empirical research in this regard.

21. This reduces the efficiency of the animals. The crude bearings used in the average cart does not permit the smooth revolving of the wheels around the hub. This again retards the natural speed of the animal and further reduces the draft coefficient. Due to these and other defects, the load carried by a conventional double-bullock cart is low — normally less than one tonne.

22. As the cart climbs a gradient, the weight tends to tilt backwards, and the strain on the animals now becomes the product of the gradient, measured by the tangent of the angle that the slope makes with the horizontal axis, and the load. Contrariwise, as the cart speeds down the incline, the tare-weight of the cart and the cargo are thrown forward squarely on the animal's shoulders. In addition, the animal has now to exert itself and act as a braking device or a retro-engine against the pull of gravity. And then there is the constant rubbing of the weighted yoke against the animal's neck, resulting in much discomfort in the short run and in the

callosity of neck tissues eventually. In the absence of a braking mechanism, the slowing down or stopping of the cart can only be effected by pulling the animal short with the help of rope-reins which are slung through the nostrils or worse still, through a steel ring passed through the snout. Similarly, to make the animals run faster or negotiate a difficult gradient, they are beaten and even the scrotum of the castrated bullocks tickled as refined punishment after the conventional ones have ceased to elicit a response from the desensitized animal.

23. The tare-weight of carts is high due to the use of unsuitable materials and over-designing. The weight of the conventional cart is around 800 kg., that of the pneumatic (ADV) tyre cart varying from 500 to 550 kg. *A priori,* the figures appear to be rather high as compared to their capacity to carry income-yielding loads. The weight reduction exercise has to be carried through deliberately as an element in the second phase of the redesign exercise of the 'seventies.

24. As the net loading capacity of the conventional cart is less than one tonne, the incomes of the owner/operator tend to be low fluctuating around bare levels of sustenance both for man and beast. Low income adversely affects the consumption of the operators if these exist at all as well as that imputable to the animals. It is not all greed or cupidity that leads the cart-operator to overload his cart; but an extenuating need to make both ends meet so that the skimpy operations might break even. The animal cannot be looked after better unless earnings improve. Even piecemeal redesign of the cart must wait on the latter condition. Increases in freight and earnings can come about only gradually through contrived increases in rural production and productivity.

25. Although the pneumatic tyre carts have served to rectify some of the defects in the conventional design, (principally those relating to rolling and braking frictions) the new designs have brought problems of their own in their wake. The weight of the empty cart is high. The small-diameter wheel fitted with pneumatic tyres cannot be driven easily over unprepared terrain and is not of much avail on slushy ground for instance. It cannot span or tread easily over a pot-hole as a large-diameter wooden wheel can. In both these cases, the pneumatic tyres tend to get bogged down. An ADV-cart cannot therefore travel cross country or, say, over a field flooded for transplantation with the same facility as a bullock-cart.

26. At present, the cart-owners/operators depend on money-lenders to meet their needs of capital, paying in effect rates of interest ranging from 40 to 100 per cent and the high servicing charges payable for debts further reduce their disposable incomes. The fact must be faced then that the existing bullock-cart system is not only inefficient but it is also unviable economically. Equally clearly, there is nothing to take its place. Indeed, it is arguable that the latter is the remediable cause. Studies conducted in Coimbatore and Bangalore districts in 1974 reveal that the internal rate of return for the conventional carts was only about 7 per cent, which was much less than the then prevalent rates of interest even in the organized money market. As against this,

some varieties of improved carts, such as those equipped with pneumatic tyres, were found to generate returns of over 30 per cent.

27. The table below affords a comparison as between the capital, expenditure, revenue and profit involved from three different types of carts:

TABLE II

CAPITAL, EXPENDITURE, REVENUE & PROFIT

The Traditional Cart and Dunlop Cart Performances Compared

(In rupees)

	Conventional Bullock-cart	Bullock-cart Improved with Truck Axle & Wheels (2)	Dunlop Cart with ADV Tyres (2) and Axle to Match
1. FIXED CAPITAL:			
(*a*) Cart ...	1320	1500	3000
(*b*) Bullocks (2) ...	1100	2000	1230
(*c*) Cost of Shed ...	1000	2000	2000
TOTAL ...	3420	5500	6230
2. MAINTENANCE EXPENSES OF:			
(*a*) Bullocks ...	2578	3958	4028
(*b*) Cart ...	35	105	164
TOTAL ...	2613	4063	4192
3. Income from Carting Dung ...	3855	7300	7650
4. Gross Profit (3 minus 5) ...	1242	3237	3458
5. Interest & Depreciation on Fixed Capital ...	752	1210	1370
6. Net Profit (4 minus 5) ...	490	2027	2088
7. Internal Rate of Return ...	70%	30%+	30%+
8. Scrap Value ...	250	300	400

28. The iron rim, in which the segments of the wooden wheel are enclosed, cuts the road surface and causes damage — the value of which has been estimated in the order of crores of rupees. This road damage represents the social cost of dysfunctional designs. It has been estimated that road damage due to bullock-carts is ten times that caused by motor transport.[2] Clearly then, the meagre private returns from the conventional bullock-cart, which is itself sub-optimal, have been obtained at heavy social cost.

Cruelty to Work-animals

29. Various types of cruelties are at present inflicted on the animals in the course of cart operations. Some of these emanating from design defects, such as the

[2]*Journal of the Indian Roads Congress*; Vol. XV, No. 2; November 1950; p. 265

undue vertical load incident on the necks and the painful use of rope-halters to stop the cart short in the absence of a better braking device, have already been adverted to. Apart from these there are avoidable cruelties, such as whipping, goading with sharp-ended instruments, the squeezing of the scrotum and the twisting of tails, putting sick animals to work, overloading and under-feeding for which a part of the blame at any rate must, under contemporary socio-economic conditions, rest with the ignorant cart-driver. The conventional-methods of castration, shoeing, and branding leave a great deal to be desired to say the least of it. All these are inhuman, and apart from that, they adversely affect the economic life of the animals as also the efficiency of the operations for the owner. In a sense, many of the cruelties attributable to design are also avoidable, for some of them like the vertical load on the animal-neck could be substantially reduced, if not completely eliminated, through well-thought-out modifications. Other forms of cruelty too can be prevented through massive educational campaigns employing mass media, the extension of facilities for veterinary departments, the more vigilant enforcement of laws against cruelty, etc.

Cart Modernization: A Boost to the Economy

30. The modernization of bullock-carts, if it results in the augmentation of carrying capacity, decreased strain to the animals, and the elimination of damage to roads, would give a great boost to the national economy in general and to the rural economy in particular. If the carrying capacity could be doubled, (and this has been achieved with pneumatic tyres) the incomes of the rural people dependent on this system would also double. No nationwide data regarding the income generated by the bullock-cart transportation system for a variety of freight, in cities and in villages, are available. On a conservative estimate, it would aggregate Rs. 4,000 crores, assuming an average working year of 100 days and a daily income of Rs. 10 per cart. Since the first edition of this paper was published in February 1977, IIM-B has been awarded a socio-economic survey of bullock-cart operations for four states in South India as also Maharashtra, Orissa, and Madhya Pradesh. Tabulated survey findings should be available towards the end of the year and help to identify priorities for redesign and the quantum of freight available for hauling by animals. Consquent on modernization, the value of freight carried by carts could be stepped up to Rs. 2,000 crores and more.

31. If improved designs could eliminate or even reduce the vertical weight carried by the animals (not hauled by them) either through better harnessing or through a third wheel, the effective pull at the draw-bars or the floating beams can be increased; the economic life of the bullocks, which is at present around ten years, could be increased by at least one year. Even a ten per cent increase in their working life would save the country and the animal-owners Rs. 200 crores.

32. Any saving on account of road damage, if that could be prevented, would be a clear social gain. According to a Report on Road Development in Madras Presidency (1948), the cost of repairing the damage caused by one bullock-cart to road surface over a period of 12 months was assessed at Rs. 254, which was higher

than the contemporary cost of the bullock-cart itself (Rs. 150 in 1934). As bullock-cart designs have not improved significantly since 1948, the road repairs necessary would remain comparable in real terms to this day. Without hazarding an estimate of the cost of any necessary repairs, one could justifiably argue that the savings to the national exchequer on account of the reduced road damage would be phenomenal.

33. Another advantage to the rural economy which could be consolidated through improved cart design would be the contributory employment potentiality, it can generate at stable and higher levels of income. Improvement would come as a great boon to the over 200 lakh people employed by the system directly and indirectly, part time and full time. Much of this employment, located in the non-organized sector, would be seasonal and fetch only low levels of remuneration. With improvements in design, the bullock-cart, and the transportation system based on it, could be made viable, and it could be equipped to play a much more stimulating role in the transport economy, particularly in the rural areas. Employment in the bullock-cart system would then be a multiple of that provided by trucks with an equal carrying capacity. The bullock-cart is furthermore an excellent example of appropriate technology for short-distance goods transportation. The capital cost of employing a single notional person in the bullock-cart is just Rs. 3,000 whereas the corresponding figure for the truck system would be ten times that figure. Ours being a capital-scarce, labour-surplus economy, the relevant technology for us would comprise labour-using and capital-saving systems. As a further advantage, the bullock-cart can use herited skills and need not wait upon the generation of new ones; fresh training for these calls for massive investments. The new jobs would not be confined only to cart-operators, but would extend to manufactuing and repairing artisans. If the bullock-carts were further neglected, the system would lose out without a fair chance. The carts may well be displaced by automobiles, but employment in the transportation sector would in the process be reduced considerably. On the other hand, if the efficiency of the carts were increased, a viable and autonomous rural transportation sector could be fostered. Its contribution to increasing rural levels of living could be palpably felt within a generation.

34. A rationalized and viable bullock-cart system could effect spectacular savings in fossil fuel. Thanks to a legacy of neglect of rural transport, automobiles are making inroads into the system. Whereas the energy for automotive trucks is derived entirely from wasting fossil assets, bullock-energy is of biological origin and is reproducible. Furthermore, the disaggregated energy units, which the bullocks represent, favour employment-intensive small-scale operation. With improved designs, it should be possible to reassign some of the short-distance traffic now carried by trucks and tractors to the bullock-cart system, or failing that, certainly arrest the substitution of carts by automobiles. It may even be possible to effect a reverse substitution — both in the cities and the villages. The resultant saving in fuel and costs generally would be enormous. There is an inherent specialization of carrying function which would suggest mutually exclusive spheres of operation for the railways, the trucks and the bullock-carts. In fact, it should be possible to organize a system of bullock-cart relays through improved designs and stage stations in order to:

(*a*) improve economic traffic as between villages, pressing into service the extension of the road system effected under the five-year plans; and

(*b*) ensure that the cost of carrying goods of rural origin and for rural consumption accrue in the rural areas in part at any rate. It would be best of course if this objective could be achieved through the market mechanism of rate and price structures.

Facets of the Work Ahead

35. The modernization of the bullock-cart system calls for a multi-disciplinary endeavour in a number of sectors. It cannot confine itself to design improvements and must take into account the effects of the original action on the sub-systems.

36. (i) The following are some of the socio-economic aspects of the project that require special investigation:

(*a*) It is necessary to reassess the extent of road damage caused by the conventional bullock-cart in terms of road maintenance cost. An estimate of the damage that can be ascribed exclusively to bullock-carts would be useful in understanding the social benefits of modernization.

(*b*) It is necessary to estimate the volume of bullock-cart transportation in relation to other modes of transport in the national economy. The importance of the bullock-cart as a mode of goods transport could then be established in a telling manner.

c) It should then be possible in the course of a further exercise to estimate the volume of employment and income generated by bullock-cart transportation in the national economy as well as the individual earnings of owners, drivers, loaders, manufacturers and maintenance personnel. The potential of the bullock-cart system both for additional and fuller employment and increased incomes in the rural and urban areas could then be viewed in perspective.

(*d*) It is necessary, too, to study the economic and cultural factors that inhibit the adoption of improved carts. Information generated through such studies will be invaluable in extension efforts to popularize improved designs specific to given commodities, communication systems, cultures and geo-climatic regions.

(*e*) Further information of regional and occupational nature is also required regarding ownership patterns and the sources and servicing costs of capital used for fresh purchases, replacements and major repairs with a view to examining the need for, and the possibility of, arranging institutional finance. This would be the only feasible way of popularizing improved designs, and may prove to be more or less costly than the traditional ones. Institutional finance and State assistance will be necessary as the new designs are required in sectors and modes of use which can least afford them.

(*f*) Finally, it is necessary to estimate the seasonal variations in the utilization of bullock-carts and in the other uses of animal energy on the farm, which are complementary to bullock-cart operations, and assess their implications

for income and employment and ensure the steady availability of the latter for a minimum number of days in the year.

37. It is necessary here to restate that one of the principal objectives of the redesign project is to avoid cruelty to the animals. Through the design improvement, the following advantages would flow. It would be possible to facilitate the pulling process for the benefit of the animal. Hence, a part of the draught power, which is now expended without work being done and is frittered away, could be economically harnessed. In other words, the carrying capacity of the carts could be increased *ceteris paribus* to about 2 to 2.5 tonnes with two bullocks, given the same scale of effort by the animal. Likewise, the increase in feasible load from 0.75 tonnes to 1.25 tonnes could be secured in the case of the single-bullock cart without the output of extra effort by the animal. This could help to increase earnings substantially and to improve the levels of living of the cart-men.

38. Ease in pulling and the avoidance of strain to the animals could be achieved through soft bearings and a better fitment between cart and animal. Besides, it may be possible to eliminate, either completely or in significant measure, the weight now resting on the neck of the animal. This dysfunctional element in the design was referred to earlier. One way of doing this would be to use a harnessing device employed in horse-carts which can articulate the pull of the animal better. In the horse-carts, the harnessing consists of leather straps which pass in front of the forelegs of the animal and are then passed round the barrel of the chest. The harness and the shafts appear to float as the cart moves; but steady and continuous contact is maintained between cart and animal at vital points. In a bullock-cart, on the other hand, the yoke rests only on the neck of the animal. A further refinement would be the introduction of a third wheel which could reduce the load vertically incident on the neck of the animal. Preliminary trials show that this innovation lies distinctly within the realm of possibility. Its applicability is probably confined to well-compacted surfaces. Design improvements have also to cope with the present problems of braking. Some simple devices, the cost and production process of which would lie within the means of the farmer in the village and which do not injure the animal unduly, could be conceptualized. Where decentralized folk technology has improvized these, they could be taken over, adapted and propagated in other regions and terrain.

39. A significant aspect of design improvement is the need to keep down the tare-weight to the absolute minimum, consistent with the requirements of terrain and the need to augment load capacity. The end in view could be secured through the selection of proper materials. Thanks to increased earnings, cart-owners should be able to feed the animals better and so ensure their good health and longevity. A farmer's animals live off the farm, and their feeding is not a function of his earnings; but in the case of a city cart-owner, the feeding schedules, intensities, food fortification and the inclusion of dry concentrates are inextricably bound up with the earnings and represent a direct charge on the latter.

40. The reduction in road damage would be the single most significant social gain of the redesign project. This could be brought about through pneumatic or hard-rubber tyres or through the broadening of the iron rims around the conventional wooden wheel. If the new cap-tyre, the commercial large-scale manufacture of which is being undertaken by a well-known tyre company, can be slipped on to the widened rims as an alternative, total road safety would be assured.

41. Bullock-carts traverse at present a variety of terrain. They are used both in the rural and the urban areas. More relevantly, the village cart has more field tracks and *kutcha* roads to negotiate while the city carts traverse well-laid roads for the most part. It has been found that most carts have often to traverse both *kutcha* and *pucca* roads in the course of a single journey. Animal types used also vary, depending on geographic concentrations of work-animal breeds. While some areas like Coimbatore district in the south and Haryana in the north have large-sized bullocks, many regions like Chittoor district in Andhra Pradesh or Thanjavur in Tamil Nadu possess only small-sized cattle which are nevertheless hardy. While the general practice is to yoke two bullocks to a cart, the single-bullock cart is commonly met with all over the country. It was for these reasons that the first meeting of the Inter-Ministerial Committee on the Bullock-cart convened by the Union Ministry of Transport in December 1976 ruled that a number of improved designs were called for — not just one master design for the whole country. Designs must take into account culture specificity; the terrain; climate; the freight to be carried; the genetic characteristics and specialization of the work-animal breeds that are locally available; and the size of the cart. No single design could qualify by virtue of each one of these requirements, but the rationale and norms of redesign are the same for all.

Genetic Improvement

42. The present breeding programmes concentrate mainly on improving the milk yields of dairy cattle. In any breeding programme, male cattle will probably form 50 per cent of the total, and plans are yet to be formulated to make good work-animals out of them. The capability of exotic cross-bred varieties for ploughing and carting is yet to be established; they are heavy feeders and not used to hard work. The exotics have been evolved to serve the specialized needs of milk production. The special procedures used for breeding beef cattle show, beyond the need for argument, that genetic handling should bear the end-use in view; the end-use will also determine in many cases the breeds one starts off with. In our country, male calves often find their way to the slaughter-houses soon after birth regardless of the fact that, if maintained for two years, they should fetch good prices in the market for work-animals. For our purposes, it is imperative to develop pure breeds of work-animals. Apart from genetics, a little hard-headed training at the veterinary farms can ensure this. As the representative from the Animal Husbandry Department of the Union Ministry of Agriculture pointed out at the Inter-Ministerial meeting, this country has reason to be proud of certain pure dual-purpose work-type breeds, such as the Kangeyam, the Ongole, the Sindhi and Haryana bulls or the Murrah buffaloes. It appears necessary, however, to project special breeding programmes in order to evolve pure work-breeds or to upgrade the work capacity of dual-purpose breeds. Certain ana-

tomical features of work-animals, such as the neck and legs, which are most exercised during work, require selective attention. These animal husbandry tasks fit well into overall national perspectives for cattle which, in this country, suffer from genetically transmitted degradation and shrinking food supplies. The overriding objective, accepted on all hands, is to decrease their numbers while upgrading their individual nutritional and health status. Berseem and lucerne grasses are already being grown in north India and in Kheda district — as second and third crops. On the basis of grassland research done at Jhansi State Departments of Agriculture could encourage the raising of soil-specific grasses as a second crop and as livestock-raising tactics auxiliary to the principal strategies of farming. Grasses are cheaper than dry feed some of which are becoming scarcer as some of the improved seed varieties are non-lodging and yield vastly reduced quantities of hay. Concurrently, seed and grain concentrates, such as bran and oil-cake, have become more expensive because of higher returns from alternative uses. Emergent product specialization in farming has made the second crop an internal need. Also, permanent pasture constitutes in many places mandatory soil cover as a precaution against erosion by the action of water and wind.

Extension and Propaganda

43. There is need for educating the farmers and bullock-cart owners both about the implications of the present defective designs and the potentialities of modernization. Presently, such vital issues as the cruelty to animals and the consequent loss of draught power, the impairment of cattle health and the shortening of the life of the animal, which constitutes the principal capital of the small farmer and the cart-owner, are accepted uncritically and fatalistically as inevitable. Improved designs do not find easy acceptance and the farmer is often a sceptical customer to convince. Improvements are rejected on the first appearance of an obstacle. The pressurization of pneumatic tyres is an instance in point. Service facilities for the mending of punctures, vulcanizing and other minor repairs as well as a second-hand market in tyres and spares, such as axles and hubs, will come up as and when a certain critical number of pneumatic-tyre carts are in operation in a given area, which can use these facilities. The lack of credit facilities is another obstacle to extension. Demonstration, propaganda and education can help to overcome an occupational conservatism in the farmer and any initial resistance to modernization.

44. It will not be possible to improve all the 14 million bullock-carts in the country at one stroke. In the first instance, attention will have to be directed at areas with assured traffic offerings and to villages based on cash crops and vegetables. From our point of view, urban centres are far and away the most promising to start off with, followed by agro-industrial concentrations like sugar factories, regions specializing in raising oil-seeds, fruit and flower crops, growth centres and finally by yet other areas that specialize in growing foodgrains. Even if bullock-carts could capture the incremental freight arising from the planned growth rates of most rural produce, the impetus for redesign will have been imparted. There exists undoubted scope for reclaiming freight for bullock-carts from trucks. The Food Corporation of India and the State Civil Supplies Departments should be persuaded to accord preferential

treatment to bullock-carts for short-distance traffic in their food procurement and buffer-stock operations.

Laws & Rules Governing Use of Bullock-carts

45. First and foremost, the existing municipal legislation that seeks to penalize cruelty to animals should be revived and enforced energetically with the help of voluntary bodies, such as the SPCA, the Lions and Rotary Clubs. The types of carts allowed or forbidden in city areas and municipal limits, the localities in which they may be plied, the maximum permitted load — all these and many other regulations have to be studied, documented and collated. It is also necessary to enact fresh laws and fill *lacunae* to ensure the humane treatment of animals and the safety of cart traffic.

46. A slow-moving vehicle like the bullock-cart retards traffic flow and affects the traffic capacity per unit of time on highways in cities and towns. The problem of the bullock-cart on the road in relation to other traffic has therefore to be looked into from a number of standpoints: rural-urban transportation, the economics of bullock-carts *vs.* other modes of transport, the optimum proportion between goods and passengers on busy thoroughfares. The question of allotting certain hours of the day or night for bullock-cart traffic or segregating cart in traffic lanes alongside of cyclists and pedestrians could also be considered.

47. Institutional manufacture should be undertaken of certain key components, the standardization of which would lower costs substantially and facilitate piecemeal substitution and the overall redesign objectives. At present, many of these are made by village craftsmen, using conventional tools and methods of production into which modern technologies have not entered and which have not even had the benefit of a critical or expert review. Today, the villagewise distribution of such facilities is characterized by uncertain occurrence and quality. The wheel-wright's trade is unknown in India, and even now, there exist better facilities for shoeing a horse or rehooping the wheel of a hansom, a buggy or a colonial coach. These facilities, such as they are, may have served the conventional cart well enough, for the latter has no sophisticated or complex components; but these have now to be systematically improved or extended over groups of villages if the redesign objective is to succeed. Following the fashioning of initial prototypes, certain key components, such as axles, bearings, light yoke-beams which improve transmission, a harness and even light wood-saving platforms can be manufactured on a large scale to great purpose and advantage. As argued before, mass manufacture will not only reduce cost but help standardize vital elements in the design and improve overall cart quality. Suitable wood is now harder to come by, and mass manufacture can also arrest the indiscriminate felling of trees. Such improvements might, however, displace certain traditional types of craftsmen in the villages. But opportunity should be taken to re-educate the existing craftsmen in the maintenance and repair of improved designs. A multi-purpose course for village craftsmen, which would include shoeing practice and the repair and maintenance of rudimentary mechanical contrivances, could be included in the curriculum of Industrial Training Institutes and addressed specially

to trainees who would work in the rural areas. A multi-purpose craftsman has better chances of earning a livelihood than one who pursues and specializes in the traditional but declining trades.

48. Carts in the rural areas are purchased mostly from owned funds. Rarely, small farmers borrow from money-lenders who charge usurious rates of interest. It is this fact that has, more than any other, restricted the purchase of improved carts as well as the improvement of existing ones. While redesigned carts may cost more and may affect the ability of small farmers to buy them, institutional finance provided at differential rates of interest may open up new potentialities for the substitution of conventional carts with new designs as well as for rural development. Happily, the Banking Division of the Ministry of Finance has kindly agreed to consider encouraging or persuading nationalized banks, those already willing and others yet to make a beginning in this sector, to lend to would-be cart-owners.

Past Efforts at Improvement

49. A brief review of past efforts at the improvement of the bullock-cart would not here be out of place. Mr. B. V. Vagh was among the earliest to make an organized attempt, but he was concerned more with preventing road damage and with the appropriate rectification of wheel design. He found that road damage was not due so much to the wobbling of wheels as to the cutting action of the iron rims. He suggested accordingly that the weight of the cart as bearing on the road surface along the tread might be decreased through the widening of the rim. His recommendation did not, however, find much favour at that time.

50. The credit for a more far-reaching and popular attempt at improvement must go to Dunlop India Ltd., essayed some 40 years ago. They were the pioneers in the production of the pneumatic tyre now universally known as ADV with which (along with soft bearings) they sought to replace the steel-rimmed wooden wheel of the traditional bullock-cart. Though Dunlops, too, stressed the vastly reduced damage caused to roads by pneumatic tyres, their carts in fact achieved greater real and monetary returns to their owners. The following table extracted from a report on *Tests on Dunlop Pneumatic Equipment for Farm Carts:* 1933–34 prepared by the Imperial Agricultural Research Institute, Pusa, New Delhi, will bear out Dunlop's claim that their cart not only reduced the chances of road damage but made cart operation more viable for the first time. For Table III, see page 47.

51. The same report also mentions that the net earnings from a Dunlop cart exceeded the income from a country cart by more than twice. However, ADV-tyred carts did not make an impact, one reason being the higher cost involved. In 1936, a Dunlop cart cost Rs. 250 as compared to Rs. 150 which was the price of a country cart. Today, carts tyrized with ADV equipment cost around Rs. 3,000 as against the Rs. 1,500 or so payable for a conventional cart. For this reason, the Provincial Government of the Punjab of those days mooted a proposal to subsidize the purchases of such carts — which proposal had evidently to be shelved due to the outbreak of the Second World War. Another reason must of course have been that the pneu-

TABLE III

PERFORMANCE OF CARTS ON COUNTRY & FIELD TRACKS

Description of Cart	Weight of Empty Cart	Cane Load	Total Weight	Draw-bar Pull	Draw-bar Pull per Maund	Comparative Draught
		(in maunds)			(in lb.)	
Dunlop Wooden Cart ...	9.75	25	34.75	48	1.38	100
Dunlop Iron Cart ...	13.25	50	63.25	100	1.58	115
Farm Cart with Iron Tyres ...	10.00	25	35.00	60	1.72	125
Country Cart without Iron Tyres ...	6.75	16	22.75	80	3.52	225

matic tyres of small diameter could not ply with the same ease on slushy ground as large-diameter wooden wheels. Also, farmers who lacked experience of the new equipment were discouraged by punctures and by the prospect of the maintenance routine. After many decades, pneumatic tyre carts are now seen in large numbers in and around urban centres, sugar factories and in prosperous agricultural areas. Yet, they account only for five per cent of the total number.

52. Carts made out of worn-out truck axles and tyres were subsequently developed as a cheaper variation and are now to be found in small numbers in certain areas mostly on the north Indian plains. In and around the city of Delhi in the north, and in Coimbatore in the south, four-wheeled ADV-tyre carts are also in evidence. Such carts are well balanced, and eliminate the need for the bullocks to carry a part of the vertical load as happens in two-wheeled carts. However, the rolling friction (that between the wheel rim and the road surface) on four-wheeled carts is greater, and they are also costlier into the bargain. Cart designs with pneumatic tyres vary one from the other in respect of size, the materials used in the fabrication of loading platforms, and in the matter of axles and wheels. ADV-tyre carts generally have platforms mounted on steel angles, and this accounts for their larger carrying capacity. An interesting correlation that has consequences for the redesign project is that variations in the material, size and shape of the platforms are intended to suit the nature of the loads to be carried.

53. Existing designs have to be examined and evaluated in terms of load capacity, draw-bar pull, speed, the burden on, and cruelty to, animals, road damage, etc. For, in fashioning new prototypes, it would be impossible to get away from the existing designs. It would be necessary to retain structures and structural elements that have already gained wide consumer acceptance and passed the test of time.

54. The recently aroused interest in the modernization of bullock-cart transportation has its origin in work being done by the Indian Institute of Management, Bangalore, over some years now. In 1974, the Institute conducted a pilot study on the techno-economic aspects of bullock-cart transportation in Bangalore and Coimbatore districts: earnings from cart operations, the nature of the agricultural enterprise which the cart serves; literacy and cultural factors prevalent in the region; and the outstanding facts about the climate, topography and terrain of the region all of which constitute vital "constraints" for determining the possibility and pace of modernization. The study underlined the technical defects of the existing carts and moreover showed conclusively that they were not economically viable. It was found that two-wheeled ADV-tyrized carts as well as others fabricated from worn-out truck axles and wheels generated substantial incomes for the owners or operators of these carts. The Director, Indian Institute of Management, Bangalore, presented a paper on bullock-cart transportation at the last Indian Science Congress held in Waltair.

Contemporary Attempts at Modernization

55. The Indian Institute of Management was among the earliest in recent years to highlight the need for the modernization of bullock-carts. The Director of the Institute, who is also the senior author of this paper, summed up the problem in operational terms at the World Congress on Productivity held in Bombay in 1972. Together with like-minded institutions, the Institute has since been able to foster a nationwide awareness of the problems of, and prospects for, the bullock-cart system in India. The previous Prime Minister's call to the scientists and technologists to apply their minds to the problems of improving the bullock-cart system in the wake of these redesign attempts gave a great fillip to research efforts. Among the few institutions in the country which have taken up the work of redesigning, mention must be made of the Indian Institute of Technology, Madras, the Indian Institute of Science, Bangalore, the Regional Engineering College, Warangal, and the Central Road Research Institute, Delhi.

56. Some time ago, the Syndicate Bank announced a Design Contest and instituted national and regional awards for modernized bullock-cart designs which were at once functional and economical. Over 150 entries were received in response to this call from various parts of the country, and they suggested modifications and additions on the basis of existing cart structures. The Director, Indian Institute of Management, Bangalore, was among those who evaluated and adjudged the entries. It was symptomatic of scientific thinking and technological work in this country that none of the entries merited the National Award; only two were awarded regional consolation prizes. The Indian Institute of Management, Bangalore; have in the meanwhile contacted a number of individuals and institutions and associated them in the task of improving the bullock-cart transportation system, which not only involves technical redesigning but the assessment of the implications of socio-economic conditions for the choice of a design which is suited to topography, locality, culture and use. Another stage in the evolution of viable bullock-cart designs was the sporadic efforts made to incorporate a braking system; this was to some extent a direct consequence of greater speed that pneumatic tyres made possible as also the growing

congestion in the traffic on city roads where bullock-carts continue to be used. Because a cheap brake is not spectacularly effective and the more sophisticated ones are expensive, the brake has not yet caught on in a large way. The most effective braking system that is also cheap has in fact been taken over from one of the traditional designs indigenous to an important cart-using region in the country.

57. Discussions were held in the Institute with Sri B. Sivaraman, Member, Planning Commission, in the hope of having the project included in the forthcoming five-year plan. The Institute sought the mediation and good offices of Dr. Krishnaswamy, the Deputy Governor of the Reserve Bank of India, in securing favourable terms for loans which would help to facilitate the redesign of bullock-carts and upgrade the rural transportation system. The State Bank and its subsidiaries and the Industrial Development Bank of India were also requested to facilitate preferential bank and term-lending for the purchase of work-animals and new carts. The Films Division and the Doordarshan Authority of India of the Ministry of Information and Broadcasting have both made short documentaries, which depict the dysfunctional character of the present bullock-cart system, the need for improvement and the prototypes under consideration.

58. The Institute itself took up a technical research project on design improvement, which was facilitated by a grant from the Department of Science and Technology, Government of India. This was a modest project considering the dimensions of the issues involved, and envisaged increases in the carrying capacity of carts, reduction in injury to animals, and reduced wear and tear to roads. Here again, piecemeal improvement beginning with local designs was the objective. The project envisaged the production of three prototypical designs within one year. In the modernization project, the PSG Institute of Technology of Coimbatore and IIT of Madras were also associated. Tube Investments, the ICPL, the NAL, Bangalore, the Indian Institute of Science, Bangalore, Dunlop (India) Ltd., Calcutta, and Firestone, Bombay, are among the other institutions concurrently working on one or more aspects or elements of the improved designs.

59. We have come a long way since then. A socio-economic survey of bullock-cart operations in seven states of the country was awarded to the Indian Institute of Management, Bangalore, by the Ministry of Shipping & Transport; and so was a second project for a Country Documentation Manual, to be published jointly by ESCAP and the Government of India, of animal-drawn carts and implements and generally on the state of the art of carting and cart manufacture; this will provide the format for a five-country manual for the South Asian region. The Ministry of Shipping and Transport are considering the financing of a redesign project which will help to finalize six production prototypes. Some of the earlier prototypes fabricated under the aegis of the Indian Institute of Management, Bangalore, were on view at the Bullock-cart Modernization Pavilion of Agri Expo 77: photographs, charts, drawings, components depicted the defects of existing cart operations and the need for, and means of, effecting several packages of improvements. A Value Engineering Workshop was also held at IIM-B early in 1978 and was attended by research workers engaged in, or concerned with, bullock-cart development.

THE MANAGEMENT OF ANIMAL ENERGY RESOURCES IN INDIA

FARMING AND CARTING OPERATIONS

1. The progress of civilization has been closely linked with the service of work-animals to mankind for millennia. Work-animals not only provide the motive power to millions of ploughs, carts and agricultural implements but also leave behind hide and bone-meal at the end of their working lives. In our country, the contribution of work-animals to the economy is of the utmost importance. Yet, by and large, we have neglected their development, utilization and welfare. We extract excessive outputs of power from the beasts of burden by resorting to cruelty. The development of animal energy resources, their proper utilization, and more timely care of the work-animals would assuredly benefit millions of poor people, farmers and carters, the environment, the economy, and society at large.

2. All over the world, scientists are searching for new forms of energy. A great deal of Research and Development effort is going on everywhere, India included, to tap energy from the sun, wind, tide, dung, etc. Here in animals is an excellent example of a ready source of energy, most appropriate and lying within the economic and technological capability of millions of farmers. Whatever efforts are now being made in the matter of work-animals are only a fraction of what is needed, considering the investment and the vast potential of economic benefits to the country and reduction in suffering to the animals.

The Extent and Intensity of Animal Power Use

3. We have roughly 80 million work-animals — 70 million bullocks, eight million buffaloes, one million horses and one million camels; in addition, donkeys and elephants are also used if only as pack-animals. Though no statistically and scientifically reliable data are as yet available for macro-calculations, it may be assumed that each animal is capable of generating, on an average, half a horse-power. Our work-animals, then, can generate 40 million h.p., *i.e.*, equal approximately to 30,000 mw. of electrical power. Incidentally, the installed capacity for electrical energy in India today is only 26,000 mw. Not many are aware of the magnitude of power made available to us by these worthy animals. To produce and make available 30,000 mw. of energy at the millions of points of application, would need an investment of Rs. 30,000 crores. As against this, the investment today in work-animals and the associated infrastructure may be of the order only of Rs. 10,000 crores. A part of this neglect is undeniably due to the impression prevalent amongst scientists and policy-makers that the utilization of animal energy for farming purposes represents a passing phase in development, and that modernization of agriculture, and even of social relations and philosophy, would necessitate the elimination of work-animals.

However, any economic analysis of the role of animal energy in farming and the relationship between prices in the organized and non-organized sectors would reveal that this is just not feasible, and may indeed not be desirable for years to come. Animal energy must remain the principal energy source for farming operations in this country for decades. Inter-country comparisons within the Third World would serve to establish the characteristic and vital role animal energy plays in farming operations. This is certainly true of India at any rate.

4. To animal-lovers, of course, this is sad news. What they would like to see is that animals are replaced altogether by motorized implements in farming as well as in rural transport. Work-animals go through untold suffering from birth to death, much of which can be avoided if only we would show compassion and actively get down to finding out how to make operations more efficient and also make things easier for the animal. In any case, so long as we do use them, everybody should do something to improve the situation for the benefit of all — the animals included.

On the Choice of Energy Technologies

5. Several methods ranging from the most primitive to highly contemporary and mechanized technologies are being used in agriculture in India. It has been estimated that two-thirds of the energy input into our farms comes from animals, and of the rest, 20 per cent owes to human exertions; only 10 per cent is derived from other forms of energy like fossil fuels and hydel power. Scientific estimates show that, if the present energy input to our farms were doubled, output could be optimized to great advantage. The same estimates reveal that there exists, too, a great shortage of energy in farming operations. But without massive amounts of capital, power inputs of such magnitude cannot be obtained from hydel and fossil sources alone. Massive investments are being contemplated during the Sixth Plan period in order substantially to augment electrical energy and to allocate a good part of it for use in the rural areas. It is not only supply that is a constraint on rural electrification. Utilization rates in the villages add to transmission and distribution costs and in the case of many small farms, animal energy is cheaper than subsidized electricity. Animal energy belongs as much in the core sector as the generation of electricity from fossil fuels or irrigation.

6. But the efficient delivery of electricity to the villages will take time, and there is meanwhile urgent demand for electrical energy from other equally vital sectors of the economy. The country is currently importing 20 million tons of crude oil and in view of the worldwide supply and price crisis, the free use of diesel for farm needs is not yet feasible. All these facts point to the need of augmenting animal energy outputs and their efficient utilization. Sporadic mechanization is bound to take place on individual farms and in the case of crops that lend themselves to the plantation kind of organization. This need not be discouraged; on the contrary, this process can even be facilitated so that, over the next few decades, work-animals can be replaced, if that is what is desired. However, the conditions for the application of diesel or electrical energy do not now exist on the great majority of farms in the country. On the contrary, animal energy is appropriate and sufficient to most

needs and in many situations. Efforts should accordingly be made to apply animal energy more intensively, productively and efficiently.

7. Improvement would, first of all, call for a survey of the present technological, economic and social status of the utilization of animal energy; the feeding and breeding of work-animals; methods of energy utilization; economic and social efficiency of operations in which they are used in relation to alternative means. Massive inputs by way of R & D, Organization and Systems are essential if the management of animal energy utilization is to be put on a scientific and humane footing. The following considerations may be pertinent:

— There is a shortage of energy on the farms.
— The work-animals already exist and energy from them is appropriate to our needs.
— The supply of animal energy from the existing stock can be increased.
— Crude oil has to be imported, and there is alternative demand for additional electrical energy generated from coal, water and oil resources.
— Animal energy is under-utilized at all levels involving tremendous wastage besides.
— There is all-round cruelty to work-animals which, apart from common humanity, entails indisputable and grave diseconomies.

Uses for Work Animals

8. Situations where animal energy is appropriate are simple and easy to comprehend. Over 50 per cent of India's holdings are less than two hectares in extent and officially classified as small. Farm size in most cases would preclude the use of tractors by small and marginal farmers, which require at least four hectares or more for economical operations. Even where farmers can afford them, the maintenance, infrastructure and technical man-power are not readily available everywhere. Though Government agencies have actively promoted tractorization, the replacement of animal energy by oil-fired implements has fallen short of targets.

9. Even small farms have farm-bred work-animals which, like the subsistence farmer, live off the farm. The farmers use the animals for a variety of purposes. The animal is used to draw the farmer's cart, if he has one, to lift irrigation water, for chaff-cutting, in *gur*-making, etc. A male calf is either kept by the farmer for his own use or sold off as work cattle. There has been no initial money investment in many cases. The feed for animals comes mainly from village pasture and fodder from farm waste and by-products, such as hay. Animal dung is useful as manure and provides fuel for the farmer's home and insect-resisting plaster for the floor and walls of the farm house. When the working life of the animal has come to an end, it is usually sold off for its meat and leather, hoof and horn. And animals belong integrally in primordial village life. Any rural energy policy must take into account these interconnections.

10. There are no reliable estimates regarding the distribution of animal energy as between various uses in farming as well as in carting. However, a qualitative analysis shows that they are used

— exclusively for ploughing
— ploughing, water-lifting and other farm operations
— ploughing and carting
— exclusively in carting as in cities and semi-urban areas
— exclusively as pack animals.

Sample surveys in selected districts show that two-thirds of the animal-drawn carts carrying goods as between villages do not have road surfaces fit and safe enough for trucks and tractors. Only animal-drawn carts can ply on these roads; they take ravines, streams, paddy fields and so on in their stride. That the animal-drawn cart does not need a prepared surface is what makes it unique and peerless. In fact, social anthropologists regard the animal-cart as a versatile vehicle and a venerable artefact from antiquity that has evolved to its present state of utility and simplicity through centuries. The loads to be carried in villages in the service of agricultural operations are far too small for tractors and trucks. Also, the distances over which these are moved are short, say, 10 to 20 kilometers, and so is the journey time. Both the loads and distances preclude the economical use of motorized vehicles. Moreover trucks and tractors are beyond the financial means of the typical farmer or even a typical village made up of small farms. All these factors render the cart the only appropriate and effective means of transportation in most rural areas. Less extensively, carts are used for passenger transport as well. Tractors and trucks will come in large numbers into the villages when conditions become favourable for operations. Meanwhile, efforts should be made to modernize cart operations based on animal energy so as to achieve basic objectives in the primary sector, *viz.*, increased production and employment and the diversification of productive activity in the villages.

11. The small farmer cannot afford his own work-animal; he hires it at present. Often he does a bad job of preparing the ground for sowing. When he ascends the hierarchy of incomes, he buys animals, and a cart at a later stage. For many small farmers, the animal represents capital. It is often the only investment a small farmer can boast of. A pair of animals, improved seeds and fertilizers, a cart and energized pump-sets are all producer goods which a small farmer aspires to — in that order. Yet again, there are many cultivators who have no capital at all. The "income effect" also leads to the progressive use of fallow land. The process of natural regeneration of fertility is shortened through artificial fertilization. Such gradual raising of economic competence may be brought about through the impact of technology based on better seeds, artificial fertilization and higher water inputs; double-, multiple- and inter-cropping; land reforms; easier credit; post-harvest technology; better prices for agricultural produce, etc. All these serve to improve his economic viability. But the modalities by which a marketable surplus and cash income lead to increased investment in farming needs to be determined empirically. When the landless labourer, peasant, share-cropper, marginal or small farmer is able to market some of his produce and acquires a cash surplus over the years, capital formation begins. He acquires

a pair of animals and with luck, a cart as well. That is probably how, thanks to the Green Revolution, the population of work-cattle and carts has been increasing in recent years. It has done so in most States except Kerala, the Punjab and Haryana, where powered contrivances have come to replace animal energy. The local reasons are always important. In Punjab, it is an abundance of water, a three-crop regimen, the productivity of the peasant and a shortage of labour during the busy season that has led to mechanization. In Kerala, plantation crops, appropriate forms of ownership and organization and a shortage of local breeds of work-animals has brought about a decrease in carting. Here again, a socio-economic survey will lead to an animal-energy policy that meets the needs of most disparate local situations. The process of increased use of animal energy on the one side and increased mechanization on the other may, and does, go on simultaneously for some years, but the predominance of animal energy in farming and ancillary operations will continue for much longer than that.

12. The extent of utilization of carts in villages and towns varies a great deal. In the villages, carting is mostly ancillary to farming and the animals are used, maybe for 30 to 100 days in a year, in this manner. To the farmer who has to keep the animals anyway for ploughing, the economics of carting is not a decisive consideration as the marginal cost of cart-use is only that of his own labour, the opportunity cost of which approaches zero in the under-employed villages. Of course, there are thousands of carts which are in use throughout the year.

13. Animal-drawn carts in towns and urban areas and even in the villages, where animals are used exclusively for carting, are able to find custom for 250 to 300 days a year. Except in the metropolitan cities, where carts are being discouraged in the city-centres, the cart population is increasing—in most urban agglomerations. Of course, the proportion of goods carried by carts to that transported in motorized trucks would be small in the cities, unlike in the rural areas where carts carry a much higher proportion of the total traffic. Cart operations are monetized in the cities, but in the villages, much of the freighting is paid for in kind or returned through labour of some kind. Cartmen all over have increased carrying capacity by using pneumatic tyres and some of them make an adequate living from tyrized carts in cities as well as in sugar-cane growing areas.

14. Carts are viable and can compete with trucks in cities under certain conditions: when the

— route-surface does not conduce to motor traffic.
— loads and distances fall below levels which trucks regard as economical.
— loading and unloading time takes longer than the journey itself.

While animals will continue to be replaced by small motorized vehicles like three-wheelers, animals and carts will be added to the stock. This would be particularly true of villages which become larger and approach the size of towns in area and population. This simultaneous progress of mechanization on the one hand and the increased use of animals on the other will probably continue for some decades. This is already happening in Indian towns and reflects supply shortages in the transport

sector in relation to growing demand. This phenomenon is noticeable even in the villages where sugar-cane and other bulky cash crops are raised and where economical loads are assured for long periods in a year for all modes of transport. This process, like the graduation of small and marginal farmers into viable income-classes which derive a net cash return and profit from farming is a part of the rural development process and will go hand in hand with it.

15. Except for the quinquennial livestock censuses, no district-level data are available from which idle and working time of cattle can be determined. Other essential information which is not available include: the population of cattle according to broad age-groups, and the relative proportions of working time spent on ploughing, carting, water-lifting, etc. Early in 1978, the Ministry of Shipping and Transport funded a socio-economic survey of bullock-cart operations in the country, which is being conducted by NCAER in north India and IIMB in the south. Results should be available by the end of 1979. A similar proposal to conduct a comprehensive socio-economic survey of animal-owners and operations and technologies using animal energy is being submitted to the Department of Science and Technology. During the last two years, pilot studies were conducted in chosen areas in order to determine the parameters and indicators and quantify them and approach the study with hypotheses that can be legitimated and will give shape to the study.

16. Though not serviceable for scientific projections, observations and perceptions serve to provide a feel of the situation. Based on these, an *ad hoc* attempt is made below to quantify the freight carried by carts. The figures regarding load levels, the number of days of operation, and distances moved are typical averages derived from pilot studies. The limitations of sample data will not overly vitiate the qualitative conclusions as the assumptions represent only orders of magnitude and do not aim at precision.

PARAMETERS OF CART OPERATIONS: SOME ASSUMPTIONS

Quantities	In Predominantly	
	Rural Areas	Urban Areas
1. Carts (in millions)	12	3
2. Average freight (in tonnes)	$\frac{1}{2}$	$\frac{3}{4}$
3. Average distance per day (in km.)	10	20
4. Average number of days of use in year	52	260
	(One day per week)	(5 days per week)

TOTAL ROUTE-KILOMETRES

1. Freight carried by carts in rural areas	$12 \times \frac{1}{2} \times 10 \times 52 = 3{,}120$
2. Freight carried by carts in urban areas	$3 \times \frac{3}{4} \times 20 \times 260 = 11{,}700$
Total: 14,820 million tonne-km., say,	15,000

17. The number of carts in the country has been estimated at 15 millions—the majority of which is bullock-drawn. Their distribution between urban and rural areas has been taken as 12 and 3 millions respectively, based on the urbanization index, which is 20 per cent. Even if projection from limited sample data may not be proper, the broad conclusions that animal-drawn carts form an important part of the country's transport system cannot be gainsaid. Nor can the importance of animal energy for farming be questioned. Both these facts support the conclusion regarding the appropriateness of animal energy resources to the context and situation of our country. Rural development should not *ipso facto* mean reduced dependence on animal energy nor increased mechanization. As argued before, the country's animal energy resources are not being put to efficient use. The intention is that the socio-economic survey should show the way to better management and fuller utilization of animal energy.

The Potentialities of Animal Energy

18. The magnitude of animal energy available for exploitation and its potential for development have not been recognized or endorsed by policy-makers, planners, or professionals in India. Leading scientists have, however, attempted to assess the energy output of work cattle, which is dependent on breed, size, weight and nutrition levels. There are wide variations in size and weight from one part of the country to another. The Haryana bullock is perhaps double the small-statured breeds met with in some parts of south India. The male Murrah buffalo of north India is easily twice the size of the Surti found in the south. In the south itself, there are the Kangeyam, Ongole and Amritmahal bulls which compare favourably with the best-bred bullocks of north India. Draught power is known to be directly dependent on animal weight and feeding rates. Further tests should serve to identify other relevant variables that can also be controlled, such as the design of cart-powered implements, their power transmission systems and traction surfaces.

19. Successful scientific work of high quality is being done in our country for evolving better breeds of milch cattle. In the result, the country has evolved high-yielding milch cattle that can be reproduced without loss of quality. Though work cattle are equally important to our economy, they have not come in for the same measure of R & D attention. The work capacity of Indian breeds needs to be reinforced. Apart from dual breeds, the selective propagation and reinforcement of work characteristics and of animals exclusively for work purposes should be attempted as a part of programmed effort at development. A massive investment of funds in personnel and breeding and training centres would be necessary. But the benefits will surely be spectacular. Already China has raised a stock of 50 million buffaloes for use as work cattle; we have hardly eight millions. The male buffaloes of certain breeds make excellent draught animals. Their performance may be region-specific in some cases. It is nevertheless true that no institutional attempts are being made to increase the male buffalo population. It is said that male calves are killed off at birth, and many healthy one-year-olds are sent to slaughter-houses for a paltry consideration whereas, at the age of three years, they should fetch the owner a minimum

of Rs. 1,000. The work potential of buffaloes and methods of raising them form an important part of this project. The draught capacity of bullocks has been estimated to vary from 0.4 h.p. to 0.6 h.p. Individual breeds of bullocks and buffaloes may be capable of greater effort . In our calculations, we have opted for the safe average of 0.5 h.p. per animal. Studies done in the IIMB show that the figure for average draught capability may be higher. For example, two bullocks yoked together are able to put forth about 125 lb. of power, and are able to move at the rate of about three miles per hour. The energy output that can be attributed to this performance may exceed 0.5 h.p. For 80 million animals, the total work capacity will therefore be 0.5 × 80 million h.p. which roughly equals 30,000 megawatts of electrical energy. This still exceeds the current rates of production of electrical energy in this country.

20. To generate, distribute and to make available one kilowatt of electrical energy at the point of use, the investment called for may be about Rs. 10,000. To replace all animal energy in the country by electrical energy would therefore need a precedent investment of Rs. 30,000 crores. There are of course other factors which work to reduce the investment required for given work-loads. For instance, electrical motors can be worked longer hours than animals. More work can be accomplished with one horse-power of uninterrupted electrical power than with two animals. But India's farms are small and cannot avail themselves of these pure energy concentrates as population and consumption densities and utilization indices all tend to be low.

21. The maintenance cost of two animals and that of a corresponding electrical power source can also be compared. For the sake of simplicity, the power output of two animals can be assumed to be equivalent to one kilowatt of energy. During eight hours, eight units will be consumed, the cost of which may be (at the subsidized rate) roughly Rs. 1.75. Surely, two animals would cost more by way of maintenance, if fed with manufactured cattle feed. Green fodder is cheaper in the villages and if carefully chosen, can replace to some extent the dry concentrates. Most of the work-animals in the villages are farm fed. In practice, therefore, maintenance costs are lower.

22. Perhaps the investment in tractorization would afford a more appropriate comparison. (The speed and rates of operation are not critical in farm operations or even in transporting the kinds of produce now carried by the bullock-cart. Animal maintenance has to be paid for even when there is no work for the farm animals while electrical motors and tractors could be shut off at will and do not require maintenance during idle time. Therefore the comparison between animals on the one hand and other modes of energy cannot be carried through beyond a point.) Even with small holdings, tractors can be utilized efficiently and economically through tractor service stations or co-operatives which serve a large number of clients. Investments in the former do not pay off and the latter have not been too successful. Thanks to the organization input and the availability of infrastructure, it has been possible in Kerala to improve farming efficiency through some measure of tractorization. Also labour costs are high in Kerala and man competes with animal for the use of land. So the

animal has yielded place to the machine. But experience in Pakistan and some other countries shows that tractorization has not produced the desired results.

23. When there is no ploughing or carting to be done, other uses for the animal have to be found. The optimum use of animal energy will depend on an enlarged base of appropriate technology for power utilization and on the diversification of uses like milling, threshing, chaff-cutting, oil extraction, etc. When economic activity in the countryside quickens, transportation by carts will also receive a fillip. When the demand for carting increases, carts will be able to compete with trucks over short distances and so improve their utilization indices both in rural and urban areas.

24. Urban carts are already being utilized for most part of the year fairly intensively. They may to some extent in the coming years replace human labour. Furthermore, there is scope for producing more appropriate varieties of use- and terrain-specific carts.

25. Water, milk, kerosene, vegetables, beverages, cereals, edible oils, crockery and cutlery for parties, furniture, paper, construction materials and innumerable other goods are to be delivered to consumption or vending points, such as households, shops, hotels, offices, construction sites, educational institutions, cinema houses. Another classical instance is garbage collection and disposal, which ought really to be done at night and not during the day as at present. Here numerous collection points are involved and carts would be the ideal mode of transport. In fact, the bins can be so designed for loading on to stillions and containers, and the empties left in position by another relay of carts.

26. The suitability of the animal-drawn cart for this use is based on the following considerations:

— short traction distances
— frequent stops for loading and unloading which take relatively greater time
— speed is not important
— average loads in municipal and conservancy services fall below truck capacity
— numerous supply and distribution points can be reached at the same time
— the narrowness of roads and service lanes.

Improved Utilization

27. In spite of the lack of sufficient data, it can be asserted that animal energy is not being utilized optimally in the country. Improvement in the utilization of the existing capacity will lead to increased productivity and can be secured in the following ways:

— Increased number of days of use per year and number of hours per day without imposing an undue burden on the animal.

— Improved transmission efficiency.
— Improved designs of implements, yoked to the animal, for increasing efficiency in the application of animal energy.
— Improved breeds of cattle, further to augment draught capacity, and improved feeding regimen based on measured quantities of carbohydrates and digestible proteins.
— Increased working life of the animal.

Studies show that productivity is low on all these five counts and that there exists great scope for improvement.

27. The distribution of the 80 million work-animals as between rural and urban areas has been estimated as follows:

Animals	*In millions*		
	Total	Rural	Urban
1. Bullocks	70	65	5
2. Buffaloes	8	8	A small number
3. Horses	1	A small number	1
4. Camels	1	1	A small number
	80	74	6

28. These are rough and ready working estimates and are by no means precise. Data from the socio-economic sample survey would be normative of these, but here again, the planning of animal energy utilization is best done at district level.

29. Most of the work-animals are to be found in the rural areas (65 million bullocks and eight million buffaloes). Among these, say, 70 millions are used in farming operations — ploughing being the predominant form of use. Ploughing and other farming operations may take up about 100 days in a year, and carting about 50. This means that the animals are at present utilized for less than half the year. Those engaged exclusively in carting in the cities would be used more intensively but in the villages, the duration of use of the specialized draught animal would be less than that of a dual-purpose animal used both for ploughing and carting. Animals equivalent to 35 million horse-power of work remain idle according to this assumption. In money terms, this waste would amount to a colossal figure.

The following may improve utilization:

— increased use of animals through multiple-cropping practices
— the bringing of fallow land under cultivation
— new and alternative uses for animal energy.

R & D Leads

30. To achieve the objectives of improved utilization of animal energy, R & D efforts must be intensified along several directions all at once. The R & D leads could be identified at each stage of activity, starting from the generation of bio-energy by the animal right up to the utilization of energy in operations like ploughing and carting. R & D needs can be briefly summarized as below:

— Harnessing devices
— Improved animal-drawn implements
— Improved veterinary services
— Better animal care
— Improved breeding
— Improved designs of carts and other implements used in conjunction with the animal.

Harnessing Devices

31. Today, in India, ploughing is typically done by two animals (a bullock or a buffalo, and in certain parts of U.P., by a team consisting of a bullock and a buffalo) connected to a pull-beam. The present harnessing device, resting on the hump of the animal, entails a certain amount of transmission loss, and reduced efficiency. Studies are in progress in IIMB to investigate if transmission efficiency could be increased through a better harnessing device. The yoking system in use in south India for water-lifting, where animals walk down a ramp lifting basins of water from a well, (the water is then discharged into the water-course when the animal reaches the far end of the ramp) would admit of similar improvement. The animals then walk backwards returning the basin down to water level without using natural gravity. This walking backwards is wasteful. In the Persian Wheel, this is avoided, since the animal's effort is continuous and water is being lifted and discharged all the time, unlike in the case of vertical lifting, where work is done only during half the cycle. Likewise, the designs of implements used in threshing, grinding, and other operations can all be improved. Better designs of implements will increase the efficiency of transmission as well as the utilization of energy.

Improved Animal-drawn Implements

32. Work animals are mainly used for ploughing. Traditionally, India has used wooden ploughs, though iron and iron-clad ploughs are in use in some parts of the country. The Agriculture Departments of State Governments, the Agricultural Universities and Agro-Industries Corporations have been propagating improved versions of ploughs for nearly two decades now. ICRISAT, too, has been experimenting with improved designs and it has been claimed that, with some of the ploughs improved by them, it may be possible to double the amount of work done without any extra burden to the animal. ICRISAT's work is essentially in dry farming where, in view of the large areas involved, mechanization has had to be resorted to. It does not appear as if the same plough can be used for wet and dry lands. Improvement of plough design for increasing transmission and work efficiency would call for rather

greater R & D effort than has been forthcoming so far. In some of the Indian Ocean countries as well as in China, the harnessing devices used to yoke the work-animal to the plough or the cart resemble the horse harness more than the Indian yoke. Differential studies to determine relative efficiencies are very essential for this project. In a rather uncommon design of the plough, it was seen that the distance between the animal and the ploughshare was unusually great; *prima facie,* there obtains some correlation between this distance and the depth of ploughing. This means an unintended benefit for the animal: the man behind the plough cannot reach it for beating or whipping. The critical distance should really be the subject of testing in a variety of soil situations with a number of plough designs. Wouldn't standardization of this distance be better than variation? Much work has been done on the water-buffalo in China as evidenced by a manual and two recent books brought out by FAO on the subject. The Chinese have reportedly been able to get more power from water-buffaloes than we in India. Similar studies should be undertaken with bullocks and buffaloes in India, and it is necessary to build up an information system for a variety of uses.

33. Thus, there exists great scope to improve designs, thereby increasing the work efficiency of implements and the working life of animals. Also, new applications have to be found which will help the farmer to make better use of his animal resources.

Veterinary Services

34. India does not lack the manpower, even by western standards, for the science and technology of veterinary services. However, the present organization and infrastructure of the veterinary health care delivery system is believed by many to be inappropriate and insufficient. The system must be operational in its own way, but it has not been able to cater to the masses of cattle-owning farmers in the villages. A special study is needed to evolve a more effective structure of veterinary services appropriate for mass use and for delivery in far-flung outposts. Enlarging the network would only be part of the solution; a well thought-out management input to make the services expenditure-effective is also necessary. There is certainly a very good case for Primary Veterinary Health Centres.

Animal Care

35. Hindu taboos and the deification of the bull and cow as Nandi and Kamadhenu in the Pantheon notwithstanding, animals in India are underfed and neglected. Their health is poor. In fact, animal energy is a good example of the disarray met with in all segments of the non-organized sector in India. The first three years in the life of cattle are crucial for the development of work capability and the maximization of energy output. A countrywide study has to be made of practices for the rearing and work-training of cattle so that an institution can take over the care of calves especially those between the ages of one and three. It should also have a work training wing. The care of the animal during its working life is as important

as the crucial care in the formative years. In China, it has been found that the shoeing of water-buffaloes has reduced the incidence of foot diseases. In India, where buffaloes are used for ploughing and carting, care should be taken to design and develop hoof-shoes of the right sizes and suitable materials. The primitive methods of castrating and branding animals often cause needless pain and sepsis and certainly lead in some cases to the shortening of animal life. Scientific methods of branding and castrating animals, which represent further advances on practices now obtaining in State Veterinary Research and Health Care Centres, should be evolved. This will introduce a salutary measure of efficiency in animal management and will also obviate the need for punishment of work-animals.

Breed Development

36. Various factors relevant to work capability enter into genetic R & D like the body dimensions of the animal, the length of the working life of animals, energy-generating capacity, resistance to disease, etc. Breed development in India has been almost exclusively confined to milch animals and not much attention has been devoted to the task of evolving better work-animal. Experiments should be enlarged to include the exclusive upgrading of the work-animal stock and artificial insemination for enlarged work capability. Adaptive research on the raising of fodder crops which can be dovetailed into scientific crop rotation and which regenerate soil fertility and remedy specific shortages in soil should be commenced in district veterinary research centres. It may be possible in this manner qualitatively to improve the present cattle population and at the same time, increase the number of breeds without diminishing the total energy ouput.

Improved Animal-drawn Carts

37. About 80 per cent of the carts are located in the rural areas, and 50 per cent of the rural areas do not have roads. In most areas, it would not therefore be possible to tyrize carts. A part of the argument for the retention of the bullock-cart as a peerless instance of appropriate technology rests on the assumption that the animal cart can go even where there are no roads.

38. Other IIM-B projects on bullock-cart redesign have proposed that, while retaining the two traditional wheels of large diameter, they could be tyrized with hard rubber. Smooth bearings, reduced tare-weight and better harnessing devices would ensure the maximum possible comfort for the animal. A brake — a simple one, such as a wooden pole hung in the rear which, when brought up sharply against the wheel, impedes motion—would make for greater comfort for the animal and the benefit would be disproportionately greater than the cost. Today the animals are being used to stop the carts or even turn them, and tremendous stress is brought to bear on their necks for this purpose.

39. The present stock of traditional carts made of wood cannot, and will not, be discarded. The wood is carried forward from the old to the new carts. They can, and should be, upgraded piecemeal for better performance — with, say, smooth

bearings, a brake and a smoother yoke. The new carts could be manufactured using approved designs. This would mean a great deal of R & D work for redesign, sustained extension work, the provision of credit and the right kind of materials.

40. For cities and urban areas with paved roads, numerous combinations and types are being envisaged: single bullock, double bullock, three and four-wheelers, hard-rubber and pneumatic tyred wheels, different types of platforms to suit different kinds of produce, and a range of load-carrying capacities. Improved versions both for rural and urban use will definitely increase payload and reduce the burden on the animal. For the rural areas, the carts could be made lighter and smaller and hauled only with one animal, thereby effecting some cost-reduction and ensuring better animal care and maintenance. Increased payloads mean larger earning capacity, increased transport capability and above all, reduced exertion by the animal. In the villages, redesign can give an impetus to accelerated rural development, increasing employment and incomes. Higher earnings for the cartman may even mean better and more food for the animal, which is today grossly underfed in many cases. With the traditional cart, the cartman often starves the animal and puts sick animals to work. He is obliged to do this since a day's loss of carting would mean starvation for himself and his beast of burden. For he leads a marginal existence himself. With increased earnings, the animals can be better fed and rested leading in turn to a longer working life and enhanced draught capability. These socio-economic considerations have profound consequences for training work-animals for small and marginal farmers who cannot afford specialization in their work-cattle. These animals will be required to do a variety of chores about the farm.

41. The traditional yoking device chafes against the animal's neck. Most animals develop sore necks resulting in extreme cases in neck gall and cancer and their working lives are reduced thereby. A year of working life lost may cost the owner Rs. 100. On eight crore animals, the loss resulting from a single faulty element in the design would amount to Rs. 800 crores, over, say, ten years, or Rs. 80 crores per year.

42. Experiments on a two-piece yoke are afoot in IIMB and the prototype is largely similar to the device used in China on a single bullock and a single buffalo. In this design concept, one piece of the yoke rests on the saddle which takes the vertical load as well as the shock loads emanating from all directions. It also absorbs the stress resulting from braking and sharp turning. The second device (which is usually a slack rope) rests loosely on the hump but is engaged immediately as the animal goes forward. See photograph elsewhere in volume.

43. All vibrations are absorbed by the first yoke. As a result, the animal's skin on the neck is unaffected. A good design applicable alike to both single and double-animal harnessing systems will be a literal break-through. Among other criteria, a good design should be judged by the contribution it makes to the length of the working life of the animal and to animal comfort. Design trials are now on at IIMB.

44. In a project funded by the Department of Science and Technology, some improvements in design were achieved. The Institute has approached the Department as well as the Ministry of Shipping and Transport for additional funds to carry on more intensive design work. Countrywide interest has been evinced in our work since SAIL, the Syndicate Bank and the U.P. Government have all awarded prizes for the best animal-cart designs. The Dunlop Company brought out their improved cart version in the 'forties, the two essential features of which were tyrization and the addition of smooth bearings. These features increased cart capacity from two to three times. Firestone is now experimenting with solid rubber tyres which could be fitted on to larger-diameter steel or even wooden wheels. This would reduce rolling friction substantially while retaining the advantages of the traditional large-diameter wheel.

45. Other cruelty to animals owes to habit, custom and wrong attitudes. On the roads and fields, India's work-animals get about 5,000 million beatings a day. Their tails are twisted, and their undersides are prodded with sharp-ended sticks. In some places, their skin is bared, and the animal is goaded at that spot in order to make it go faster. Andhra Pradesh carts have dispensed with the rein-rope passed through the snout of the animal; this was another avoidable cruelty. The muted animals which become useless for man are marched off to slaughter-houses after having served him faithfully for years. Death to them is no deliverance, and they are literally hacked and maimed without a stunning device before they die writhing and wailing. The exception to this rule is to be found only in one or two slaughter-houses in India. Even in death, man would have his pound of flesh. He does nothing beyond feeding them and that for the most blatant reasons of self-interest.

Conclusions

46. There is under-utilization of animal energy resources due to low transmission efficiency in animal-using implements. Farms in India are desperately in need of extra energy, which cannot be readily obtained from alternative fossil or hydel sources at prices which small farmers can afford. This paper does not argue for the retention of animal energy as a perennial source, but it does point to its contemporary appropriateness to India's context and situation. The case made out for animal energy here is a low-profile one.

47. The simultaneous increase in use of animals and the replacement of animal energy by trucks and tractors will continue as long as there is unsatisfied transport demand, but the problem has to be studied in depth from the technical, social and economic standpoints. R & D of animal energy, commercial manufacturing operations and distribution procedures will all come in for review against animal energy perspectives. This paper has attempted merely to assess the orders of magnitude involved in animal energy, both demand and supply, and its distribution amongst sectors of application. But for action-oriented redesign work, figures from a socio-economic survey would be essential.

48. Given the figures, simple arithmetical exercises should serve to define economic relations between man and animal, and animal and other forms of energy. Cost-benefit analyses, the break-even point at which animal energy can replace other forms of energy, the number and cost of tractors and trucks that would be hypothetically required to replace animal energy on the farms and roads can also be worked out from that data. The orders of magnitude are sufficiently impressive. It can be asserted safely that animal energy is appropriate to India due to the number of reasons set forth in this paper.

Animal Energy Development Corporation

49. Accordingly, it is proposed that an Animal Energy Development Corporation be set up immediately for the co-ordinated development and management of animal energy resources in the country. (Objectives and functions have been postulated for it in the following paper.) To initiate and fund research on, and training in, the socio-economic aspects of bio-energy utilization, it is proposed that an Animal Energy Institute be set up as an adjunct to the Corporation. As animal energy is appropriate to the needs of most other developing countries besides India, the activities of the Institute will have international relevance. This proposal accords well with the adumbrated policies of UN agencies, such as the FAO, ESCAP, UNIDO and the World Bank.

50. The Corporation will advise the Central and State Governments on the co-ordinated development and use of animal energy resources. It will extend financial support to institutions engaged in research on the development of animal energy resources. It will lay down norms and standards for manufacturers of improved agricultural implements and animal feed. It will offer improved designs of whole implements for exploitation or of parts thereof which are crucial for development. It will ensure the distribution of these at points of consumption as desired. The Corporation will also take up extension and education activities in villages and will organize training, retraining and functional literacy programmes for craftsmen involved in the repair, maintenance and manufacture of animal-powered and animal-based agricultural implements. In essence, the Corporation will form the central nervous system of all animal energy activity. Economists, design and metallurgical engineers, communication specialists, operation researchers and social scientists can all collaborate in the day-to-day functioning of this Institute.

NOTE

1. The calculation of the average energy output (in horse-power) by a work-animal hitched to a cart is based on the formula: Energy output in h.p. = Draw-bar pull × distance moved per second ÷ 550 ft./second. Tests have shown that a pair of bullocks yoked to a traditional double-draft cart exerts 90 to 195 lb. of pull in order to move one tonne of load at about 3 m.p.h. The natural speed of the animals is two to three miles per hour along a level surface. Pneumatic-tyred carts can carry

as much as three tonnes, but this figure is usually realized only on concrete or macadamized surfaces. The pull effort at the draw-bar and the speed of the cart can be taken to be about the same. In the calculation below, 50 Kg. (50×2.2 lb) which is an empirical figure is taken to be the draught capacity of a single bullock in a single harness cart. The same value for a single animal derived from a double harness cart works out to rather less than 50 Kg. because of transmission losses due to inefficient yoking Taking the mid-point of pull and speed for calculation, the following value for draught is obtained for one animal

$$\frac{2.2 \times 50 \times 2.5 \times 5280}{550 \times 3600} = 0.6 \text{ h.p.}$$

It was argued earlier that the redesign exercises did not seek to maximise the speed of the cart, It follows therefore that it should ideally be possible for the cartman to increase weight of the freight by 20 per cent if he decides to drive the cart at an average speed of 2.5 m.p.h. over long distances rather than, say, at 3. m.p.h.—without bringing to bear any extra stress on the animal.

2. The energy output actually ranges between 0.4 to 0.8 h.p. For purposes of aggregate calculation, a lower figure of 0.5 h.p. has been taken. The figure is somewhat higher than averages assumed by ICAR veterinarian researches. This paper would urge at least two considerations which suggest an upward modification of that figure. Animal-powered implements have been substantially if partially improved during the last few decades, and horse-power ratings should accordingly be increased Also, the draught effort in the ICAR Survey (1958-60) was found to vary from about 90 to 195 lb. The steady output of energy over extended periods of time will naturally be smaller and it would be safe to assume a less-than-average draught of 120 lb. for a pair of bullocks. And then there is the further question as to what the safe and permissible effort wwuld be for any given animal over a period of time.

3. Assuming the same figure for all the 80 million work-animals, they would yield 40 million h.p. which is equal approximately to 30 million mw. or 30,000 million kilowatts of electrical energy. While negotiating slushy terrain, a gradient, or passing over potholes or depressions on the road surface, etc., animals have to put forth much greater amounts of energy.

4. The above tests are crude. Scientific tests to measure the capacity of traditional carts and their performance under different conditions of freight and terrain and the result of improved components are yet to be conducted. The NAL at Bangalore is designing a testing rig for simultaneous multi-variate testing of carts.

TEST DATA FOR CARTS

PARTICULARS OF CART	SPEED OF CART IN Kms./Hr	KIND AND CONDITION OF ROAD	DRAUGHT FOR PULLING CART				H.P. REQUIRED FOR PARKING CART		REMARKS
			EMPTY		LADEN				
			EMPTY CART Kg.	DRAFT Kg.	LADEN CART Kg.	DRAFT Kg.	EMPTY CART	LADEN CART	
RURAL USE CARTS WITH LARGE WHEEL DIAMETER & NARROW RIMS	3·25	KATCHA	250/325	32	1008	60	0·42	0·70	LOCAL CRAFTSMEN BUILT CART
	4·00	PUCCA	250/325	20	1008	30	0·39	0·50	
SEMI URBAN USE CARTS FITTED WITH PNEUMATIC WHEELS OF SIZES	$3\frac{1}{2}$	PUCCA	350/425	10/14	1000/1500	20/38	0·25	3·5	—,,—
URBAN USE CARTS FITTED WITH AUTOMOBILE DISCARDED TYRES OF SIZE 8·25/20 OR 9·00/20 SIZE PNEUMATIC	$3\frac{1}{2}$	ASPHALTED OR CONCRETED	450/500	12/20	1200/3000	35/120	0·35	3·0	—,,—

A NOTE ON THE PROPOSED ANIMAL ENERGY DEVELOPMENT CORPORATION

1. For the co-ordinated development, management and utilization of the animal energy resources of this country, upon which the rural economy largely depends, it is proposed that the Government of India establish a Corporation to be named the Animal Energy Development Corporation (AEDC) during the period of the Sixth Five Year Plan. There is need to promote action-oriented research activity on animals and on the uses of animal energy. Research attention should begin at birth and continue to the end of the animal's life. Admittedly, some work is being done on various aspects of bio-energy utilization. Such activities have to be planned and co-ordinated centrally, and implementation should be intensified. This agency should itself engage in research work and also promote research by other agencies. The organization and extension inputs are particularly vital. Such an organization would carry out policy and operations research to provide data support for various institutions — private, voluntary and governmental.

2. Here are some of the activities that may be postulated for the proposed agency:

(*a*) the redesign of carts, implements, tools and machinery using animal power;

(*b*) extension work through mass media, documentaries, posters, children's books;

(*c*) the manufacture of improved and standardized versions of animal-drawn carts, accessories, implements and machinery;

(*d*) the provision of credit all over the country for the use of improved and standardized designs of animal-powered implements;

(*e*) software research on organization, credit, user acceptance, training, extension, etc., also in order to establish the machinery for enforcing existing laws as bearing on the wastage of animal-power; and

(*f*) the codification of existing laws and the enactment of new ones in order to prevent the abuse of animal-power and cruelty to animals.

3. A number of ministries, departments and agencies of the Central and State Governments would be directly or indirectly concerned with the objectives and functions postulated for it. However, since animal energy is used for the most part in the agriculture and rural development sectors, it is suggested that the Corporation be set up under the administrative surveillance of the Ministry of Agriculture of the Government of India.

4. The projected Corporation, then, would co-ordinate, fund, study, regulate and support various aspects of the development, management and utilization of animal energy resources in the country.

5. Specific functions, such as education, training, research and management consultancy, should, however, be identified and entrusted to a separate Institute for Animal Energy which will form an adjunct to the Corporation. Given the high world prices payable for crude oil and taking into account the capital costs of alternative sources of energy, such as thermal and hydel power, research in animal energy holds out great promise for India and developing countries generally. The work of the Institute will be of international significance because animal energy will continue to play a dominant and crucial role in the growth of developing countries for many years to come. It is even possible that the United Nations and international agencies, such as the Food and Agriculture Organization, the World Bank and others, might evince interest in assisting the growth of the proposed Institute. The development of linkages and the exchange of research results and information with other Third World countries would be another important function of the Institute.

6. A number of R & D institutions, the Dairy Development Corporations, the Veterinary Research Institutes of the State Governments as well as a large number of public and private sector undertakings are directly concerned with the utilization of animal energy resources. The proposed Corporation would first survey the status of animal energy utilization in the country and recommend to the appropriate departments and ministries the steps necessary to ensure the optimal utilization and management of animal energy in the country.

7. The activities of the Corporation may be conceived under the following seven heads. These functions will not be mutually exclusive and the categorization does not preclude some overlapping and areas of common interest. Indeed, a considerable amount of interaction is envisaged and the procedures will as a rule be inter-disciplinary. Each division will be primarily concerned with studies, surveys, the identification of gaps in R & D and in the evolution of action-oriented region- and case-specific procedures. The seven divisions will relate to:

(*a*) Breed Development
(*b*) Veterinary Health Care
(*c*) Socio-economic Studies
(*d*) Energy Utilization
(*e*) Animal Feed
(*f*) Infrastructure for Animal Energy, and the
(*g*) Design and Manufacture of Agricultural Implements, Components and Spares.

Breed Development

8. In relation to the human beings and plants in the ecology, the 80 million work-animals in this country constitute an over-population. Although attempts

have been made in the past to eliminate scrub and inferior cattle, and upgrade existing stock, this has been done with a view to increasing milk yields. Also, there has been no significant effort towards the development of work and climate-specific breeds. The great variety of geophysical conditions obtaining in this country causes great changes in animal behaviour and imposes varying constraints on the energy input required for farming. The first need is survey and documentation: breeds and breed characteristics, body weight, physiological characteristics, work capability, versatility or aptitude for work specialization, feeding habits and correlation between these and the occurrence and development of region-specific grasses; folk habits in the rearing and work-training of animals; susceptibility and resistance to disease, and their health care based on indigenous systems of medicine. The functionality of local breeds for work purposes, the specifically milch and work breeds, the work performance of thoroughbred stock and dual-purpose animals will also form the subject-matter of the survey. The findings of the various agencies and institutions of the Central and State Governments will be pressed into service for the management of action programmes. The Breed Development Division of the Corporation would pursue R & D leads, and co-ordinate and monitor research programmes. This would to some extent be the function of the AEDC itself, and not its divisions although their advice would be valuable.

Veterinary Health Care

9. Though India has a reasonably well-developed network of major and minor veterinary health care centres and dispensaries, the health of the average work-animal tends to be poor. The Veterinary Health Division will make quantitative and qualitative analyses of the present structure and function of the health services available for animals in India.

10. It will also address itself to the task of surveying the skilled veterinary personnel available in the States and the number and quality of recruits required to man countrywide Primary Health Centres for the care and treatment of dairy cattle and work-animals. For this purpose, the survey will also generate a complete picture of the veterinary services available in various regions of the country and for various types of work-animals. It will study the felt needs of animal-owners and study the region-specific incidence of diseases and epidemics among cattle. It will also work out nutritional norms based on local availabilities.

Socio-economic Studies

11. The Economics Division will be concerned with studies on the socio-economic aspects of the use of animal energy. It will make quantitative studies on the costs of maintenance, including that of shelter, feed and health care and the treatment of diseases. From the point of view of the demand for rural transportation and the costs thereof, the Socio-economic Division would conduct studies on the suitability of the 25 prototypes or so available for particular uses and preferences. The Division will essay a project-based approach to the economic utilization of by-

products from slaughter-houses, such as bone, skin, and flesh. It will undertake periodic censuses of cattle referred to earlier as well as countrywide surveys of socio-economic conditions of animal energy exploitation with special reference to the owners of these animals. Some of the work of funding extension and research will also devolve on it.

Utilization

12. Animals are used in India for a large number of purposes. They are used, principally and for the bulk of the time, for ploughing, carting or providing power for agricultural implements, for water-lifting, for extracting oil from oil-seeds and crushing sugar-cane. The Utilization Division would undertake studies on the appropriateness of each of these existing technologies, intermediate as well as advanced, and using animal energy. It will study the use of animal power for emergent intermediate technology applications, such as a seed-and-fertilizer drill or a mould-board, harrow or disc-plough and devices for shaping and levelling arable land.

13. Available figures suggest that the bulk of the aggregate quantum of animal energy available for farming is used for purposes of ploughing before sowing. In many villages, however, a number of small farmers have combined to hire tractors for the joint ploughing of their fields; this has moreover been found to be less time-consuming and more economical. There is everything to be said for reducing costs to small and marginal farmers; but the findings here are not conclusive. Most of these farmers are probably still obliged to keep animals—just one or a pair of them for a variety of other uses about the farm. The Socio-economic Division of the AEDC will work out the relative economics of these two methods and suggest alternative means by which the Agro-Industries Corporations and veterinary institutions can hire out pairs of multi-purpose animals at a daily rate to farmers for short durations. The sharing out of animal energy as between indigent farmers, who cannot afford their own animals, can also be attempted through the AEDC Centres or the State Agro-Industries Corporations in the same manner as tractor services are sold on a custom-hire basis to a number of consumers.

14. Based on its own findings, the AE Division will take up R & D activities aimed at the development of technologies for more efficient utilization. It would explore possibilities of the diversified use of animal energy so that the latter could be used for entirely new purposes not hitherto contemplated. This Division would take up research work on the identification of injuries and impairment of working capacity caused to work animals through unscientific methods of branding, shoeing, castrating, roping, yoking, etc. In both cases, the objective should be to increase the working life of the animal and with this end in view, to secure the best possible fitment between animal and implement. The avoidance of palpable cruelty is the first method by which the economics of animal energy utilization can be secured.

15. A major aspect of the Utilization Division's work will relate to the development of modified designs of animal-drawn implements and carts to be manufactured

under the overall guidance of the Corporation. The Corporation will use the production facilities existing in the country to propagate the new designs and improved components or will itself engage in the direct production of components of desirable designs such as a yoke-*cum*-harness. It will also, in consultation with the appropriate bodies, lay down norms and standards in the interests of safety to roads and animals. Cart dimensions and the use of materials will also come in for regulation in the furtherance of overall programme objectives.

16. The Corporation will operate training centres for work-animals in different parts of the country to train them for work with various improved models of implements and carts chosen from the region. The improvement of existing carts through the progressive upgrading of disaggregated components will be attempted on the basis of such work. Wherever district dairying ventures have sprung up, these will be associated with the rearing and training of male calves between the ages of one and three. Facilities for veterinary care and treatment will also be pooled.

Animal Feed

17. The Feed Division will undertake a survey of the existing practices of producing and consuming processed and fortified feeds. Feasibility studies for the starting of cottage-level industries using local resources will also be undertaken.

18. The Division will study the impact of the quantity and quality of feed on the power output and working life of the animal—both green grasses and fodder locally available as well as dry concentrates for which a money price has to be paid. The availability of pasture land is a crucial factor in animal feeding and this Division will also develop an appropriate land-use policy in consultation with the Grassland Research Institute in Jhansi. Fresh enclosure of land for pasture may not be feasible in many villages due to over-population of both man and animal. In such cases, where the local demand and use patterns of work-animals warrant it, and where a money price is actually paid for local grasses, region-specific fodder should be raised as a second or third crop. The Corporation will formulate action programmes for co-ordinating the incentives already being provided for this purpose. It will take up studies on the relationship of feed with the production of beef and the quality of skin for various uses. It will co-ordinate the activities of private manufacturers and public sector agencies in the area of cattle-feed manufacture.

Infrastructure Development

19. Animals provide the bulk of the motive power in the rural economy. The optimized utilization of animal power depends on the formation of well-organized infrastructure throughout the villages of India. In order to be successful, infrastructure requires bank credit for the purchase of carts and animals, the standardized manufacture of well-designed agricultural implements, the delivery of veterinary health care at the farm and the production and distribution of feed to the animals. Farming experiments to intensify the production of cheaper fodder and cost reduction in the making of dry concentrates are necessary. In the villages, where animals are

farm-fed, most owners cannot afford bought-out concentrates. The assignation of village lands between pasture and second or third green fodder crops will have to be planned as part of infrastructure activity. In all these cases, existing knowledge, facilities, and institutions would be drawn upon and the maximum possible use made of them. The objective is not to displace these but to use them more fully in the interests of increasing incomes and employment in the villages. Safe and standardized procedures for shoeing, castration and the repair and maintenance of newly designed carts should be provided for groups of villages where such facilities do not already exist. Where the amenities exist, the craftsmen should be retrained in the new technologies or artifices for repair and maintenance.

Manufacturing

20. For the efficient and increased utilization of animal energy, it is necessary to systematize and regulate the manufacture of various animal-drawn implements and carts throughout the country. The research activities of the Utilization Division could be extended to cover the manufacture of more apposite agricultural implements. The Corporation would not normally take up the responsibility of direct manufacture but suggest designs, control and regulate manufacture in the private, public or the joint sectors throughout India. If necessary, however, the Corporation may take up the direct manufacture of parts like the yoke or harness or a yoke-*cum*-harness and other items not covered by improvements essayed by private manufacturers of components. The Agro-Industries Corporations under the administrative control of the State Governments will also be pressed into service for production and distribution purposes as feasible and necessary. This Division would further ensure the continuous and systematic distribution of the items manufactured under its control at prices which will especially benefit small and marginal farmers.

21. Rural roads are less directly related to the utilization of animal energy save in the case of animal-powered transportation. Design improvements were effected during the 'forties of this century on the assumption that the improved carts would traverse prepared or paved surfaces. The bulk of the benefits deriving from tyrization was based on this proposition. However, it is in moving freight along *kutcha* roads and field tracks that the animal-drawn cart comes into its own and is in fact peerless.

22. Latter-day designs have returned to the large-diameter wheel fitted with a cap tyre which makes it possible for the cart to negotiate all kinds of traction surfaces available in the villages. Any design now made especially for roadless conditions will be able to stand up to competition from motorized vehicles over a longer time. However, rural roads are required to promote the exchange of goods of rural and urban origin and enable farmers to produce marketable surpluses and so to increase the duration of gainful employment and incomes. Animal-powered carts have an important role to play in the fulfilment of this objective. Redesigned animal-drawn carts should be used to foster an autonomous rural transport sector based on intra-

village, inter-village, and village-town traffic. This process must derive strength from increasing farm production and a resultant access in the exchange of goods between towns and villages. Increased production and exchange will serve to monetize operations to a greater degree, and it is only in this manner that differentiated rural activity can be accentuated in the villages which, after all, is what constitutes rural development.

PROJECT DETAILS

In the Appendix, projects for typical research, development, survey, and infrastructure development are proposed. The list is far from exhaustive, and much work has already been done by the ICAR and the State Veterinary Research Institutes. This work is region-specific and must be extended to the rest of the country. Again, the findings have not been conclusive or generalized enough and have in any case not been available for implement redesign work.

(*a*) *Breed Development*

(i) Cattle census: sex, breed and age-groups; reproduction rates; details of stray, uncared for cattle and population slaughtered before the age of ten; studies to bring about reductions in natural reproduction rates; studies progressively to eliminate stray and sub-standard cattle. Meetings with, and studies of the work of, professional breeders.

(ii) Physical characteristics of dominant breeds.

(iii) The geographical distribution of thoroughbred and crossbred stocks in relation to work needs;

(iv) Typical merits and weaknesses of various breeds;

(v) R & D leads for breeding out and eliminating above weaknesses.

(vi) Data for genetic work in order to reinforce draught, or work output, and the correlation of draught and work capacity with breed and age.

(vii) Slaughter-house practices and the economics of utilization of animal products by the pharmaceutical and leather-using industries; and

(viii) The distribution of work-animal time as between ploughing, carting, water-lifting, oil-extracting, etc., with a view to establishing correlations between breed and work aptitude.

(*b*) *Veterinary Health Care*

(i) A study of the availability of veterinary health care to animal-owners, based both on western and indigenous systems of medicine.

(ii) Cost and appropriateness of veterinary health care, and the commitment of the health-care personnel to their tasks.

(iii) Feasibility data for establishing Animal Health Care Centres.

(iv) Study of traditional methods of health care in India and the means of incorporating proven remedies and procedures in State-run centres.

(*c*) *Socio-economic Studies*

(i) Analyses of relative costs of production—animal energy *vis-a-vis* other forms of energy. Imputed costs of the rearing and work-training of calves between the ages of one and three and that of the maintenance of farm-based work-animals and superannuated animals put out to pasture.

(ii) The enumeration of specific empirical advantages of using animal energy in preference to other energy forms as derived from field studies.

(iii) An analysis of the socio-economic feasibility of providing improved feed; proper shelter; adequate health protection; of institutionalizing the feeding, breeding and training of work-animals; of introducing artificial insemination procedures to produce work-animals with desired characteristics.

(iv) A feasibility study for the AEDC and the economics of investing it with production and revenue-earning functions and its relation to the work of the Central and State Veterinary Research Farms and the Agricultural Engineering Institute at Bhopal.

(v) A futurological survey on the preferability of animal energy to fossil fuels on ecological and socio-economic grounds: the duration over which the assumptions would hold good. Studies on the techno-economic feasibility of improved carts and implements. Studies to determine the metallurgical quality and functionality of designs of agricultural implements and the desirability of using steel or other metals and alloys including plastic in place of wood; ensuring feed-back from the art of the village blacksmith particularly in the use of scrap metal and customer-oriented services while upgrading the technology content of his art.

(*d*) *Utilization*

(i) The design and development of more efficient and appropriate technologies for using animal draught in mechanical systems like ploughs, carts, etc., and the devising of new implements, such as seed-drills and weeders, which will mechanize an increasing number of farm operations.

(ii) The design and development of standardized items like hoof-shoes.

(iii) The development of hoof-shoes and nails for buffaloes.

(iv) The modernization of slaughter-house practices.

(v) The design and development of better load-bearing systems for animal-using implements.

(*e*) *Animal Feed*

(i) The identification of proper feed quality and quantity for different types of animals at different ages and in different parts of the country.

(ii) Fostering maximum utilization of local and natural raw materials for feeding, particularly grasses. Exploring the utilization of food industry wastes, such as molasses, for enriching cattle feed.

(iii) The identification of gaps in (ii) above and the development of processed feed for manufacture in rural industrial establishments.

(iv) The effect of quality and quantity of feed on the working life and work capacity of animals. Similar studies have already been conducted regarding the lactation cycles of dairy cattle. An integrated study on the economics of dairying and work-cattle utilization.

(v) Ensuring strict quality control of processed animal feed and, simultaneously, its easy availability.

(vi) The development of special feeds for supplemental foods of various types during the formative years in the life of work-animals.

(*f*) *Infrastructure*

(i) The setting up of executive agencies of AEDC at district or block level to implement its plans. Extension services development for enhanced use of animal feed, work training and health care as recommended by the Corporation and its Divisions.

(ii) The provision of training and guidance to rural craftsmen in the manufacture of the modified and developed designs of carts and agricultural implements, etc. Retraining and functional literacy for craftsmen and animal-owners.

(iii) Ensuring easy availability of bank loans for the purchase of animals, improved implements and carts.

(iv) Ensuring quick and easy distribution of animal feed, hoof-shoes, modified implements, carts, etc.

(v) The development of animal care units to ensure the healthy growth of animals during the first three formative years. Integration of these with dairying arrangements at district level.

(vi) Extension of veterinary health care to the field.

(vii) Ensuring inputs from the field and feed-back to fill R & D gaps.

(viii) Funding, fostering and farming out of research on animal sciences to Universities and institutions engaged in social sciences and animal sciences research.

(g) *Manufacturing*

(i) The identification of agencies for the manufacture of animal feeds: individual entrepreneurs, co-operatives, and panchayat bodies.

(ii) Quality and quantity of modified agricultural implements and components, etc., to be manufactured by individual entrepreneurs. Filling of gaps in production plans through State effort in design, the procurement of materials and products.

(iii) Transfer to manufacturers of R & D inputs mentioned in (i) & (ii) above developed at the Animal Energy Research Institute.

(iv) Research in design and materials both as relating to cost and strength. Formulation of projects for the wood research institute as concerning the structural use of wood in animal-powered implements.

COMPARISION OF INVESTMENTS IN AND LOADS CARRIED BY DIFFERENT MODES OF TRANSPORT

Transport System	Investment in Rs. Crores	Load Carried In Billion Tonne-kilometres
Bullock-cart	3,000	18
Truck	2,500	100
Railways	4,000	200

GROWTH OF ANIMAL-DRAWN CARTS IN INDIA

Year	Number in Millions
1947 Vagh's figure	8.0
1956	11.0
1961	12.1
1966	12.7
1975*	14.0
1978*	15.0

*Estimated

INCREASING ANIMAL PRODUCTIVITY AND REDUCING CRUELTY TO WORK-ANIMALS

1. During the last few years, I have been advocating, and working on, the modernization of the bullock-cart system. This has possibly spread the impression that I am striving to retain the antiquated bullock-cart — an anachronism in modern India, which has already designed and manufactured aircraft, the Aryabhatta and even computers. This is a retrograde proposal, it is contended, particularly as India has further progressed so that she today has the third largest scientific and technical man-power in the world. For different reasons, animal-lovers — unable to withstand the plight of animals — have been fondly hoping that these carts would somehow disappear from the Indian scene. They are worried lest my ideas should lead to the perpetuation of these carts, which means continued suffering for the animals. Meanwhile, the drivers of fast vehicles on the highways curse and swear at the carts to their heart's content, as their free and fast movement is impeded by these slow-moving curios. If these people had their way, they would keep this relic from the past off the roads. As long as the cow-slaughter-*wallahs* and the bullock carts remain in India, — the argument runs — the country can have no hope of progress.

Need of Animal Power

2. Let me state my position here unequivocally. I, too, dream of eliminating the use of animals in the drawing of carts, ploughs and other farm equipment. If I had Alladin's Lamp, I should replace these carts with trucks and tractors. What a relief it would be to see our roads and farms free of these animals, now ill used by the beast in man! But, alas! This is wishful thinking. While we lay claim to achieving miracles, it is simply not possible to eliminate animal power in the foreseeable future. If prayer would serve, I would even pray for hastening this process of elimination. This result is unlikely, however, to come about for economic reasons. We have therefore to persist with animal power for many years to come. Why not, then, re-order the system so that the country can get more out of it and help its cartmen as well as its suffering animals? To those who argue that the suffering of animals in harness is by itself an argument for their elimination — whatever the economic consequences — my reply would be that there is no way of getting rid of the carts immediately. Therefore, redesigning the cart is a more realistic way of relieving animal suffering.

Types of Cruelty

3. One of the main objectives of modernization, then, is to reduce cruelty to animals. One kind of cruelty is quite independent of the cart itself, such as the crude

methods employed for branding and castration, savage methods of slaughter, whipping and beating. All this can be stopped only through education, propaganda and the induction of veterinary services and scientific and humane slaughter-houses. The other kind is to be ascribed to the present unscientific design of the cart and has to do with the unsatisfactory fitment between it and the animal. In our society, the Economic Man is still more important than the Political Man or the Cultural Man. To ensure maximum profit from carting, the owner or driver *would* starve the animal and overload it. Carts are manufactured in their hundreds by ill-equipped carpenters and wheel-wrights in the non-organized sector. There is no standardization of materials or of design. Concepts of manufacture are crude in many ways. The net result is that animals are put to untold and needless suffering. It is necessary to return to the cruelties inflicted on the animals and the reasons for each kind because this paper deals with that subject. Meanwhile, the role of animal power in the Indian economy must be emphasized because it is the economic viability of animal power that makes it at all possible for organizing the kind treatment of animals.

4. Though this paper is on work-cattle, design improvements and certain kinds of cruelty pertain to bullock-carts only. The term "bullock-cart" is here used to denote not only bullock-drawn devices but buffalo-carts also. It is necessary to redesign so as to improve other farm implements as well, such as the *ghani*, the plough and the Persian Wheel—again, in order to get more out of the animal that supplies the power and also ensure its humane use. Unless the redesign concept were generally extended to other farm implements, the fuller utilization of animal power through the better treatment of these beasts of burden would become impossible of realization.

Economics of Animal Power

5. There are around 80 million work-cattle in the country — 70 million bullocks and eight million buffaloes. Besides, there are a million horses and an equal number of camels. According to rough estimates, all these together provide about 40 million h.p. of energy; but nothing more precise is being attempted than an idea in outline of the magnitudes involved. Work-cattle provide about two-thirds of all the energy available on the farm. In order to maximize returns from farming, the optimal energy availability will have to be doubled. NDRC researchers have come out with the remarkable finding that agricultural production in our country has suffered on account of an acute energy shortage on the farm, the shortfall being a third to one half of the present levels of energy utilization. There is no possibility of augmenting other forms of energy to any appreciable extent in the near future. Therefore, cattle must continue to provide the energy needed on our farms for a variety of uses over many years to come. Though no clear estimates are available, the bulk of the farmers are using work cattle for drawing carts as well. Besides, in the cities and towns, a large number of bullocks are used exclusively for drawing carts.

6. Another rough estimate has it that there are about 15 million animal-drawn carts in the country. The indications are that the number is still increasing

except in two or three States. Most of these carts are bullock drawn. In northern India, buffaloes are being increasingly used for ploughing and drawing carts. Horse-drawn carts are popular particularly in the smaller towns, while camels are used in Rajasthan and in some parts of Haryana and Gujarat.

Bullock-cart in the Indian Economy

7. First of all, the investment in the bullock-cart system, including the animals, is of the order of Rs. 3,000 crores. About 20 million people are employed in the system — part time or full time, directly or indirectly. It is estimated that the bulk of the rural produce is carried to the *mundis* in bullock-carts; and so are the inputs originating in towns and bound for the farms and rural households. In some regions, carts are also used for passenger transportation. Carts figure in intra-village transportation, in traffic between village and village, and between village and town. Where road-length per square kilometer or thousand of population served is low, the bullock-cart still remains the only feasible method of carrying goods and people.

8. Only about 50 per cent of our villages have paved roads on which trucks can ply. Freight carried by carts is far too small and therefore uneconomical for trucks and tractors. Also, the distance over which these are moved is too short. The low average freight in the rural areas is at once the rationale of the bullock-cart and a constraint on the financing of the redesigning. In most cases, where carts are used, the loading and unloading operations take up the bulk of the time, and transporting time is relatively small. In such cases, trucks are ruled out. Therefore, for short distances, carts are most economical. Furthermore, the cost of petroleum has risen so high that bullock-carts are bound to reclaim some of the load being at present carried by trucks. We require our limited oil resources for other more important uses. The worldwide oil crisis is another reason then why bullock-carts should have a fresh charter and an added lease of life. Animal-lovers would be disappointed; but there is no doing without the work-animal in the near future. Instead, the country must set about the task of getting the utmost bio-energy from its animal population in a manner that is also humane.

Wastage

9. Let us now look at the system as it exists today. Due to defects in design and manufacture, the cart can only use half the output of energy by the animal. In itself, this is an enormous loss and must add up to a few million horse-power. In the past, isolated experiments were undoubtedly conducted towards improving the carts, the results of which show that cart capacity could be easily doubled without in any way imposing an extra burden on the animal. Even assuming that 20 of the 80 millions are used to pull carts, the loss in draught effort may be of the order of three to four million horse-power. The wasted effort shortens the animal's life, and the fodder it consumes is almost directly proportional to this effort. By inference, the wasted draught effort must be worth crores of rupees.

Cart Economics and the Animal

10. With improved designs, the effort required by the animals for the same load can be reduced to one half. Redesign will thus not only attempt extension of capacity but press into service smaller animals which can be used to haul smaller payloads — often the only ones available in the villages. Such redesigned carts will, however, have to be cheaper than the traditional ones if they are to win the farmer's favour and catch his fancy. This would straightaway mean that animals will work comfortably and without impairment of health while pulling the same load and need not struggle as they do today. Animals will live and work longer. Due to the poor design, the carrying capacity of the cart is low today; therefore the earnings are low. The carts are moreover only an adjunct to farming which is the principal operation. In most farms, animals are compulsory for ploughing but returns attributable to animal use in carting are marginal. The economics of carting operates in a peculiar fashion for, if the cart were not there, the farmer would have to pay an inordinately high price for obtaining its use on hire. He simply could not afford it. Improved design will help operations to break even while incomes increase simultaneously. The employment potential of the bullock-cart is greater than that of the trucks which are themselves employment-intensive. Slowly, an autonomous rural transport sector will emerge and help to diversify the rural economy now dependent heavily on farming. This is an important long-term macro-objective for bullock-cart redesign.

11. In towns and cities, the level of earnings and utilization of capacity are rather better but the scope and need for improvement are as great — and for the same reasons. As the cartman himself earns very little, he cannot afford to be fair to the animals. He overloads his cart and works the animals for longer hours for extra money. By doing so, he is really living off his capital and does not know it. He works the animals even while they are sick as he cannot afford to keep the cart idle. A day off the road may mean that he and his family go hungry that day. Even as things are, the city animals do not get enough by way of feed. On a lean day, they get less. When the design is improved so as to augment capacity, the cart-owner's earnings will automatically go up. Hopefully, a more prosperous cart-owner may be kinder to the animals. He would not overload them and overstretch their capacity for distance as he does today. If he is able to save money after meeting his expenses, he may even deign to rest the animals.

Design Improvements

12. When the design improvements are effected in a majority of carts, the bulk of the 80 million animals will straightaway benefit — each in some measure. Contemporary modes of cruelty by way of underfeeding, overloading, and overworking, the drafting of sick cattle to work will, hopefully, be somewhat mitigated. The animals will benefit, thanks to the vastly reduced effort that will be required for pulling the same loads. Design improvements proposed are such that the animals will always be left with a reserve of draught power, which is how it should be. This reserve of energy will be available to the wretched animals even when the carter overburdens them. For overloading is going to be much more difficult to control even after other

cruelties have been taken care of through better design and the more diligent enforcement of existing laws. The problem is going to be as intractable as man's cupidity itself. Strangely enough, concern for animal welfare has never prompted any of the redesign attempts. The pneumatic tyre introduced in the 'thirties did eliminate road damage valued at crores of rupees as it was intended to; it even improved cart efficiency somewhat. But it did nothing to relieve the animal of its ancient burden or salve its unhealing wounds.

13. The principal elements of structure that will figure in any major redesign attempt are a lighter platform, smooth bearings, wheels designed for dynamic motion, a better harness and a brake. There will be a variety of designs to suit varying types of terrain and freight — slushy roads in the villages as well as the concrete surfaces of the city and for both heavy loads, such as construction steel and high-volume and low-density loads like hay or vegetable. While smooth bearings will be universal in all new designs, the large wooden wheel from the traditional country cart will be retained for use on village roads alone. The new designs will be so conceived as to provide for widely varying sizes of animals. Both hard-rubber and pneumatic tyres will be used. They commend themselves especially for loads on paved or smooth city roads. Four-wheeled carts with pneumatic tyres could be used for carrying heavy loads in the cities — even up to a maximum of three tonnes. For bulk loads are available only in the cities. Some buffalo-carts in Delhi have trailers attached to them — like a jeep or a tractor. Single-bullock carts of improved design would be adequate for loads up to one tonne on all kinds of terrain. This arrangement will serve well the bulk of the carts in our country. Many of the existing double-bullock carts which only carry a one-tonne load can be converted for hauling by a single animal and the economies so effected in maintenance costs can be considerable. Multi-purpose carts with interchangeable parts are also a distinct possibility. Importantly, improved designs will be such that, to the extent possible, they may continue to be manufactured in the non-organized rural sector with a view to ensuring the utmost utilization of rural manpower. Also in the manufacture of carts, local materials will continue to be used.

14. Probably half a million tyrized carts even today carry two-to-three-tonne loads, particularly those transporting sugar-cane and construction materials. Most of these improved carts are of the Dunlop design and use the latter's patented pneumatic tyres. Other improvised versions use worn-out axles and tyres from discarded trucks and are sizeable in number—particularly up country. Four-wheeler carts are commonly seen in Madras and New Delhi and do brisk business. Earnings from these carts can be as much as Rs. 40 a day which is four times the daily earnings from a traditional cart.

15. Animal-lovers will readily appreciate that it is more probable that a hungry man eking out a marginal existence will be more cruel to the animal than another who makes a bit more out of his cart. This point cannot be over-emphasized. Also, when he overloads the cart or presses into service sick and hungry animals, he has to

use the whip far more than he would normally. Thus, it is hoped that when the animal is able to pull the weight comfortably, there will be less need of punishment.

16. It is assumed that carters beat the animals partly to force them to haul loads and such treatment strains both animal and cart capacity. Or they have to climb a steep hill or cope with a bad patch of road surface pitted with holes or congested traffic conditions. This feature of cart operations can be effectively tackled in the improved cart. The carter also beats the animals out of boredom, sheer habit or in a fit of sadism. A drunken carter is also liable to be merciless with his animal often to no conscious purpose. He would abuse the animal and make it put on bursts of speed. In Meerut, I have seen buffaloes being made to trot. Now, buffaloes walk rather more slowly, though they can pull heavier loads than a bullock.

The Pernicious Yoke

17. The most pernicious part of the traditional design is its harnessing device, of which the yoke is the most important member. In the unimproved cart, the neck of the animal forms the third point of the load. Besides pulling the carts, which is their primary function, the animals have to carry a vertical load on the neck. Studies have shown that 50 to 60 kilograms (out of the combined weight of the cart and the freight) rests on the animals' necks. This not only tires the animal prematurely in the course of the journey, but has also deleterious effects on its health in the long run. In the revised designs, attempts are being made to ensure a balanced load which would reduce the weight on the animal's neck.

18. Three-and-four wheelers automatically relieve the load vertically incident on the animal's neck, though they add to the tare-weight of the cart and call proportionately for greater draught effort by the animal. The two-wheeler design is the best for village roads, for, on these rough and unformed surfaces, wheels tend to get in the way of the cart rather than help it to go along. For light loads on paved roads, too, two-wheelers are economical. A number of ideas for yoke redesign are being tried out, such as a padding for the neck under the yoke, and a two-piece yoke of which only one would rest on the animal and the other would be linked to the harness strapped to the back of the animal. Furthermore, another kind of injury resulting from a defective yoke is very widespread and causes much pain. The common run of yokes is by no means smooth. As the yoke rubs and chafes the neck of the animal with every turn of the wheel, the skin tissues die off and become callous. Most of the animals develop neck-gall which is a form of cancer. Spot studies in one town showed that as many as 40 per cent of the animals ended up in the slaughter-house well before the end of their normal working life because, in this manner, the animals become unserviceable for draft.

19. There are two consequences, then, of bad design — the economic loss and the suffering of the animals. It is necessary to distinguish between them because the need of kindness to work-animals is well founded in economic common sense. The redesign project is not therefore an extravagant indulgence of my or any one else's over-sensitive humanitarianism. It has been estimated that the working life

of the animals is reduced by as much as one-tenth to one-fifth, and this can be directly attributed to cruelty as the cause. Even if we take the resultant capital loss to be equivalent to the value of one year of animal life, social costs would be of the order of Rs. 200 crores. This is a fantastic amount by any reckoning. Even if improved designs make a ten per cent difference to operations, measured either by money yields or the longevity of the animal so achieved, the economic benefits to cartman and country could be substantial. It must be noted that the benefits will mostly accrue to the small man in the non-organized sector.

20. No language form can describe the agony of the animal which is hurt in the neck. The effort put forth by the animal under a heavy load is readily perceived. It stretches its neck, its head lowered, and it exercises neck and head up and down to produce the energy for draft. Each contact with the yoke sends a shock of pain throughout its body. You can see it wince if you look carefully enough. There is more to it than a needless vertical load and the constant rubbing of the yoke and skin. Since the chassis of the cart does not rest on springs or shock absorbers, the shock load resulting from the uneven terrain is furthermore transmitted to the neck through the wheel, axle, platform and the yoke — in fact through all the principal members of the cart structure.

21. Again, in the improved designs of today, the neck of the animal is used to slow down the cart and stop it — a most ingenious device indeed! A variety of forces impinges on the poor animal's neck. The neck which is a vital part of the animal is being abused in the most outrageous way in the existing design. Man assumes that the hump is God-given so that the animal may serve man the better. It would be edifying to undertake an enumeration of bullocks suffering from neck injuries all over the country. The attempt to provide a harness for the bullock is addressed therefore to a problem that is at once economic and humanitarian.

22. Another kind of unnecessary injury is caused by the two beams floating on either side of the yoked animal. Since the distance between the two pull-beams is often short, the body of the animal rubs against the beams and this results in open wounds. This is entirely avoidable and can be stopped by increasing the distance between the pull-beams. This form of cruelty is in evidence in the double-bullock cart in particular.

Other Design Features

23. The fitment between the animal and the yoke is the most difficult and challenging part of the design. Other aspects, such as a smooth bearing, a lighter platform, reduced tare-weight, and more functional wheel dynamics, etc., are relatively easy to achieve both in redesign and manufacture. The concept is easily exemplified from the design of the much lighter and faster horse-cart. The pull-beams in the single-horse cart float. They are secured or lashed to the animal with straps. The weight of the cart is so balanced that the pull-beams do not impinge vertically on the animal's neck. The carter can easily detect this point of balance. Even when the pull-beams oscillate up and down, the stress or the shock is not transmitted to the

animal. It is dissipated through the harnessing. The horse has merely to pull the weight, not carry any of it like the bullock. Also, the fit is so clean that the animal's body or skin is not injured because no part of the cart comes into direct contact with the body of the animal. A comparable harness for the bullock and buffalo-carts has not even been thought of. Steel chains are used to secure the buffalo, the camel and the mule to the cart. This, too, is wasteful of the energy output only. a fraction of which is transmitted to the cart system. Perhaps, they are as cruel as the yoke.

24. Another major defect in the traditional cart is that it has no brake. In Kerala, a log of wood is hung at the rear of the cart and connected by means of rope to the reins which the cartman holds. The log can thus be manoeuvred by the carter. This device is commonly used in the hilly areas. Another variation uses two logs of wood in the front and the rear of the wheels and is worked through a pulley. A further improvement is being tried out whereby a block of wood can serve the same function as the logs and for greater efficiency, it could be manipulated through a lever system.

25. The animal's neck is at present used to slow down the cart or to stop it. It is also strained whenever the cart has to be turned sharply. Under this system, one animal is made to stop and serve as a pivot round which the other animal is made to turn. The bullocks suffer greatly in the process. The milling animals present a pathetic picture on the streets. For the animals, it is very difficult indeed to stop a traditional cart which is loaded with a tonne of freight and is going down an incline at a speed of four miles an hour — through the exertion of their neck muscles alone.

26. I saw a heart-breaking scene at one of the traffic intersections in Bangalore. A single bullock-cart fully loaded with sugar-cane was approaching an incline. The animal tried to stop the cart with its neck. It had an open wound on the neck; the pain was so excruciating that the animal collapsed. Three men tried to make it get up by systematic torture: one stopped the nostrils and the snout to prevent the animal from breathing; the second man twisted the tail, and the third one was beating the animal. The poor animal was dead beat and simply unable to get up. The men explained to me that the animal was feinting and nothing was wrong with it. At my suggestion, the cart was detached and rolled down the incline, and the animal got up on its own.

27. Literally thousands of such scenes are enacted under one's very nose. We notice them and pass on unconcerned or, worse still, helpless. The law of the land must make brakes compulsory for bullock-carts. Technically, brakes become mandatory when smooth bearings are introduced. Today, the roughness of the parts, the crude fit between axle and wheel and the resultant friction help slow the cart. But the same grinding friction acts against the animal when the cart is being hauled over a gradient. In a sense, the smooth bearings are harder on the animal as it has now to provide the retro-force to stop the cart. I am told that animals drawing carts

equipped with smooth bearings fall down because of the enforced speed at which the cart hurtles down an incline.

28. Carters also use nose-ropes for manoeuvring the animals. This is unnecessary. In Andhra Pradesh, where there are almost a million carts in use, they manage without the execrable nose-rope. The rope is taken round the mouth and the horns. This Andhra variation of the rope-reins and the Kerala brake deserve to be introduced all over the country. Here are obvious and inexpensive methods of averting some measure of animal hardship.

29. There are at least three kinds of suffering which the animal undergoes. One kind is a direct or indirect consequence of defective design; the waste of draught power, the animal having to supply the deficit; the vertical load incident on the neck; the rubbing of the yoke and pull-beams against the skin; the absence of a brake are examples of the first kind of suffering. Means of remedying these defects have been referred to before. The second kind of cruelty is due to the bad fitment between animal and cart, resulting in overloading, overworking of the animals and the suffering they undergo as a consequence. These too have been described in some detail. The third kind of cruelty has nothing to do with the cart, but arises due to other factors. One is the constant beating, whipping and goading of the animals. This third mode of inflicting cruelty calls for attitudinal changes in people working on the cart and the animal and cannot be dealt with through design.

Torture of Animals

30. The way cattle are beaten in the normal course of work, quite irrespective of their performance, defies the imagination. The cartman's hand is ever held high, ready to come down on the animal at the least provocation. This image of the carter is indelibly impressed on memory. Every day, an approximate 50 million animals are yoked to carts or to the plough. They get five thousand million beatings on the basis of 100 beatings a day per animal on an average. Animal-lovers are usually quicker to notice the scars on the animal's body. In the case of the buffalo, the bruises and the cut skin from which blood is oozing stand out better. These are not isolated instances; they take place in the presence of each of us several times on the road in the course of each day. Most of us cannot be bothered, and even an SPCA-scale of voluntary effort with a modicum of support from legislating and enforcing agencies is going to be difficult to organize. Thus 70 million bullocks and eight million buffaloes receive 1000 crores of beatings per year in our holy land. Immediate action has to be taken to ban the use of whips, sticks and other weapons which hurt the animals. In western countries, any evidence of cruelty found on the animal's body is a cognizable offence and the owner can be apprehended for it. We, who profess compassion for animals on the authority of our scriptures in unbroken continuity right from Vedic times, are too apathetic and insensitive to prevent the cruelty being inflicted all around us. This is a sad reflection on our value system.

31. Other forms of cruelty are used to urge the animal on faster or to pull loads heavier than they can bear. A nail fixed to the end of a stick is used to hurt the animal.

Recently, in Andhra Pradesh, I stopped a cartman and chided him about this. He explained to me that he hardly ever used it and that the nail was intended as an adornment to the stick. Yet another form of cruelty is wanton excoriation and the animal's bared skin is touched with a stick to cause pain. Though the last two methods are not as widespread as whipping, the practice is encountered with in scattered parts of the country. The twisting of the tail is well nigh universal in all regions with the result that the tails of some bullocks remain permanently disfigured. The animal was given its tail to keep off flies, but man disposes and besports himself with this perverse diversion!

32. At traffic intersections, the *sahibs* in cars and scooters are always in a hurry to be on their way. They hoot their horns (incessant hooting is man's inhumanity to man) and curse anyone who dares to cross their path or slow them down. The cartman always finds himself at the hearing end of this daily transaction. He then vents his feelings on the animal which gets another spate of beatings. Animals making a desperate dash to the other side of the road and having to compete with other faster traffic doing so are a daily sight. The *sahibs* say indifferently: "This country cannot improve unless the carts are taken off the road. It is my misfortune that I should be born in this backward country and put up with all this." Meanwhile, the traffic light goes red again. The motorist in a hurry has been thwarted. As for the bullock-cart, it is caught in the middle of the road and now holds up the new stream of traffic perpendicular to the earlier one. Are traffic lights suitable and adequate in a country where vehicular traffic moves at different speeds—pedestrians, cyclists, motor-cyclists (who always get off to a flying start), motorists and truck-drivers? Nobody has cared to study this. A traffic policemen has to modulate his instructions to suit the speed of the slowest vehicle in the stream. Once, some of us in a car crossed a traffic point following the green signal; yet the traffic policeman stopped us. When we protested pointing to the green light, he shouted back at us: "Never mind the green light! Why didn't you notice my signalling you to stop?"

33. Another kind of torture is applying a stick to the scrotal sac of the castrated animal, and drivers sometimes use their toes for this purpose. This tickles the animal to the point of pain. Here is methods study in full swing: the toes prod the scortum, a hand twists the tail and the other works the whip unremittingly or just a plain stick that hurts even more. It is a pitiable sight to see half-starved animals bravely lowering their manes in order to cope with their heavy burden and their eyes glazed over with a numbness to pain. When the animal falls down, chilli powder is blown into its nostrils in order to make it to rise on its legs again.

Veterinary Services

34. Another unnecessary cruelty is the way the animals are branded or marked indelibly with a hot iron. This is still done in some parts of India to establish ownership. This leaves as intended a permanent mark on the body of the animal. The same result can be got with chemicals, and much suffering thereby avoided. In a farm in Ooty, a numbered tag is strung through the animal's ear. The initial pain is minimal and is in any case not recurrent. Again, though modern methods of

castration are available at every State Veterinary Farm, I am told that animals are still castrated in the same old excruciatingly painful way. Law must enjoin that the castration operations can only be performed by qualified doctors or technicians using modern scientific methods. The veterinary services in the country are as yet woefully inadequate. Inexpensive field-based veterinary services ought to be introduced to cover the whole countryside so that our cattle population get adequate treatment and health cover. The country possesses 180 million white cattle (bullocks and cows), 58 million buffaloes, 40 million sheep, 60 million goats, six million pigs, one million horses and another million camels. Thus, India has the largest goat population and the second largest cattle population in the world. Their capital value can be rated, according to a conservative estimate, at Rs. 15,000 crores. Surely, the country can afford better veterinary services to service such a huge investment. The difficulty in paying for the services arises from the fact that half of the animals are probably owned by the poorer sections of our population. It is of course known that, when cattle diseases break out in epidemic form, it is easier to destroy the large animals than to treat them or to contain the disease. Yet it is undeniably true that animals in our country suffer because of the inaccessibility of rudimentary veterinary assistance to most cattle-owners.

Last Journey

35. Their last journey to their ultimate peace can be a gruesome affair. The cattle are marched for miles without food or water, as they have to reach the shanty where they will be slaughtered by a given date. They are made to run all along the journey: why waste money on the food of animals about to be killed? In order to save on the manpower necessary for herding and managing the animals, they are tied together in twos and fours. Motorists hoot their horns to clear the way when they are obstructed by the herd. A veritable stampede thus breaks out every time a motor car or a truck passes, and the animals get a few more gratuitous beatings. Some fall down and get trampled upon. The animals are all over the road, and they are beaten each time so that they may be gathered on one side of the road. As they are tied together, it is difficult for them to get up. I once saw a naked torch being applied to the skin of the animal in order to make it get up. Thus, after serving man usefully for years without demur or reward, the animals are led off mercilessly in a forced march to death, following which their life is ended in the most savage way.

Savage Slaughter-houses

36. The method now used for slaughtering cannot be termed as anything else but savage. There are nearly 3,000 slaughter-houses in India, and about 38 million goats and sheep are slaughtered every year. About 1.5 million white cattle and buffaloes are also slaughtered, some of which are draught cattle, either disabled or superannuated. The slaughter-houses are unorganized and unregulated. Animals are not stunned before slaughter. Each animal is done to death in the most cruel way in the presence of other animals. Though Herculean efforts are being made to introduce stunning devices, progress has been all but negligible. Fear leads to excessive secretions from the endocrine glands which are a valuable source of hormones

and pharmaceuticals; these are now lost through unscientific slaughtering methods which are also painful into the bargain. Immediate legislation on the subject is called for. Our Prime Minister has spoken touchingly in his compassion for animals. It is hoped that, during his regime, slaughter-houses would not only be reformed but modernized. Apart from the avoidance of cruelty, there are influential economic reasons for modernizing them. At present, animals are sold only for the value of their skin; the by-products of the slaughter-houses can be used in a variety of ways and with great profit.

37. Work-animals which are rented out are beaten more than others which are worked by their owners. Once a pair of animals came back from a trip totally mauled by the driver who had rented in the cart. When asked about this, he replied, "I did not hire in your animals to do *pooja* to them."

38. It is for us to ponder why we are so cruel to the animals in a country which gave birth to divine human beings, such as the Buddha and Mahavira, who have preached compassion. Our ancient folklore appeals to us to be kind to animals. Our mythology is replete with animal worship and dedication to the cause. Kamadhenu is noble, God-like and Cornucopia personified. Nandi is the popular God of the Gate in every Siva Temple. Even the buffalo is the *vahana* of Yama Dharmaraja, the Lord of Death. Yudhishtira refused to enter Heaven without the loyal dog at his heels. We worship snakes; Naga Panchami is observed in every part of India. Mattu Pongal is celebrated all over South India when the cow, the giver of wealth, is venerated. Hanuman, the monkey-faced king, is part of our pantheon.

39. We are perhaps the only nation in the world which preaches and practises vegetarianism as a creed and a way of life. Yet we treat animals unfeelingly and callously. Perhaps alien rule for centuries has stripped us of our own culture without intimating to, or impressing on, us the nobler values of their own more ethical and humane civilization. For it was the selfsame aliens who initiated the Hackney Carriage Act and the SPCA laws. We have not implemented these faithfully, nor have we thought of new, more Indian laws to take their place. There is no violence in our culture that brutalizes. Yet, why are we so apathetic — particularly in the face of cruelty inflicted on other sentients in our presence?

40. Everybody would agree that compassion for animals should be inculcated from childhood. I am now surveying children's text-books and stories to check whether they foster and evoke sensitiveness towards animals. *Alice in Wonderland* and *Wind in the Willows* endear animals to childlike imaginations, and the Hindu *puranas* teach children to eschew fear in the presence of animals and indeed regard them as a God aspects. I find that Westerners who are non-vegetarians are yet more compassionate to work-animals and pets. In many countries, slaughtering without anaesthesia is a criminal offence; so is the beating of animals in some others. Children's attitudes to animals are the easiest to alter and to improve. The nameless *Panchatantra* characters would be lovable if the tales were not so didactic, Winnie the Pooh may be genteel and addicted to honey, but he is deeply and widely loved.

instantaneous. The hunter's code prevents him from maiming the animal without killing it. In the case of work-cattle, the cruelty starts the day it is born and does not cease until the moment of death.

47. The good God did not invest cattle with a voice to protest, and man did not give them votes to dispose of political power. It is hoped that the easy conscience of our countrymen can be aroused once again so that our fellow-citizens—the work-cattle — who serve us so well can get a better deal.

A NOTE ON STUNNING AND SLAUGHTER

The stunning of slaughter animals was stopped in the Bombay *abbatoir* following a decision of the Corporators. To most Indians, compassion for living beings is not only a matter of sentiment but is enjoined as a part of their life and religion. For long, the deplorable conditions prevailing in hundreds of approved slaughter-houses and thousands of backyards in the country have been kept out of public gaze and the purview of criticism. Consequently, there is much ignorance about everything regarding slaughter among policy-makers and the public at large. It is high time that a national debate is launched to rouse the public to a consciousness of the frightening state of affairs. Nobody gains and no cause is served—religious or ritualistic—by these barbarous methods. In fact, the primitive and most reprehensible slaughter practices now in use in India lead to loss of hide, flesh and other by-products, both in quantity and quality. Furthermore, the animals are subjected to needless cruelty.

Certain sections of the Muslim community mistakenly believe that the animal is dead, or nearly dead, after it has been stunned, and therefore, is not alive when the throat is severed. On the contrary, the animal is very much alive during slaughter. It is kept alive so that religious stipulations are met. All that stunning does is to immobilize the animal by benumbing its senses so that it does not struggle during slaughter and possibly so that it does not feel the pain which is reduced as in anaesthesia. But stunning is resorted to only in one or two slaughter-houses in India.

Since members of some religious groups may not partake of carcass meat, it was considered essential that the animal be kept alive at the moment of slaughter. Furthermore, to ensure compliance, this was enjoined in the scriptures of the respective religions. Modern stunning methods by captive bolt fulfil conditions laid down while ensuring many advantages. Therefore, facts regarding stunning should be explained to those who object.

In the present practice, the animal's brain is under great stress due to fear and pain resulting in the loss of hormones from the cattle pancreas. Twisting, rolling and being thrown and tossed about on the rough, unhewn floor damage its skin. Man easily overpowers smaller animals—sheep and goats. But buffaloes and oxen are difficult to control, which makes stunning a greater need. In any case, the bigger animals are not being stunned in Bombay. From the moment the animal is slated for slaughter, wanton violence is inflicted on it till its death. As a preparation, about 20 animals are thrown down and their legs tied up. While assistants clamp the animal down into position, butchers take turns cutting throats one by one. The carcasses are dragged from place to place and ripped open and flayed. Frightened by their horrifying struggles to wriggle out, the other terror-stricken animals panic to free themselves. They scream and wail, nervously urinating and defecating on the floor already bespattered with the urine, dung and blood of the slain animals! Thus, writhing in pain, they thrash

about in this medley of filth while others wait for their turn to come. Such gruesome scenes are not visualized even in the conventional pictures of hell.

Stunning quietens the animals, making them easier to handle. In modernized slaughter-houses, animals are led off one by one—to a ramp, stunned and slaughtered. Those that wait their turn in the queue are spared the agony of witnessing the process Here, animals are kept cool, calm and rested for one or two days—not so much for reasons of humanity but for improving the quality of the meat.

In western countries, animals due for slaughter are transported in special vehicles. Inside the *abattoir*, they are taken to the slaughter machine on conveyer belts; they are mercifully kept oblivious of their impending fate. Alas ! in our country, when their utility to man is over, they are tied up in twos and fours, and marched mile after mile to distant gallows. During this last lap of their journey on man's earth, they do not qualify for food or even water. From western Tamil Nadu, animals are made to travel 200 miles on foot, up hill and down dale, so that they may serve their masters in Kerala, who have a pronounced preference for their meat.

All along the route, man abuses them as they impede his journey to work and pleasure. Every hoot of the horn from passing vehicles means a shower of beatings for the animals. The scramble and trampling over of the fallen ones tied together are routine scenes on the highways. Unlike slaughter-houses, which are kept out of man's sight in order not to offend his aesthetic sensibilities, these wicked practices are carried through in his very presence. He hardly notices them, not to talk of his doing anything to prevent them. Muttering a curse, he turns his face away to savour the beauty of Nature in contrast to man's brutality. He does not see that Nature is "red in tooth and claw".

Concerned over these practices elsewhere, Britain put an end to the export of its live animals. Slaughter without stunning and abuse in any form are punishable under law in western countries. While we imitate western concepts and technology, should we not emulate their humanity to animals? To them, animals are commodities while to us, they are sacred. Kamadhenu and Nandi, Ganesa and Mahisha, Naga and Anjaneya—are all part of our pantheon and adorn temples. Buddha and Mahavira—the immortal sentinels of *ahimsa* and *karuna* to all living beings—heralded our heritage. As inheritors of an ancient culture and as spiritual aspirants, we should subdue the beast in us and avoid torture in slaughter.

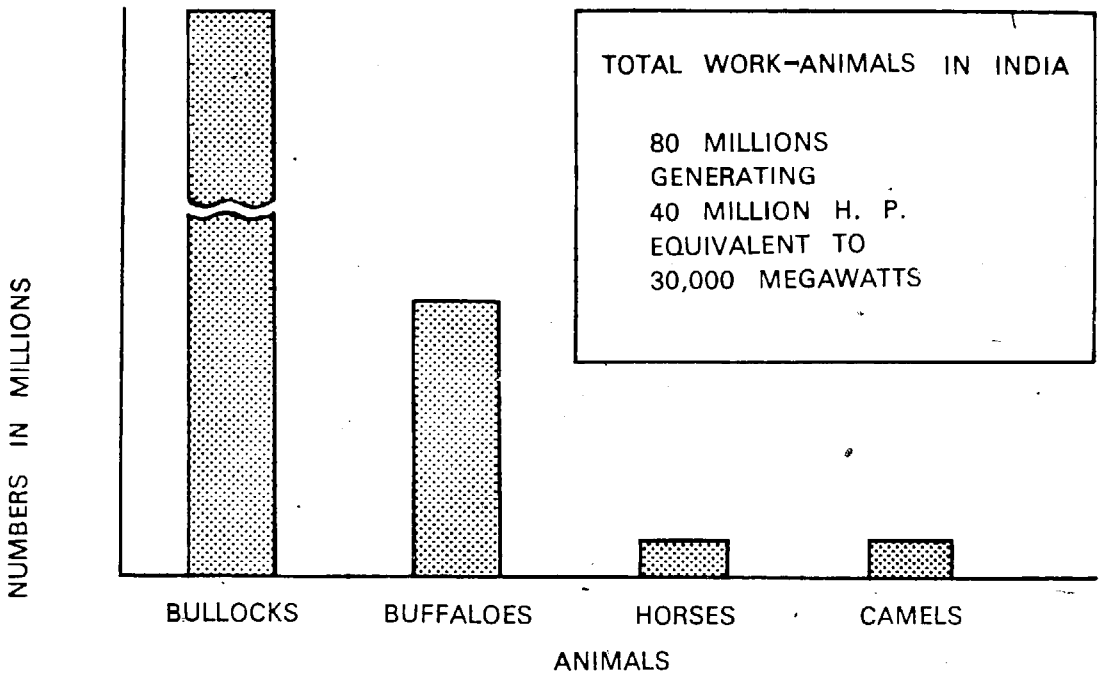
Even according to a purely economic rationale, our attitude to, and treatment of, animals should be subject to review. From the dawn of civilization, man and animal have been partners in progress. During their life-time, animals provide us with milk and medicine, draught power and energy, entertainment and companionship. In death they leave behind their flesh and hide, hoof and horn, bone and hormone. Their bodies are used for medical research. In spite of their magnificent contribution, man is not only ungrateful but cruel. Millions of male calves — mostly of buffaloes — are abandoned a few weeks after birth—to die of starvation, or they are buried alive. Those

concerned cannot afford to maintain them and no attempt is made to seperate and save the prospective work-animals. Millions of kilowatts of potential energy are thus lost.

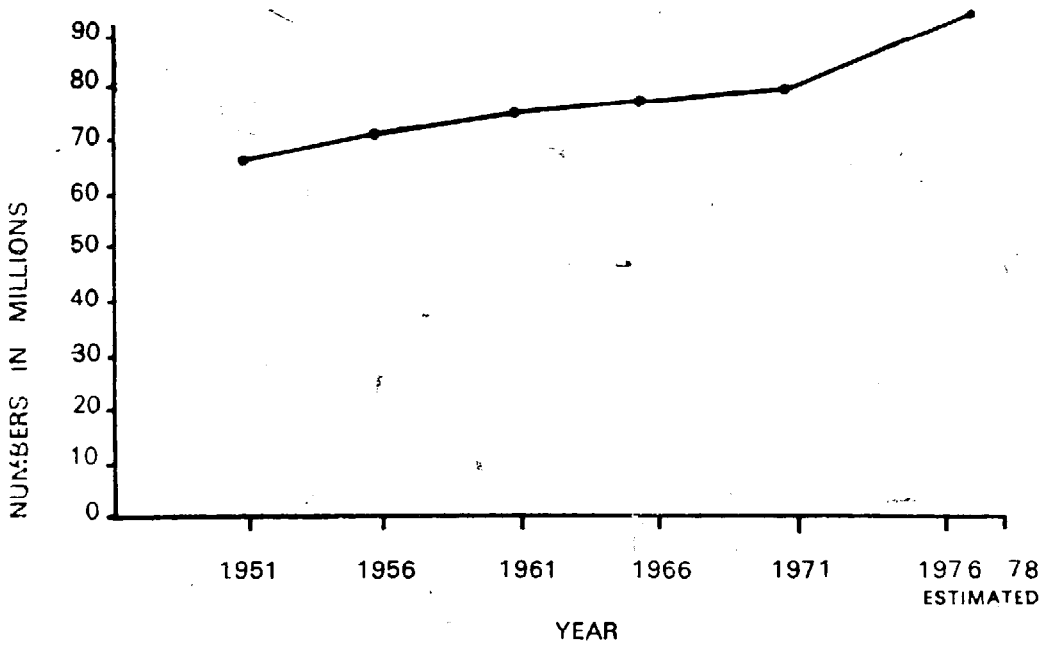
Slaughter for meat cannot be avoided till man becomes vegetarian. Meanwhile, millions of animals will be slain in wicked ways. Our pretensions to humanity will, however, remain a mockery till we modernize slaughter. Professions and trade unions, institutions and organizations, and the nation-state—all fight to foster the sectarian and parochial interests of classes and communities. To plead the cause of hapless and helpless animals, there are not many around. For unknown reasons, the compassionate creator did not give them strength and voice to organize and protest. Economic man did not endow them with money and franchise to please political parties.

Hopefully, those who oppose cow-slaughter might be expected to campaign for the humane treatment of all animals, particularly during slaughter. The meek and mute conscience of man has still enough strength left for a massive movement for the education of those concerned with animals—their utilization and trade, transport and slaughter—so that rational policies and methods are evolved and enforced to help the millions of animals who serve us so well.

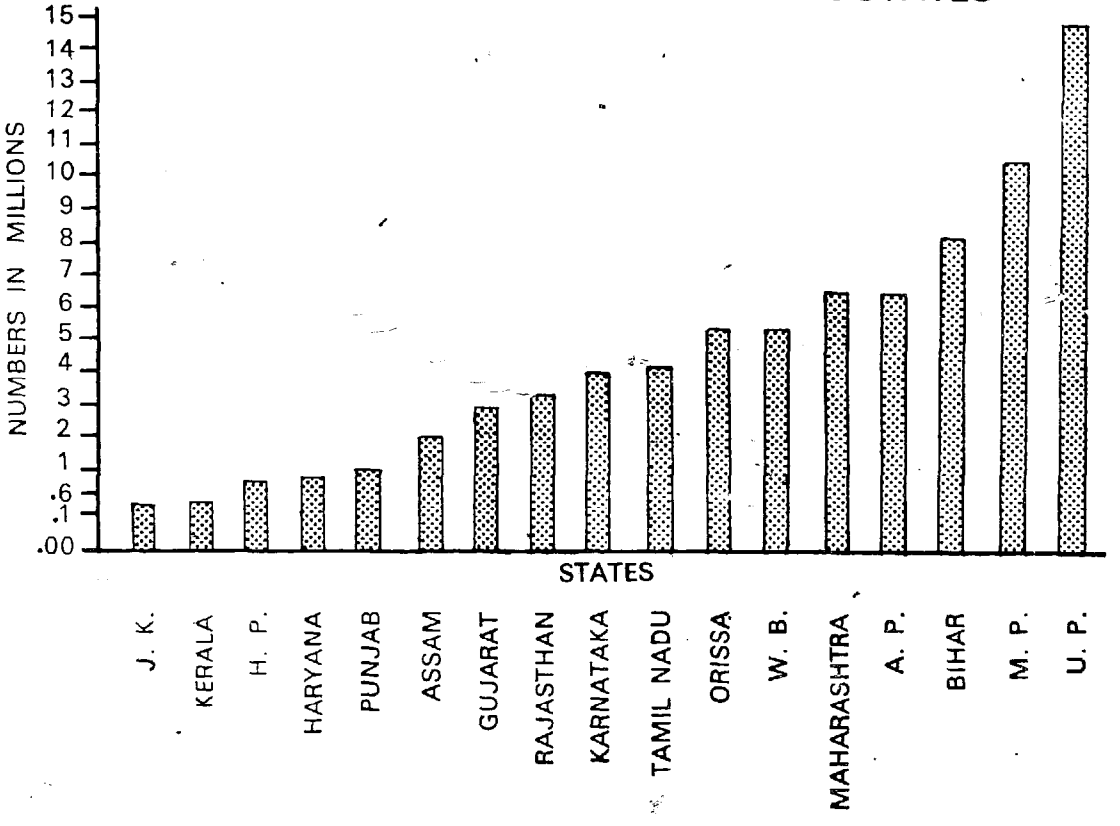
WORK-ANIMALS IN INDIA



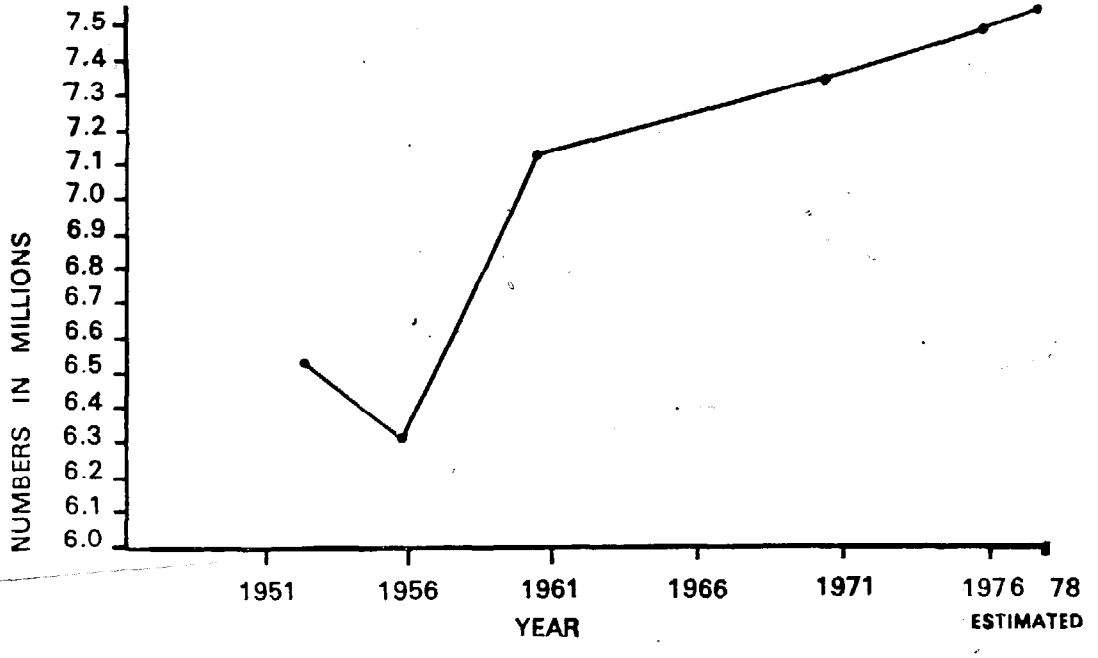
GROWTH OF WORK-ANIMAL POPULATION : 1951-78



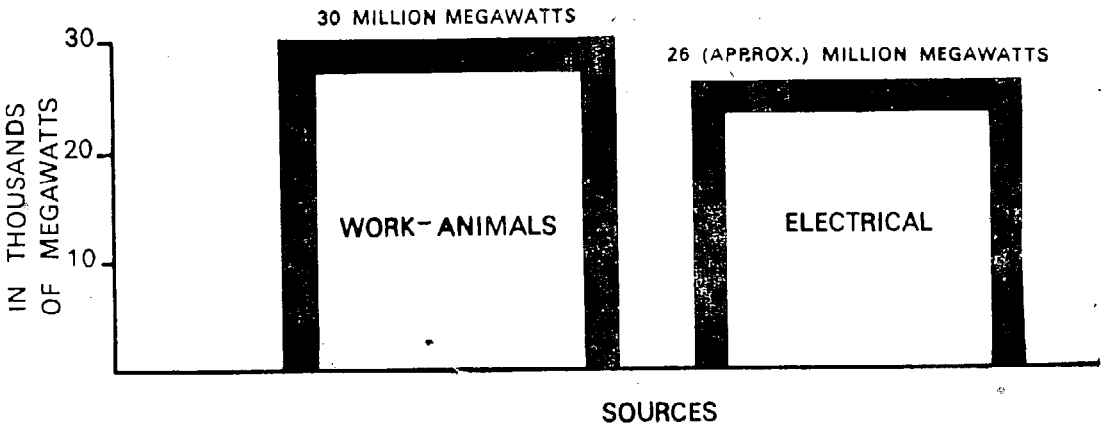
WORK-ANIMAL POPULATION IN THE STATES



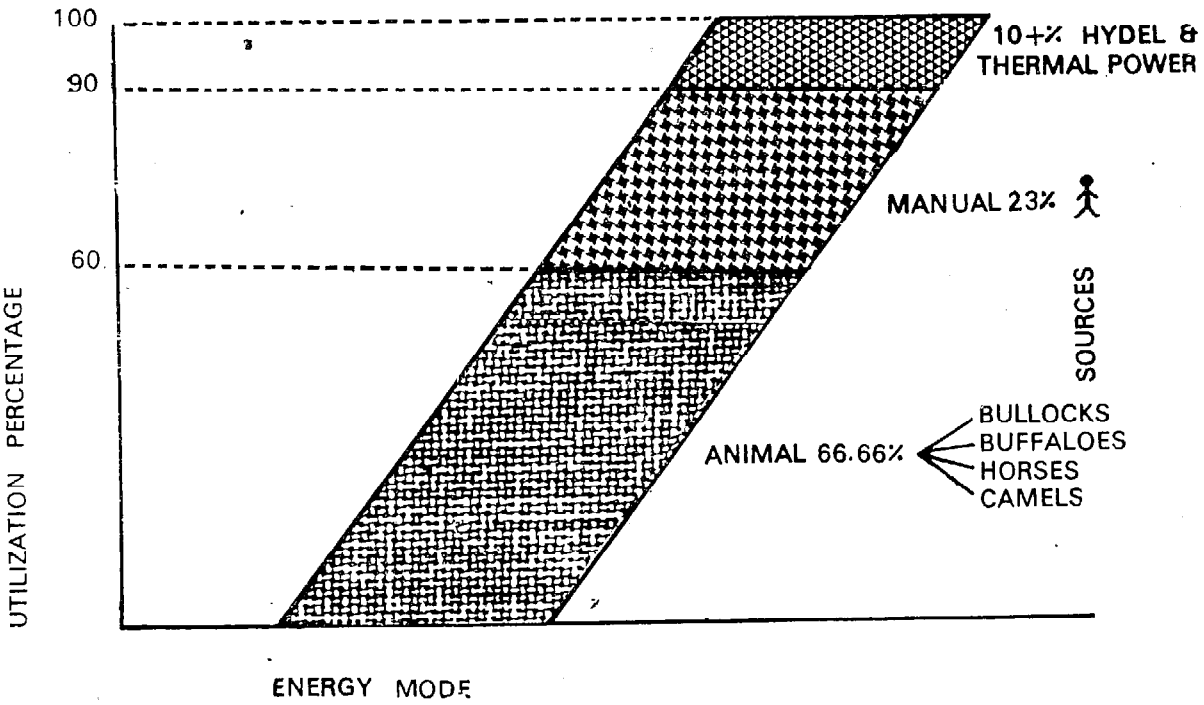
USE OF BUFFALOES AS WORK-ANIMALS: 1951-78



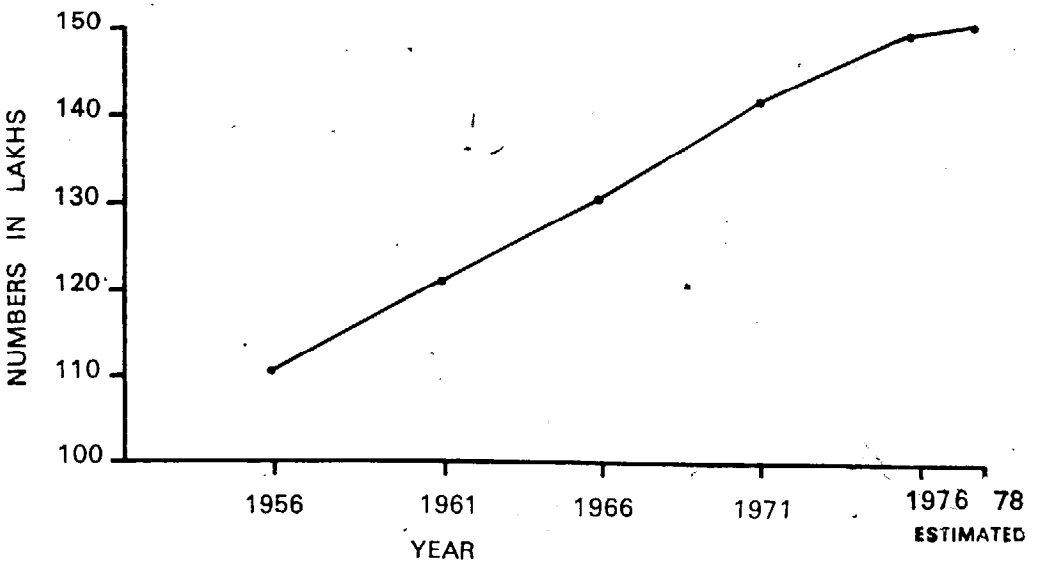
ENERGY PRODUCED IN INDIA BY ANIMALS & FROM FOSSIL & HYDEL SOURCES



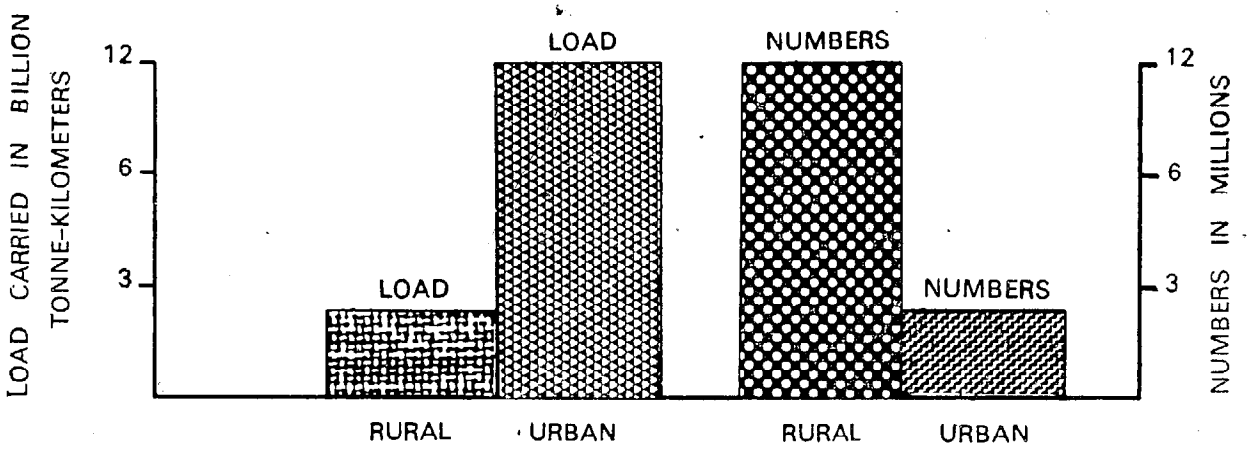
ENERGY INPUT IN FARMING



GROWTH IN CART NUMBERS : 1956-78



ANIMAL-DRAWN CARTS IN INDIA & LOAD CARRIED IN RURAL & URBAN AREAS



TEST DATA FOR COUNTRY-CARTS

SERIAL No OF CART	SPEED OF CART IN MILES/HR	KIND & CONDITION OF ROAD	DRAFT FOR PULLING CART				H.P. FOR PULLING CART	
			EMPTY		LADEN			
			EMPTY CART	DRAFT	LADEN CART	DRAFT	EMPTY	LADEN
1	2	KACHA	720	120	2400	200	–	–
	1½	,,	720	140	2400	225	–	–
	3	PUCCA	720	120	2400	190	–	–
	2½	,,	720	130	2400	200	–	–
2	–	NOT TESTED	–		–	–	–	–
3	4	KACHA	700	40	3000	105	0·42	1·1
	5	TAR ROAD	700	35	3500	80	0·47	1·6
4	2½	FIELD	400	18	1200	65	0·12	0·43
	4	TAR ROAD	400	16	1500	70	0·17	0·54
5	3½	MUD ROAD	900	50	2500	130	0·46	1·2
	5	TAR ROAD	900	45	4000	175	0·60	2·3
6	2	KACHA	892	80	–	–	0·43	–
	1·25	–	–	–	2128	225	–	0·75
	2·5	PUCCA	892	50	–	–	–	–
	2·0	–	–	–	2128	103	–	0·55
7	–	– NOT TESTED	–		–	–	–	–
8	2·5	KACHA	720	75	–	–	0·50	–
	2·1	,,	–	–	1000	138	–	0·77
	3	PUCCA	720	43	–	–	0·34	–
	2·6	,,	–	–	1000	76	–	0·52
9	3	KACHA	770	73	–	–	0·60	–
	2·5	,,	–	–	1000	140	–	0·94
	4	PUCCA	770	45	–	–	0·48	–
	3·7	–	–	–	1000	80	–	0·80
10 TO 16	2·5	PUCCA	920	90	2870	150	0·48	0·80
	1·5	KACHA	920	120	2870	225	0·52	0·90
17	1·5	PUCCA	575	65	1600	120	0·26	0·48
	1	KACHA	575	100	1200	190	0·27	0·50
18	2·5	KACHA SANDY ROAD	964	60	1840	160	0·40	1·07
19	2·5	METAL ROAD	300	60	2000	250	–	1·2
20	1½	PUCCA	480	10	1568	119	0·04	0·48
	1	KACHA	480	21	1568	175	0·06	0·47
	1	SANDY	480	32	1568	196	0·09	0·52
21	1½	KACHA DRY	1312	196	3280	280	0·78	1·12
22	2	KACHA DRY	2050	56	4100	184	0·3	0·45
23	3 EMPTY / 2 LOADED	FAIR WEATHER	900	40	4000	160	0·32	0·85
24	2·5 EMPTY 2 LOADED	FAIR WEATHER	700	40	1700	131	0·26	0·70
25	2·3	KACHA	8995	14	2394	182	0·15	3·4
	1·9	,,	,,	21	2394	392		

SLAUGHTER OF CATTLE

Sentiment and Sanity
The Management of Modernisation

The issue of slaughter of cows has been in the news during the last few weeks. The Chief Ministers of Kerala and West Bengal have not acceeded to Bhave's appeal to ban cow slaughter. The Acharya has ended his fast. Strangely, public response has been restricted largely to the propriety of the Acharya in taking such a drastic step, the sentiment of the people in Kerala, the apprehension of communal violence, etc. There are a number of related issues which have not been discussed at all in public. For a variety of reasons — ignorance, public apathy, unwillingness to face harsh realities and religious sentiments — issues connected with slaughter of cattle and other animals have been kept out of public gaze and attention. Consequently, this has led to enormous economic loss to the nation, particularly to the small man, and untold suffering to millions of animals being tortured during their working life and in death. This is an opportune time to launch a national debate on all aspects of slaughter of cattle.

Ban on cow slaughter — genesis

If the ban on cow slaughter derives its sanctity from the fact that it is included in the Directive Principles of the Constitution, one can point out that there are equally important principles listed in the Constitution which are yet to be taken up for implementation. If the appeal for ban of cow slaughter is based on religious sentiments, bullocks qualify equally for such a regulation — perhaps even more. Bullocks are equally sacred to Hindus who worship them in the form of Nandi. To a lesser degree is the case of the buffaloe, which is the Vahana of Yamadharma. If slaughter is to be considered for regulation, all animals, particularly those useful to man, should come within this purview.

Supreme Court ruling

The Supreme Court judgment of 1958, as quoted in the papers, states that "total ban of slaughter of cows of all ages and calves of the buffaloes (male and female) was quite reasonable and valid and in consonance with the Directive Principles, laid down in Article 48 of the Constitution. A total ban of slaughter of she-buffaloe, or breeding bull or working bullock (cattle as well as buffaloes) as long as they are milching or as draught cattle was also reasonable and valid. A total ban on slaughter of she-buffaloes, bulls and bullocks (cattle and buffaloes) after they cease to be capable of yielding milk or of breeding or working as draught animals could not be sup-

ported as reasonable in the interest of general public." All the States, except Kerala and West Bengal, have enacted laws in varying forms in the light of the above ruling.

Economic aspects

We may now review the economic aspect. The number of cows, bullocks and buffaloes may be about 234 millions in India (See Appendix). The total investment on these animals will be anywhere between 15 to 20 thousand crores of rupees — and that too of the small man. If we add camels, horses and donkeys, sheep, goats and pigs, the total investment may be about 25 thousand crores of rupees, which is roughly the investment in industry in the organised sector. In spite of such a vast investment and their tremendous contribution to the economy, the attention given to the animal system is far less than what is needed. Except in the case of breeding of milch cattle and dairying and development of hospital based veterinary services, most of the other aspects of animal system have been neglected from the point of view of animal care, feed and utilisation — particularly of draught animals. Methods of slaughter and recovery of by-products of all animals are totally neglected. The loss to the nation will be in terms of hundreds crores of rupees. Therefore, the whole cycle of animal system, from birth — through utilisation and care — to death should be studied and appropriate policies formulated.

Work Animals — economic contribution

If the reason for banning cow slaughter is economic, then work animals qualify far more for regulation of slaughter. 70 million Bullocks and 8 million he-buffaloes as well as a few additional millions composed of cows and female-buffaloes used for draught, horses, camels and mules — all together — make available about 40 million horse power as energy. This energy is critical to the country, and not easily replaceable for some years to come in the rural sector. This is more than the electrical power installed in the country. The investment in the animal energy system may be of the order of ten thousand crores of rupees and replacement by other forms of energy may need twice that amount. Fifteen million carts are hauled by work animals, and they cannot be replaced for a number of years by trucks. Investment in the bullock cart system is Rs. 3000 crores.

Dependence on Animal Energy

Even replacement is not easily feasible, since animals are the only form of energy which are appropriate to existing conditions. 60 million farms are below 2 hectares where work animals are the only economic and feasible possibility. Tillers and tractors need a much larger area for economic operation. Half of India's villages do not have roads fit enough for trucks and tractors, and only bullock-drawn vehicles can ply on these terrains. For short distances and small loads, tractors and trucks are uneconomical.

Two-thirds of rural energy input comes from animals, and only ten per cent from hydel and fossil fuel sources the rest is provided by humans.

The present energy input has to be doubled in order to get optimum output. Such vast quantities of energy can come only from work animals. Millions of marginal farmers do not even have animals and they have to rent them. Petroleum will become more and more scarce; and we may have to fall back on animals.

Such is our dependence on animal energy. We have neither recognised their contribution nor cared for their welfare. In fact, Mao Tse Tung himself had led an agitation for ban of bullock slaughter. China is raising work buffaloes in a big way. In contrast to this, we are, relatively speaking, neglecting work animals — not only their effective and economic utilisation but also their welfare. Cows, buffaloes and bullocks not only serve man during their working life but leave behind for man their meat and skin, blood and bone, horn and hoof, harmones and several other by-products. Lack of appreciation of their contribution is part of the reason for their neglect.

Slaughter — economic compulsion

Now let us look at the picture of what is going on. Ban or no ban, animals will be looked after and slaughtered according to the economic conditions of the owner and their utility to him. This may sound rather cynical and laying too much stress on the economism of man; but it is true. In spite of the ban on cow slaughter, in most of the States, cows are being slaughtered in large scale in clandestine ways. This is evident from the all India statewise statistics. For the country as a whole, there are only 70 cows for every 100 bullocks, which means that 30 cows for every 100 bullocks have been slaughtered. Bullocks can work till their last muscle becomes weak or they become sick, after which they are sent for slaughter. In the case of cows, they stop lactation 4–5 years ahead of their normal life and, therefore, are sent for slaughter soon after. The normal sex ratio at birth for the country as a whole is 1:1 and, generally speaking, mortality rates are the same. Therefore, what these figures mean is that cows are being slaughtered after their utility to man is over. which, compared to bullocks, is a few years ahead of their natural life span. And hence this imbalance in the male-female ratio of bovines. As per the report of National Commission on Agriculture, there were 72 million bullocks and 56 million cows — all adults, excluding young stock. Therefore, in one generation, if say 12 years, 16 million cows have thus been slaughtered.

Strangely, it is precisely in Uttar Pradesh and Bihar, where we have a number of active proponents of cow slaughter ban, that we have the lowest ratio of cows to bullocks. There are only 55 cows in UP and Bihar for every hundred bullocks. Thus, in one generation in these two States alone — millions of cows have been slaughtered. Strangely again, it is in Kerala that there are three times cows than bullocks. This is of course not due to any special affection for cows. Bullocks are raised for slaughter as they do not need so many bullocks for ploughing. Cows

are well cared for their milk. Kerala gets their requirements of cows and bullocks from the other states.

It is admitted that part of this is due to natural death, since most of the farmers do not want to see their dear cows being sent to slaughter. Their sentiment has to be admired. Wherever they have pasture land, they will keep them till their natural death; but this is not true of most parts of India where there is dearth of pasture land which can be spared for such useless cattle. In fact, availability of land per animal in India is low indeed. As the owners cannot stand the emotional strain of sending their cows, or for that matter their bullocks as well, for slaughter, they find various ways of disposing them of, satisfying their conscience that they are not responsible for its eventual slaughter. Sentiment should also have some value, and it should be appreciated.

Case for no-slaughter

In a society which reveres cows and bullocks and treats them as partners — and not as commodities as in the Western countries — there is perhaps a case for keeping cows and bullocks till their natural death. After all, we do not kill off people soon after their utility is over. Just like capital appropriates value from labour power, man appropriates value from animals. The total contribution of an animal — milk or draught — can be amortised over the natural life span of these animals. After all, the animals have worked and contributed when they can, why not give them some rest and allow them a natural death? But economic man does not consider animals in that light, though for purposes of sentiment, Hindus would like to feel that way. But economics supersedes sentiment.

Case for slaughter

There may be about 5 million cows which have never calved at all. There may be another 5 million which have finished their lactation period and, therefore, will not yield milk any more. This means that, at any one time, there may be as many as one crore cows not useful to man in living state, except as a companion or object of love. Even if we take a conservative estimate of spending one rupee a day for keeping them alive, we may need 300 to 400 crores of rupees per year. Pinjrapoles and Goshalas are being tried, but these are far too small in number to be of any significance. But in order to satisfy the sentiment of Indians, this need not be discouraged by public policy.

Suffering of Animals — Cruelty & Economics

Bullocks are worse off than cows. Cows suffer only due to starvation and occasional abuse as well as in death. Bullocks suffer right through their lives. They are branded with hot iron; their horns are removed in some parts of India; a good number of them get castrated in the most painful way by their testes crushed; they are under-fed and overworked; and sick animals even with injuries are worked.

They get millions of beatings every day right in our presence, their tails are twisted and their bodies pricked with sharp nails — all to make them pull loads beyond their capacity. They are subjected to inhuman cruelties right through their working life; and when their utility is over, they are marched upto 300 miles to death, tied in twos and fours. There are economic penalties for each one of these cruel acts. For instance, branding and beating damage leather, long marches affect quality of meat, and castration by the crude method is dangerous for their health and so on.

Plight of he-buffaloes — Losses

The state of affairs of male buffaloes is pitiable from the economic and humanitarian point of view. There are 58 million buffaloes, 8 million males and 30 million females and the rest are young, sex ratio of which is not known. This just shows that 22 million males have been disposed of before they came to adulthood. This is a fantastic loss indeed. It is euphemistically said that the male mortality is high. This is simply not true. Male calves are not cared for and are actually abandoned, soon after birth, to die of dehydration and starvation. This is being done at a time when there is shortage of energy in the farms and thousands of marginal farmers do not have any animal at all. If these animals were raised with proper food, they can be used as draught cattle or for meat or for both. Taking an eleven year span, about two millions are being abandoned like this every year, which means at least 200 crores worth of buffaloes are just thrown away every year. Compared to this, China has raised 50 million work buffaloes. Care for them is so much that it is reported that buffaloes are given nylon-netted socks to protect their feet. Work buffaloes may not be suitable in all areas. But they can be raised in selective areas where they can work and where there is pasture. Statewise statistics are available of sex ratio which reveal extent of deliberate disposal of young ones. She-buffaloes are cared for, since they produce milk; and 60 per cent of India's milk production, it seems, comes from buffaloes.

Thus the economic analysis shows that in spite of sentiment for these animals and the ban on slaughter, actual situation is totally different. Banning sends slaughter underground, as in the case of prohibition. However, in our country, slaughter in approved slaughter-houses as well as in the clandestine methods in the backyards are equally cruel. Therefore, animals suffer under both conditions. Regulation of slaughter of productive cattle can be done only when slaughter system and organisation are modernised.

Case for Modernisation

Both from the humanitarian and economic points of view, modernisation of slaughter, rather than banning issues, is the most urgent task before us. But there is so much of ignorance about slaughter in the country amongst all sections — leaders, policy-makers, professionals and public at large. Since the whole process is so brutal and gruesome, the matter has been kept out of public gaze. There will be enormous economic gain — private and public — by modernising slaughter. Unfortunately,

even the recommendations of the Task Force Report of the Government of India advocating modernization of slaughter-houses have not been implemented yet with any vigour.

Except two or three slaughter-houses in India, all others — 3000 Municipal slaughter houses and 5000 others run by Panchayats are most primitive and crude. Nobody gains by these practices. In fact, everybody loses — man and animal as well as the society. Losses are in hundreds of crores of rupees. This is a tragedy of our society that such wanton cruelty is being inflicted on the animals with no corresponding gain to anybody, but loss to everybody. And this too, in our country, where animals are sacred.

When modernised slaughter-houses are introduced, smaller animals — goat, sheep and pig — can also be slaughtered in adjunct slaughter-houses. Presently these smaller animals are also slaughtered in painful ways. In fact, pigs are slaughtered by beating them or burying them.

Methods of Slaughter

There are three methods of slaughter. The Jutka method, where the head is severed at one stroke, is the best method from the animals point of view, as it reduces pain. But the blood gets clotted inside. The blood is the carrier of viruses, and therefore, this method is a health hazard. In the Halal and Koshar methods, the jugular vein is cut partially and the animal is bled to death. There is less health hazard, and it is reported that the meat is better. The latter two methods are preferred from the point of view of meat eaters.

Stunning is the first step in modernisation, which is essential for making it easier to employ the Halal and Koshar methods. Unfortunately, a certain section of the Muslim community mistakenly believe that stunning does not satisfy certain conditions laid down in their scriptures. But this is a wrong impression which can be explained by showing that the animal is very much alive after stunning and during slaughter. In some Muslim countries, stunning has already been introduced without any difficulty. The problem in India is ignorance and lack of effort to explain matters to those who object. In one or two slaughter-houses in India, stunning has been introduced which has been accepted by people.

Modernisation — stages

Stunning:

Modernization can be carried out in various stages and aspects. The immediate need is to introduce stunning, before slaughtering the animal, which is beneficial to all.

Firstly, stunning quietens and immobilises the animal, rendering slaughter easy and faster. Secondly, stunning reduces pain for animals which is a great relief

to all Indians, particularly animal lovers. Thirdly, draining of blood before death — so essential for maintaining the quality of the meat and preventing health hazards — can be ensured. Stunning is relatively a simple method and can be introduced not only in large modernised slaughter-houses but also in small ones run by panchayats.

In the case of larger animals, stunning is done by use of a captive bolt pistol which may cost about Rs. 2000/- or so. Even if we were to distribute such pistols to all slaughter houses, it will cost only about five crores of rupees. Cost per slaughter for stunning will work out to less than a rupee per animal. Smaller animals such as goats, sheep and pigs can be stunned with an electrical device, the cost of which will be about the same. This is the minimum that a country like India could do *i.e.*, investing Rs. 5 crores, when the investment in the animal system is twenty thousand crores of rupees. Unfortunately, the priorities of our society are such that an important subject from the religious, psychological, moral, economic and social points of view is receiving very little attention.

The *second step* in modernization is to see that animals are slaughtered one by one outside the presence of other animals awaiting slaughter. In the existing practice, animals are herded in one room and all the other animals see the process of slaughter of their species. Seeing the wailing and struggles of animals being slaughtered, the other animals awaiting their turn get frightened and terror-stricken. Apart from the psychological pain they undergo, the quality of the meat is affected. It is also believed that they secrete valuable harmones which can otherwise be recovered. In Western countries, animals are taken one by one and slaughtered outside the presence of other animals. This can be even now implemented, even without stunning. All that is required is a separate room or, to begin with at least a screen. The present sight is brutal and gruesome indeed where animals, with their feet tied, wallow for hours in blood, dung and urine of their own kith and kin, awaiting their turn.

Hygiene:

The third element of modernization is to improve hygiene. It is a paradox that foyers and drawing rooms are kept clean, while slaughter-houses from where meat is recovered for consumption, are kept so unclean. It can be easily seen that the meat gets tainted, after being smeared with blood, urine and dung and other wastes. All these are health hazards.

Transportation:

The fourth element of modernisation is to bring the animals in specially made trucks and trains. Today they are marched long distances which affect the quality and quantity of meat. Also, it is a health hazard, since animals also secrete certain toxic substances, which are harmful to man. Thousands of animals in South India are marched to Kerala where there is no ban on any slaughter.

By-products:

The fifth element of modernisation is mechanisation of the process and introduction of modern methods for recovery of by-products. Today, meat and part of

leather are being recovered. Blood and bones are also recovered partly. But recovery can be substantially improved. An analysis shows that Rs. 200 to 300 crores worth of by-products can be additionally recovered by modernising slaughter-houses. If we export them, the value will be far more. Some items such as harmones and enzymes could be of significant value to the country not only from the pure economic point of view but from health point of view as well.

When slaughter-houses are modernised the same organisation can be used to recover some products out of dead carcass. Meat, blood and bones of dead animals can be recycled as animal food. Today dead animals are buried, though in some locations certain communities eat the meat and salvage part of the leather. Today, our slaughter houses are a health hazard from the ecological point as well.

Conclusion:

Thus it can be easily seen that from the health and economic as well as humanitarian points of view, immediate attention should be given for modernization of slaughter-houses in various stages and aspects. Except the technology of recovery of certain by-products such as harmones, enzymes, liver extract, etc., which need foreign collaboration, all other aspects can be implemented with Indian know-how. Further processing and distribution of certain products may need, selectively, foreign help. Export potential will be enormous. There will be great scope for additional employment in recovery and processing of by-products. Investment required for total modernization of slaughter may be in the region of 500 crores of rupees. But we can make a beginning with State capitals, District towns and taluk-towns. Panchayat slaughter-houses can be modernised partly with the introduction of stunning, slaughtering one by one and improving hygiene.

The total animal system is so crucial to the country that it needs immediate attention from the economic point of view as well as from the humanitarian aspect. Westerners have already modernised. India, of all countries, must not lag behind in its treatment to animals. Therefore, along with this issue of ban on slaughter, modernisation of slaughter should be of public interest.

APPENDIX

Livestock Population as of 1972

(Figures in million)

CLASS			TOTAL
Cattle			
Adult Cows	56		
Adult Bullocks	74		
		130	
Young stock		48	
			178
Buffaloes			
She Buffaloes	30		
He Buffaloes	8		
		38	
Young stock		18	
			56
Bovines (Cattle & Buffaloes)			234
Large Animals			
Horses & Ponies		1	
Donkeys		1	
Mules		1	
Camels		1	
			4
Small Animals			
Sheep			40
Goats			68
Pigs			6

Source: Report of the National Commission on Agriculture, VII, 1976.

Gains of Modernization of Slaughter

I. Input

(IN MILLION)

	Cows	Bullocks	Buffaloes Male	Buffaloes Female
Population (1972 Census)	56	74	8	30
Mortality[1]	5.6	7.4	0.8	3.0
Population Alive	50.4	66.6	7.2	27
Animals Available for slaughter every year[2]	5.0	6.7	0.7	2.7

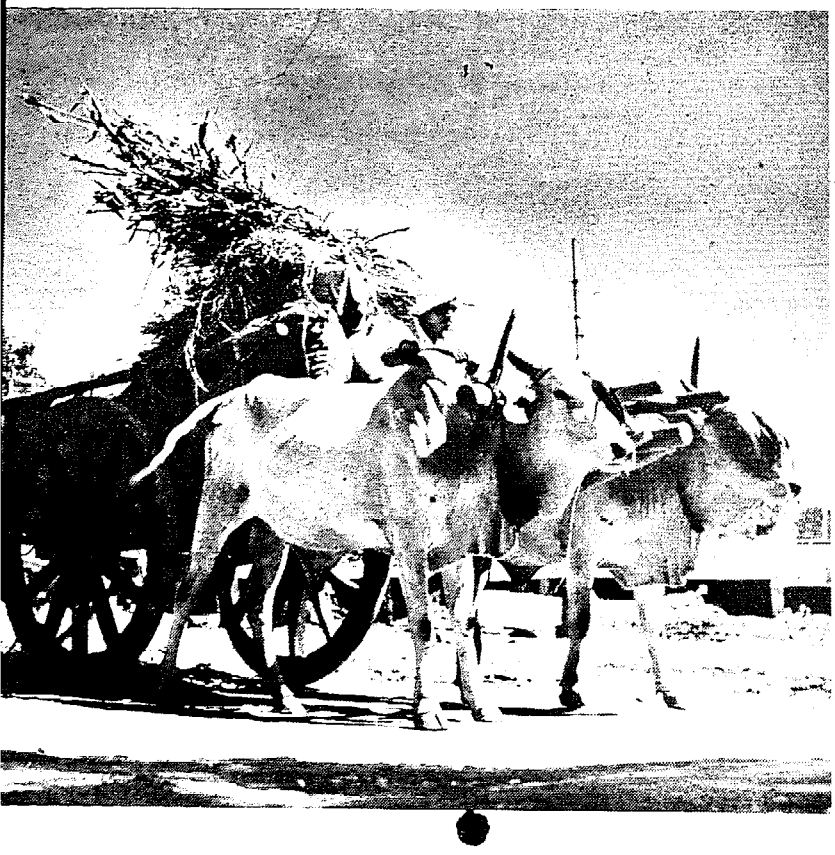
II. Output

(IN MILLION)
KGs

	Cows	Bullocks	Buffaloes Male	Buffaloes Female	Total	Value In Crores Rs.
Meat (at 50 Kg/Animal)	250	335	35	135	755	377
Blood (at 8 Kg/Animal)	40	54	5	22	121	6
Bone (at 30 Kgs/Animal)	150	201	21	81	453	45
Hicks (at 15 Kgs/Animal)	75	100	10	41	226	68
Horns and Hoofs (Million pairs)	15	20	2	8	45	2
Fat (at 5 Kg/Animal)	5	7	1	3	16	5
Harmones/Glands (1 Kg/Animal)	5	7	1	3	16	3
						506[5]

1. Mortality due to natural causes is taken at 10 percent.
2. The population alive is spread over 10 years to derive the number of animals available for slaughter each year The weight of the live animal is taken as 200 Kgs.
3. Average values assumed are (a) Rs 5 per Kg of meat (b) 0.50 paise per Kg of blood (c) Re 1.00 per Kg of bones (d) Rs 3 per Kg of Hide (e) 0.50 paise per pair of Hoofs and Horns (f) Rs 3.20 per Kg of fat and (g) Rs 2 per Kg of Harmones and glands.
4. In addition to the by-products referred in the table, there are other items such as tongue, lungs, spleen, offal, Kidney, casings, punch and stomach which can also be collected and utilised.
5. Under the present method of slaughter only 20 per cent of this value is recovered.

A pair of camels used for chaff cutting →
in Rajasthan



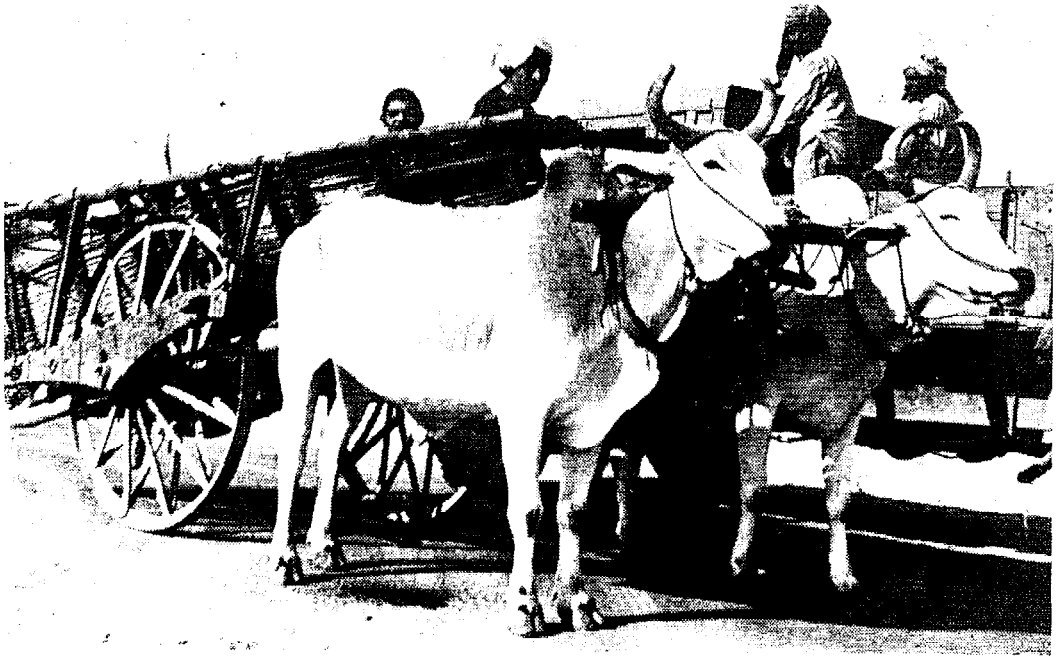
← A traditional wooden cart from South India
drawn by a pair of pedigreed bullocks

Bagasse is used as fuel by sugar factories in India. The cost of sugar production comprises a high transport component. ↓

In a village near Hosur, wood is being cut possibly for cart-building and loaded on to a bullock-
All over India, in the villages, wood for fuel and construction is carried in animal-drawn carts.

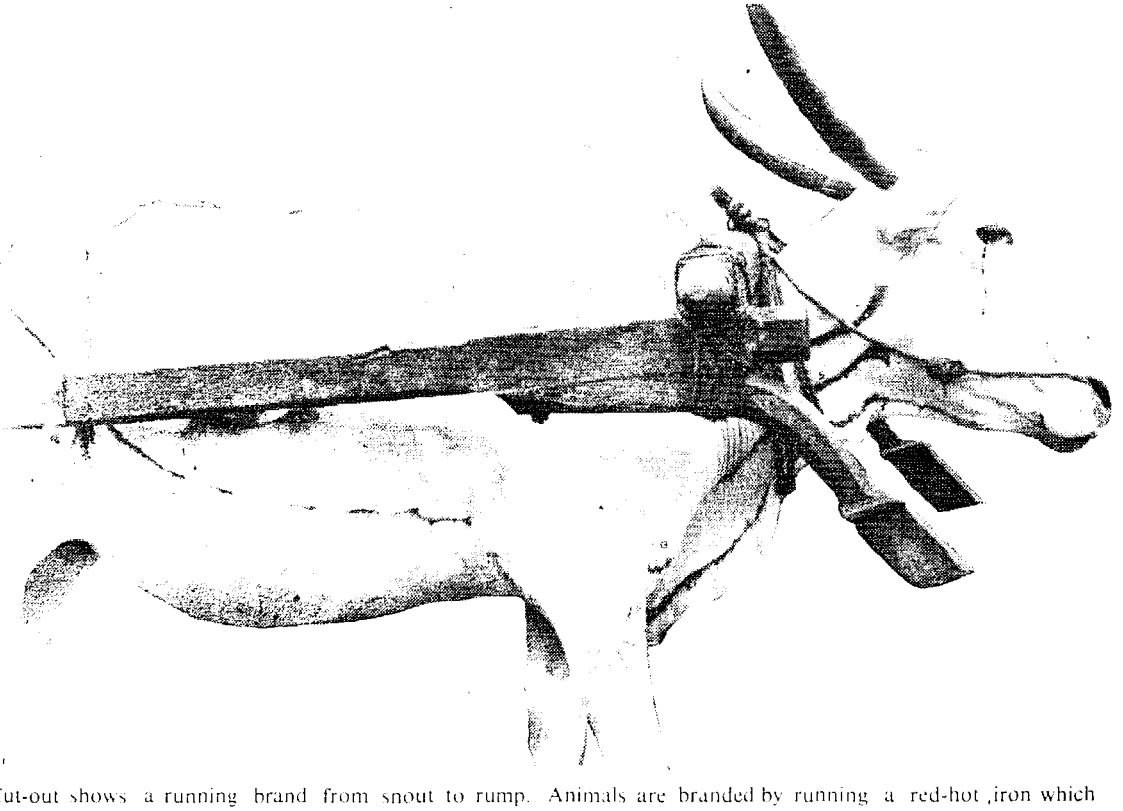
An HM-B Photo

These thoroughbred Hallikars insist on rest. Work-animals have to be frequently rested between spells of v



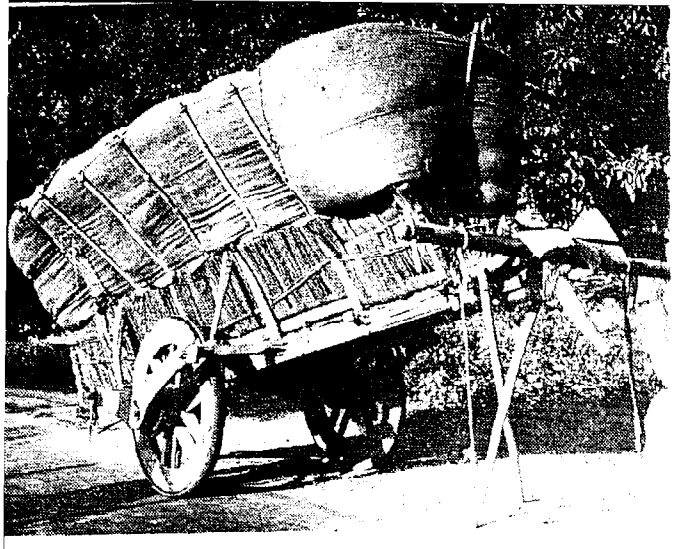
A traditional metal-wheeled cart on the Delhi-Gurgaon road drawn by an impressive pair of Haryana bullocks. The bulk of the carts in the interior of Haryana are of this design. Tyrization of the wheels with hard rubber will greatly improve tractive performance and reduce road damage.

An IIM-B Photo



Cut-out shows a running brand from snout to rump. Animals are branded by running a red-hot iron which singes the coat and burns into the flesh. Resorted to for a variety of reasons, superstitious and other, branding entails needless cruelty to animals. The same objectives can be achieved by chemical marking.

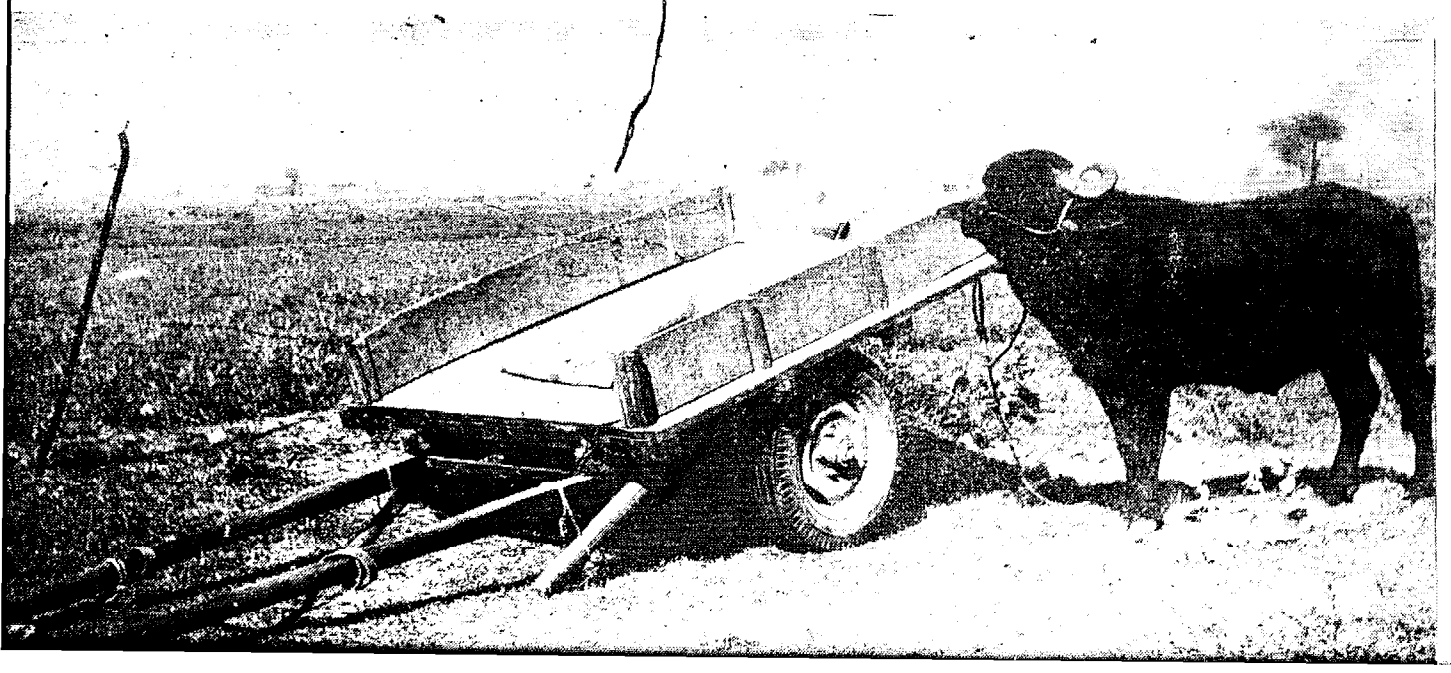
An IIM-B Photo



A traditional cart with supernumerary components in use in Rajasthan and Haryana. It is often used to carry chaff, dry fodder, and fuel.

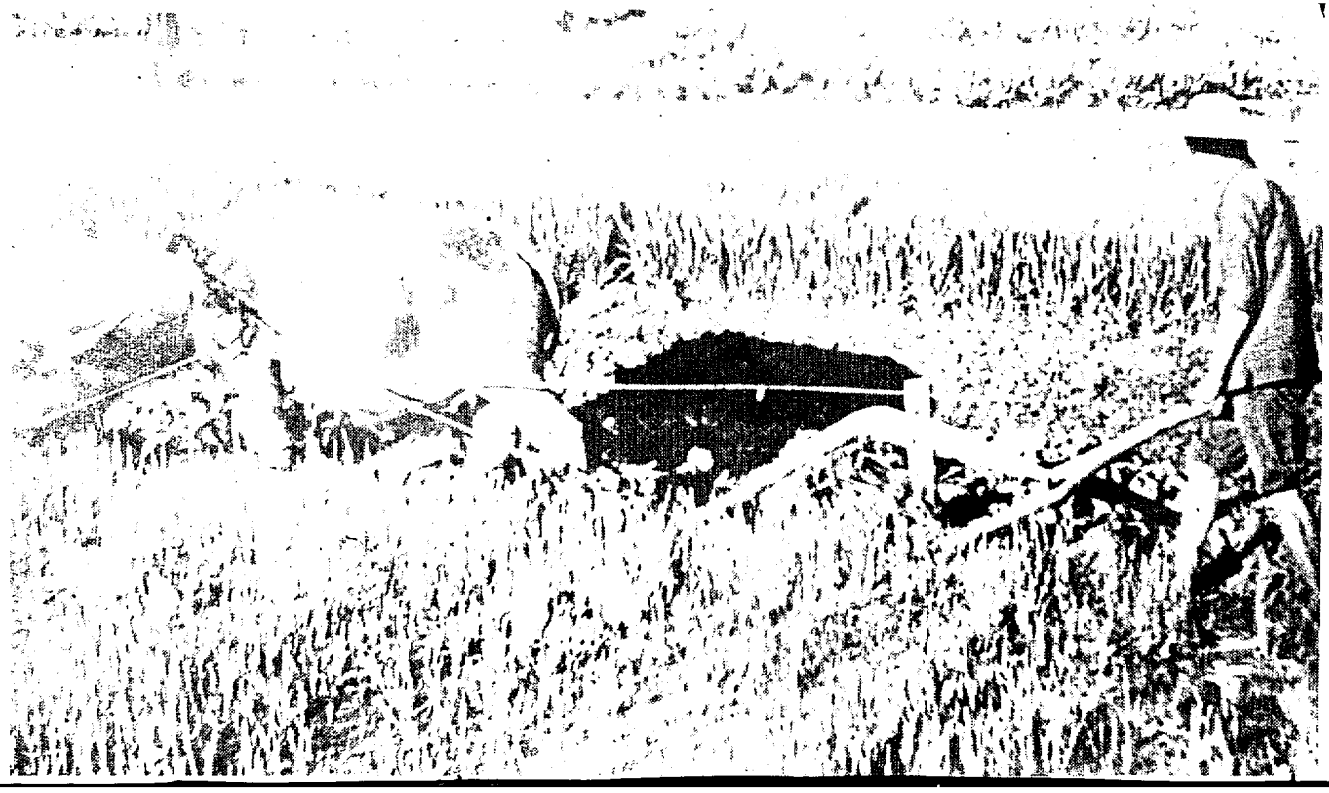
In Ooty, carts like the one below carry the hill-station's entire requirements of retail consumables. Yoked to a Jersey bullock, which makes a good work-animal, the cart has a low tare-weight. The pole-brake at the rear is barely visible.

A plain buggy used in conjunction with discarded truck tyres and axle. Yoked to a buffalo, it is a common sight in the sugar-cane growing districts of U.P.

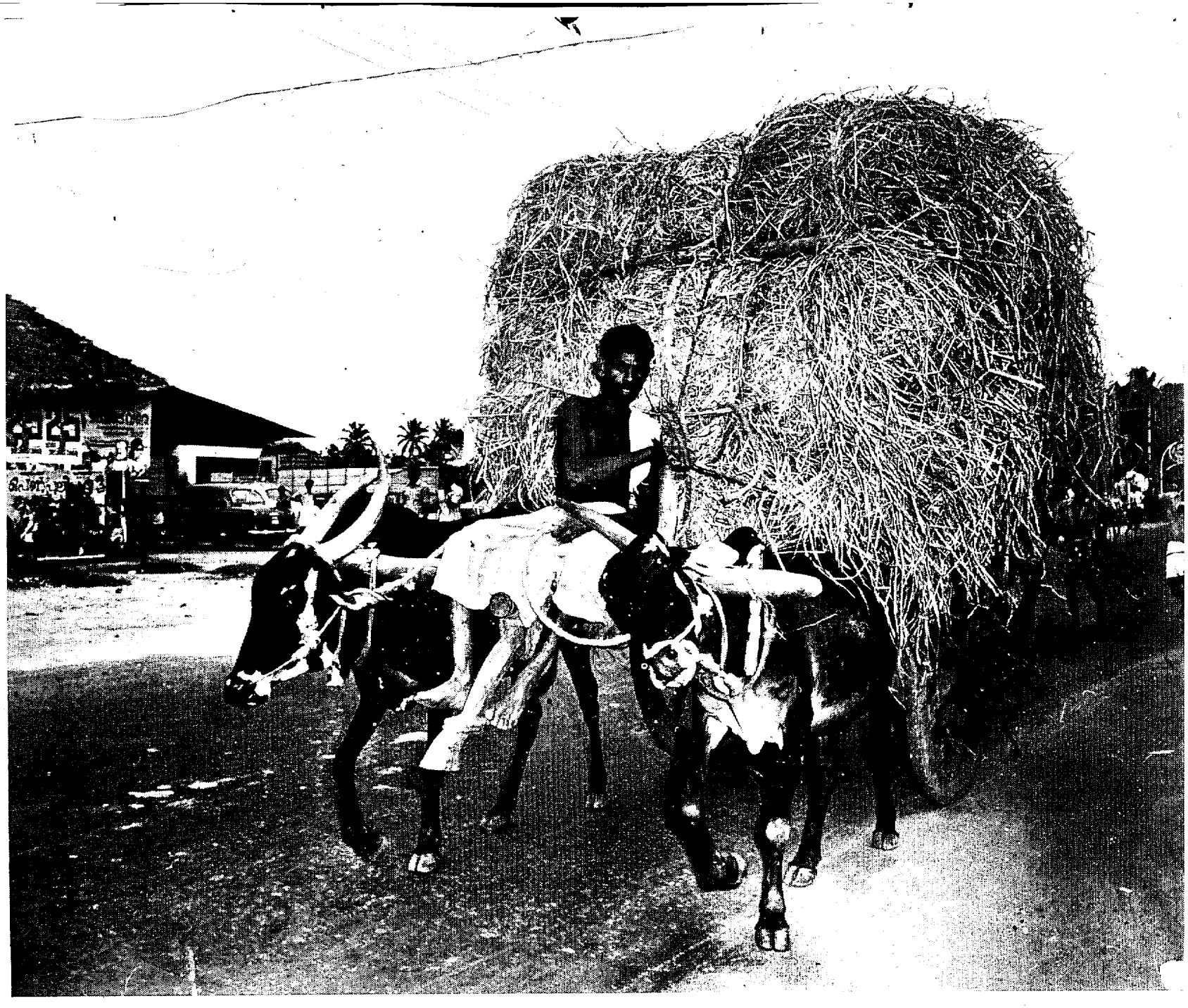


In Orissa and Andhra Pradesh, small animals whose output of power is low are set to plough fields in large numbers. These non-descript and scrub animals are to put to good use by small and marginal farmers. The animals cannot plough large areas, and soil penetration is low. They are undernied and take a deal of punishment. Ploughing is the principal mode of animal energy use.

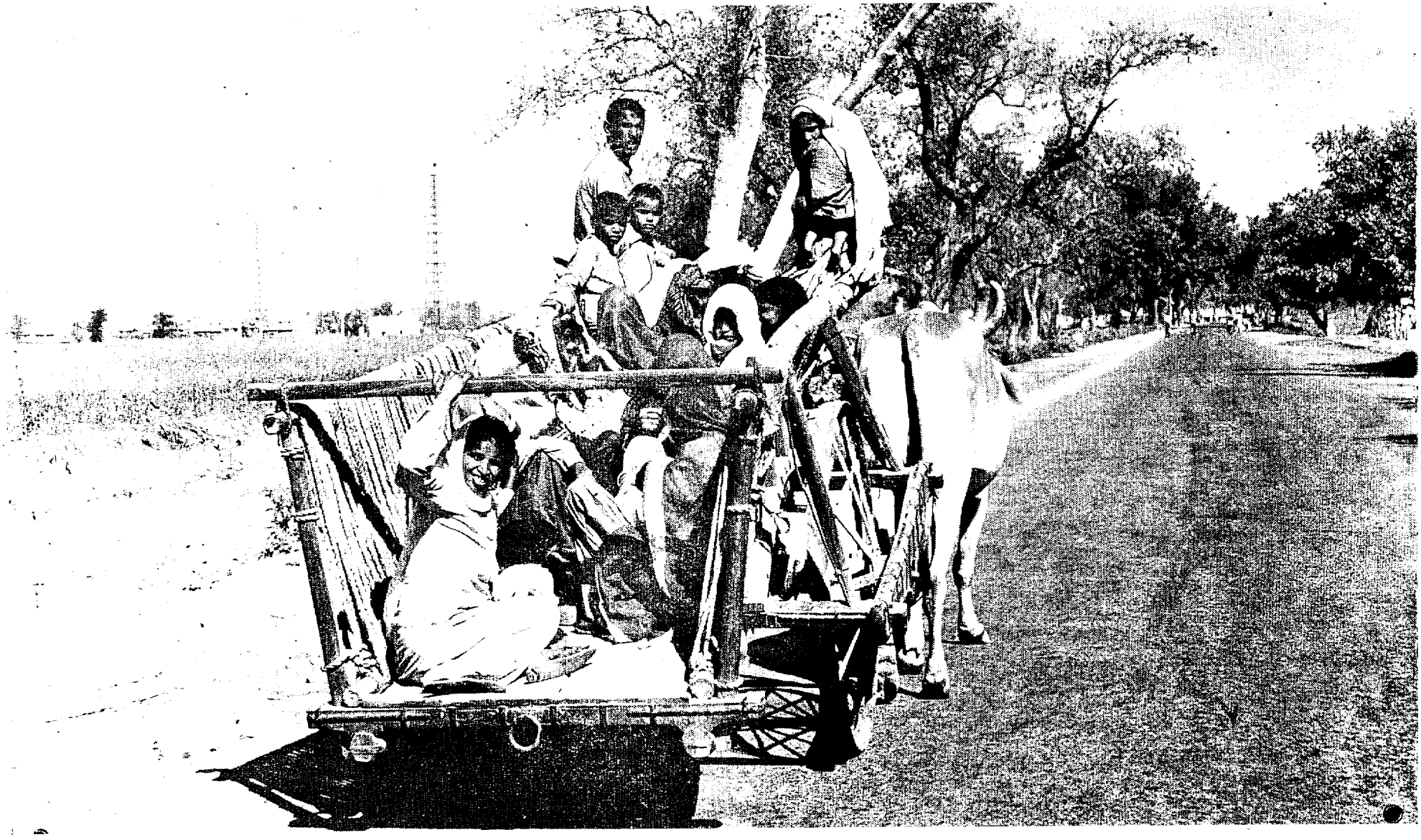
An array of traditional and improved carts at a sugar-cane *mandi* in Karnataka. Most improved carts are in use for carrying sugar-cane from farms to factories.



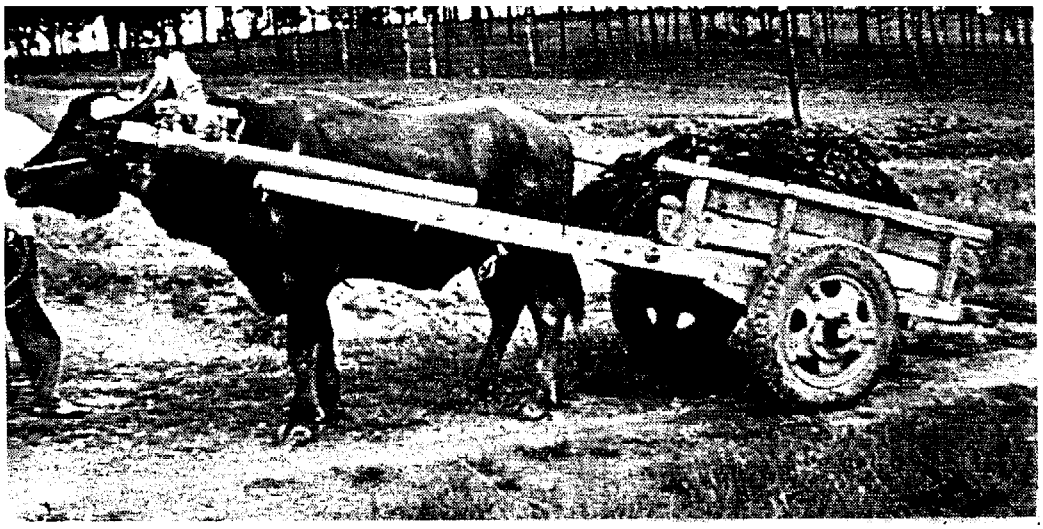
A Chinese plough. Note the distance between the animal and the plough-handle. The redesign project for agricultural implements proposes that this distance be optimized and laid down in recommended designs. Likewise the distance between two animals in a double-harness cart can lead to the dissipation of tractive effort by animal, if increased beyond a point. The IIMB project recommends detailed testing for the fixing of design parameters and control variables not only those of the animal-drawn cart but all farming implements used in conjunction with animals.

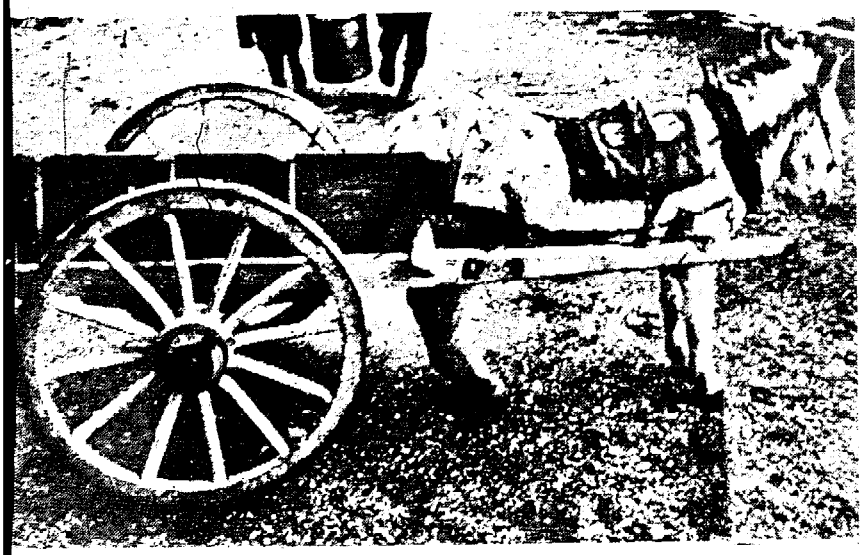


Hay and straw are common cargo for animal-drawn carts all over India. A marketable surplus of hay is disappearing fast thanks to the quick-maturing, non-lodging varieties of improved seeds which are economical of leaf and stalk. A team that does not pair well comes in for much punishment, the smaller animal receiving the major share



Carts are used for passenger traffic all over the country: Haryana, Bihar, Tamil Nadu, Gujarat and Rajasthan.

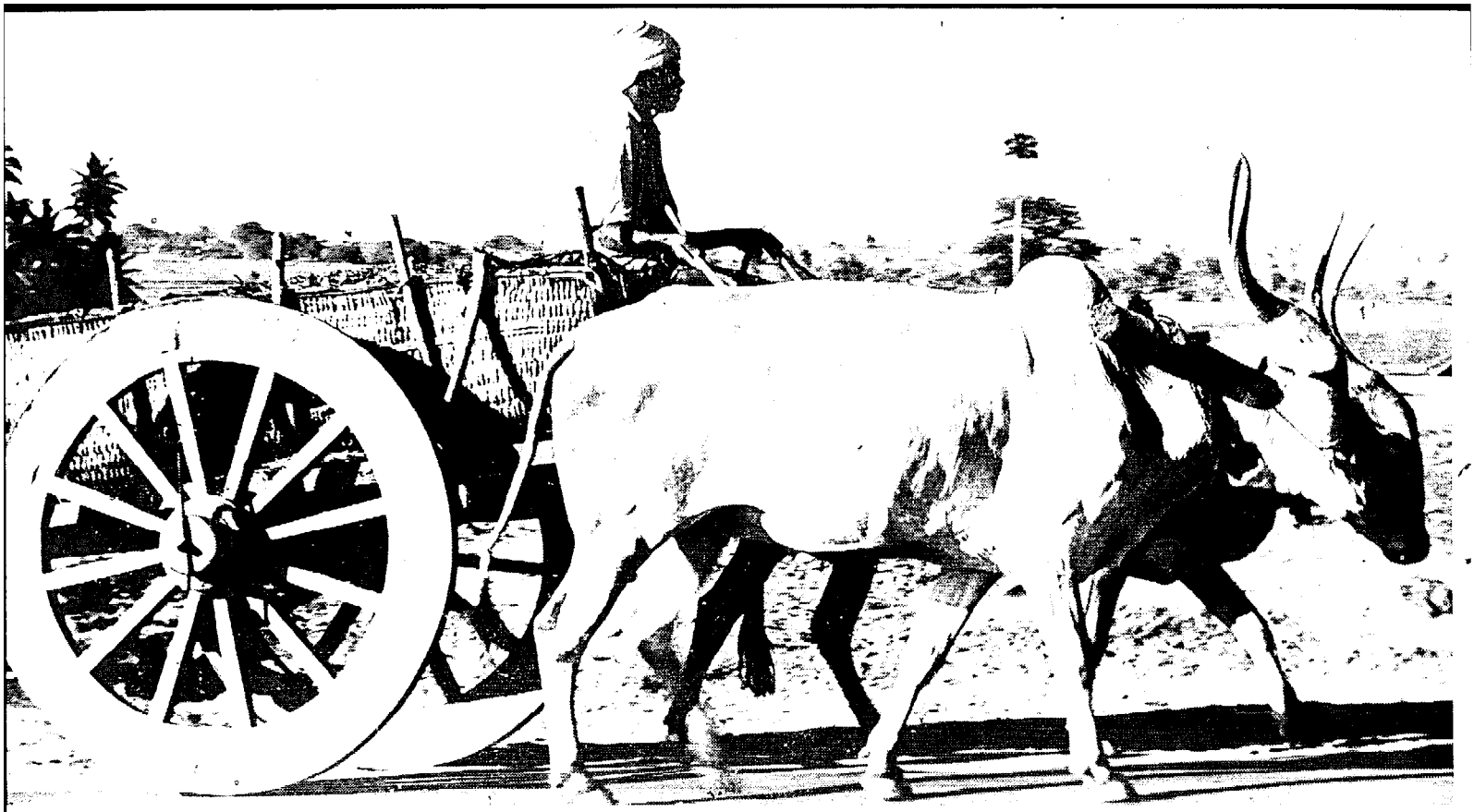




↑ A two-piece harness used on a "buffalo-cart" in China. It serves to avert the vertical load incident on the animal's neck and increase draught efficiency. Courtesy: W. Ross Cockrill: *The Buffalo of China*; Freedom from Hunger Campaign: FAO; Rome; 1976.

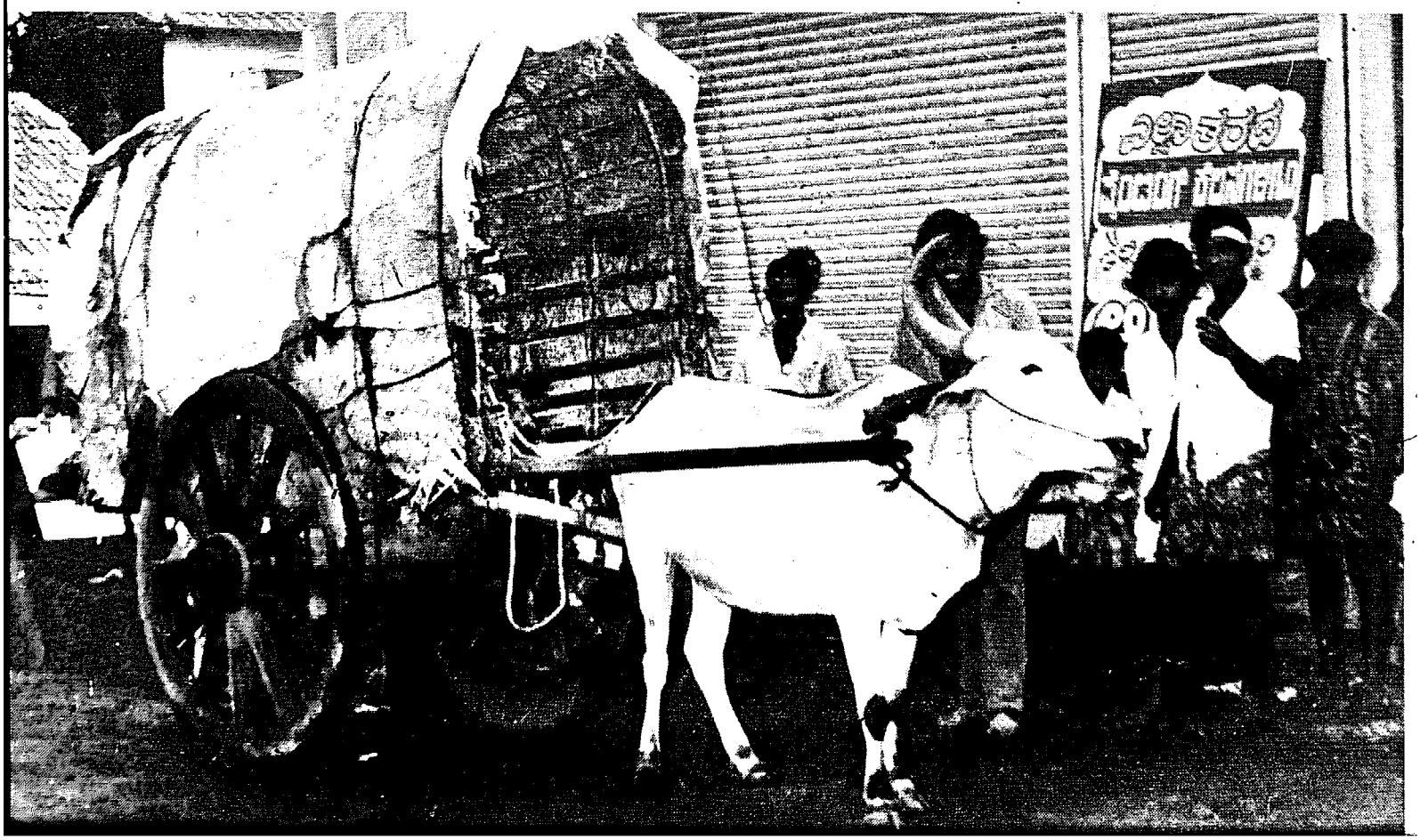
← A donkey-drawn milk float with improved wheels of traditional diameter Courtesy: Adam Woolfitt: *National Geographic*; Vol. 154. No. 5; November 1978.

A single-harness buffalo-drawn cart In China. The cart is nominally improved with pneumatic tyres, and has a traditional yoke partially but simply modified for animal comfort. The single-harness cart is carrying about a tonne of bran or husk. Courtesy: W. Ross Cockrill; FAO; *op. cit.*



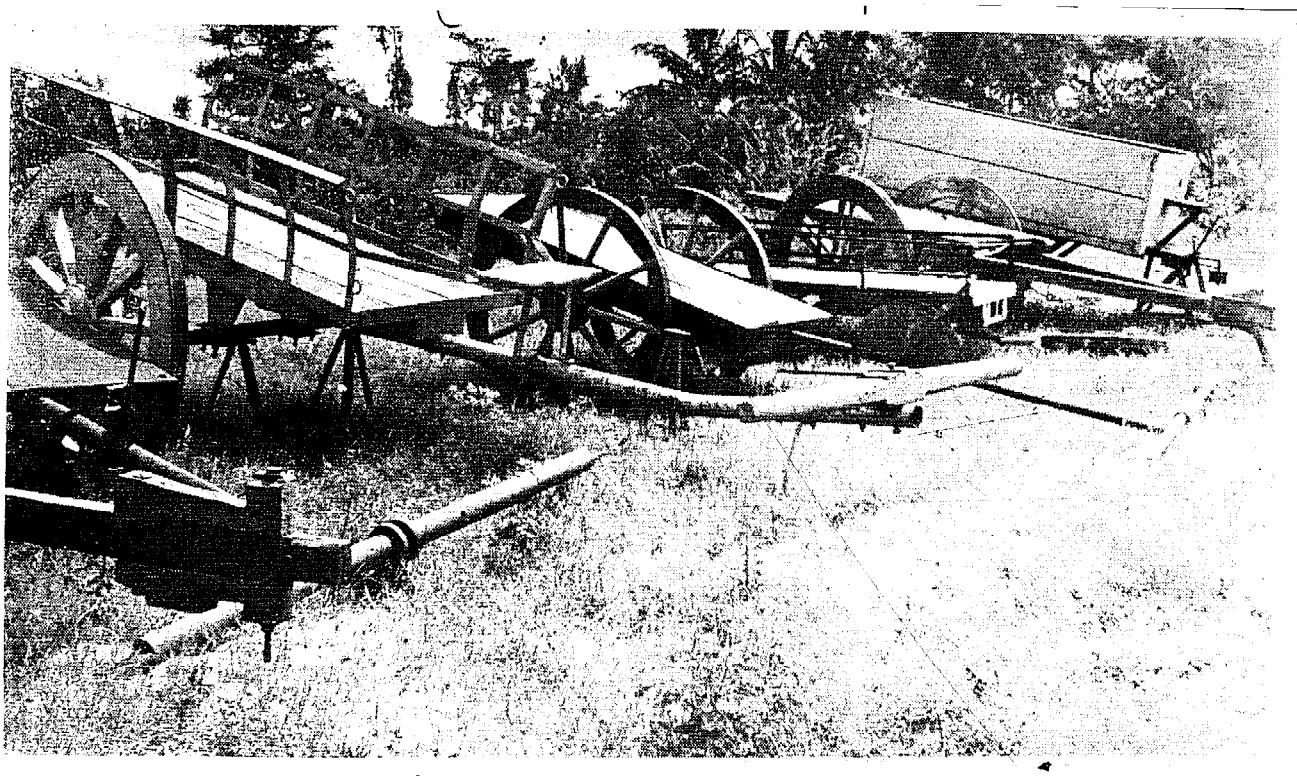
A traditional double-harness bullock-cart. In its present condition, it cannot carry much more freight than one tonne. When freight is available, these carts a unconscionably overloaded. The woven wicker or cane is used as a container for lime, sand, garbage and even fertilizer and inferior grain. With smooth bearin and axles, an improved yoke and materials of high strength-weight ratio, these carts can be made to carry as much as 2.5 to 3 tonnes of load.

This hooded cart common in all States of South India is used for passenger and goods traffic; it affords protection against rain and sun. A convoy of car travels all night carrying rural produce and inputs for farming and is met with on most National and State Highways.



At the National Dairy Research Institute in Bangalore. Local animals crossbred with Jersey cows and so upgraded make both good work-animals and milk-yielders. This cart is carrying *jowar* used as fodder to the stalled cows.

An IIM-B Photo

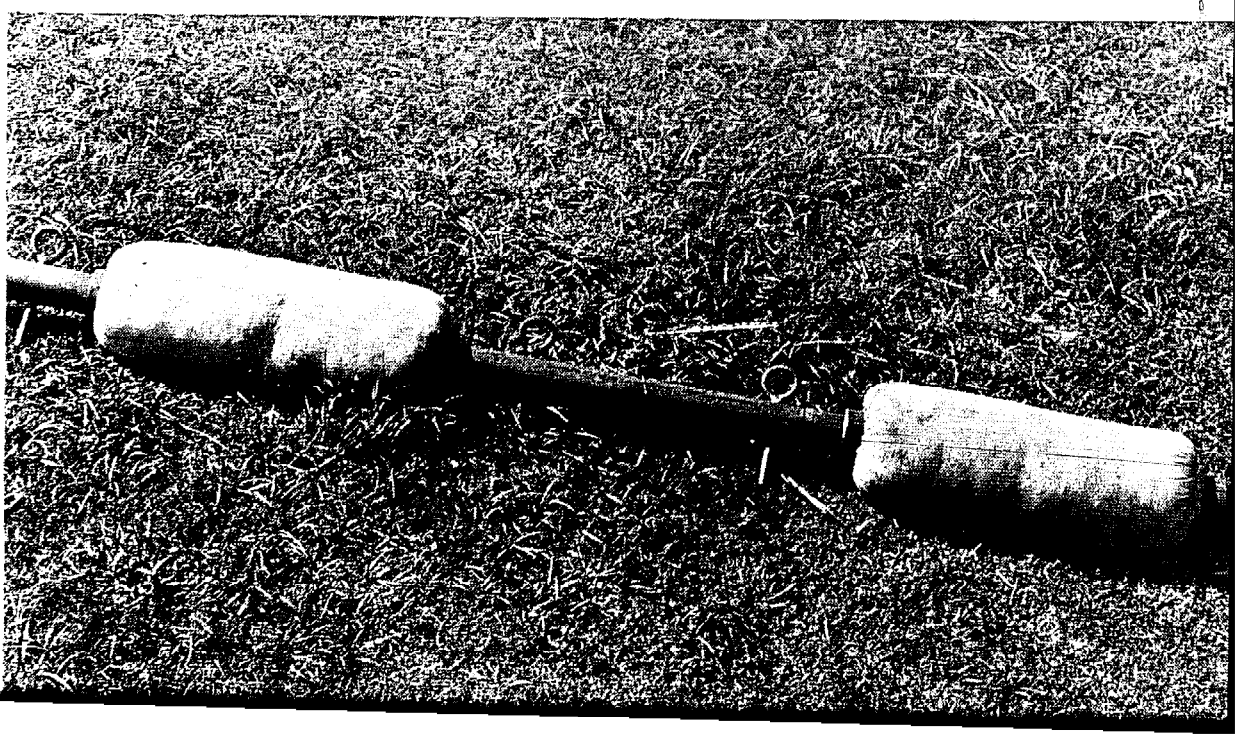


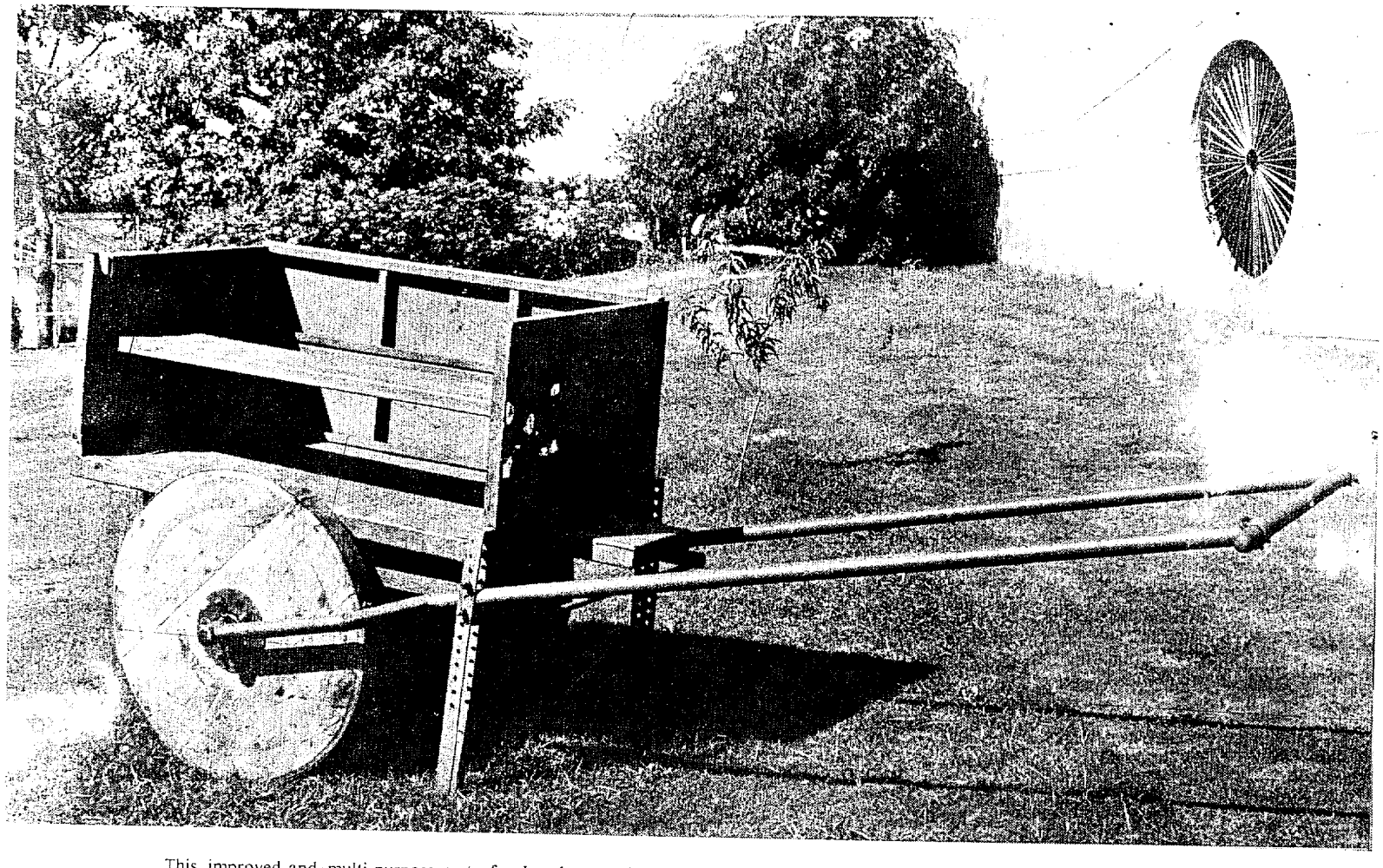
A panoramic view of prototypes built by IIMB under the Modernization of the Bullock-cart Project funded by the Department of Science and Technology in 1976. Some have been designed afresh while others are existing designs which have been improved piecemeal.

An IIM-B Photo

An improved yoke with padding. An IIM-B design exhibited at Agri Expo-77, Delhi. The objective is to reduce neck callosity in the animal.

An IIM-B Photo

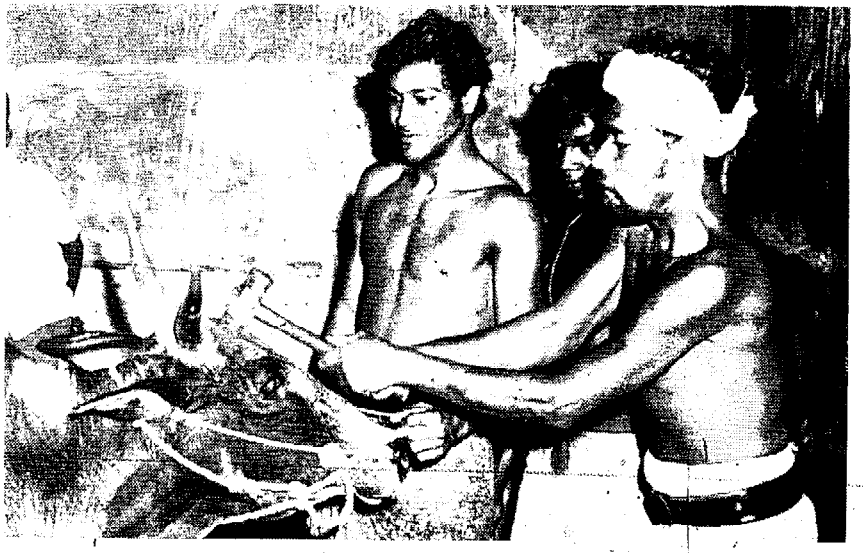




This improved and multi-purpose cart of reduced tare-weight was designed by IIMB and Dunlop engineers. It was shown at Agri Expo-77 in New Delhi. The cart can be pulled by a single animal or a human being and can carry passengers as well as goods.

An IIM-B Photo

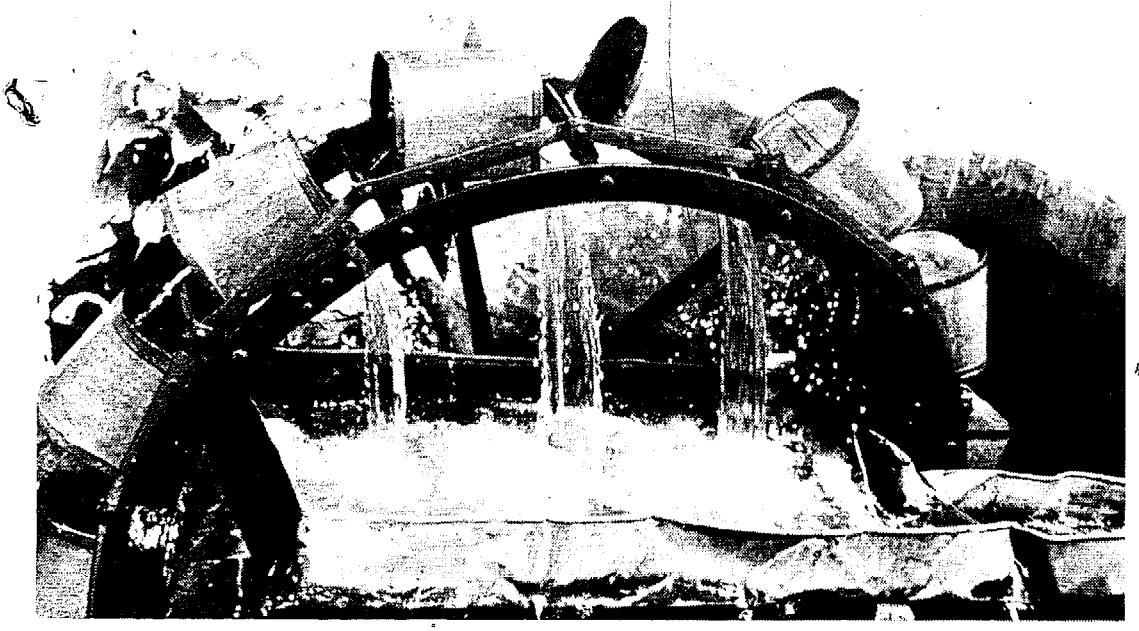
Here a live and sentient animal is being held down by four men and hacked to death.



The animal is hammered into unconsciousness before slaughter. In many backyards, even this crude pre-stunning procedure is dispensed with. See " A Note on Stunning", p. 93

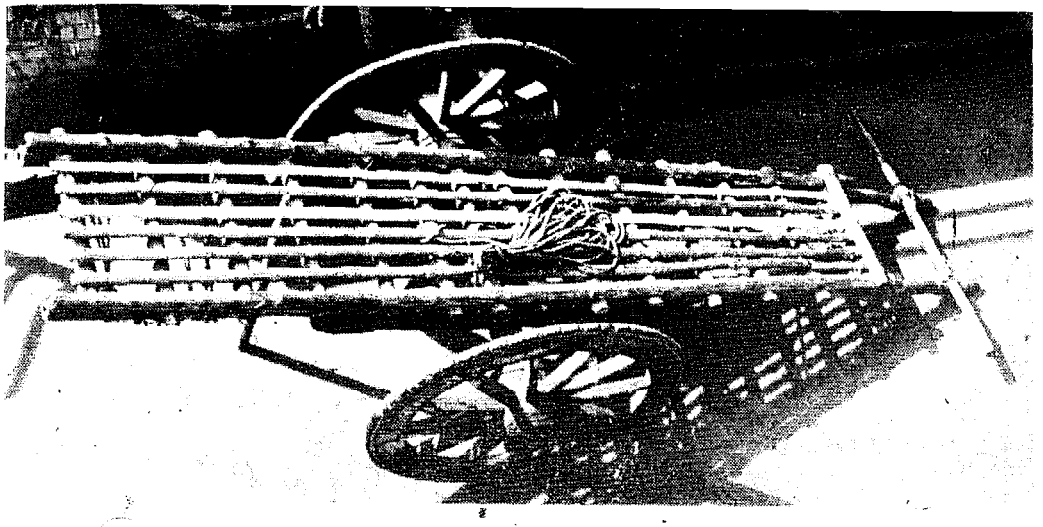
For shoeing, the animal is thrown prostrate on its side, its legs are tied up in pairs, and two or more men hold it down. While the ill-fitting shoes, invariably too large or too small, are nailed on to its hoofs. Often, because of the long nail, sepsis sets in.

A Persian Wheel worked by buffaloes in Muzaffarnagar district of Uttar Pradesh. Buffaloes are increasingly coming into use as work-animals.



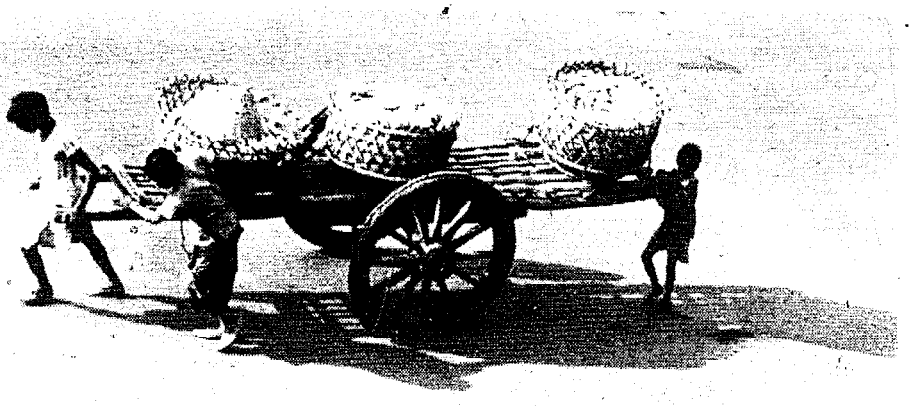
IIMB Photo

Water buffaloes do not work well in the hot sun. Otherwise, the Murrah buffalo of North India makes a splendid and versatile work-animal. The buffaloes of South India probably need to be generally upgraded for better work capacity and milk yields. At present, the male calves are killed off at birth.



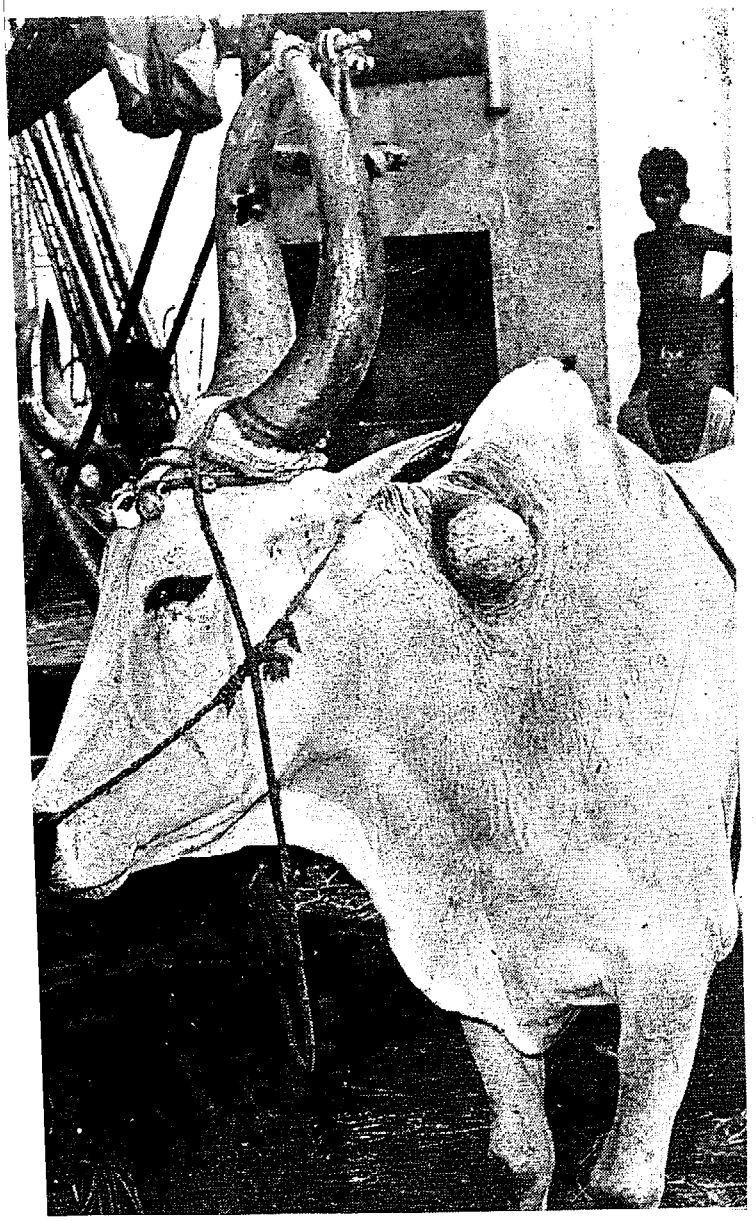
A hand-pushed cart from Calcutta. Note the large Orissa-type wheels are rubberized and the long platform fashioned from relatively cheap bamboo. In Calcutta, push-carts and trucks are wholly complementary. Within city limits, animal-drawn carts are probably prohibited.

IIMB Photos



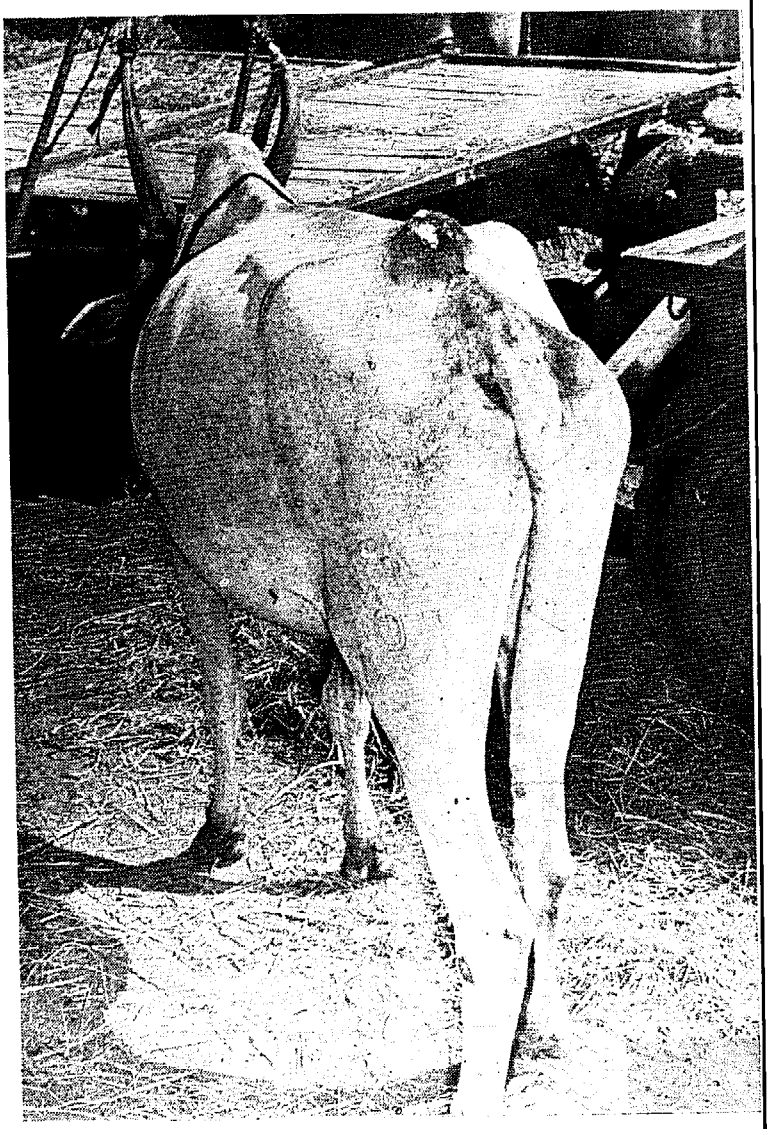
Donkeys being used as pack-animals for carrying fertilizer somewhere near Tirupati in Andhra Pradesh

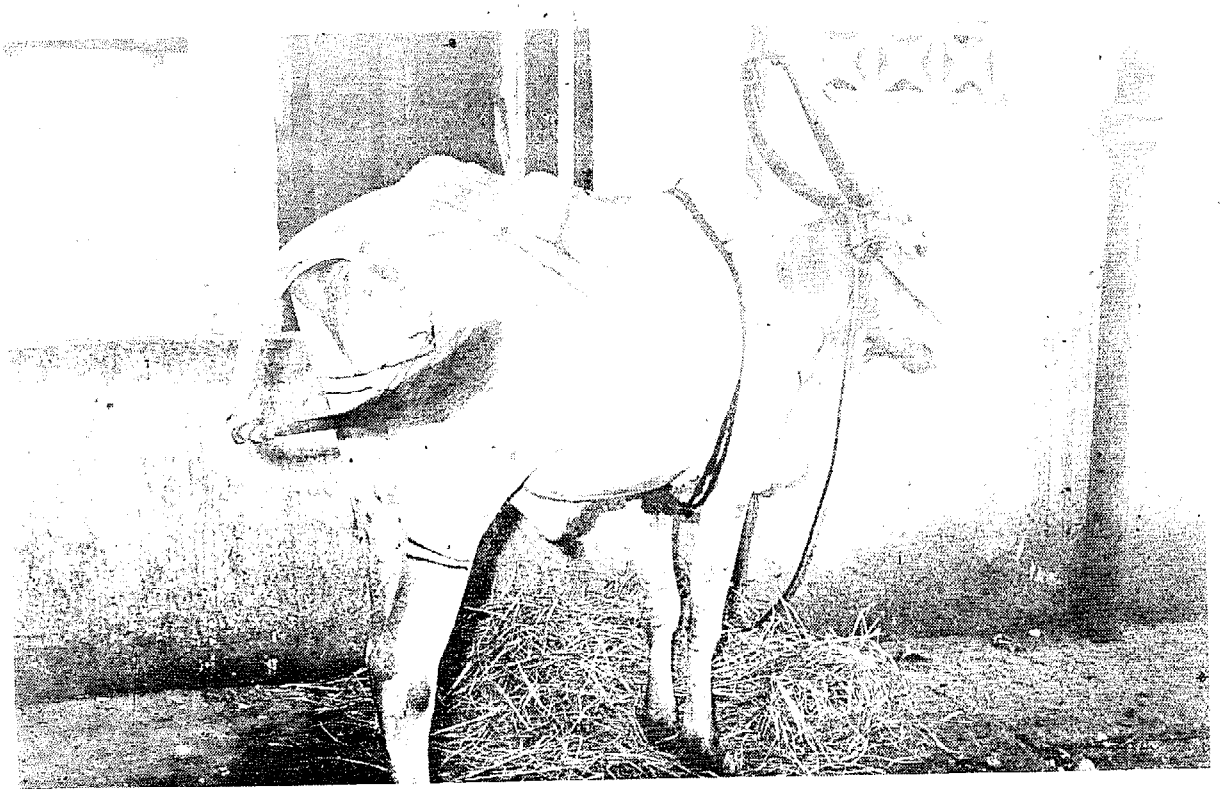
IIMB Photos



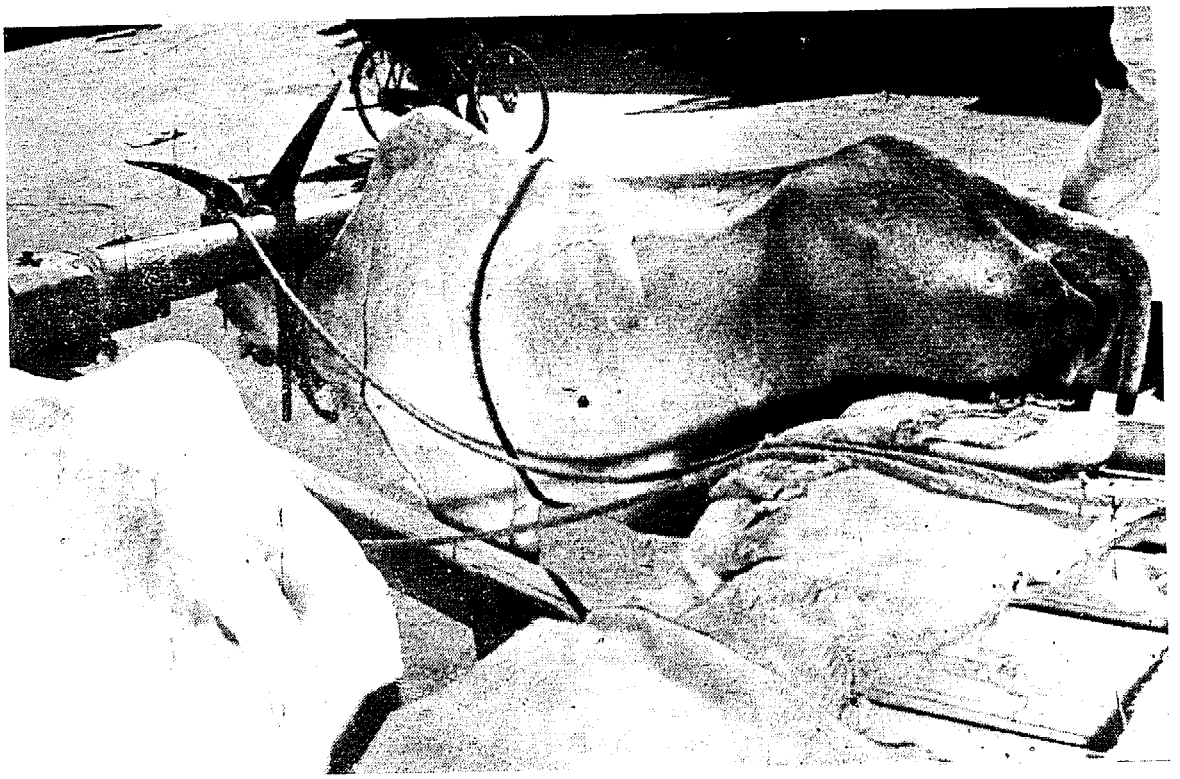
Neck sore: Due to constant rubbing of the yoke against the skin, animals develop neck gall and cancer. As animals are put to work even with sore and bleeding necks they continuously suffer.

Sore on the animal's back: Materials rubbing against the animal's back causes this kind of wound.

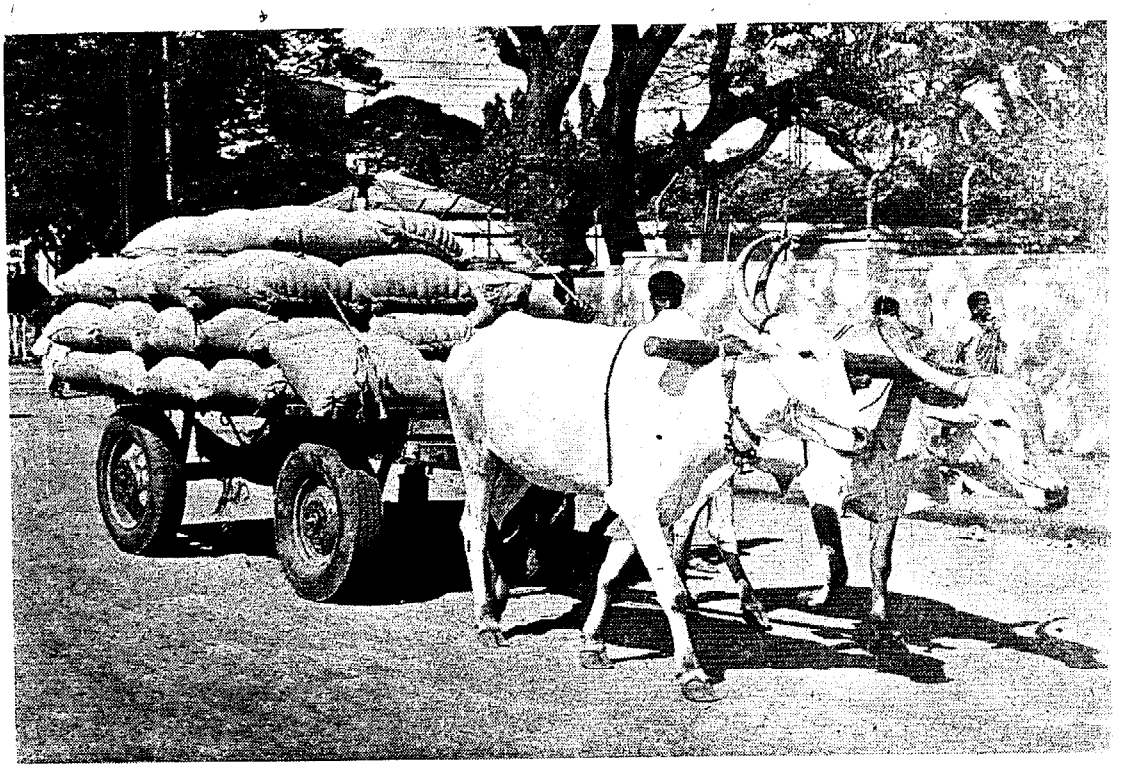




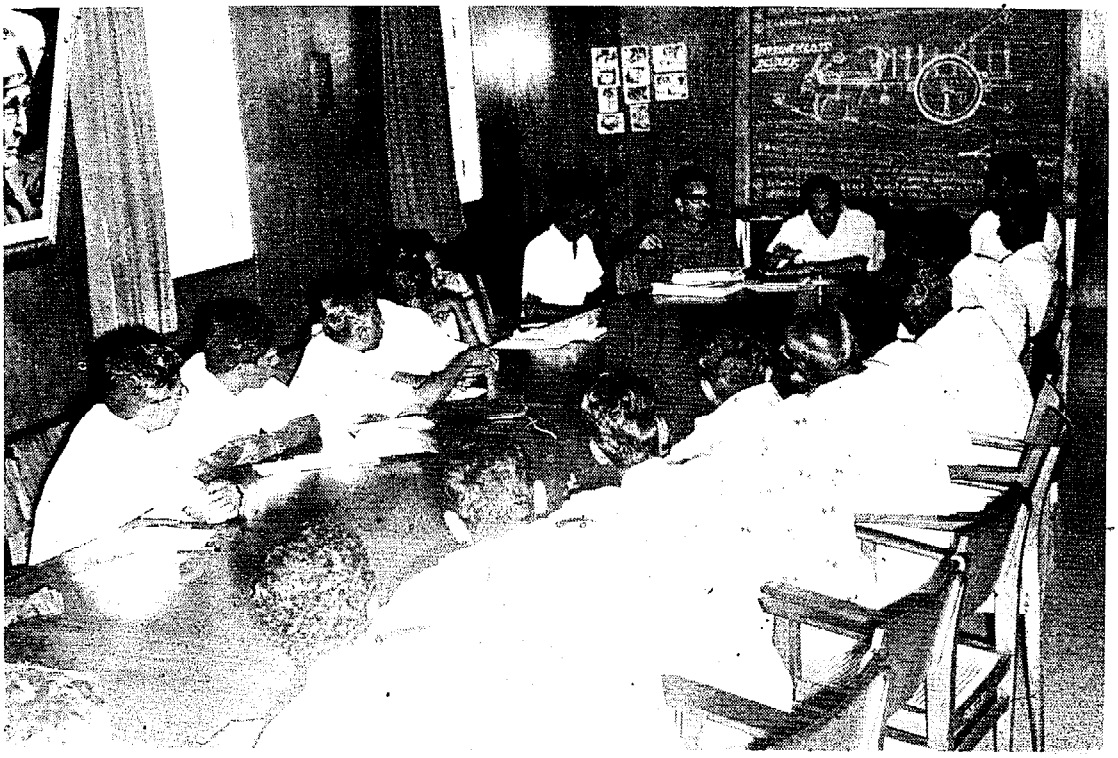
Branding: Animals are branded with hot iron, due to the superstition that branding will prevent certain kinds of diseases. Apart from the cruelty, the skin gets spoilt, losing valuable leather.



In order to goad animals to pull loads beyond their capacity, all kinds of cruelties are inflicted. Marks caused by whip-lashes and beating can be seen on most of the animals.



Four-wheeler carts—double bullock and single bullock drawn: one of the improvements brought about in some cities is the introduction of pneumatic tyred four-wheeler carts. As against the normal capacity of one ton of a traditional cart, such tyred carts carry as much as 4-5 tons on level roads. On a four-wheeler, that vertical load on the animal's neck and constant rubbing is eliminated.



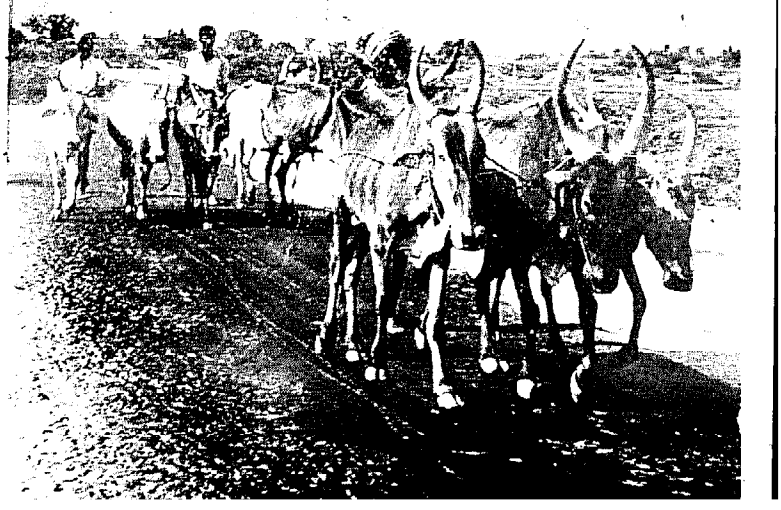
A Workshop for cart manufacturers in session, conducted by HM-B in the College of Engineering, Guindy, in collaboration with Periaringar Anna Technological University. Cart manufacture is in the decentralised sector, involving thousands of small manufacturers concentrated all over the country.

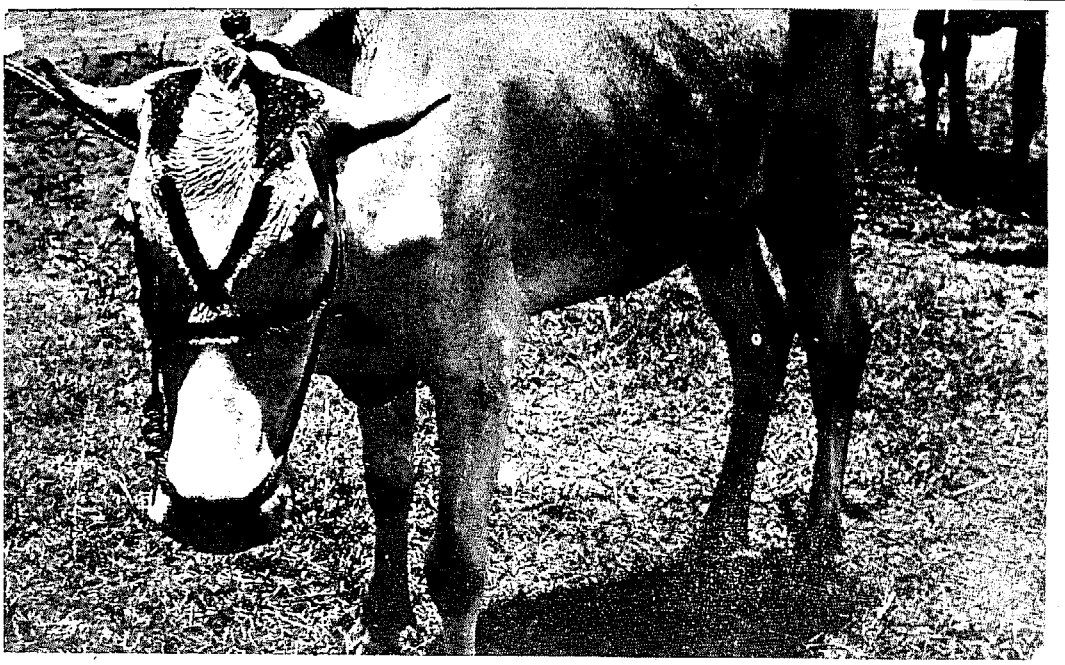
Animals are slaughtered not only in the approved Municipal slaughter-houses, but in backyards and mandis as well. Animals are herded into one room where they are slaughtered one by one. Seeing the struggle of those being slaughtered, the other waiting animals get terrified. This is wanton cruelty.

A ghastly neck sore; but still the buffalo is being worked. Buffaloes make excellent draught animals in certain regions. An estimated 22 millions were killed off soon after birth during the last ten years. China has a stock of 50 million buffaloes. In our energy-starved farms, buffaloes should be raised as work-animals. Buffaloes are ill-treated far more than bullocks, which are treated badly enough.

Though the creator did not give animals the voice to protest, their eyes wet with tears speak tellingly of their agony.

This last journey on man's earth is a telling commentary on our values. Thousands of work-animals are marched up to 200 miles to distant gallows. They are tied two and four together, and many fall down and get trampled upon. Normally, no food, not even water, is given to them *en route*. In Western countries (where there is less hypocrisy on this issue) animals are transported in special vehicles.

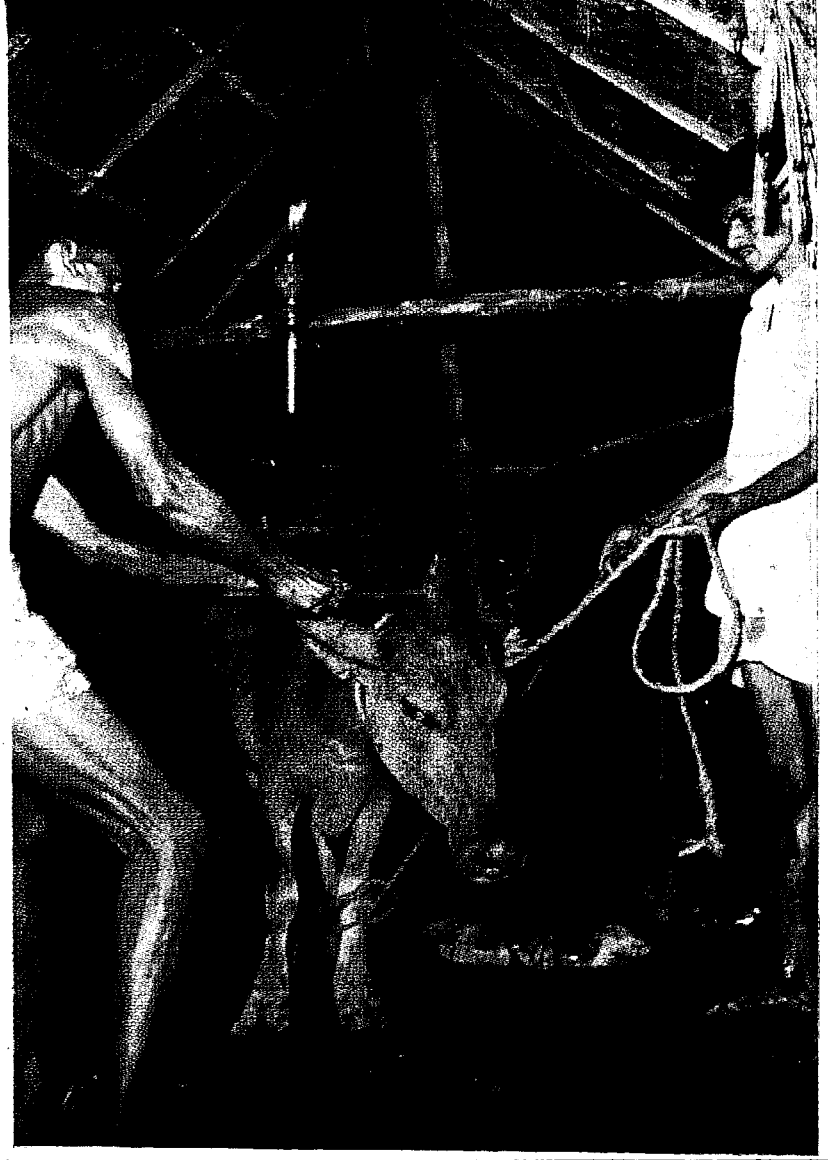




A lovely animal has been disfigured by branding all over the face. Besides the pain of branding with hot iron, the leather is also damaged. Its horns have been removed by pealing the skin and burning the roots with hot iron-a process, which causes excruciating pain. Such unnecessary cruelties are inflicted on bullocks and camels all over the country.

A young bullock has been roped for castration by the primitive method where the testes are crushed with stone. This process is far more painful than any other wound on the body. Note the way the animal is roped, which itself is cruel.

A Pig is being killed by bea with an iron rod. Besides the cr involved, this is a bad pra from the health point of view blood will clot inside. Pigs are k in the presence of piglets. A nu of people gather around beating pig merrily till death releases animal from the brutality of man



Most large animals are slaughtered in backyards, illegally. Here, a young buffalo is being got ready.

The head is hit with a hammer to immobilize the animal so as to make it easy for handling. How much of the agony the animal could have been saved if only a captive bolt pistol had been used to stun the animal! The animal is shutting its eyes, so that it may not witness the betrayal by man whom it has served so well.

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This buffalo is being bled to death. The bulk of the blood is now wasted. Stunning facilitates bleeding. In the existing method, the animals suffer excruciating pain. There are 30 million female buffaloes, but only eight million males. Male calves are abandoned a few days after birth to die of dehydration and starvation.

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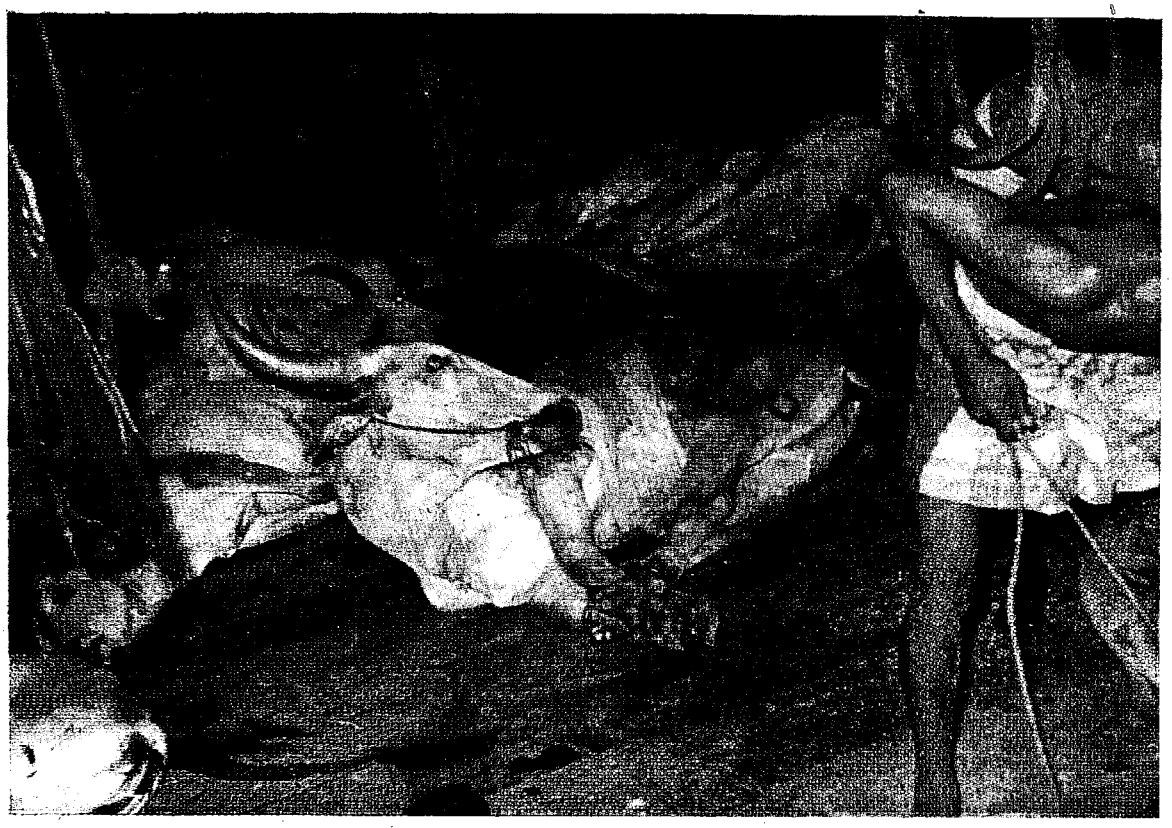
A handsome healthy bullock is smelling death. Its eyes speak volumes of man's inhumanity, for whom bullocks work till the last ounce of their energy. In U.P., Bihar and other states, most cows are killed after the lactation period — ban or no ban.

Another healthy bullock is being roped in. Its head is twisted and the animal is pulled by the nose-rope in order to fell it. In some places, the head is smashed after felling. Note the severed head beside the animal. We have 72 million bullocks. Most of them are slaughtered after their utility is over, and many before then. Bullock-power exceeds the installed capacity for electrical power in India.



In illegal slaughter, several animals are slaughtered in small dingy closed rooms. They are slaughtered in the presence of other animals – which is brutal indeed. Animals awaiting their turn wallow for hours in blood, excrete and the viscera of their kith and kin, watching the struggle of those undergoing slaughter. This is totally unnecessary cruelty.

The throat is being cut while the head is clamped down in a painful position. In Western countries, animals are stunned and slaughtered, one at a time on a ramp, without other animals watching the gruesome process. Terror-stricken animals excrete urine and dung during the struggle, and all this contaminates the meat.

The head is hit to quieten the animal. A captive bolt pistol costs only Rs. 1,000, and the cost per cartridge is only 30 paise. Stunning can be introduced all over the country by spending about Rs. 5 crores. A country which worships Kamadhenu and Nandi should spend this paltry amount to make the end of these mute animals a peaceful one — at least to salve human conscience.

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The carcass is being dressed in an unhygienic way. By modernizing slaughter, we can recover more by way of skin and bone, hoof and horn, flesh and blood, harmones, etc.—worth may be Rs. 300 crores or more, and they provide additional employment. The investment would only be worth Rs. 500 crores. Animals, the small owner and society will all benefit. It is a pity our priorities and values do not give importance to this aspect, though the investment in animals is Rs. 25,000 crores, same as that in industry.

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