# ERGONOMIC STUDIES OF DRAFT ANIMAL-MACHINE SYSTEM UNDER TRACTIVE WORK CONDITIONS

*by*

M.R. VARMA
CENTRE FOR RURAL DEVELOPMENT AND TECHNOLOGY

*Submitted*
in fulfillment of the requirements of the degree of
DOCTOR OF PHILOSOPHY

*to the*

INDIAN INSTITUTE OF TECHNOLOGY, DELHI
HAUZ KHAS, NEW DELHI - 110 016, INDIA

August, 1997

## CERTIFICATE

This is to certify that the thesis entitled "ERGONOMIC STUDIES OF DRAFT ANIMAL - MACHINE SYSTEM UNDER TRACTIVE WORK CONDITIONS" being submitted by MR. MANSHA RAM VARMA to the Indian Institute of Technology, Delhi for the award of DOCTOR OF PHILOSOPHY is a record of bonafide research work carried out by him under our guidance and supervision in conformity with the rules and regulations of Indian Institute of Technology, Delhi.

The results contained in this thesis have not been submitted, in part or in full, to any other University or Institute for the award of any degree or diploma.

V P S SORAYAN
Asstt. Professor
Centre for Rural Development & Technology
Indian Institute of Technology,
New Delhi-110 016
INDIA

P.M. Singh
Professor & Head
Department of Agricultural Engineering
Narendra Deva University of Agriculture
& Technology, Kumarganj-224 229
Faizabad (U.P.)
INDIA

# ACKNOWLEDGEMENTS

I wish to express my cordial thanks to Dr. V.P.S. Sorayan, Asstt. Prof. of the Centre for Rural Development and Technology, (RDAT) IIT Delhi and Dr. P.M. Singh, Prof. and Head Deptt. of Agriculture Engg., Narendra Deva University of Agriculture and Technology (NDUAT), Kumarganj, Nardendra Nagar, Faizabad, U.P. for the considerable efforts extended by them as my research supervisors and guides, in puting their valuable suggestions and enabling me to report my research efforts in the present form of the thesis. It is gratifying to note the interest with which my attempts at investigating and explaining the erogonomic studies in terms of certain fundamental concepts have been encouraged.

I would like to thank Dr. Rajendra Prasad, Prof. and Head, Centre for Rural Development and Technology, IIT, Delhi, for his generous support in extending all the research facilities in the centre.

Thanks are also due to Dr. G. Singh, Director CIAE, Bhopal, for helping in formulation of the study at its initial stage and guidance from time to time. The constant inspiration and encouragement extended by him all through the course of the research work is thankfully acknowledged.

I am also thankful to Sh. R.P. Mahna, for his kind help and encouragement for providing suitable instrumentation at various stages.

I acknowledge with thanks the support received through ICAR adhoc project on "Study on local draft animals and adoption of improved implements for Eastern U.P."

I also acknowledge the financial support provided through ICAR, Senior Research Fellowship during my study period at IIT Delhi.

I also thanks Dr. U. C. Upadhyay the then Vice Chancellor of NDUAT Faizabad to permit for the study and to provide necessary facilities to conduct this study at NDUAT, Faizabad.

I would like to thank Dr. N.S.L. Srivastava, Asstt. Director General (Engg.) ICAR, New Delhi for his valuable guidance from time to time.

I also wish to express my thanks to Er. Ram Kishore, Prof. Agril. Engg., NDUAT, Faizabad, Dr. A.P. Srivastva, Sr. Scientist, Dr. S.K. Adalakha, Principal Scientist Div. of Agricultural Engg., IARI, New Delhi and Dr. Jag Pal Singh and other faculty members of RDAT, IIT, Delhi.

In the last but not least, I would like to sincerely thank my wife Mrs. Sarla Verma and my daughters Km. Rekha and Rita and son Mr. Surendra Kumar for their great perseverances during my study.

I would also like to thank Dr. D.N. Verma, Dr. L.P. Verma, Dr. R.B. Verma, Dr. T. Singh, Professors of NDUAT, Faizabad for their valuable help during this study.

(M. R. Varma)

# ABSTRACT

The present investigation is an effort in the direction of developing a systematic method to formulate procedures which could be used in taking the decision for identification of the matching combination of animal-machine system so as to enable the farmers to make best use of the animal operated systems with optimum efficiency and to obtain a suitable work-rest cycle which can reduce the animal fatigue. In order to achieve the most suitable animal- machine system, which can be useful under actual field conditions, we ought to know the forces and the rate of work that can be derived from specific breeds of DAs, and physiological stresses imposed on them by various tractive work conditions.

Although some ergonomic studies have been conducted in the recent past to know the work performance, draft capacity and other related aspects of DAs, but the information is scarce, and location specific. Realising that the DAs differ considerably in their physical attributes from breed to breed and region to region, their work performance being greatly influenced by the work environment, a systematic programme of ergonomic study of animal-machine systems was undertaken.

The present work aims to evaluate the work performance of Gangatiri (G), local non-descript (L), local breeds of bullocks of Eastern U.P, as well as crossbred (C), bullocks under varied tractive work conditions and to advise the local farmers through on-farm demonstrations for better agricultural production and reduction of drudgery to the animals.

The study showed that L, G, and C breed bullock pairs could pull draft load equivalent to 16, 14, and 12% BW in winter, and 14, 12, and 10% BW in summer and hot- humid seasons respectively without getting over-fatigued (FS < 20) while pulling Animal Loading Car on tarmacadam road under sustained working of 4 hours duration.

After assessing the draft capacity of experimental bullocks under sustained working, they were subjected to three higher levels of draft loads i.e, Gangatiri breed 12, 14, and 16% BW., local non-descript breed 16, 18, and 20% BW., and the crossbred 12, 14, and 16% BW. Using them to pull an animal loading car on tar-macadam road, the physiological parameters and distress symptoms were recorded after each work duration and rest pause as well as during recovery period. The speed, pull and angle of pull were also measured during experimentation in both, the summer and winter seasons. It was observed that with appropriate work-rest cycle bullock pairs of test breeds were able to pull higher draft load comfortably with enhanced system efficiency.

Based on test results, suitable matching farm implements/machines were identified. The identified animal-machine system package gave better system efficiency with the reduced drudgery. The study indicated that the identified/ improved farm implements and machines package was 33 to 51 per cent more time efficient in comparison with traditional implements used in the area. The improved and matching farm equipment package used for raising paddy and wheat crops also gave 12.5 and 17.8% higher grain yield with that of traditional implements package respectively.

## CONTENTS