FINAL REPORT OF CONSULTANCY

ON

AGRICULTURAL MECHANIZATION

FOR

NORTHEAST BRAZIL

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Mechanization Specialist
IICA/EMBRAPA-CPATSA

Petrolina, Nov. 20, 1985

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PREFACE

I have worked as Mechanization Specialist/Consultant for Northeast Brazil stationed at CPATSA (Agricultural Research Centre for the Semi-Arid Tropics) of EMBRAPA (Brazilian Enterprise for Agricultural Research) through its contract with IICA (Inter-American Institute for Cooperation on Agriculture) for last six years. Over this period of six years, I have been associated in planning, executing and evaluating number of research and development activities related to mechanization.

The information on all these activities is available in various publications of the centre (CPATSA), in national or foreign journals and different reports prepared for CPATSA/EMBRAPA or for IICA from time to time.

Never-the-less, this final report of my consultancy is aimed to provide general outline of the research and development activities carried out by me and achievements of these activities in relation to overall objectives of the CPATSA and that of IICA/EMBRAPA Contract.

The report is divided in three main parts. The first part describes briefly the various research and development activities, giving the list of publications, carried out. The scope of these activities was always aimed to meet the aims and objectives of the CPATSA/EMBRAPA and the needs of the region. This part is further sub-divided into the following sub-headings based on the types of activities:

- Program Development
- Evaluation of Present Status of Mechanization
- Machinery Development and Adaptation
- Machinery Evaluation and Management

- Agronomical Studies Related to Machinery (Tillage and Planting)
- Multi-disciplinary Research and Extension (Farming Systems and Training).

The second part of the report describes some suggestions for the future work in the field of agricultural mechanization for the region. In making these suggestions the on-going research activities and past experience of the centre has been given due considerations.

The third part entitled as "SOME CONCLUDING REMARKS" is aimed to provide some suggestions to IICA/EMBRAPA Coordination cell in order to facilitate for the consultants to play their role more effectively and hope to minimize the frustrations which he (the consultant) faces from time to time because of the present administrative and technical set up.

It is hoped that the report will be useful for IICA in evaluating the contribution of its consultancy services to CPATSA, and for CPATSA/EMBRAPA and its staff, the report will serve as a ready reference on the activities and achievements of its consultant in the field of agricultural mechanization. Last but not the least, the report will serve as handy reference for my future consultations on my achievements during my employment as a Mechanization Specialist with IICA/EMBRAPA-CPATSA over the period of six years from Oct. 1979 to Nov. 1985.

HARBANS LAL

Petrolina, Nov. 15, 1985

ACKNOWLEDGEMENT

I would like to register my deep hearted gratitudes for IICA (Inter-american Institute for Cooperation on Agriculture) to provide me the opportunity to work as Mechanization Specialist in its category of international professional staff and to EMBRAPA (Brazilian Enterprise for Agricultural Research) and its regional centre CPATSA (Agricultural Research Centre for the Semi-Arid Tropics) in accepting me for such a responsibility.

My special thanks are due to Dr. José Irineu Cabral, ex-director of IICA office in Brazil, Dr. Jorge Soria, sub-director general, IICA, Costa Rica & ex-coordinator of IICA/EMBRAPA contracts, Dr. Juan Carlos Scarsi, director IICA-Brazil and ex-coordinator IICA/EMBRAPA contract, Dr. Elmar Wagner, coordinator IICA/EMBRAPA contracts and Dr. Daniel Gustafson, Technical Assessor of IICA/EMBRAPA, in providing the administrative briefing and support from time to time during my sojourn as a mechanization specialist.

The Department of International Cooperation of EMBRAPA headed till recently by Dr. José Maria Pompeu Memoria, has also been very helpful in carying out professional duties at CPATSA/EMBRAPA and deserve my gratitudes.

The integrated and continuous encouragement of Dr. Renival Alves de Souza, Chief of CPATSA have been really a moral boosting excercise to achieve various professional objectives during my stay at CPATSA/EMBRAPA. The administrative help of Depty Chiefs (technical and administrative) of CPATSA has also contributed significantly in meeting my professional goals of consultancy.

During my stay at CPATSA, I have had opportunity of working with number of researchers and other professionals of CPATSA/EMBRAPA

and that of other research and extension organizations of Brazil and would like to register my thanks for their critical and creative help in making my present venture a success. The names of Mr. Péricles F. Nunes, my Brazilian Counterpart from begining (1979) till 1983 and Adão de Mattus da Costa, trainee of CNPq/EMBRAPA who were associated almost full time with my work need special mention for their help both on professional and social aspects.

I would also like to thank, ICRISAT and its directors (Drs. L.D. Swindale & J.S. Kanwar), FSRP- Farming Systems Research Program of ICRISAT and its ex-leader Dr. B.A. Krantz and FPE- Farm Power and Equipment sub-program and its ex-leader Mr. G.E. Thierstien who were kind enough in reliving me to take up the present assignment for the initial period of 16 months.

Last but not the least, the thanks are due to my wife Chitra Arora and my daughters Bhawna, Monika and Prerna, who shared with me both enjoyments and depressions through which we passed during our stay at Petrolina(PE) in deep Sertão of Pernambuco.

HARBANS LAL

Petrolina, Nov. 15, 1985

AIMS AND OBJECTIVES OF CONSULTANCY

The consultancy started in Oct., 1979 for the initial period of 16 months which has been renewed and extended on yearly basis. The details of the job description supplied by IICA alongwith the first appointment is followed:

JOB DESCRIPTION

Title of positions:

Specialist on Agricultural Mechanization.

Responsible to:

Head of IICA Office in Brazil through the General Coordinator of the IICA/EMBRAPA contract and the head of the Semi-Arid Tropics Agricultural Research Center (CPATSA of EMBRAPA).

Objectives:

To participate with CPATSA specialists in activities geared to strengthen the farm machinery program technical capacity by planning, executing and evaluating research on farm machinery suited for the cropping systems adapted to the semi-arid tropics.

Specific duties and responsabilities:

1. To analyse the problems and needs of mechanization and to fix (decide) research priorities to produce farms machinery and equipments efficiently adapted to cropping systems (traditional & modified) and ecological and socio-economic conditions of the semi-arid tropics of Brazil.

2. Together with the specialists of EMBRAPA to design, construct and evaluate manual, animal traction and mechanical farm machinery and equipment to improve the efficiency and economics of production and to conserve the resources of soils and water of the semi-arid cropping systems.

3. To test and/or adapt agricultural machinery or equipment available locally to improve its efficiency and economics and to suggest modifications or improvements to the makers.

4. To develop in-service training programs for researchers of the CPATSA and other units of EMBRAPA on methodologies and laboratory and field techniques in your speciality.

5. Advise and guide theses research projects on farm mechanization carried out in CPATSA to EMBRAPA graduate students.

6. To prepare documents and technical reports, according to the need of IICA/EMBRAPA Contract, at the request of the General Coordinator of the Contract and the Head of the Centre.

7. To cooperate with the Head of CPATSA to perform your activities integrated to the multidisciplinary team of researchers.

Duration of contract:

Initially for sixteen months (16), starting Oct. 13th, 1979 and extended on yearly basis till Dec. 1985 but resigned on Nov. 21, 1985 to pursue higher studies leading to Ph.D. degree.

Residance Headquarters:

Semi-Arid Tropics Agricultural Research Center - Petrolina - State of Pernambuco - Brazil.

THE CPATSA AND ITS MECHANIZATION PROGRAM

The CPATSA (Agricultural Research Centre for the Semi-Arid Tropics) was created in 1975 with the objective of generating new technologies to improve the quality of life of the farmers of the region.

The Centre is located at Petrolina(PE) in the Sertão region of Pernambuco state and coordinates three national programs and participates in others through its team of about 60 researchers of different levels (B.S., M.S. and Ph.D.).

The three principal programs and their objectives coordinated by CPATSA are:

- Evaluation of the Natural and Socio-Economical Resources in rural environment (PNP 027) aimed to assess the traditional farming systems, their boundaries, limitations and potentials to be improved.

- Utilization of Natural and Socio-Economical Resources (PNP 030) aimed to carryout analytical and synthetical research at experiment station in order to search the solutions for the limitations assessed and the synthesis of promissing alternative farming systems (models).

- Development of improved Farming systems for the Semi-Arid Rural Environment (PNP 033) aimed to assess the level of adoption of technologies.

The mechanization program of the Centre (CPATSA) right from the beginning has been contributing to the three national programs (PNPs) in function of each of them. The mechanization program was initiated in May 1979 with principal objective of developing and using animal-drawn implements in order to facilitate the introduction and application of crop production technologies to make the farming systems of the region more efficient. This program was reinforced in

Oct. 1979 through the consultancy of IICA consultant and later through French specialists through the "Convênio" of CEEMAT/EMBRAPA/EMBRATER, initiated in June 1980.

The two programs; proposed by IICA's consultant and that through the Convênio (CEEMAT/EMBRAPA/EMBRATER) have been operating at CPATSA simultaneously through specialized projects. The team, responsible for mechanization research at CPATSA/EMBRAPA consisted of two local researchers and three consultants supported by short term trainees from time to time. In 1983 one of the local researcher, directly associated with my work, went to France for higher studies, thus leaving only one local researcher to accompany three foreign Consultants. This lead to paralization/cancellation of some of the projects initially planned. Never-the-less, I have been able to complete most of the activities I have initially planned. These activities, apart from solving the regional problems, have resulted in number of publications thus enriching the literature on agricultural mechanization for northeast Brazil. The fig. 1 presents the cronogram of the activities carried out and their relationship with three national programs coordinated by CPATSA/EMBRAPA.

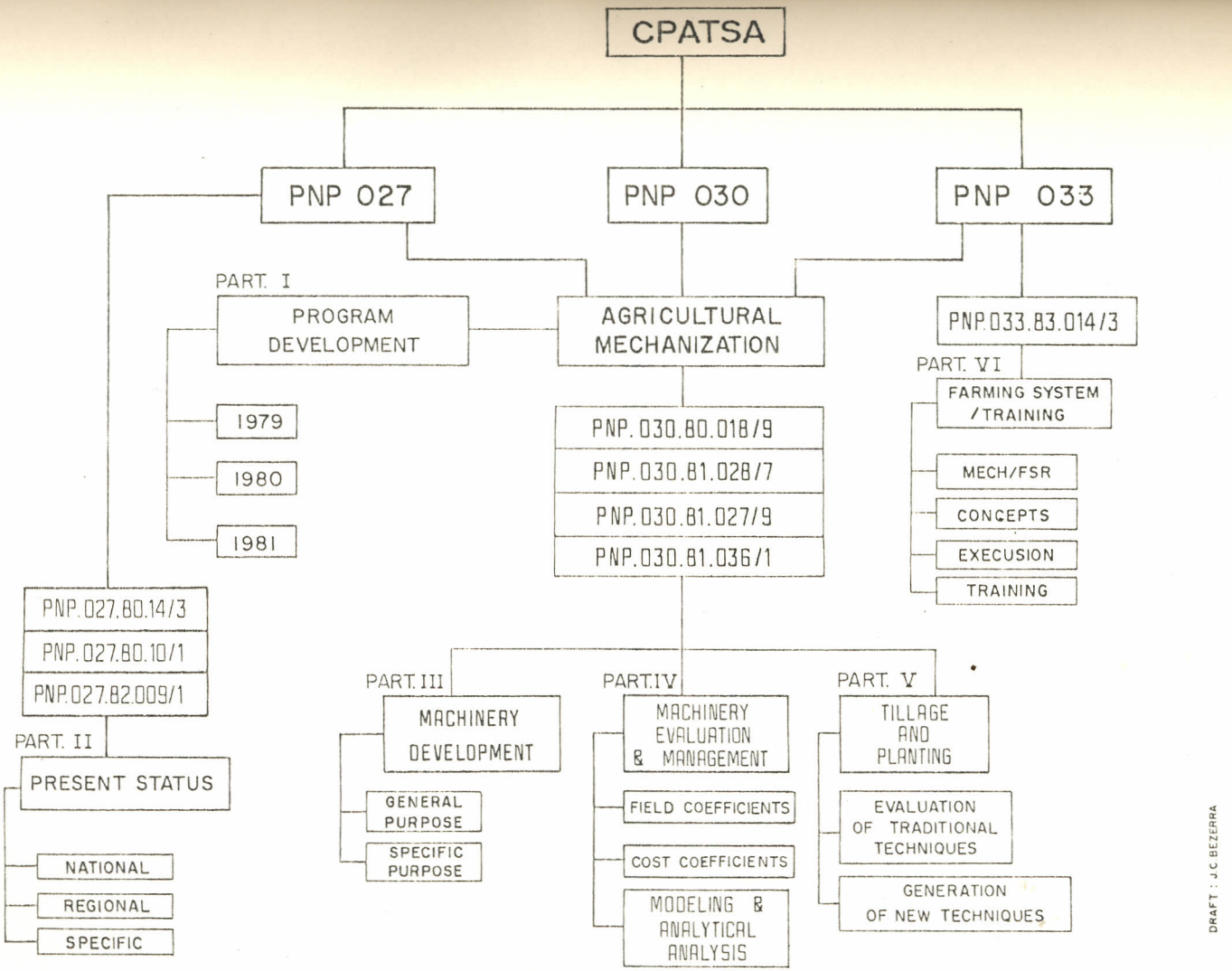

Fig. 1. Cronogram of research and development activities and their relationship with national programa coordinated by CPATSA/EMBRAPA.

CHAPTER I

RESEARCH AND DEVELOPMENT ACTIVITIES

CHAPTER 1.1

PROGRAM DEVELOPMENT

Introduction

The temporary nature of my assignement of IICA and limited knowledge about the region did not permit me to develop long term proposals right in 1979. However by 1981, the proposals for the program were finalized which has been followed till date. The program development passed through following three phases:

- Research Program 1979
- Research Program 1980
- Research Program 1981

Publications

LAL, HARBANS, Agricultural Mechanization research program for SAT Brazil, IICA/EMBRAPA-CPATSA, Petrolina(PE), Oct. 1979, p. 5.

NUNES, P.F. and LAL, H, Programa de Pesquisa em Mecanização Agrícola para a região do Trópico Semi-Árido do Brasil, CPATSA/EMBRAPA, Petrolina(PE), Jul. 1980, p. 11.

LAL, HARBANS, Programa de Pesquisa em Mecanização Agrícola do CPATSA (Retrospectivas e prospectivas). DRELA, Costa Rica, Vol. 15, No. 2, December 1983.

LAL, HARBANS, 1985. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for Northeast Brazil; Part I. Program Development and Summary, IICA/EMBRAPA-CPATSA, Petrolina(PE), Brazil. pp. 1-68.

CHAPTER 1.2

PRESENT STATUS OF MECHANIZATION

Introduction

The activities related to evaluation of the present status of agricultural mechanizaton of the region can be broadly classified into:

a) Systematic analysis and interpretation of the informations already published by different national institutes related to agricultural mechanization.

b) Collecting and analysing the informations using specialised questionnaires, through personal visits to farmers' field and to other mechanization related institutions.

The first type of activity covered the studies on (i) Tractorization of Brazilian Agriculture (ii) Mode and intensity of use tractores in the valley of river San Francisco and (iii) Variations of production, sale and Unit-price of principal agricultural machines used in northeast.

The information on the inventory of presently possessed implements by the farmers, its mode and intensity of utilization have been collected through a set of questionnaires put to selected sample of farmers. A survey on transport means used by the farmers for transporting agricultural inputs and production and a detailed study on the animal-drawn carts was also carried out in the Ouricuri region of Pernambuco state.

Publications

LAL, HARBANS, COSTA, A.M. and NUNES, P.F., 1983. Tractorization of Brazilian Agriculture 1950-82. XIII Brazilian Congress of Agricultural Engineering, 18-21 Jul. Rio de Janeiro(RJ), Brazil, (portuguese).

LAL, HARBANS, COSTA, A.M. and NUNES, P.F., 1984. Development and Oscilations of National Industry of Tractors, A Lavoura, National Society of Agriculture, Rio de Janeiro (Brazil). Jan./Feb. 84, Ano LXXXVI, pp. 40-44, (portuguese).

LAL, HARBANS, 1985. Characterization and Utilization of Rural Transport Means in Ouricuri(PE) Region of Northeast Brazil, Revista de Economia Rural, Brasília(DF), (in press).

LAL, HARBANS, 1985. Moto-Mechanization in Irrigated Perimeter of River San Francisco (Case Study of Project Bebedouro), Pesq. Agropec. Bras., Brasília(DF), (in press).

LAL, HARBANS, 1985. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for Northeast Brazil; Part II. Evaluation of Present Status, IICA/EMBRAPA-CPATSA, Petrolina(PE), Brazil. pp. 69-136.

CHAPTER 1.3

MACHINERY DEVELOPMENT AND ADAPTATION

Introduction

The machinery developed or adapted over the period of 6 years can be broadly classified in two following categories:

- General purpose machines
- Specific purpose machines

The general purpose machines such as Multicultores (Multicultor CPATSA and Multicultor CPATSA II) are those machines which can be used for different agricultural field operations under different farming and production systems. On the other hand the specific purpose machines (Ridger-blades and weeding blades etc.) have been developed for specific requirements of an operation in the modified soil management and tillage system found promising for the region.

The both types of machines have been adapted keeping in view the possibility of these being produced by urban based workshop with limited resources of technical capabilities. The experiences with this approach of machinery development has been dual fold. On one side the simplicity of the machines impressed many local workshops to initiate their fabrication and generated interest in wide variety of public ranging from farmers to students. Table 1 presents the statistics of about 1000 letters received by CPATSA after a television broadcast on Multicultor CPATSA. Though number of small workshops started fabricating this machines in northeast and other regions of Brazil but CPATSA patronized a local workshop "OFICINA VENCEDORA" to meet the immediate demand about this machine principally for multi-location testing. Unfortunately this workshop was not able to maintain the required level of "quality control" for the fabrication. Many

STATISTICS OF REQUESTS ON MULTICULTOR CPATSA

STATES	FARMERS	INDUSTRIALISTS	STUDENTS	INSTITUTES	TRADERS	OTHERS	TOTAL	(%) PER STATE
São Paulo	141	08	22	03	06	37	217	22.24
Rio Grande do Sul	83	04	14	06	05	21	133	13.63
Minas Gerais	98	01	04	10	05	19	137	14.04
Rio de Janeiro	49	03	06	01	01	11	71	7.27
Manaus	02	-	-	-	01	-	03	0.31
Mato Grosso do Sul	06	-	-	01	-	03	10	1.02
Mato Grosso	04	01	-	01	01	-	07	0.72
Goiás	17	01	01	01	-	02	22	2.25
Santa Catarina	07	01	02	02	04	02	17	1.74
Distrito Federal	20	01	04	03	-	10	38	3.89
Pará	11	-	01	-	-	01	13	1.33
Espírito Santo	22	-	10	01	-	07	40	4.10
Paraná	50	05	09	01	03	16	84	8.61
Alagoas	05	-	02	-	-	-	07	0.72
Sergipe	08	-	01	-	-	-	10	1.02
Maranhão	04	-	01	-	-	01	06	0.61
Paraíba	09	03	01	-	-	03	16	1.64
Rio Grande do Norte	06	01	06	02	-	01	16	1.64
Ceará	13	-	04	02	01	03	23	2.36
Pernambuco	21	01	05	01	-	06	34	3.48
Bahia	49	02	10	01	01	08	72	7.38
TOTAL	625	32	103	37	27	152	976	100,00%
PERCENTAGE OF TOTAL	64.04	3.28	10.55	3.79	2.77	15.57	100	-

OBSERVATIONS:
- Approximately 90% of the requests expressed their desire to fabricate the machine (100% industrialist and 95% of farmers)
- The column of "others" includes professionals like agronomists, agricultural technicians, economists, medical doctors, lawyers etc.
- 18.85% requests came of northeast and 81.15% from other regions of northeast Brazil.

of the initial units supplied by this workshop did not withstand the rigorous testing under different soil conditions, thus forcing CPATSA to look for the alternative. On the other hand the industrialized production of similar machines by CEMAG (Ceará Máquinas Agrícolas) Fortaleza, through the Convênio CEEMAT/EMBRAPA/EMBRATER also contributed in reducing the interest on the part of CPATSA and on my personal behalf in boosting the fabrication of this type of machines by local workshop.

The specific purpose machines developed so far have been tested on experiment station and on farmers' field and no systematic effort has been made, so far, to get them manufactured on the comercial scale.

The publications related to this activity have been of two types. The first type, in the form of technical circular or communication were aimed to meet the need of urban workshops and others interested in fabricating them. The second type, in the form of technical articles, have been aimed for divulgation of basic concepts of new machines and their operational details.

Publications

LAL, HARBANS and NUNES, P.F. 1980. How to Construct Multicultor CPATSA in urban workshop, Technical Comunication nº 3. CPATSA/EMBRAPA, Petrolina(PE), Brazil. pp. 22. (portuguese).

LAL, HARBANS and NUNES, P.F. 1981. Multicultor CPATSA: Fabrication and Use, Technical Circular nº 6, CPATSA/EMBRAPA. Petrolina(PE), Brazil. pp. 96. (portuguese).

LAL, HARBANS and NUNES, P.F. 1981. Development of Multicultor CPATSA II. A Research under Progress nº 13. CPATSA/EMBRAPA. Petrolina(PE), Brazil. pp. 6. (portuguese).

LAL, HARBANS, 1984. Low Cost Animal-drawn wheeled tool carrier. World Animal Review. FAO, Rome. (in press).

LAL, HARBANS, SILVA, A.S., PORTO, E.R. and COSTA, A.M. 1984. Ridger-blade; a multipurpose equipment for cultivation system of "in-situ" rain-water harvesting technique. Pesquisa Agropecuária Brasileira, Brasília, 19(11): 1385-1393, (portuguese).

LAL, HARBANS and SILVA, A.S. 1985. Development of Appropriate Mechanization for "W" form of Soil Management System. Soil and Tillage Research, Amsterdam, Netherlands (under review).

LAL, HARBANS, 1985. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for Northeast Brazil; Part III. Machinery Development and Adaptation. IICA/EMBRAPA-CPATSA, Petrolina(PE), Brazil. pp. 137-253.

CHAPTER 1.4

MACHINERY EVALUATION AND MANAGEMENT

Introduction

The activity on machinery evaluation and management has been geared to evaluate the performance of the agricultural machines on experimental test plots or on the operational scale. The basic objectives have been to quantify field capacity, field efficiency and economical parameters of traditional and newly developed machines.

The studies carried out under this activity can be broadly classified into two following categories:

- Field scale experimentation and observations to quantify operational parameters of the machines
- Analytical studies aimed to develop simple mathematical models to predict the performance of the machine.

Both types of studies have generated number of publications.

Publications

LAL, HARBANS, 1981. Operational performance of animal-drawn wheeled tool carrier for broadbed-and-furrow system. Proceedings of XI Brazilian Congress of Agricultural Engineering 22-7 Jun. Brasília (DF). pp. 1147-59 (portuguese).

LAL, HARBANS and NUNES, P.F. 1982. Operational performance of wheeled tool carrier for plowing and ridging. Pesquisa Agropecuária Brasileira, 17(8): 1191-1212. (portuguese).

LAL, HARBANS, 1983. Simple Mathematical Model of field efficiency and quantification of its components for animal-drawn wheeled tool carrier, Pesquisa Agropecuária Brasileira, 18(3): 649-56. (portuguese).

LAL, HARBANS and FREIRE, L.C. 1984. Operational cost of animal-drawn agricultural implements in various sizes of farm holdings. Research Bulletin 21. CPATSA/EMBRAPA, Petrolina(PE), Brazil. pp. 33. (portuguese).

LAL, HARBANS, 1984. Improved nomographs for estimating field capacity and field efficiency for agricultural field operations, AMA-Agricultural Mechanization in Asia, Africa & Latin America, Tokyo, Japan. (in press).

LAL, HARBANS, 1985. Mechanics of animal-drawn wheeled tool carrier, Journal of Agricultural Engineering Research, London, UK (in press).

LAL, HARBANS, 1985. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for Northeast Brazil; Part IV; Machinery evaluation and management, IICA/EMBRAPA-CPATSA, Petrolina(PE), Brazil. pp. 254-346.

CHAPTER 1.5

AGRONOMICAL STUDIES RELATED TO MACHINERY

(Tillage and Planting)

Introduction

The agronomical studies relatedto machinery has been aimed to define the "Soil, Machine and Plant Relationship" under traditional and improved crop production systems.

The traditional crop production systems of the region for dryland agriculture (totally dependent on rainfall) based on the engineering aspects (soil management and implements use) can be grouped, predominently in the following three categories:

a. Cultivation on flat using tractorized implements for land preparation (plowing and harrowing) and animal-drawn or manual implements for other operations (planting, weeding etc.),

b. Cultivation on flat using animal-drawn implements for land preparation and weeding, and manual implements for other operations (planting, etc.).

c. Cultivation on flat using manual implement for all the operations.

The cultivation on flat generally along the slope on slopping lands with low management level results in low productivity of the land and manpower under eratic and badly distributed rainfall of the region. Table 1 presents precipitation received at Petrolina(PE) during 1981-85 showing the variation of rainfall distribution within a rainy season and over a period of five rainy seasons. It has been estimated that for Petrolina region, with presently used production and management techniques, the probability of success of any crop is only 10%.

TABLE 1: Precipitation received at Dry-land Experiment station of CPATSA/EMBRAPA during 1981-85*.

YEAR	MONTHLY PRECIPITATION (mm)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
1981	30.8	4.3	45.3	41.6	-	-	-	1.7	-	-	15.0	11.4
	(5/1)**	(3/0)	(15/0)	(6/2)	-	-	-	(1/0)	-	-	(2/1)	(5/1)
1982	73.5	26.4	51.5	44.0	1.4	8.3	4.1	10.2	7.4	-	-	42.3
	(5/2)	(3/1)	(7/1)	(6/1)	(1/0)	(6/0)	(3/0)	(2/0)	(3/0)	-	-	(4/1)
1983	77.7	116.1	115.1	-	4.1	-	17.5	0.9	-	1.8	89.5	13.7
	(9/2)	(7/4)	(12/3)	-	(1/0)	-	(2/1)	(1/0)	-	(1/0)	(5/3)	(2/1)
1984	9.6	3.1	317.2	146.2	25.3	5.3	-	-	-	-	-	-
	(2/0)	(4/0)	(15/8)	(15/3)	(6/0)	(3/0)	-	-	-	-	-	-
1985	286.6	84.9	172.0	151.6	15.6	69.9	5.6	NA	NA	NA	NA	NA
	(22/7)	(8/3)	(15/5)	(13/7)	(10/0)	(10/3)	(3/0)					

*Supplied by Mr. Malaquias da S. Amorim Neto, Agroclimatologist of CPATSA/EMBRAPA, Petrolina(PE),

**Figures in the brackets represents the ratio of total number of rainy days to the rainy days with more than 10 mm of precipitation.

NA- Not available.-

It means that farmer is going to lose his crop for 9-years out of every 10 he plants. To reduce this risk, planting a mixture of crops with little or no systematic arrangement is the common practise followed by the farmers of the region. The other common practice, to reduce the affect of draught during cropping season, is to maintain low plant population. It has been observed on farmers' field, the population of 10,000 hills/ha of beans with two to three seeds per hill as compare to 20,000 hills/ha,. generally, recomended for the region. Under these circumstances where crop failure or low crop yield are associated with inadequate water supply, the research to quantify the causes of failure and to develop and evaluate alternative means to increase and stabilize the production breeks no delay.

As a mechanization specialist, I also contributed to these efforts by evalua ing traditional tillage and planting techniques and developing and evaluating alternatives soil preparation and planting systems to improve the probability of success of crop production in the region.

The systematic efforts on this line of action was initiated from 1983 so most of the publications on this aspects of mechanization have been recently compiled which have been recently submitted to scientific journals in for their initial review.

Publications

LAL, HARBANS, SILVA, A.S., PORTO, E.R. & NUNES, P.F. 1983. A new type of "in-situ" rainwater harvesting technique for stabilizing crop production in semi-arid tropics. XIII Brazilian Congress of Agricultural Engineering 18-21 Jul. Rio de Janeiro(RJ), Brazil. (portuguese).

LAL, HARBANS, 1985. Characterization and need of tillage research for dryland agriculture for northeast Brazil, Journal of Agricultural Engineering, ISAE, India (under review).

LAL, HARBANS, 1985. Effect of different methods of soil preparation on soil moisture loss, weed growth and soil compaction, Agricultural Mechanization for Asia, Africa and Latin America, Tokyo-Japan. (under review).

LAL, HARBANS, 1985. Specific pull for plowing with different tool bars/carrier over various moisture regimes, Agricultural Mechanization for Asia, Africa and Latin America, Tokyo-Japan (under review).

LAL, HARBANS, 1985. Influence of different levels of press wheels on seedling emergence under various moisture regimes of Latossol of northeast Brazil, Soil and Tillage Research, Amesterdam-Netherlands . (under review).

LAL, HARBANS, 1985. Evaluation of flat and broadbed-and-furrow systems of cultivations using animal-drawn and tractorized implements, Pesquisa Agropecuária Brasileira, Brasília-Brazil (under review).

COSTA, E.M. and LAL, HARBANS, 1985. Experiences with new type of "in-situ" rainwater harvesting techniques during 1983. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for northeast Brazil, agronomical studies related to machinery (tillage and planting), IICA/EMBRAPA-CPATSA, Petrolina(PE), Part V. pp. 368-85, (portuguese).

LAL, HARBANS, 1985. Complimentary results of the experiments about the new technique of "in-situ" rainwater harvesting. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for northeast Brazil, agronomical studies related to machinery (tillage and planting), IICA/EMBRAPA-CPATSA, Petrolina(PE), Part V. pp. 386-441, (portuguese).

LAL, HARBANS, 1985. Evaluation of different types of "W" form of soil preparation systems, IICA/EMBRAPA-CPATSA, Petrolina(PE), (under review).

LAL, HARBANS, 1985. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for northeast Brazil; Part V. Agronomical studies related to machinery (tillage and planting), IICA/EMBRAPA-CPATSA, Petrolina(PE), Brazil. pp. 347-441.

CHAPTER 1.6

MULTI-DISCIPLINARY RESEARCH AND EXTENSION

(Farming Systems Research and Training)

Introduction

The role of agriculture mechanization in the multi-disciplinary research and extension can be summarised through the following citation (INN, 1980)*.

"The machinery should be looked as a requirement to support the farming systems that has been formulated and not other way round. The farming system is a dog and machinery the tail. And it is accepted practise that the dog should wag the tail".

With these point in view the efforts right from the beginning has been to develop activities in agricultural mechanization to fit in the overall objective, "to develop appropriate farming systems for the northeast", of the CPATSA.

The activities carried out under this line of action has been tripple fold:

- To generate documents relating agricultural mechanization activities to farming systems being developed by the CPATSA,
- Colaborate with other specialists of the CPATSA in elaborating documents on farming systems research of CPATSA,
- participate in planning and executing research on farming systems on experiment research station and on farmers' field alongwith other specialists of the CPATSA.

As regards the extension activity (training) it is well recognized

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* INN, M. 1980, Animal Power in Agricultural Production with special reference to Tanzania, World Anim. Review, FAO: 2-10.

that mechanization alongwith appropriate soil and crop management systems developed for improving and stabilizing crop production for the region can only bear fruits if the training of extensionists and other fellow researchers of state organization is organized on regular basis. I have been participating in specialized training programs on operation and maintenance of animal-drawn tool bars and tool carriers and traditional implements and also collaborating with land and water management and inter-cropping groups in trainings related to their respective fields by contributing special lectures on agricultural mechanization.

The wider divulgation of the research results have been made by participating and presenting papers in various national congresses and simposiums apart from publishing them in national and foreign journals. The Appendix II gives the list of training and extension activities, in which I have participated during my stay at CPATSA/ EMBRAPA.

Publications

LAL, HARBANS and NUNES, P.F. 1981. Agricultural mechanization for farming systems of small and medium farmers of semi-arid tropics. Proceedings of II National Meeting of Soil Conservation Research. 28 July-1 Aug. 1981. Recife(PE), Brazil, pp. 49-72, (portuguese).

LAL, HARBANS and NUNES, P.F. 1981. Agricultural mechanization with wheeled tool carrier and some experience of CPATSA. Proceedings of XI Brazilian Congress of Agricultural Engineering 22-7 Jun. Brasília(DF), Brazil. pp. 1567-76, (portuguese).

LAL, HARBANS, 1983. Animal-drawn wheeled tool carrier a solution for small holdings. Revista de Mecanização Rural, São Paulo, 3(18): 24-30. (portuguese).

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Publications

LAL, HARBANS and NUNES, P.F. 1981. Agricultural mechanization for farming systems of small and medium farmers of semi-arid tropics. Proceedings of II National Meeting of Soil Conservation Research. 28 July-1 Aug. 1981. Recife(PE), Brazil, pp. 49-72, (portuguese).

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LAL, HARBANS, 1983. Animal-drawn wheeled tool carrier a solution for small holdings. Revista de Mecanização Rural, São Paulo, 3(18): 24-30. (portuguese).

LIMA, A.F., PORTO, E.R., PINARE, A.G.V., LOPES, L.H., OLIVEIRA, M.C., VALLEE, G.J.A., DORASWAMY, G. and LAL, HARBANS, 1984. Farming Systems Research in the Brazilian Semi-Arid Tropics; the Experience of Ouricuri, State of Pernambuco, Farming Systems Research Symposium, Kansas State University, Oct. 7-10, p. 22.

LAL, HARBANS, 1985. Animal-drawn wheeled tool carrier; An appropriate mechanization for improved farming systems. AMA- Agricultural Mechanization for Asia, Africa and Latin America. Tokyo-Japan, Vol. 16, nº 1, pp. 38-44.

LAL, HARBANS, 1985. Quinquennial (1980-84) report of research and development activities on agricultural mechanization for northeast Brazil; Part VI. Multi-disciplinary research and extension (Farming Systems and Training). IICA/EMBRAPA-CPATSA, Petrolina(PE), Brazil. pp. 441-547.

CHAPTER II.

LOOKING AHEAD

(Suggestions for Future Work)

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Unlike many consultants who are generally hired for solving specific problems in an established program, I have had the chance to participate in the mechanization research program of CPATSA right from begining (1979) till date (1985). During this period, the program has developed sufficiently and has acquired a definite position among the national and international colleagues working on similar aspects.

Never-the-less, the mechanization research just like that of other areas of agriculture is a continuous process demanding continuous attention of local researchers and administrators. Therefore, I would like to register here some of the general guidelines about the future prospectives and line of action of the program.

The mechanization research program of CPATSA has received on continuous basis, apart from my consultancy, the French Experts within the agreements of CEEMAT/EMBRAPA/EMBRATER. I feel that with my contributions and that of French and local Experts the research program (Agricultural Mechanization) has developed sufficient number research projects on virtually every aspect of mechanization ranging from development of machinery to the studies related to alternative energy sources. However, due to the lack of appropriate coordination and necessary support staff, many of the projects were cancelled or are paralised. Therefore a critical analysis is urgently sought for to reactivate some of the important but paralised/cancelled projects.

The definition and scope of research project within EMBRAPA system has been changing and becoming clearer since 1981. Unlike 1980 when it was thought appropriate to develop a single project on agricultural mechanization covering the proposals of my consultancy and that of the French Expert, at present, a research project is set to be problem oriented with a well defined objectives, hypotheses and methodology. With this definition of a research project, the execusion of one project would lead to identification of many other related problems, apart from solving the initial one. Therefore, I would suggest that the on-going research projects should be executed with awareness to identify other related problem and to continue the process.

At this moment, I recall the well established definition of research and the role of researcher. The research and job of the researcher is not complete till the experiences of both (research and researcher) are widely known. One of the easy and fast media of wider circulation of the results is through publication in recognised scientific and technical journals. I feel, the mechanization team of CPATSA/EMBRAPA need to be motivated to analyse a great pool of data generated and make the results available to the scientific and farming community of Brazil and elsewhere.

The success of agricultural mechanization research, specially its aspects of machinery development and adaptation, depends very much on the participation and the interest of machinery manufactureres of the region. It is therefore recommended that the industrialists should be involved, right from beginning, in the development of new prototypes or adapting the existing one. I feel, rather strongly, that the development of new machine is not complete till some manufacturer has taken it up for mass production. With this point in view, it is

recommended that development of new prototypes should be restricted to the machines which are urgently needed for the region and should be made simple enough to generate interest of the manufactureres for its mass production and commercialization.

Till date, the major efforts of the research team on agricultural mechanization of CPATSA has been concentrating on various aspects of dryland agriculture; totally dependent on rainfall or supported by life saving irrigation. And virtually no systematic efforts have been made to look into the possible areas where mechanization team could contribute significantly in irrigated agriculture which is ever increasing in the region. It is, therefore, recommended that appropriate attention should be given to this neglected area. These efforts could range from developing appropriate simple equipment for various field operations to developing appropriate tillage techniques to minimize the power input for irrigated agriculture. A study on Mechanization of Irrigation Project, Bebedouro (PE) showed that a large number of field operations, except initial land preparation, are still done by manual labour, thus leaving a lot of scope for developing simple and inexpensive equipment for these operations. The same studies also showed that a standard mode of soil preparation (plowing and/or harrowing complete area) is used for all the crop, thus leaving a good scope of experimenting alternative soil preparation techniques inclusive minimum and zero tillage for certain crops.

The other field which has been completely neglected so far, and mechanization specialists of the CPATSA could make significant contribution is the post-harvest technology both for dryland and irrigated crops of the region. There is an urgent need to evaluate the existing threshers and to identify most appropriate one(s) for the

crop varieties of the region.

The role of a research centre like CPATSA. whose clients in general are small and medium farmers with little educational and technical knowledge, is not complete till they (the farmers) are trained simultaneously in using the developed technology (specially the machinery aspects) by the centre. The researchers in collaboration with the extensionists should always be ready to impart formal and informal training to the users of the generated technologies. Once the technology (the machines in particular) has passed the initial phases (development and comercialization) the researchers of the centre should aim to generate information regarding the grade of acceptability and mode of utilization of the developed machinery in the region, either through specialized research projects or through the casual visits to the region where the machine has become popular. These efforts should also be aimed to identify causes of non-acceptability of the machine in other region. A modest start on this aspect has already been made by developing a special project to identify the degree of acceptability and utilization of the wheeled tool carrier/tool bars types of machines on which CPATSA has been working for last 6 years. This project will be carried out from early 1986 under the coordination of Dr. G.M. Calegar, Economist of CPATSA/EMBRAPA.

CHAPTER III.

SOME CONCLUDING REMARKS

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My stay at CPATSA/EMBRAPA, as an IICA Consultant has been very rewarding both on professional and social fronts. The number of pages of my CV (Curriculum Vitae) has substantially increased with list of publications and other activities carried out during this period. My family size has also increased with two more lovely daughters who were born in Petrolina and would remember it (Petrolina) as their birth place for whole of their life. I am quite satisfied with my achievements and my wife joins me on these feelings. We, once again, would like to repeat that all this has been possible with the cooperation and help of my Brazilian and other colleagues with whom we have had social and professional contacts during our stay at Petrolina.

Never-the-less, I would like to register here some of my thoughts about the role and aspirations of a consultant like me. I have discussed on these aspects with IICA and CPATSA administration from time to time.

It is not within the scope of the present report to define specific roles and aspirations, individually of any consultant. However, in general terms, one could say that an international consultant, hired with the intension to serve on long term basis, should play the role of a senior researcher. He should be able to organize his own research projects and should collaborate with other researchers in helping them to develop and carry out research projects of their interest. In response to these duties, he (the consultant) aspires for due recognization of his contributions and expects from the local administration to provide him with sufficient opportunities to divulge

his work, in person, to national and international scientific community.

Whether the present administrative and technical set up of IICA/EMBRAPA Contract provides the necessary conditions for the consultants (internationally hired) to play this role and achieve his aspirations described above, has been a matter of controversy among the various IICA/EMBRAPA Consultants with whom I have had opportunity to discuss on these points over last six years. Therefore I strongly recommend that IICA/EMBRAPA Coordination should look into the matter and analyse the existing administrative and technical set up and modify it, as required, to develop necessary directives within IICA/EMBRAPA Contracts which would facilitate for the Consultants to play their role more effecively and also would minimize the frustrations, which he (Consultants) faces from time to time because of present administrative and technical set up.

With these concluding remarks I would like to say good-by to all those who have made my present venture, as a mechanization specialist of IICA stationed at CPATSA/EMBRAPA for last six years, a great success. I would always like to maintain my professional and social contacts with all of them. I know that my contributions in solving mechanization problems for northeast Brazil, has been like a drop in ocean but I am aware that if I would not have done so, this drop would have always been missing from the ocean.

APPENDICES

APPENDIX I.

ABOUT THE CONSULTANT

NAME	:	Harbans Lal
DURATION OF CONSULTANCY	:	6 years
PERMANENT ADDRESS	:	IV/0/48, Lajpat Nagar New Delhi - 110024 - India
PLACE OF BIRTH	:	Kashipur (UP) - India
DATE OF BIRTH	:	January 6, 1949
CITIZENSHIP AT BIRTH	:	Indian
PRESENT CITIZENSHIP	:	Indian
SEX	:	Male
MARITAL STATUS	:	Married
NUMBER OF DEPENDENTS	:	4

LANGUAGES PROFICIENCY:

Language	Read	Write	Speak
Hindi	Excellent	Excellent	Excellent
English	Excellent	Excellent	Excellent
Portuguese	Very Good	Very Good	Very Good
Spanish	Good	Good	Good
French	Slight	-x-	-x-

EDUCATION:

(a) University or Equivalent

Name and Place	Years Attended		Degree and Academic Distinction	Main Subjects
	From	To		
Indian Institute of Technology, Kharagpur (WB), India	1966	1971	B.Tech.(Hons)	Agricultural Engineering
Indian Institute of Technology, Kharagpur (WB), India	1971	1973	M.Tech.(FMP)	Farm Machinery and Power

(b) Schooling and Other Formal Trainings

Name and Place	Type	Years Attended		Certificate/ Diploma
		From	To	
.Central Board of Secondary Educational, New Delhi-India	Higher Secondary	1963	1966	Certificate
.Tractor Training and Testing Centre, Hissar(Haryana) India	Agricultural Machinery Utilization and Management	Jan.74-Mar.74		Certificate
.The Maharastra Agro-Industries Development Corporation Ltd. Poona, Maharastra (India)	Machinery Management	Apr.74-Apr.74		Certificate
.Andhra Pradesh Productivity Council, Hyderabad (India)	Quantitative Techiques, PERT and CPM	Feb.78-Aug.78		Diploma
.Indian Institute of Management,Banglore (Mysore)- India	Operations Research and Computers	Oct.78-Oct.78		Certificate
.Department of Human Resources, EMBRAPA, Brazil	Scientific and Technical Writings	Sept.-Oct.81		Certificate
.Education Foundation of Petrolina(PE), Brazil	COBOL and BASIC Computer Programing	May-Oct.84		Certificate

EMPLOYMENT RECORD: (Starting with most recent post).

I. TITLE OF THE POST : Agricultural Mechanization Specialist

DATES : From Oct. 1979 till Nov. 1985

REASON FOR LEAVING : To pursue higher studies leading to Ph.D. in Agricultural Engineering

NAME AND ADDRESS OF EMPLOYER : IICA- Inter-american Institute for Cooperation on Agriculture, Coronado, Apartado 55 - San José, COSTA RICA

DUTY STATION : CPATSA/EMBRAPA
Petrolina(PE), Brazil

NAME OF SUPERVISOR(S): Dr. Daniel Gustafson
Technical Assessor IICA/EMBRAPA

NATURE OF WORK : Research, Development and Training

JOB RESPONSIBILITY : To organize activities of CPATSA (Agricultural Research Centre for Semi-Arid Tropics) in the field of agricultural mechanization by planning, executing and evaluation of research in farm machinery and power adopted to farming systems of semi-arid tropics of northeast Brazil

PROJECTS HANDLED AND ACHIEVEMENTS :

a. Present status of Agricultural Mechanization in the region:

-Tractorization of Brazilian Agriculture (1950-82)
-Comercialization of Agricultural Implements in Brazil (1977-82)
-Mechanization of Irrigated Agriculture in the Valley of River San Francisco, Petrolina(PE)
-Rural Transportation Systems in Ouricuri region of Pernambuco State.

b. Design and Development of improved agricultural implements:

-Development of Multicultor CPATSA and its basic implement set
-Development of Multicultor CPATSA II
-Development of animal-drawn and tractorized implements for implantation, reformation and wweding for the soil preparation system in the form of "W"

c. Machinery Evaluation and Management:

-Operational performance of wheeled tool carrier for basic tillage operations
-Operational cost of animal-drawn implements for different sizes of land-holdings
-A simple mathematical model and nomographs for estimating field efficiency and field capacity for agricultural field operations
-Mechanics of animal-drawn wheeled tool carrier

d. Tillage and Planting:

-Quantification of effect of different means of soil preparation (manual, animal-drawn and tractorized implements) on soil moisture loss, weed growth and soil compaction
-Quantification of specific pull for plowing with different tool bars (Policultor 300, 600 e 1500) on different soil moisture regimes
-Performance of EBRA planter with different soil compaction wheels on various soil moisture regimes
-Evaluation of flat and broadbed-and-furrow systems of cultivation with animal-drawn and tractorized implements
-Development of a system of soil preparation in the form of "W" to improve rainwater harvesting efficiency for arid and semi-arid region
-Quantification of optimum dimensions of "W" form of soil preparation
-Quantification of effect of soil conditioners (fertilizers, vermiculite and multch) and different level of weedings on crop yields for the "W" form of soil preparation system
-Adaptation and testing of "W" form of soil preparation system to facilitate planting and inter-row cultivation with available animal-drawn implements.

II. TITLE OF THE POST	:	Agricultural Engineer
DATES	:	From Aug. 75 to Feb. 81
REASON FOR LEAVING	:	Wider responsability and better prospects
NAME AND ADDRESS OF EMPLOYER	:	ICRISAT- International Crops Research Institute for the Semi-Arid Tropics Patancheru (PO) AP 502.324 - India
DUTY STATION	:	Hyderabad (India)
NAME OF SUPERVISOR(S):		Mr. G.E. Thierstein
NATURE OF WORK	:	Research, Development and Training
JOB RESPONSABILITY	:	To organize and carryout applied research on agricultural mechanization as a team member of Farm Power and Equipment sub-program of FSRP/ICRISAT, Hyderabad (India)
PROJECTS HANDLED AND ACHIEVEMENTS	:	a. Machinery development and adaptation:

-Selection, adaptation and testing of attachments for Tropicultor for broadbed-and-furrow system of cultivation
-Development of cart-based tool carrier and its attachments for operations on broadbed-and-furrow system of cultivation

b. Machinery evaluation and management:

-Evaluation of different types of tool carriers for improved farming systems
-Quantification of implement use efficiency as affected by various factors
-Comparative and operational evaluation of various machinery systems for broadbed-and-furrow systems of cultivation
-Quantification of command area for of wheeled tool carrier

c. Adoption constraints for improved implements:

-Satisfaction level derived by the farmers from presently used equipment package
-Necessity for improved implements felt by farmers
-Awareners about improved implements
-Factors contributory for limited adoption of improved implements.

III. TITLE OF THE POST: Research Technician

DATES : From Aug. 74 to Aug. 75

REASON FOR LEAVING : Promoted

NAME AND ADDRESS OF EMPLOYER : ICRISAT- International Crops Research Institute for the Semi-Arid Tropics 1.11-256, Begampet- Hyderabad (AP)- India

DUTY STATION : Hyderabad (AP) - India

NAME OF SUPERVISOR(S): Dr. J. Kampen

NATURE OF WORK : Research, Development and Training

JOB RESPONSABILITY : To participate in the operational scale farming system research of ICRISAT with the responsability for selection, adaption and testing of appropriate machinery for improved and traditional systems of farming

PROJECTS HANDLED AND ACHIEVEMENTS :

a. Development and testing of machine:

-Development of animal-drawn relay planter cum fertilizer applicator
-Modification of animal-drawn buck-scrapper
-Adaption of KENMORE tool carrier
-Adaption of a local seed-cum-fertilizer drill.

IV. TITLE OF THE POST	:	Full time volunteer
DATES	:	From June 73 to Aug. 74
REASON FOR LEAVING	:	Wider responsability and better prospects
NAME AND ADDRESS OF EMPLOYER	:	FREA- Front for Rapid Economics Advance for India, Bombay (Maharastra) India
DUTY STATION	:	Patoda (Dist.Bir.) - Maharastra
NAME OF SUPERVISOR(S):		Mr. Ulas Gore
NATURE OF WORK	:	Development, Extension and Management
JOB RESPONSABILITY	:	To strengthen FREA team of Marathwada region of India through planning and instalation of an Agro-Service Centre to make its Patoda (Bir.) base self suporting
SPECIFIC WORKS CARRIED OUT	:	-Organization and execution of custon hire service of agricultural machines available at FREA- base in Patoda -Adaptation of a tractor-drawn 9 tine cultivator to a.9- row planter -Orientation to the farmers in proper use of traditional and modified equipment.

MEMBERSHIP OF PROFESSIONAL SOCIETIES

Member- American Society of Agricultural Engineers (USA)

Member- International Soil Tillage Research Organization, Wageningen (NETHERLANDS)

Ex-Member- British Society for Research in Agricultural Engineering (UK)

Life Member- Indian Society of Agricultural Engineers (INDIA)

Member- Brazilian Society of Agricultural Engineering (BRAZIL)

Member- National Society of Agriculture (BRAZIL).-

INTERNATIONAL AND DOMESTIC TRAVELS

I have considerably toured around the world I have been to Paris (FRANCE), Rome (ITALY), London (UK), Amsterdam and Wageningen (NETHERLANDS), Bangkok (THAILAND), Tokyo (JAPAN), and Los Angels, Columbus and New York (USA). In India and Brazil, I have visited most of the institutions and universities engaged in research, extension and teaching in Agricultural Engineering and have visited National Tillage Laboratory (NETHERLANDS) and University of Reedings (UK).

SPECIAL REMARKS

. I have been actively involved and have made significant contributions as a mechanization expert in multi-disciplinary team of researchers of ICRISAT and that of CPATSA/EMBRAPA in their Farming Systems Research Program at experiment stations and on farmers' field.

. I have been faculty member in various courses and training programs organized by CPATSA/EMBRAPA in Brazil and by ICRISAT in India.

. I have attended numerous national and international congresses, conferences and seminars and presented technical and scientific papers.

. I have worked as a Coordinator of Discussion Group on Mechanization and Energy during I Brazilian Symposium of Semi-Arid Tropics, in Olinda(PE), Brazil.

. I have delivered number of invitational lectures at various Indian and Brazilian Universities.

. A television report on Multicultor CPATSA (A machine developed by me in Brazil) was considered the best of the year (1980) and CPATSA received over 5000 letters requesting the details of the machine.

. Over ten thousands copies of the bulletin on Multicultor CPATSA of my authorship have been distributed attending the requests within Brazil and overseas.

. I have oriented graduate (M.S.) research thesis of agricultural engineering students of UFPb (Federal Universities of Paraíba), Campina Grande.

POSSIBLE ADDRESSES FOR FUTURE CONTACTS

. c/o Mr. RAM LAL
IV/0/48, Lajpat Nagar
New Delhi - 110024
INDIA

. c/o Dr. J. WAYNE MISHOE
Graduate Coordinator
Agricultural Engineering Department
IFAS, University of Florida
Frazier Rogers Hall.
Gainesville, Florida 32611
USA

APPENDIX II.

TRAINING AND EXTENSION ACTIVITIES

Trainings:

- For animal operators about the use of wheeled tool carrier types of implements (Jan.-March 1980),
- For extensionists and reserchers about agricultural mechanization, Petrolina(PE)(April 1981, April 1982),
- For extensionists about the "in-situ" rainwater harvesting technique, Petrolina(PE), Oct. 1982,
- For engineers of Sertanejo Project about the implantation of "W" form of soil preparation system, Ouricuri(PE)(March 1984).

Demonstrations and Orientations:

- Operational demonstration of Multicultor CPATSA II to Technology Diffusion Team of CPATSA/EMBRAPA, July 1981,
- Orientation to local workshops in fabrication and repair of wheeled tool carrier types of implements (1980-82).

Participations and Presentations of Papers:

- Internal Seminar to CPATSA researchers on "Agricultural Mechanization Research Program for Farming Systems of Semi-Arid Tropics", Petrolina(PE), July 25, 1980,
- IIIrd. National Meeting about Soil Conservation Research, Recife(PE), July 28-Aug. 1, 1980,
- I Regional Meeting of Engineers of Project Sertanejo, Petrolina(PE), July 14-17, 1980,
- National Meeting on Small Irrigation, Brasília(DF), Aug. 11-13, 1981,

- XI Brazilian Congress of Agricultural Engineering, Brasília(DF), July 22-28, 1981,

- Internal Seminar to CPATSA researchers "Agricultural Mechanization Research Program of CPATSA: Retrospectives and Prospectives", Petrolina(PE), Aug. 28, 1981,

- Short Course on Scientific and Technical Writing, Petrolina(PE), Sept. 28-Oct. 2, 1982,

- XII Brazilian Congress of Agricultural Engineers, Itabuna(BA), July 19-23, 1982,

- VI Academic Week of Agricultural Engineering, UFPEL- Federal University of Pelotas-RS, Pelotas(RS), Sept. 20-24, 1982,

- I Brazilian Symposium of Semi-Arid Tropics, Recife(PE), Aug. 16-20, 1982,

- I Regional Meeting of Intercropping, Petrolina(PE), Nov. 10-12, 1982,

- XIII Brazilian Congress of Agricultural Engineering, Rio de Janeiro(RJ), July 18-21, 1983,

- Regional Meeting on Farming Systems Research, Petrolina(PE), Aug. 18-28, 1983,

- XIV Brazilian Congress of Agricultural Engineering, Fortaleza(CE), July 22-27, 1984,

- Invitational lecturers at various Indian and Brazilian Universities (July-Sept. 1982),

- Program Meeting on Farming Systems Research on Dryland Agriculture, Ouricuri(PE), Aug. 21-22, 1984,

- Program Meeting on Farming Systems Research on Irrigated Agriculture, Petrolina(PE), Sept. 24 and Oct. 1, 1984,

- Presentation of Mechanization Research Program of CPATSA to the term of directors of international programa of various american universities, Petrolina(PE), Nov. 27, 1984,

- Presentation of Quinquennial (1980-84) report on research and development activities on agricultural mechanization of northeast Brazil to various authorities of IICA/EMBRAPA and to professors and students of various Brazilian Universities, Brasília(DF), Campinas (SP), Piracicaba(SP), Campina Grande(PB), Petrolina(PE), Mar.-Sept. 1985.-

APPENDIX III.

ANALYTICAL SUMMARY OF PUBLICATIONS PRODUCED DURING EMPLOYMENT WITH IICA/EMBRAPA

(Oct. 1979 to Nov. 1985)

Year	Conference or popular articles	Published Articles						Total
		Institute		Brazilian journals		Foreign journals		
			in press		in press		in press	
1980	2	1	-	-	-	-	-	3
1981	4	2	-	-	-	-	-	6
1982	1	-	-	1	-	-	-	2
1983	4	-	-	2	-	1	-	7
1984	3	1	-	2	-	2	3	11
1985	6	-	-	-	2*	-	6*	14
Total	20	4	-	5	2	3	9	43

*Under review.-

APPENDIX IV.

SOME ADDITIONAL PUBLICATIONS AND CONTRIBUTIONS

Publications

LAL, HARBANS, 1971. Components of water loss form puddled paddy field. B.Tech. Thesis. I.I.T. Kharagpur (WB), India. pp. 31.

LAL, HARBANS, 1973. Design and development of paddy stripper harvesting. M.Tech. Thesis. I.I.T. Kharagpur (W), India. pp. 55.

KRISHNA, J.H. and LAL, HARBANS, 1975. Optimum resource management and use of improved animal-drawn implements in farming systems research at ICRISAT. Annual Workshop on Agricultural Engineering Research 28-31 Oct. 1975. Punjab Agricultural University, Lundhiana, India.

THIERSTEIN, G., LAL, HARBANS, KAMPEN, J. and KRANTZ, B. A. 1976. Farm Machinery Program at ICRISAT. Annual Research Engineers Workshop for Research and Development of Farm Implements and Machinery, 17-27 Dec. 1976. Andhra Pradesh Agricultural University, Rajendra Nagar, Hyderabad. India.

BANSAL, R.K., LAL, HARBANS and MAYANDE, V.M. 1980. Mechanizing farming in semi-arid tropics. Andhra Pradesh Chapter, Indian Society of Agricultural Engineers, Hyderabad, India.

LAL, HARBANS, 1981. Present status of agricultural mechanization of India and its evolution at ICRISAT. Proceedings of XI Brazilian Congress of Agricultural Engineering 22-7 Jun. Brasília(DF), Brazil, pp. 1339-47 (portuguese).

Contributions to Institutes' Reports:

FSRP/ICRISAT Annual Reports

1974-75

. Adaptation of Planet Jr. Seeders for relay planting and fertilizer application (pp. 65),

. Modification of buck scrapper (pp. 62),

. Adaptation of Kenmore tool carrier (pp. 62),

. Adaptation of fluted feed roller mechanism for fertilizer application (pp. 64).

1975-76

. Evaluation of different types of tool carriers for improved farming systems,

. Selection and fabrication of attachments of Tropicultor for improved farming systems.

1976-77

. Implement use efficiency as affected by different factors,

. Quantification of time efficiency for different field operations,

. Development of cart-based tool carrier and its attachments.

1977-78

. Evaluation of low-cost tool bars and tool carriers for improved farming systems,

. Effect of field lay-out on machinery capacity for bed farming and inter-row cultivation.

Annual Bulletin of EMBRAPA's Research Results

1981

. Development of Multicultor CPATSA.

1982

. Improvements in Multicultor CPATSA,

. Development of Multicultor CPATSA II.

Special Reports:

Research program on farmer's field in the region of semi-arid tropics (retrospectives and prospectives). CPATSA/EMBRAPA. Petrolina (PE), Brazil (1983).

Evaluation of impact of technologies generated by CPATSA as an integrated component of farming systems of farmers of Ouricuri(PE) region. A Research Project, Research Program of Farming System of Semi-Arid Tropics. CPATSA/EMBRAPA. Petrolina(PE), Brazil (1983).

The "in-situ" rainwater harvesting technique of CPATSA/EMBRAPA, ISTRO-INFO. Soil and Tillage Research, Amsterdam, Netherlands, No. 21. Sept. 1984. pp. 495-98.

APPENDIX V

TIPS FOR EFFICIENT CONSULTANT AND USEFUL CONSULTANCY

- In general, as far as effective use of a consultant is concerned, one must separate two major activities: the institution building and problem solving, and define these two functions and the type of foreign technicians accordingly.

- It needs to be recognized that an individual with specialised competence can often make a notable contribuition in a short period of time, provided the existing staff are able to convey their experience and understanding of problems to the new staff member and in turn profi from his special knowledge and skill. But all too often the core staff to provide that continuity and fruitful interaction has been lacking.

- It is almost inevitable that a foreign scientist will lack a deep understanding of existing farming systems and the constraints that conditions the ability and willingness of local farmers to accept innovations.

- The "Capacity Transfer" should be the major role of Institution Building Consultants. They should build in the host country a capacity that with time will enable the production of locally adaptable technology following prototypes which exists abroad or might even creat completely new prototypes together with local researchers and supporting institutions. They should show how to modify imported machinery designs in order to meet local climatic and social requirements and factors endownment of the economy.

Extracts from "Making Effective Use of Expartriate Personnel" by Eliseu Roberto de Andrade Alves and Levon Yeganiantz, Respectively Ex-president of EMBRAPA and Ex-consultant IICA; A paper presented at the workshop on "Increasing the Productivity and Impact of Agricultural Research" held at Gadjah Mada University, Yogyakatra, Indonesia (Asia), November, 1980.-

- It is highly desirable that the contract of Institution Building consultant be long term so that he can become completely involved with the problems of the country/organization that he is serving.

- It is advisable that the national institution who employs the consultant helps them to feel that they are welcome and useful. They should be part of all meetings, field days etc. including social events. By clearly specifying what is expected of them and then giving them complete freedom to work the necessary relationship can be achieved.

- The Problem Solving Consultant hired on short term basis can make his best contribution if at first the local technicians and admistrators have defined clearly the specific research problem.

- The work of expartriate scientists should be looked on the basis of the of cooperation and partnership. The visiting scientists should not be working "for" the host institution and their scientists, rather they should work "with" them.

APPENDIX VI

SCHEDULE FOR ELABORATION AND PRESENTATION OF FINAL REPORT

1. Inter-american Institute for Cooperation on Agriculture (IICA).
2. Name of the Consultant: Harbans Lal
3. Name of the Project: Agricultural Mechanization for Semi-Arid Tropics of Northeast Brazil
4. Name of the Activity: To strengthen Semi-Arid Production Systems
5. Objective: Refer to Job Description (Page V)
6. Period of Consultancy: Oct. 13, 1979 to Nov. 20, 1985
7. Local: Petrolina(PE), Brazil
8. Organization Benefited: CPATSA/EMBRAPA and other regional research, extension and teaching organizations
9. Collaborating Scientists: Refer to authors of Publications produced
10. Persons Interviewed with relations to activities Developed : Local farmers and farm equipment manufacturers.
11. Activities Developed: Refer to Cahpter I (Page 1 to 17)
12. Results of the Activities: Refer to Chapter I (Page 1 to 17)
13. Conclusions: Refer to Chapter I (Page 1 to 17)
14. Technical Recommendations and Suggestions : Refer to Chapter II (Page 18-22)

15. Circumstances and Happenings outside IICA affecting activities of Consultancy : Refer to Chapter III (Page 23-24)

16. Signature of the Consultant: _____

17. Date of Presentation: Nov. 15, 1985.