

REPORT  
ON  
THE SOCIO ECONOMIC SURVEY  
OF  
THE NAGARJUNA SAGAR PROJECT AREA

VOLUME - II  
TECHNICAL REPORT

ANDHRA UNIVERSITY  
WALTAIR.

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CHAPTER 1  
SAMPLING DESIGN OF THE SURVEY

1.1 Genesis of the Survey.

It is a special feature of the Nagarjunasagar Project that its Control Board realised the need for a survey of the Project Area even while the project work was in its early stages. This is due to the desire to achieve a rapid development of the ayacut in the case of this Project unlike what has been experienced in some of the other projects recently completed. The construction of the canals is only one aspect of a project, viz., the engineering aspect. Equally important in this connection are the factors such as the resources and agricultural experience and knowledge of the farmers of the area, the additional credit and transport requirements, and the like for the project to yield quick results and to progress rapidly towards reaching an optimal or near optimal stage.

With this object in view, the Control Board invited in 1956 suggestions from various institutions, and constituted a Technical Advisory Committee to consider these aspects from time to time and advise. Prof. B. Sarveswara Rao Head of the Economics Department, Andhra University submitted a comprehensive memorandum,<sup>1</sup> and the Indian Council of Agricultural Research also sent a memorandum to the Control Board. These were circulated to the members of the Technical Committee consisting of the Administrator, Chief Engineer, Nagarjunasagar Canals, Representatives of the Gokhale Institute of Politics and Economics, Representative of the Bureau of Economics and Statistics of Andhra Pradesh, Representative of the Indian Council of Agricultural Research, Director of Agriculture of Andhra Pradesh and two representatives of the Andhra University.

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See Appendix 1.

The Reserve Bank of India agreed to depute Sri T.S. Rao, Deputy Chief of its Rural Credit Department for important meetings of the Committee.

The first meeting of the Technical Committee was convened in 1957, at which it was decided to have a survey of the Project region in two parts to cover the Socio-Economic and the Agro-Economic aspects. It was further decided that the Indian Council of Agricultural Research would be in supervisory charge of the Agro-economic Survey.

As for the Socio-Economic Survey, no institution commanding the confidence of the Control Board came forward to shoulder the responsibility of conducting it. So the Technical Committee desired that we should be incharge of this survey. We felt that we could supervise the Socio-Economic Survey, if the Control Board would organise the field work, but the Control Board expressed its inability to organise the field work. Therefore the Committee requested us to undertake the actual conduct of survey in the field also. The Andhra University was approached for approving the proposal/ <sup>of</sup> permitting

both <sup>of us</sup> to be jointly in complete charge of the Socio-economic Survey of the Project area. Though the financial aspects were not decided in that meeting, a token sum of Rs. 3,000/- was sanctioned to meet any expenses for preliminary work by way of touring the area, collecting data etc. But subsequently the Agro-economic survey was dropped and certain important aspects of it were required to be included in the Socio-economic Survey itself. This necessitated the dropping out of Urban Surveys and Employment Surveys, <sup>Originally included in the scope of the Socio-Economic Survey</sup> as it was decided not to increase the expenditure but keep it at Rs. 2.3 lakhs as previously decided upon.

2 Background data.

Before undertaking a tour of the Project region to know first hand the various problems likely to arise out <sup>of</sup> the impact of the project on the area, Sri K.V. Satyanarayana, Research Officer, Bureau of Economic Research Andhra University, was sent round in summer, 1957 to visit the Taluk Offices in the ayacut area and gather information on various aspects of the economy of this region. The Project Authorities made available the firkawise lists of villages of the proposed ayacut in May, 1957.

On the basis of these lists, Mr. Satyanarayana gathered information in respect of each village regarding population, households, acreage under crops, crop-yields, etc. Using this information, the characteristics of villages in the Project region were examined in detail.

3 Criteria for stratification.

The latter part of the summer of 1957 was spent in going through the above data, looking for meaningful criteria to classify the villages into Strata.

After this, questions of stratification, of preparation of frames, and of sampling procedures, etc. were discussed with the late Sri T.S. Rao, Dr. N.S.R. Sastry and Sri V.N. Murty of the Reserve Bank of India at Bombay and later with Mr. N.V. Sovani of the Gokhale Institute of <sup>and Economics</sup> Political Politics at Poona.

The total number of towns and villages as per the delimitation of the ayacut made by the project authorities in the year 1958 came to <sup>669</sup> on the Right Canal side and <sup>276</sup> on the Left Canal side. It is found that villages having different population ranges are fairly uniformly distributed over the whole area. It is also found that commercial crops like chillies, groundnut, tobacco, and cotton are raised predominantly in a good number of villages situated on the Right Canal side of the project. Although most of these villages raised commercial crops to a large or small extent, it was felt that the economy of the villages in which the area under the commercial crops is relatively high, is likely to be different from that of the villages where these crops are not so extensively cultivated. Accordingly, the ayacut villages on the Right Canal side are divided into two strata, viz. S<sub>1</sub>, the stratum in which the commercial crops are important, and S<sub>2</sub>, the stratum consisting of the rest of the villages. The criterion of importance of commercial crops for any villages was taken to be that the area under any one of the four commercial crops mentioned above was at least 500 acres, or the total area under these four *Commercial* crops put together was 650 acres or more. On the basis of this criterion the number of villages (excluding villages having a population exceeding 5000 each, villages uninhabited or merged with others and towns) came to 196 in S<sub>1</sub>



and 385 in  $S_2$ . The commercial crops of importance in the villages on the Left Canal side of the project are groundnut and castor. It was found that the acreage under these crops was more or less evenly distributed in these ayacut villages, and therefore stratification of the villages on the left canal side on the basis of the importance of commercial crops was not made. All the 275 ayacut villages lying on the Left Canal side of the Project thus constituted the third stratum,  $S_3$ . Obviously  $S_3$  is one compact region but  $S_1$  and  $S_2$  are not separate compact areas. The villages in  $S_1$  and  $S_2$  lie interspersed.

4 The objectives of the <sup>Sample</sup> Survey and the choice of a frame.

The Socio-economic survey of the Project area has been undertaken firstly to serve as a bench mark in respect of the various aspects of social conditions and economic activities in the region, and secondly to obtain an appraisal of the regional income, the present position regarding resources, and the input-output data for the various activities (Farm and Non-Farm) that are going on in the area. The information is intended to be collected Stratum-wise. Though we have the lists of villages in each of these strata, we have no adequate data to go by, to arrive at the various types of appropriate frames to draw samples from, for different types of surveys. It was felt that this difficulty can be surmounted only by treating a sample of villages in each stratum as representative of the stratum itself and collecting information on basic items of interest from every household in each of the villages chosen for study.

.5 Selection of villages and the Census Survey.

By simple random sampling 8 villages from  $S_1$ , 12 villages from  $S_2$  and 9 villages from  $S_3$  were selected for purposes of this survey. But in 1959, the Project Authorities decided to exclude from the original ayacut, a compact area

called 'Pulichintala Block', as it was mainly a Virginia tobacco growing area. This resulted in our having to delete 4 of the sampled villages on the Right Canal side. In the process of replacing these four villages, we took note of the fact <sup>that</sup> the deletion of the 'Pulichintala Block' has brought down the relative size of the Right Canal area and so it was decided to reallocate the overall number of 29 villages as follows:

$$S_1 : 7; S_2 : 12; S_3 : 10.$$

Accordingly, we added one randomly sampled village to the sample villages in  $S_1$ , 2 randomly sampled villages to those in  $S_2$  and one randomly sampled village to those in  $S_3$ .

The sampled villages in the final list and their location are as follows:

<u>Sampled villages</u>			
STRATUM-1.	<u>Village</u>	<u>Taluk</u>	<u>District</u>
	1. Nemalapuri	Sattenapalli	Guntur
	2. Mothadaka	Guntur	Guntur
	3. Mittagudipadu	Palnad	Guntur
	4. Madala	Sattenapalli	Guntur
	5. Bandarupalli	Guntur	Guntur
	6. Veluru	Narasaraopet	Guntur
	7. Pernamitta	Ongole	Guntur
STRATUM-2.	1. Gollapadu	Sattenapalli	Guntur
	2. Chandalur	Darsi	Nellore
	3. Bandlamudi	Ongole	Guntur
	4. Lakshmipuram	Ongole	Guntur
	5. Peda-Agraharam	Palnad	Guntur
	6. Nagulavaram	Vinukonda	Guntur
	7. Darsi	Narasaraopet	Guntur
	8. Kolachenakota	Ongole	Guntur
	9. Palapadu	Narasaraopet	Guntur

STRATUM-2.	<u>Village</u>	<u>Taluk</u>	<u>District</u>
	10. Peddavaram	Vinukonda	Guntur
	11. Kalavakur	Ongole	Guntur
	12. Kamepalli	Narasaraopet	Guntur
STRATUM-3.			
	1. Adiviravulapadu	Nandigama	Krishna
	2. Singareddipalem	Khammam	Khammam
	3. Tripuravaram	Huzurnagar	Nalgonda
	4. Siripuram	Jaggayyapet	Krishna
	5. Wadapalli	Miriyalaguda	Nalgonda
	6. Nandipahad	Miriyalaguda	Nalgonda
	7. Vallabhi	Khammam	Khammam
	8. Pedaveedu	Huzurnagar	Nalgonda
	9. Dondapadu	Huzurnagar	Nalgonda
	10. Bhimavaram	Jaggayyapet	Krishna

At the same time we selected 2 villages of the S<sub>1</sub>-type 2 villages of the S<sub>2</sub>-type and 3 villages of the S<sub>3</sub>-type which will not get the benefit of water from the project but lie close to the ayacut region. These are intended to serve as control villages. They are included in the present survey, and a repeat survey at a later date will indicate the growth of the three types of villages during the period without receiving the benefit of water from the Project. The following are the Control villages.

Control Villages

	<u>Village</u>	<u>Taluk</u>	<u>District</u>
S <sub>1</sub> -Type	1. Katrapadu	Bapatla	Guntur
	2. Koppuravuru	Guntur	Guntur
S <sub>2</sub> -Type	1. Atmakuru	Palnad	Guntur
	2. Potlapadu	Darsi	Nellore
S <sub>3</sub> -Type	1. Gottumukkala	Nandigama	Krishna
	2. Madugulapalli	Miriyalaguda	Nalgonda
	3. Mothe	Suryaraopet	Nalgonda

Though these villages have been surveyed, the tabulation and analysis of the data have not been taken up, as it can be more meaningfully done at the time of the repeat survey.

Next, the question was considered about the need for the survey of some villages in the vicinity of the ayacut region which received the benefit of canal irrigation in the last decade. The purpose of a survey of such villages was to know the problems which the farmers are likely to face in the wake of the construction of the project and the changes likely to come about after water is made available for irrigation to the ayacut villages.

The villages are referred to as "Wet Villages". They are 4 villages in all. All of them taken together are referred to stratum-4 or S<sub>4</sub>, 3 of them which are near Vijayawada are collectively referred to as S-4 A and the remaining village as S-4 B.

The following are the details of the wet villages

	<u>Name of Village</u>	<u>Taluk</u>	<u>District</u>	<u>Source of Irrigation</u>
Stratum-4 A.	1. Rayanapadu	Vijayawada	Krishna	The Krishna Cooperative irrigation and Agricultural Improvement Society, Guntupalli.
	2. Guntupalli	Vijayawada	Krishna	
	3. Gollapudi	Vijayawada	Krishna	
Stratum-4 B.	1. Pynampalli	Khammam	Khammam	Palair Reservoir Scheme

Information was collected for the year 58-59 during the period April to June 1959 from each of the households, in all the sampled and selected villages on

- i) Land ownership
- ii) Land utilisation
- iii) Operational holdings
- iv) Cropping pattern
- v) Human population, working and non-working population

- vi) Occupational pattern
- vii) Non-farm activities
- viii) Cattle wealth
- ix) Agricultural and non-agricultural assets *and*
- x) Incomes from land and other sources for the year 1958-59

For the results of this survey, the reader is referred to a separate chapter on this in the Report.

#### 1.6. Design of the Intensive Farm-Surveys.

One main object of the Census Survey in each of the sampled and selected villages was to prepare a complete list of the households in the villages. The investigators were asked to report any discrepancies from the information on households <sup>in</sup> 1951 related to the Population census of the villages. These discrepancies were examined and reconciled and then a finalised list was prepared. In view of the fact that the Agro-economic aspect of the survey was dropped, it became necessary to carry out a ~~some-what~~ <sup>what</sup> more detailed survey of the farm activity in the villages than originally programmed. The picture of each stratum is taken as being given by the villages sampled from it. In a village itself we may broadly say a household forms a unit. The definition of a household adopted by us is the same ~~is~~ as in the Population census viz. all the members residing in a premises and taking food from the same kitchen. Whenever a household, any member or members of which, are engaged in cultivating any extent of land either owned or taken on lease is referred to as a cultivator or cultivating household. Thus all households are dichotomised into cultivator households and non-cultivator households. This definition of cultivating household is irrespective of the amount of income derived from cultivation. For the study

of the farm enterprise in the village we have adopted a farmer's holding as a unit. This is defined as the land actually cultivated under one management including the leased-in land but excluding the leased-out land. This is also called an operational holding. While most of the times the management of a farm is under one household, it happens occasionally that the same farm might be jointly operated by more than one household. Thus in a village the number of cultivating households is nearly the same as the number of operational holdings but may slightly exceed wherever there are joint operational holdings.

In each village the operational holdings are listed out in descending order of their extent and divided into quintile groups. A ~~group~~ simple random sample of 4 holdings from each quintile group is drawn giving a sample of 20 farms <sup>for</sup> each of the sample village. Such a sampling procedure was felt to be the best in our discussions, as it ensures representation of farmers of different sizes operating in the village. This design bears similarity to the one adopted in the Rural Credit Survey. This procedure is uniformly adopted not only in the sampled villages of the ayacut region but also in the Control villages and the wet villages. The survey was conducted from May '59 to April '60. Each investigator was assigned a fixed number of sampled farmers belonging to three <sup>or four</sup> close by villages. He was required to be in constant contact with the farmers during a period of one complete crop year (1959-'60) and collect detailed information in <sup>three to four</sup> rounds as per the prescribed instructions and enter <sup>the same</sup> in the schedules.

For the results of this survey the reader is referred to a separate chapter on this in the Report.

1.7. Design for the Survey of Non-farm enterprises.

On the basis of our Census information, a list of the enterprises in these villages other than cultivation was prepared. In the ayacut region 16 enterprises were found to be at least of some importance, whereas in the wet villages, they were 18 in number.

Dairying by a cultivating household was treated as a part of farm enterprise, but it was treated as a non-farm enterprise when the household engaged in this activity was not cultivating any land. In respect of each of the non-farm activities, a list of households having this activity in each village was prepared. Often times the number of households in a village in such a list was found to be small. This was anticipated even at the time of the original discussion at Bombay and Poona, and it was decided not to make village-wise frames but pool the data and prepare frames for each stratum, or frames for the entire Right Canal and Left Canal regions, and if necessary a single frame for the entire ayacut area.

In each frame, the households were stratified, wherever relevant, into two strata consisting of households for which the activity is carried on as a household activity and the rest. These two groups of households were again classified in the case of some enterprises into cultivator households and the rest. The households in each of these sub-groups were listed in descending order of income from the particular enterprise, and further divided into sub-strata on the basis of high, medium, or low income ranges. From these sub-strata, households are drawn by simple random sampling so as to make up a sample which is not too small.

Before we give details of the regions for which different frames were made, we may draw the attention of

the reader to the fact that the same household may be simultaneously engaged in cultivation and some other non-farm enterprises too, and accordingly may be included in a number of frames, with the possibility of its inclusion in samples for farm studies as well as one or more non-farm studies.

From a study of the data collected in our census survey, it was found that only 16 non-farm enterprises were of any importance to the Project area. They are listed in the table <sup>No 1.1</sup> below. The same table shows how the regions are pooled to arrive at frames containing households not too small in number. For rearing of sheep and goats,  $S_1$  and  $S_2$  are taken together and a frame is prepared for this entire area, and another frame is prepared for  $S_3$  separately. For weaving, separate frames are prepared for cultivating households of  $S_1$  and for non-cultivating households of  $S_1$ , and similar frames have been prepared for  $S_2$  and also for  $S_3$ . In respect of carpenters the entire Project area is taken as a single region, and for this region four mutually exclusive frames are prepared as follows:

(i) frame of all cultivating households in the area where the enterprise is run as a household one, (ii) frame of all cultivating households which have carpentry as a non-household enterprise, (iii) frame of non-cultivating households which have this enterprise as a household one, (iv) frame of non-cultivating households of the area having carpentry as non-household enterprise.

In respect of goldsmithy, all relevant households of all the sampled villages in the three strata are listed as a single frame.



The table No. 1.1 below shows all these details in respect of each of the 16 enterprises considered.

The sample sizes in the table are either 15, 10 or 8, or 5. In the case when the size is 15, the sample has been obtained as follows:

The households in the frame are arranged in descending order of incomes, and stratified into 3 equal parts which may be called the strata with households of high, medium, and low incomes, and a simple random sample of size 5 is drawn from each stratum to make up the total sample of size 15.

When the sample drawn is of size 10 (or 8) the procedure adopted is that the households in the frame are listed in descending order of their incomes accruing from the enterprise and stratified into two strata each containing equal number of households, so that stratification results in division into higher income households and lower income households. By simple random sampling, samples of size 5 (or 4 as the case may be) from each stratum are drawn, so that a sample of size 10 (or 8 as the case may be) is finally arrived at from the frame.

Table No. 1.1 Sample  
TABLE SHOWING SAMPLING DETAILS OF THE NON-FARM ENTERPRISES IN THE VILLAGES OF THE AYAGUT AREA

Sl. No. of enterprise	Name of the enterprise	Description of the frames	Sample size proposed	Range of income (in Rs)		Size of the frame		
				Minimum	Maximum			
(1)	(2)	(3)	(4)	(5)	(6)	(7)		
1.	Rearing of sheep and goats	Pool S <sub>1</sub> and S <sub>2</sub>	15	6	900	267		
		S <sub>3</sub>	10	-200	600	88		
2.	Rearing of pigs	Pool up the entire information	15	8	400	111		
3.	Poultry	Pool up the entire information	15	2	100	141		
4.	Dairying	Consider separately among the non-cultivator households	S <sub>1</sub> 10	8	360	211		
			S <sub>2</sub> 10	15	300	108		
			S <sub>3</sub> 10	30	300	106		
5.	Weaving	Consider cultivator and non-cultivator households from all the 3 strata	S <sub>1</sub>	Cultivators	8	50	900	18
				Non-Cultivators	8	40	600	74
			S <sub>2</sub>	Cultivators	8	30	400	38
				Non-cultivators	8	20	720	41
			S <sub>3</sub>	Cultivators	8	50	960	35
				Non-cultivators	8	20	1200	79
			6.	Ambercharka	Pool up the entire information	5	20	100
7.	Tailoring	Pool up the entire information	15	50	1200	161		

(Contd.)

Sl. No. of enterprise	Name of the enterprise	Description of the frames	Sample size proposed	Range of income (in Rs.)		Size of the frame	
				Minimum	Maximum		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
8.	Cobblers	Pool up S <sub>1</sub> , S <sub>2</sub> and S <sub>3</sub> households	10	10	516	491	
		Non-households S <sub>3</sub>	12 (Complete enumeration)	20	300	12	
9.	Blacksmithy	Pool up all the household information	10	80	800	29	
		Pool up all the non-household information	5	100	350	8	
10.	Goldsmithy	Pool up the entire information	10	100	850	43	
11.	Basket making	Pool up all the household information	10	20	720	106	
		Pool up all the non-household information	5	80	520	14	
12.	Pottery	Pool up all the household information	10	30	850	114	
		Pool up all the non-household information	6 (Complete enumeration)	20	250	6	
13.	Carpentry	Pool up the information as cultivator and non-cultivator households under the category of household and non-household					
		Cultivator	Household	8	50	1500	58
			Non-household	8	75	420	10
		Non-cultivator	Household	8	50	1200	70
		Non-household	8	100	800	12	

15  
Com. No.

Table No. 11 (Contd)

TABLE SHOWING SAMPLING DETAILS OF THE NON-FARM ENTERPRISES IN THE VILLAGES OF THE AYACUT AREA (CONTD.)

Sl. No. of enterprise	Name of the enterprise	Description of the frames	Sample size proposed	Range of income (in Rs.)		Size of the frame
				Minimum	Maximum	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
14.	Transport	Pool up S <sub>1</sub> and S <sub>2</sub> in the Non-cultivator households only	10	200	720	25
15.	Laundry	Pool up the entire information	10	15	800	410
16.	Casual labour (Agricultural labour)	Cultivator S <sub>1</sub>	8	10	1600	1073
		S <sub>2</sub>	8	25	2200	858
		S <sub>3</sub>	8	10	1200	907
		Non-cultivator S <sub>1</sub>	8	20	1200	1343
		S <sub>2</sub>	8	30	1000	672
		S <sub>3</sub>	8	20	1000	1259
<b>COMPLETE ENUMERATION</b>						
1.	Cobblers	All the villages combined		20	300	12
2.	Blackmithy	-do-		100	350	8
3.	Pottery	-do-		20	250	6
4.	Carpentry	-do-		75	420	10
5.	Brass-ware making	-do-			600	1
6.	Mills	-do-		200	2000	7

Other Surveys.

This section deals with certain other Surveys wherein information is collected without any sampling design.

(i) Village Surveys.

In respect of each of the surveyed villages, information of general interest was gathered from the <sup>well informed</sup> people and officers of the village in a schedule intended for the purpose.

(ii) Taluk Reports.

To have a general picture of the ayacut as contained in the taluks, information from the existing records at the Taluk offices was gathered and compiled. These are referred to as 'Taluk Reports'. They refer only to the Ayacut part of the taluk concerned. Where the ayacut area in a taluk is small, or the information scanty, the reports have not been prepared for such taluks. Data were also collected from the Assistant Directors of Industries regarding the details of existing industries in the different taluks.

(iii) Credit, Marketing and Transport Surveys.

To understand the existing position regarding credit, marketing conditions, and transport facilities, important centres on the Right and Left Canal sides were selected, and data were gathered on the following main aspects:

- (a) agencies providing credit, (b) membership and capital structure of banks, (c) pattern of receiving and repayment of loans by <sup>traders, etc.</sup> (d) warehousing and marketing conditions at these centres and (e) the way in which <sup>agricultural</sup> produce, fertilisers, etc., are transported from and to the ayacut region.

## CHAPTER - II

### PROCEDURES OF ESTIMATION AND ESTIMATES

In order to estimate the <sup>direct</sup> benefits from agriculture that will accrue due to the supply of water from the Nagarjunasagar project to the ayacut villages, we have to estimate the present income <sup>from crop production</sup>, and for this we have to first estimate the total cultivated area in this region, the intensity of cropping, the cropping pattern, the rate of yields for the different crops, and the average prices.

#### 2.1. Net cultivated Area in a stratum.

Figures of the net cultivated area are available in the 'Census Survey' carried out in each of the sample villages. These figures are totalled for the sample villages in a stratum, and the average per village obtained. This average is taken as the estimate of the net cultivated area per village for the entire stratum. If the net cultivated area in the  $j$ -th village of the  $i$ -th stratum is  $a_{ij}$ ,  $i=1,2,3$ ,  $j=1,2,\dots,n_i$ ,  $n_1=7$ ,  $n_2=12$ ,  $n_3=10$ , the estimate of the stratum average under consideration is  $\bar{x}_i = \frac{(\sum_{j=1}^{n_i} a_{ij})}{n_i}$ .

#### 2.2. Net cultivated area for the right canal side.

Weighting the estimate for the average per village in  $S_1$  by the total number of villages in the frame for  $S_1$  and similarly weighting the estimate for  $S_2$  by the total number of villages in  $S_2$ , an estimate of the over-all average of net cultivated area per village on the right canal side is obtained as  $\frac{N_1 \bar{x}_1 + N_2 \bar{x}_2}{N_1 + N_2}$ .

where  $N_1$  is the number of villages in the frame of villages for  $S_1$ , and  $N_2$  is the corresponding number for  $S_2$ . Then the estimated total net cultivated area on the right canal side is

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! The census survey here refers to collection of data on certain items from all the households of the sampled villages. This should be distinguished from the population census of India.

$$(N_1 + N_2) \cdot \frac{N_1 \bar{x}_1 + N_2 \bar{x}_2}{(N_1 + N_2)} = N_1 \bar{x}_1 + N_2 \bar{x}_2$$

which is simply the sum of  $T_1 = N_1 \bar{x}_1$  and  $T_2 = N_2 \bar{x}_2$  which are the estimated totals for  $S_1$  and  $S_2$ . The same weighted average could have been obtained by first aggregating the estimated totals  $T_1$  and  $T_2$  and then dividing the sum by  $N_1 + N_2$ . At several stages in the work when the averages for the right canal side, or for the entire project area have been used, this procedure of taking the weighted average which would be equivalent to aggregating the totals, and then averaging suitably is adopted.

### 2.3. Intensity of Cropping.

The actual extent of land in which crops are raised, irrespective of the number of times crops are raised on a part or the whole of it in a year, is called Net Cultivated Area.

The extent of land on which crops are raised, counting every part of land as many times as the number of times crops <sup>are</sup> grown on it in a year, is called Gross Cropped Area. This will not contain current fallows.

The ratio of gross cropped area to net cultivated area is known as Intensity of Cropping. This ratio is generally greater than or equal to unity, but when the extent of current fallows exceeds the area on which crops are grown for a second (and third) time in the same year, it can be less than unity. Pooling the information from the Intensive Farm Surveys relating to all the sampled farms in the sample villages of a stratum, the intensity of cropping for these farms was obtained.

This intensity is used as the estimate for the intensity for the entire stratum.

Remarks: While, in respect of the villages listed in the frame of  $S_1$ ,  $S_2$  and  $S_3$ , the gross cropped area is estimated using the estimates of net cultivated area, the reverse procedure has to be used in respect of towns and villages excluded from the frames.

2.4: Gross cropped Area:

There is no information regarding the gross cropped area under different crops. The ayacut area given by the project authorities is the culturable commanded area, but not the cultivated area, as the former includes some areas that can be brought into cultivation at a future date. Village-wise or stratum-wise cultivated area under different crops could not be worked out from the information available at the Taluk offices because of the gaps in them. The 1951 Census data was also of no avail, as the figures were average for the 5-year period preceeding 1951. *The reliability of these figures as given in the Hyderabad State Census is open to doubt.*

Therefore cultivated area in each stratum, could be arrived at by relying entirely on the results of <sup>our</sup> ~~the~~ survey.

The estimated net cultivated area for each stratum was multiplied by the corresponding estimate of the intensity of cropping to obtain an estimate of the gross cropped area in that stratum.

Gross Cropped area when towns and villages with population over 5000 and uninhabited villages are also included:

There are the towns, villages with population over 5000 and uninhabited villages which are not included in the frames of  $S_1$ ,  $S_2$  and  $S_3$ . The gross cropped area for these is obtained by using the information in the Taluk Reports. To the estimated gross cropped area in any stratum, the corresponding figure for towns and villages left out of the frame is added so as to obtain the estimate of the entire region.



Remark: By using the estimate of the intensity of cropping for the stratum, net cultivated area for the entire region of a stratum including all towns and villages excluded from the frame was worked out.

Total area available for Cultivation:

The percentage of uncultivated area and grazing land in the sampled <sup>villages</sup> in  $S_1$ ,  $S_2$ , and  $S_3$  are used as estimates for working out figures of uncultivated and grazing land in towns and villages excluded from the frame. These extents are also available for cultivation, besides the cropped area.

Cultivable Waste and Permanent Fallows and Forest Land in towns and villages excluded from the frames are also worked out in a similar way using the corresponding percentage figures of such areas in sample villages.

Cropping pattern:

For each sampled village in a stratum, the net cultivated area obtained from the census survey is multiplied by the estimate of the intensity of cropping for the stratum<sup>2</sup>. This estimate of the gross-cropped area for the village is allocated to different crops on the percentage basis of the cropping pattern obtained by pooling the data from the intensive Farm Survey of the sample farms in that village. The area under each crop for the different sample villages are then aggregated, and the percentage distribution under crops worked out. On this percentage basis, the estimated gross cropped area of the stratum is allocated to different crops. The estimate of the cropping pattern for the Right

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<sup>2</sup>The intensity of cropping is very nearly unity. The difference between the village and the stratum intensities would be so small that the error introduced by simplifying the calculations by using the stratum intensity for each village is negligibly small.

canal side, and the entire project area can now be got by just aggregating the gross cropped area under different crops for the relevant regions.

Before we close the section on the estimation of cropped area, it may be mentioned that we preferred the above method to other methods. For example, the data obtained by way of background information for each of the sample villages contain information on this item. But the data therein were given by the village officers, basing them on old settlement records. Nor could the information of the 1951 population census in respect of the cultivated area be adopted, as that also is too old. Even the latest information available at the Taluk offices could not be used, as it was not complete, and was not recorded on a uniform basis for the Right and Left canal areas of the Project region.

Hence it was that the above procedure was finally adopted as the best under the circumstances for estimating the net cultivated area, and cropping pattern.

## 2. 5. Number of households in a stratum:

For working out an estimate of the number of households it was felt that 1951 population census data could be advantageously used. Taking the total number of households in all the sample villages in a stratum as per 1951 population Census and the total number of households in the very same villages as per the present census survey for 1959, we could get reliable information on the rate of growth of the number of households in these sample villages from 1951-59. Attributing this rate of growth to the total number of households in the stratum as per 1951 population Census, the estimate of the number of households in the stratum for 1959 was obtained.

If  $h_{ij}^{(1)}$  is the number of households in the  $j$ -th sample village of  $i$ -th stratum as per our census survey for 1959,  $i = 1, 2, 3$ , and  $h_{ij}^{(0)}$  is the corresponding population census figure of 1951, and  $H_i^{(1)}$  refer to the estimated totals for the  $i$  th. Stratum in 1959 and the actual total in 1951 we have by our assumption

$$\frac{H_i^{(1)} - H_i^{(0)}}{H_i^{(0)}} = \frac{\sum_{j=1}^{n_i} h_{ij}^{(1)} - \sum_{j=1}^{n_i} h_{ij}^{(0)}}{\sum_{j=1}^{n_i} h_{ij}^{(0)}}$$

As this method is based on consideration of the growth it is preferred to other methods.

2. 6. Number of cultivating households in a stratum.

The number of estimated households in the stratum was divided into the number of cultivating households and the rest on the basis of the observed ratio of these in the Census survey for 1959 in the sample villages of the stratum under consideration. The method of using growth rates could not be applied to estimate separately the number of cultivating households and the rest, because the population Census data or other available data do not give their relative sizes in 1951. This is due to the fact that the definition of a cultivating household adopted in this survey is a household cultivating any extent of land irrespective of size, ownership or income, and there is no such classification of households in population census data. But this definition has had to be adopted and used for classification, as contribution to agricultural production from farms of all sizes has to be taken into account.

2.. 7. Mean of per-acre-yields of a Crop, or mean of any other farm characteristics in a stratum:

For any farm characteristic, an estimate of its mean in a stratum is obtained on the assumption that the sampled farms

in all the sample villages in that stratum constitute a representative sample from the entire collection of farms in the stratum. Accordingly, information on 140 sample farms in  $S_1$  is pooled together and estimates are worked out for that particular farm characteristic. Similar procedures are adopted in respect of the 240 sample farms in  $S_2$  and the 200 sample farms in  $S_3$ . The pooled data are frequently classified by size groups of operational holdings.

As previously mentioned, a suitably weighted average of the different averages in the different size groups of <sup>operational</sup>operated holdings is worked out in each instance, so that the procedure becomes equivalent to aggregating the estimated totals for each size group, and then averaging over the total number of acres under the crop, or other relevant units as the case may be.

## 2.8 Inputs.

The average inputs of different types for a crop are also estimated by the procedure mentioned <sup>above</sup>.

2.9 Prices: The average prices used are also weighted average<sup>s</sup>, the weight used being the quantities of yields in the sample farms corresponding to the different prices.

## 2.10 Non-Farm Survey:

After analysing the data contained in the schedules relating to the households in the sample for each non-farm enterprise it is found that the input-output figures relating to only 12 enterprises will be meaningful and they have been worked out. For the non-farm study, this is the only estimation that was carried out. As sufficient care was taken to make the sample fairly representative, the inputs and outputs were arrived <sup>at</sup> by giving equal weight to all the households in the sample. The standard errors are not calculated as the information gathered was too meagre.

The following table <sup>No 2.1</sup> gives the enterprises and the <sup>non-farm</sup> input-output relationship obtained in the survey.

Table No. 2.1.

## Input-Output Structure in Non-Farm Enterprises.

Name of enterprise.	No. of households sampled	No. of households analysed.	No. of Family workers	No. of hired employees	Fixed Capital (in Rs)	Cross value of production (in Rs)	Cost of material inputs (in Rs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Weaving	48	45	111	4	4189.94 (93.11)	26007.00 (577.93)	17209.10
2. Ambercharka	5	3	3	-	360.00 (120.00)	43.00 (14.33)	15.56
3. Tailoring	15	14	17	-	3193.24 (228.09)	3900.87 (278.63)	326.69
4. Cobblery	22	22	33	-	93.15 (4.23)	1972.50 (89.66)	1400.18
5. Goldsmithy	10	9	9	-	517.79 (57.53)	2332.00 (259.11)	271.08
<del>6. Basket Making</del>	<del>15</del>	<del>14</del>	<del>14</del>	<del>27</del>	<del>xx</del>	<del>47.74</del>	
6. Basket Making	15	14	27	-	47.74 (3.41)	2395.38 (171.10)	682.50
7. Pottery	16	14	43	-	424.86 (30.35)	2055.14 (146.79)	505.05
8. Blacksmithy	18	16	26	1	2706.75 (169.17)	6574.00 (410.88)	214.00
9. Carpentry	34	28	41	3	2356.36 (84.16)	13472.34 (481.16)	139.00
10. Transport	10	10	10	-	2818.50 (281.85)	7440.00 (744.00)	1241.25
11. Laundry	10	10	30	-	108.26 (10.83)	2789.00 (278.90)	266.13
12. Mills	7	3	4	5	19326.75 (6442.25)	4146.00 (1382.00)	952.50

NB. Figures in brackets are averages per household.

Table No. 2.1 (Contd.)  
Input-Output Structure in Non-Farm Enterprises (Contd.)

Name of Enterprise.	Wages paid for hired Labour (₹ Rs)	Depreciation (₹ Rs)	Maintenance or repairs (₹ Rs)	Other Payments (₹ Rs)	Total Cost (₹ Rs)	Net Income (₹ Rs)	Net Income per household. (₹ Rs)
	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1. Weaving	245.00	209.50	450.00	133.00	18246.60 (405.48)	7760.40	172.45
2. Ambercharka	<del>18000</del>	18.00	12.00	--	45.56 (15.19)	-2.56	-0.85
3. Tailoring	--	159.66	280.00	24.12	790.47 (56.46)	3110.40	222.17
4. Cobblery	--	4.66	66.00	--	1470.84 (66.86)	501.66	22.80
5. Goldsmithy	--	25.89	27.00	76.00	399.97 (44.44)	1932.03	214.67
6. Basket Making	--	2.39	42.00	2.33	729.22 (52.09)	1666.16	119.01
7. Pottery	--	21.24	42.00	22.00	590.29 (42.16)	1464.85	104.63
8. Blacksmithy	78.75	135.34	80.00	--	508.09 (37.76)	6065.91	379.12
9. Carpentry	825.00	117.82	140.00	343.00	1564.82 (55.89)	11907.42	425.27
10. Transport	--	140.93	200.00	1818.44	3400.62 (340.06)	4039.38	403.94
11. Laundry	--	5.41	30.00	--	301.54 (30.15)	2487.46	248.75
12. Mills	1450.00	966.34	300.00	141.00	3809.84 (1269.95)	386.16	112.05

NB Figures in brackets are averages per household.

2.n. Estimates.

The actual values of the estimates obtained in the survey are all given in Chapters IV, V and VI of Volume I, excepting estimates of farm resources which are given in Chapter II. of the same volume. We may mention here that estimates of various types of income obtainable from the Input-Output data are also presented in Chapter V of the Same Volume. Net incomes arising from various agricultural and non-agricultural occupations are given in Chapter II. of this volume. However, no mention is made of the procedure of estimation in the case of these net incomes as they are worked out by simple averaging.

*The estimates relating to the Survey of non-farm enterprises are presented in table No 2.1 above.*

CHAPTER III  
RELIABILITY OF ESTIMATES

3.1 Standard errors.

In large sample methods, the standard error is used for appraisal of precision. The basis for this is that the estimates in such samples are approximately normally distributed under fairly general conditions which are assumed to hold good. We shall here refer to the standard error, expressed as a percentage of the corresponding estimate, as the "Coefficient of Variability", and we shall use this as a convenient measure of the reliability of the estimate.

In this survey, there are several difficulties in the computation of standard errors and the Coefficients of Variability. This fact was realised even in the first meeting of the Technical Committee of the Nagarjuna Sagar Project. At this meeting it was decided to divide the survey into a purely Agro-economic part, to be carried out by the Indian Council of Agricultural Research over a period of 3 years, with a view to make firm estimates, and a Socio-economic part to be carried out by the Andhra University, wherein data are to be collected over a wide range of social and economic activities of the people of the Project Area without much stress on the calculation of <sup>standard</sup> errors.

Later on, there was a considerable reduction in the amount sanctioned for the socio-economic survey with the result that the scope of the survey became considerably restricted. Further, the agro-economic survey was also dropped for want of funds and its main features had to be incorporated in the present survey itself, without the sanction of any additional expenditure. So it has come about that the agricultural part of the survey originally intended to be carried out over a period of 3 years was done for only one year. Necessarily, there is bound to be some loss of precision due to the reduction of time.



In many surveys of this type work relating to the appraisal of precision is either usually taken up at a very late stage or not taken up at all. In the present case considerable effort has been put into the computation of standard errors of at least some of the important estimates. The Ratio Method of Estimation has been mainly employed in the present survey. The standard errors of Net Cultivated Area, Gross Cultivated Area, Total Number of Households, Average Number of Households per village, Per-acre inputs of Human labour, Bullock labour and Other Variable Inputs for important crops for each of the three strata have been calculated. Some of the cases where computations were heavier were left out. Since the purpose is to have an idea of the extent of variability in our estimates, the computation of standard errors in some typical cases would generally suffice.

For some estimates the Coefficients of variability are comfortably low, while for some others, they are in the neighbourhood of 10% which is also good enough. However, in the case of inputs for irrigated paddy as now grown in the Project area the variability is much higher. This crop seems to be grown under widely varying conditions under wells and tanks. If the survey had extended over 3 years, smaller standard <sup>errors</sup> would have been obtained.

Before proceeding to give details of the formulae used for calculating standard errors and giving the values obtained by them, it may be pointed out at this stage that standard errors are not helpful for forecasting purposes. What the Project region will become like can be guessed only by studying the economy of the regions of this type which have come under canal irrigation.

The main purpose of working out the estimates and their standard errors is to provide bench mark data for future repeat surveys of this area, which is one of the objectives of this survey.

When we compare the results of adopting the optimal cropping pattern with the present position given by this Benchmark, we are obliged to consider the question of precision attained in the present survey. Taking the entire agricultural activity in the region as an industry going on at constant returns to scale, it seems reasonable to suppose that the output (as also the value added) is subject to the same order of variability as the inputs.

We now proceed to give details of the standard errors which have been worked out.

Formulae used for computing Standard Errors of Ratio estimates

In the case of estimation of the Standard Error of the estimated total number of households in a stratum the formula used is

$$\sqrt{V(\hat{Y}_{R_i})} = \sqrt{\frac{N_i(N_i - n_i)}{n_i(n_i - 1)} \left( \sum Y_{ij}^2 + \hat{R}_i^2 \sum X_{ij}^2 - 2\hat{R}_i \sum Y_{ij} X_{ij} \right)}$$

where  $\hat{Y}_{R_i}$  is the ratio estimate of the total number of households in *i*th stratum,  $V(\hat{Y}_{R_i})$  is the variance of  $\hat{Y}_{R_i}$ ,  $Y_{ij}$  is the number of households in 1959 of the *j*th village in *i*th stratum

$X_{ij}$  is the number of households in 1951 of the *j*th village in *i*th stratum

$$\hat{R}_i = \frac{\sum_j Y_{ij}}{\sum_j X_{ij}}$$

$N_i$  is the number of villages in the frame of *i*th stratum

$n_i$  is the number of sample villages in the *i*th stratum

Also the Standard Error of the mean number of households per village in 1959 in a stratum is obtained

$$\text{as } \sqrt{V(\hat{Y}_R)} \div N_i$$

In the case of the estimation of the Standard Error of the ratio estimates of value inputs (human labour, bullock

(labour and other variable inputs) in crop production, as obtained from the intensive farm surveys undertaken during 1959-60, the formulae used is

$$V(\hat{R}_{ij}) = \frac{N_i - n_{ij}}{N_i n_{ij}} \frac{1}{X_{nij}} \frac{1}{n-1} \frac{1}{ij} \frac{n}{k} (Y_{ijk} - \hat{R}_{ij} X_{ijk})^2$$

$$\text{where } \hat{R}_{ij} = \frac{\sum_k Y_{ijk}}{\sum_k X_{ijk}}$$

$Y_{ijk}$  is the input in value terms (human labour or bullock labour or other variable inputs) of  $K^{\text{th}}$  farmer in the production of  $j^{\text{th}}$  crop in  $i^{\text{th}}$  stratum,  $X_{ijk}$  is the area in acres on which  $j^{\text{th}}$  crop is grown by  $K^{\text{th}}$  farmer in  $i^{\text{th}}$  stratum,  $\hat{R}_{ij}$  is the ratio estimate of the input per acre of  $j^{\text{th}}$  crop,  $N_i$  is the number of sample farmers in  $i^{\text{th}}$  stratum,  $n_{ij}$  is the number of sample farmers growing  $j^{\text{th}}$  crop in  $i^{\text{th}}$  stratum

$$\bar{X}_{nij} = \frac{\sum_k X_{ijk}}{n_{ij}}$$

#### Other method.

Besides the ratio estimate discussed above, we have also made use of the method of simple arithmetic mean in the estimation of certain characteristics. In the case of estimation of the net cultivated area and gross cultivated area per village this method is followed. Its standard error is found out by using the following formula

Standard Error of mean net cultivated

$$\text{area per village} = \sqrt{\frac{\frac{1}{N_i} \sum_j X_{ij}^2 - \bar{X}_i^2}{n_i}}$$

where  $X_{ij}$  is the net cultivated area in  $j^{\text{th}}$  village in  $i^{\text{th}}$  stratum,  $N_i$  is the number of sample villages in  $i^{\text{th}}$  stratum and

$$\bar{X}_i = \frac{\sum_j X_{ij}}{N_i}$$

The standard error of the gross cultivated area per village is obtained by multiplying the above by the intensity of cropping. We now give estimates of important characteristics, their standard errors and their Coefficients of variation in table <sup>No 3</sup> ~~4~~.

Table No. 3.1

ESTIMATES, THEIR STANDARD ERRORS AND COEFFICIENTS OF VARIABILITY

Characteristic	Stratum 1			Stratum 2			Stratum 3		
	Est.	S.E.	C.V.	Est.	S.E.	C.V.	Est.	S.E.	C.V.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>I. Based on the Ratio method of estimation</u>									
1. Total number of households	1,21,761	3,142	2.58	1,23,454	2,758	2.23	71,563	2,780	4.01
2. Average number of households per village	621	16	2.58	321	7	2.23	260	10	4.01
3. Value of human labour input per acre of (in Rs.)									
i) Virginia tobacco	97.28	7.40	7.61	92.50	9.62	10.40	-	-	-
ii) Country tobacco	48.53	4.05	8.35	-	-	-	-	-	-
iii) Chillies	48.55	4.99	10.28	110.43	30.90	27.98	-	-	-
iv) Groundnut	32.52	2.11	6.49	32.22	1.79	5.56	-	-	-
v) Variga	24.39	1.57	6.44	27.72	1.18	4.26	16.56	1.87	11.29
vi) Irrigated paddy	74.00	14.97	20.23	77.82	11.59	14.99	-	-	-
vii) Bajra	22.67	1.49	6.57	32.41	3.61	11.14	-	-	-
viii) Jowar	24.39	1.54	6.31	-	-	-	-	-	-
ix) Jowar + Redgram	25.18	2.48	9.85	22.46	1.35	6.01	-	-	-
x) Ragi	-	-	-	131.34	10.18	7.75	-	-	-
xi) Castor	-	-	-	14.54	1.99	13.69	-	-	-

(Contd.)

ESTIMATES, THEIR STANDARD ERRORS AND COEFFICIENTS OF VARIABILITY

Characteristic	Stratum 1			Stratum 2			Stratum 3		
	Est.	S.E.	C.V. %	Est.	S.E.	C.V. %	Est.	S.E.	C.V. %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>3. Value of human labour input per acre of (in Rs.)</u> (Contd.)									
xii) Variga + Jowar	-	-	-	32.61	1.49	4.57	-	-	-
xiii) Korra	-	-	-	-	-	-	9.09	1.91	21.01
xiv) Jowar + Cucumber	-	-	-	-	-	-	25.14	1.77	7.04
xv) Groundnut + Redgram	-	-	-	-	-	-	32.56	3.33	10.23
<u>4. Value of bullock labour input per acre of (in Rs)</u>									
i) Virginia tobacco	44.10	4.80	10.88	25.81	5.37	20.81	-	-	-
ii) Country tobacco	26.77	3.84	14.34	-	-	-	-	-	-
iii) Chillies	22.69	3.09	13.62	29.24	10.38	25.50	-	-	-
iv) Groundnut	12.20	1.33	11.31	20.52	1.72	8.38	-	-	-
v) Variga	40.18	8.41	20.93	33.45	2.45	7.32	20.24	2.73	13.49
vi) Irrigated paddy	44.96	16.14	35.90	48.87	21.05	43.07	-	-	-
vii) Bajra	24.32	4.18	17.19	30.18	4.53	15.01	-	-	-
viii) Jowar	28.32	3.81	13.45	-	-	-	-	-	-
ix) Jowar + Redgram	18.57	3.06	16.48	15.53	1.49	9.59	-	-	-
x) Ragi	-	-	-	87.83	11.02	12.55	-	-	-

(Contd.)

ESTIMATES, THEIR STANDARD ERRORS AND COEFFICIENTS OF VARIABILITY

Characteristic	Stratum 1			Stratum 2			Stratum 3		
	Est.	S.E.	C.V. %	Est.	S.E.	C.V. %	Est.	S.E.	C.V. %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>4. Value of bullock labour input per acre of (in Rs)</u> (Contd.)									
xi) Castor	-	-	-	19.26	3.87	20.09	-	-	-
xii) Variga + Jowar	-	-	-	48.58	4.09	8.42	-	-	-
xiii) Korra	-	-	-	-	-	-	9.25	3.08	33.30
xiv) Jowar + Cucumber	-	-	-	-	-	-	21.30	2.29	10.75
xv) Groundnut + Redgram	-	-	-	-	-	-	14.98	2.01	13.42
<u>5. Value of other variables input per acre of (in Rs.)</u>									
i) Virginia tobacco	103.40	10.16	9.83	79.81	8.44	10.58	-	-	-
ii) Country tobacco	47.72	5.90	11.87	-	-	-	-	-	-
iii) Chillies	79.44	7.81	9.83	180.87	85.94	47.51	-	-	-
iv) Groundnut	34.90	3.95	11.32	37.28	3.84	10.30	-	-	-
v) Variga	42.88	8.17	19.05	29.99	3.08	10.27	15.66	5.01	31.99
vi) Irrigated paddy	104.18	27.68	26.57	64.59	11.74	18.18	-	-	-
vii) Bajra	13.14	5.79	44.06	16.24	3.70	22.78	-	-	-
viii) Jowar	20.57	2.79	13.56	-	-	-	-	-	-
ix) Jowar + Redgram	5.11	0.76	14.87	3.88	0.36	9.28	-	-	-
x) Ragi	-	-	-	43.09	6.52	15.13	-	-	-

(Contd.)

ESTIMATES, THEIR STANDARD ERRORS AND COEFFICIENTS OF VARIABILITY

Characteristic	Stratum 1			Stratum 2			Stratum 3		
	Est.	S.E.	C.V. %	Est.	S.E.	C.V. %	Est.	S.E.	C.V. %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>5. Value of other variable inputs per acre of (in Rs.) (CmH)</u>									
xi) Castor	-	-	-	2.61	0.69	26.44	-	-	-
xii) Variga + Jowar	-	-	-	44.31	2.17	4.90	-	-	-
xiii) Korra	-	-	-	-	-	-	4.42	2.35	53.17
xiv) Jowar + Cucumber	-	-	-	-	-	-	7.35	0.97	13.20
xv) Groundnut + Red gram	-	-	-	-	-	-	36.52	2.62	7.17
<u>II. Based on Other method</u>									
6. Average net cultivated area per village (in acres)	2,619.92	421.13	16.07	1522.97	242.18	15.90	2156.17	359.90	16.69
7. Average gross cropped area per village (in acres)	2,724.72	437.98	16.07	1492.51	251.87	15.90	2393.35	374.30	16.69

NB. Est = Estimate · SE = Standard error ; C.V. = Coefficient of variability.



## CHAPTER IV

### OPTIMAL CROP PATTERN BY LINEAR PROGRAMMING

#### 4.1 Introduction:

The completion of the Nagarjunasagar Dam on the river Krishna will make water available for irrigation in the First Phase for nearly 20.0 lakhs of acres in parts of Guntur, Narasaraopet, Sattenapalli, Vanukonda, Palnad, Ongole and Markapur taluk of Kurnool district, and Darsi taluk of Nellore Bapatla taluks of Guntur District/on the right canal side, and district parts of Nandigama and Jaggayyapet taluks of Krishna District, Huzurnagar, Khammam and Miriyalaguda taluks of Nalgonda district on the left canal side. Among various programmes of agricultural development that should be undertaken, adoption of a crop pattern, which ensures utilisation of water and other farm resources yielding the maximum benefit, is of utmost importance. In what follows an attempt is made, using Linear Programming technique, to work out an optimal crop pattern which can be adopted in the ayacut villages soon after water becomes available for irrigation without bringing about any appreciable change in the current agricultural practices. Incidentally, on the basis of the suggested optimal crop pattern which is readily feasible under conditions of increased farm resources, an estimate of the direct benefit from the project is also obtained.

#### 4.2. Assumptions : General.

In order to find out the optimal crop pattern in the Nagarjunasagar project area by using Linear Programming technique, we must know the nature of crops that will be grown under canal-irrigated conditions and their input-output coefficients. Projections of input-output coefficients for the crops to be grown in future are made on the following assumptions.

Though water will be supplied for irrigation as soon as the construction of the dam is completed, still the change from dry to wet cultivation will not become complete, because it takes time for agriculture to adapt itself to new conditions.

The farmers have to take to new methods of farming, <sup>growing of</sup> new crops etc., and make the necessary investment. In order to increase investment in agriculture, they should have increased incomes. In view of the time factor involved in the change-over, it is appropriate to discuss the crop pattern in two relevant periods, viz: the short-run period in which the techniques or methods of cultivation will not change, and the long-run period in which the techniques of cultivation change. The short run period in agriculture may be taken as 10 years and the long-run as 25 years. We shall now concern ourselves with the question of what best can be done straight-away in the short-run. In this short-run period of 10 years we assume that the farmers grow only those crops with which they are familiar, and continue to employ more or less the same methods of cultivation as hitherto. But we can assume that the farmers will not feel it as a change to use more of material inputs than at present in the shape of bullock power, manures and fertilisers as well as better seed. It is found that ~~the~~ majority of farmers in the project area are so poor that they cannot afford to use more of material inputs in crop production than at present. Therefore we suppose that the Government will come forward to help farmers to secure the required additional material inputs and the improved seed by granting loans to them, and wherever possible, make the materials directly available to them through the agencies of community development, cooperative societies and the like. On this assumption, we worked out the amount of additional requirements of the farmers in the project area to adopt the optimal crop-pattern without any change in technology during the short-run period.

#### 4.3. Assumptions: Technical:

A farmer has a limited amount of land, and other resources which he can employ in any given period to grow some or all of a

finite number of crops which can be grown. He can allocate his land and other resources to these crops in a number of alternative ways, based on his experience. We may generally assume that he will try to grow the most profitable combination of crops. This may not be obtained by allocating resources so as to grow the maximum possible quantity of the maximum profit-fetching crop. Such a procedure generally leaves parts of some of the resources unused. By releasing for another crop a fraction of an entirely used-up resource, corresponding fractions of other resources would also be released. The newly released resources together with other unused amounts of the resources might make it possible to grow another crop so that the total profit exceeds the profit to be got by growing only the most profitable of the crops on the maximum possible extent of the farm. In this way it is easily seen that the best way of allocating resources to different crops will be such a combination 'C' of these that even when any fraction of one or more of the resources used up in that combination are released and diverted to growing other crops, the total gain would still be less <sup>than</sup> that for 'C'. Such a combination 'C' is called an optimal combination. The process of farm budgetting done by experience does not often lead us to this optimal choice. The mathematical solution of the optimal combination under the given limitations on the factors is generally obtainable by the 'Simplex Method' in Linear Programming.

The following are the assumptions for the applicability of the Linear Programming method:

- i) The function to be maximised which is here taken as the value added to the materials is a linear combination of variables (resources or inputs)
- ii) The restrictive conditions are in the form of inequalities or equalities involving linear combinations of the above variables.
- iii) The variables vary continuously.

The first of these assumptions is satisfied if we regard each crop of a given variety and grown under a given technology as a separate activity, and the total product as the aggregate of the individual outputs. Even for the same crop, if the inputs are different in two methods, each of the methods of growing the crop must be considered as a separate activity. Further, we consider only a finite number of production processes or activities, each going on at constant returns to scale.

The nature of the second assumption is clear enough. Each quantity of any available resource is non-negative, and when not unlimited, can only be used at a level not higher than available.

The third restriction implies divisibility of resources and outputs in any manner, and accordingly, the divisibility of the magnitude of any of the activities is assumed.

The above assumptions are realistic in respect of crop production in the Nagarjunasagar Project Area in the short-run period.

Now the problem is to obtain the 'Optimum' combination of the activities. An optimum combination may contain only one or two or all the activities. A little reflection makes it clear that, if for a unit of desired gain each of the inputs is individually more for activity 'I' than for activity 'S' then activity 'I' can be advantageously replaced by activity 'S'. The result is that 'I' will not occur in the optimum combination. Activity 'I' is said to be inefficient or inferior when compared to activity 'S'. For convenience, we shall hereafter refer to any activity which is not inefficient as efficient.

The problem of maximising the gain which is linear in the rates of gain for different activities each of which is in turn linear in the levels of inputs under given conditions of resource limitations is mathematically the same as the problem of

minimising the resource requirement for attaining a given value of gain by choosing the 'most economical' combination of the activities.

In any optimal solution it may happen that some parts of the resources are left unutilised, for, to utilise them we may have to go in for activities which are either inferior, or reduce the total gain. It is clear that Linear Programming will have to be worked out with activities which have been designated above as efficient. However, it can happen that some of them get knocked out in the programming process, and do not occur in the optimal combination that finally emerges.

For the 'Simplex' method of solution of the Linear Programming problem the reader may refer to books on Linear Programming.

#### 4.4. Details of the procedure followed:

For purposes of programming we have to know how the human labour, bullock labour, other variable inputs and yields in existing cultivation are likely to change when the crops are irrigated under canals. Irrigated crops need more of labour inputs than unirrigated crops, because of the additional operation of irrigation, and of the increased yields due to irrigation requiring more of threshing labour etc. Labour input requirement will also vary widely depending on the source of irrigation. For instance, well irrigation needs more of labour inputs when compared to canal irrigation.

For all the crops considered for programming the inputs and outputs (including by products) under irrigated conditions as assumed by us are presented in Tables No.3-PT-3 and PT-13 for the right and left canal areas. For the purpose of obtaining an optimal crop pattern on the right canal side, Strata I and 2 are combined, as it is felt that, since both the strata are contiguous and interpenetrating areas, there is no need to

getting canal water for differentiate between them after/irrigation. The left canal area i.e. Stratum-3 which is a compact area is <sup>taken</sup> ~~taken~~ as the other homogeneous ~~unit~~ <sup>when there is the facility of canal water</sup> ~~unit~~. The inputs and outputs for crops, as assumed by us after irrigation, are based on the data given in Farm-Management Studies in Andhra Pradesh, Madras, Madhya Pradesh and Punjab, Season and Crop Reports of Andhra Pradesh, Crop-cutting experiments conducted by the Bureau of Economics and Statistics of Andhra Pradesh and the Techno-Economic Survey of Andhra Pradesh. This information is furnished in Tables No. 1 and 2. It may be noted here that the main product and by-product of different crops after irrigation on the right canal side and the left canal side are valued at the average prices of products prevailing in the respective areas in 1959-60. These are given in Tables No.3-PT-3 and PT-13. The inputs after irrigation are also valued at the same constant prices of 1959-60, used for evaluation of the present <sup>input</sup> ~~output~~. As regards the resources which will be available with the farmers, after/irrigation for <sup>getting facilities for</sup> growing crops we assumed reasonable increases in the resources now available. In some cases the increase assumed is of the same order as the natural growth of the resource that can be normally expected. But in other cases, the assumed increase is far above the natural growth. In such cases, we expect that proper measures will be taken by the State Government to fill in the gaps. The resources available at present and assumed to become <sup>soon</sup> ~~soon~~ <sup>getting facilities</sup> ~~available~~ after/irrigation for different types of farmers are presented in Table No.4-PT-4 and PT-14.

The concept of income which is here adopted, for the maximisation of which we are now going to employ Linear Programming technique, is the gross value added to material inputs. Costs of bullock labour, seed, manures and fertilisers, irrigation charges, hire-charges for implements are considered as costs of material inputs. Gross value added, in effect, represents the return to human labour, fixed capital and land.

4.5. Right Canal side (S<sub>1</sub> + S<sub>2</sub>)

According to the Nagarjunasagar Project Authorities, nearly 11.24 lakhs of acres will be irrigated in the first phase. Out of this, 1/3 of the area will be under wet irrigation, and 2/3 under dry irrigation. The idea in formulating such a policy of irrigation is to give the benefit of irrigation to as large an extent as possible and thus to eliminate the uncertainties of rain-fall, the failure of which has often been the reason for frequent draughts and famines in the project area.

We have divided all farms into four size groups, namely, (i) 0.01-2.50 acres, (ii) 2.51 - 7.50 acres, (iii) 7.51 - 15.00 acres, and (iv) above 15.00 acres.

The estimated area under cultivation in S<sub>1</sub> and S<sub>2</sub> taken together comes to 12.11 lakhs of acres. It is also estimated the additional extent of 1.53 lakhs of acres of cultivable land exists in the Project Area; but we have assumed that it will be used up as land covered by canals, tributaries and field channels, as grazing lands, and as land around villages to be left out of cultivation as precautionary measure against malaria. As the Government has proposed to give water only to 11.24 lakhs of acres, we have accepted this figure as final for purposes of arriving at an optimal crop pattern. This will mean that the balance of about 87,000 acres of land will have to remain under virginia tobacco and other unirrigated crops.

Average Size of the Farm:

One method of programming for irrigated crops to be grown over 11.24 lakhs of acres will be to treat the entire area as a single farm. This aggregative approach is not quite realistic. Therefore, it is decided to consider the farms of different sizes, derive the best pattern for the region by aggregating the areas under each crop for the various farms. For convenience we have assumed four sizes of farms viz. 1.26 acres, 4.83 acres, 10.65 acres and 24.81 acres, <sup>in the four different</sup> ~~size-groups.~~

The sizes of these four typical farms are not the mid values of the ranges, but they are the averages of the farms in those ranges as revealed by the Census Survey. Among these four sizes, the area of 11.24 <sup>lakh.</sup> acres for which water will be given is allocated in the proportion of the existing cultivated area in the corresponding four size groups. For each of these four types of farms the optimal crop pattern is worked out, and the aggregates for 11.24 lakhs of acres are obtained.

This will mean that the balance of 87,000 acres of land which will not get water will grow virginia tobacco and other unirrigated crops.



Before proceeding to the details of programming for optimal crop-pattern, it should be noted that the entire discussion is in respect of only one crop in the year.

Ad hoc allocations for Chillies and Country tobacco:

Under dry irrigated conditions, the crop of Chillies would become the most profitable crop. But it does not appear reasonable to suppose that Chillies will be raised on too extensive an area, as it is not a food crop. The same consideration has weighted with us in respect of the next important crop, namely, Country tobacco. Accordingly, in each typical farm, extents are set apart for Chillies and Country tobacco, and the total area under these crops fixed at 1.5 lakhs and 1.0 lakh of acres respectively on an ad hoc basis. Though, the extents are fixed arbitrarily, they are felt to be reasonable.

Coming to the question of actually setting <sup>a</sup>aprt extents for Chillies in the 4 typical farms, 1.5 lakhs of acres are allocated to them in the proportion of the total cultivated area in these size groups: 1941.70, 7384.76, 10801.79, 16396.86 which works out in percentages to 5.30, 20.17, 29.75, 44.78. The one lakh of acres set <sup>a</sup>aprt for Country tobacco is also allocated in the same proportion. After doing this, the extents of land set apart for Chillies and Country tobacco in each typical farm are arrived at.

Paddy:

Also, 1/3 of the extent of each typical farm is set apart for paddy, since 1/3 of the ayacut on the right canal side will be given wet irrigation facilities.

Resources:

The resources are classified into four categories, viz. (i) land, (ii) human labour, (iii) Bullock labour, and (iv) other variable inputs. The last category comprises of seed, manures, fertilisers, hire charges for implements and interest on crop loans. As this is a lumped resource containing different types of items, its aggregated money value is used for representing its magnitude.

The first three resources available now are calculated for each of the 4 size groups on the basis of the data obtained in our Census Surveys of the sampled villages, and the fourth resource from the intensive Farm Surveys.

In passing, we may mention at this stage that, our procedure is equivalent to using weighted averages of Stratum 1 and Stratum 2 for factors, resources, prices, etc.

Regarding the resources that will become available in the short-run, we assume *that for full utilisation of land resource:*

- i) Human labour is not a limitational factor,
  - ii) 50 percent more of bullock labour than at present for the peak month of June/July or Sept./Oct. will become available.
  - iii) As regards other variable inputs, the amount which will become available for the farms is assumed to be ~~30-40~~ <sup>much</sup> more than what is available now. *The assumed additional resources range from 40 to 125 percent for the different typical farms.*
- ~~These details are presented in Table No.4-PT-4.~~ These details are presented in Table No.4-PT-4.

Though ad hoc percentage increases over the existing resources in respect of bullock labour and other variable

inputs - resources are assumed as mentioned above so as to leave no land unutilised in programming, they <sup>need be</sup> not the actual requirements, which are <sup>known only</sup> after completing the programming work.

Variable inputs, which are assumed at suitable levels after some preliminary trials, are completely used up in all the optimal combinations of crops in respect of each typical farm on the Right-Canal Side. The actual requirements are presented in Table No. 10-PT-1.

Of the 14 activities considered for programming, some activities got eliminated, being inefficient in the sense that they require more of each input than any other activity to give the same income. The details showing the efficiencies of all the above activities are presented in Table No. 5-PT-5. From this table, it can be seen that Cotton, Groundnut, Oil-seeds-I, Fodders, Vegetables, Jowar+Redgram, Ragi-II turn out to be efficient crops. The working out of crops by the Simplex Method is separately shown for each of the 4 typical farms in Table No. 6-PT-6.

The optimal crop patterns obtained are presented in Table No. 7-PT-7 for the 4 typical farms. Only two activities viz. Ragi II and Jowar+Redgram have come into the final optimal pattern in all the typical farms after programming. The actual extents under these two activities which came out in the programme are given in Table No. 7-PT-7 for the 4 typical farms. The overall crop pattern for the entire Right Canal Side (i.e. 11.24 lakhs of acres) is presented in Table No. 8-PT-8. The breakdown of the total acreage is as follows:

<u>Crop</u>	<u>Acreage</u>
1. Chillies	1,50,000.00
2. Country tobacco	1,00,000.00
3. Paddy	3,74,591.03
4. Ragi - II	3,38,679.52
5. Jowar+Redgram	1,60,729.45
	<u>11,24,000.00</u>

~~Resulting~~  
Results of programming:

The total requirements of resources for adopting the overall optimal crop pattern are given resource-wide and crop-wise in Tables No.9 and 10 - PT-9 and PT-10 respectively.

The resources that have to be increased for adopting the optimal crop pattern on the right canal side are Sept./Oct. bullock power and other variable inputs. The required percentage increases in these resources are <sup>14.32</sup> 11.7 and <sup>76.48</sup> 10.5 respectively as can be seen from Table No.9-PT-9.

It will be seen from Tables No.11-PT-11 that, after getting facilities, irrigation/the gross value added per acre in the typical farms on the right canal side will increase by percentages ranging from 313 to 566.

The overall increase in the total gross value added for the entire Right Canal area will be more than ~~300~~ 300 per cent as can be seen from Table No.12-PT-12 and PT-22. The corresponding figure for the left canal side is more than 500. For the entire project area the increase in the gross value added works out to a figure only slightly less than ~~400~~ 400 per cent.

4.6. Left Canal Area (S<sub>3</sub>)

Stratum 3 is treated as one homogeneous unit for working out an optimal crop pattern. The input-output coefficients of crops as assumed by us under irrigated conditions are presented in Table No.3-PT-13. As stated earlier, they are based on the data on irrigated crop-yields and their input requirements as obtained from various sources.

Nearly 8.0 lakhs of acres on the left canal side of the Nagarjunasagar Project area will be irrigated. So, an optimal

crop pattern is worked out for 8.0 lakhs of acres. This area of 8.0 lakhs of acres comes close to the cultivable area as estimated by us on the basis of the information obtained in our survey. The cultivable area comprises not only the actually cultivated area but also fallow lands, pastures and forests.

The area of 8.0 lakhs of acres has been allocated to 4 size groups of farms viz: (i) 0.01-2.50 acres (ii) 2.51-7.50 acres (iii) 7.51-15.00 acres and (iv) above 15.00 acres, on the basis of the proportion of the existing cultivated areas in these groups as obtained in our Census Survey of sampled villages.

Average Size of the Farms:

The average size of farms used in the programming in the four size groups are not the mid values but the averages obtained in the Census Survey of the Sampled villages. The average sizes are: 1.47, 5.00, 10.69 and 27.62 acres, and these constitute the typical farms on the left <sup>canal</sup> side.

Ad hoc allocation for Chillies, Country Tobacco and Vegetables:

As in the case of the right canal side, here also it is decided to set apart extents in each of the 4 typical farms for chillies and country tobacco. There is another feature present on the left canal side, namely, the growing of vegetables on the farms. Accordingly, we have set apart some extent of the farm for vegetables also. The areas allocated to chillies, country tobacco, and vegetables are 10,000, 5,000, and 10,000 <sup>acres</sup> respectively. The extents set apart in the typical farms for these three crops <sup>are based on</sup> the existing proportion of the <sup>total</sup> ~~total~~ extents in the size groups i.e. in the ratio of 651.47 to 3968.22 to 5588.53 to 11353.44 which in percentages comes to 3.02, 18.40, 25.92, 52.66.

Paddy:

Further, in each size group,  $\frac{6.5}{8} = .81$  of the average size of the farm is set apart for Paddy, for, out of 8.0 lakhs of acres on the left canal side, 6.5 lakhs of acres will be under wet irrigation, and the remaining 1.5 lakhs of acres will be under dry irrigation.

Resources:

The resources considered for the 4 typical farms here are (i) land (ii) human labour (iii) bullock labour and (iv) other variable inputs. ~~After resetting the~~ <sup>facilities the</sup> irrigation for resources for ~~the typical farms~~ are assumed to become available as follows:

(i) Human labour is not considered a limitational factor so far as the first two size groups are concerned.

(ii) To ensure that land is fully utilised, it has been assumed for programming purposes that human labour will become available in the peak season of June/July in the 3rd and 4th size groups at levels which are 40 percent and 220 percent more than the farm family labour now existing. ~~However,~~ <sup>Even</sup> if we assume that <sup>households with</sup> non-cultivating agricultural labour <sup>as main employment</sup> as well as the surplus farm family labour (of cultivating households) from the first two size-groups will also be available in this season for agricultural operations, there <sup>will be a serious</sup> shortage in the human labour resource for adopting the optimal crop-pattern. *This may be seen from table No 9-PT-17.*

iii) In respect of bullock labour for the peak month of June/July, 50 percent more than what is actually existing at present is assumed to become available in the first three size groups of farms. But in the case of the 4th typical farm, this increase of 50 percent is found to be inadequate and hence this resource is assumed to become available at a level 60 percent more than at present.

(iv) As regards other variable inputs, the amounts which will become available to the farmers are assumed to be 50 per-

cent, 100 percent, 150 percent and 200 percent more in the 1st, 2nd, 3rd and 4th size group<sup>of</sup>/farms respectively. These different increases in the resources are assumed to ensure that land is fully utilised. These are presented in Table No.4-PT-14.

Though ad hoc percentage increases over the existing resources in respect of bullock labour and other variables inputs resources are assumed as mentioned above so as to leave no land unutilised in programming, these are not the actual requirements. The actual requirements which are assessed, after completing the programming work, are presented in Table No.10-PT-10.

Programming with efficient activities:

There are 7 important activities on the left canal side; but among these, only Groundnut, Jowar+Cucumber, Groundnut+Redgram, and other-mixtures are found to be efficient. These details relating to the efficient activities are presented in Table No.5-PT-15. Programming is carried out with these efficient crops only. The working out of the optimal crop pattern by the 'Simplex' method is separately shown for the 4 typical farms in Table No.6-PT-16.

The optimal crop pattern finally obtained is presented in Table No.7-PT-17 for the 4 typical farms.

When programming is done for the balance of land left after ad hoc allotments are made for chillies, Country Tobacco, paddy and vegetables, only three crops emerged in the final optimal crop patterns for the four typical farms. Groundnut+Redgram came into the final patterns of all<sup>the four</sup> typical farms, while Jowar+Cucumber appears in the two size groups 7.51 - 15.00<sup>acres</sup> and above 15.00 acres, and other-mixtures figured<sup>only</sup> in

of  
the size group/2.51-7.50 acres. The overall crop pattern for the entire left canal side (i.e. for 8.0 lakhs of acres) is given in Table No.8-PT-18.

The breakdown of the total acreage is as follows:

<u>Crop</u>	<u>Acreage</u>
Chillies	10,000.00
Country tobacco	5,000.00
Paddy	6,50,000.00
Vegetables	10,000.00
Groundnut+Redgram	48,626.00
Jowar+Cucumber	63,563.00
Other-mixtures	12,811.00
Total.	<u>8,00,000.00</u>

#### Results of programming:

The total requirements of resources for adopting the overall optimal crop pattern are given resourcewise and cropwise in Tables No.9 and 10-PT-19 and 20.

The adoption of the optimal crop pattern would require additional resources in respect of human labour, bullock power and other variables inputs. These additional requirements (s given in Table No.9-PT-19) are 140.76% in the case of June/July human labour, 3.50 percent in respect of June/July bullock labour and 90.71 percent in the case of other variable inputs of their 40.21 levels of the present.

It may be seen from Table No. 11-PT-21 that, if the optimal crop pattern is adopted, the increase in the gross value added will be between 307 and 619 percent, depending on the size of the typical farm.

The overall increase in the gross value added for the entire left canal side will be nearly 513 percent.



#### 4.7 Limitations of the results obtained:

(i) The pattern of crops obtained by programming depends firstly on the input-output relationships and the relative price-structure of the inputs and yields. In course of time, when improved methods of agriculture come to be adopted, and the pace of development of the region gathers momentum, the input-output relationships will naturally change in a marked way. Consequently, the optimal crop pattern will also change correspondingly.

Again, as time passes, the relative price structure will vary and therefore induce an alteration in the ~~opt~~ optimal pattern of crops.

Thus, our programming results will generally hold as long as there is no appreciable change in the price structure from what it was in the Project Area in 1959, and the input-output pattern remains close to the one used in the programming work.

(ii) The optimal pattern obtained by use does not have sufficient diversification of crops. The farmers may like to grow a few other crops which have not come into the final pattern obtained by programming.

(iii) The suitability of soils to crops to the extent that will be required for the adoption of the optimal combination of crops could not be examined. It is hoped that <sup>deficiencies</sup> on this account will be of a marginal nature.

(iv) Allotment of extents in each typical farm to Chillies, Country tobacco, Vegetables, and in a sense

Paddy too is on an ad-hoc basis. A part of the gap in the value added as given by the programme and as is realised later on will be naturally due to this arbitrary allocation of extents to the above crops.

(v) When it is said that this programme is feasible in the short-run period of 10 years, what is meant by it is that, if the gaps in resources are made available to the farmers by the Government during this period, the optimal crop pattern can be adopted at least by the end of the 10-year period, commencing from the time of supply of project waters for irrigation for the entire ayacut proposed.

(vi) On the left canal side there is at present a large area under cotton. The yields are low and the quality is poor. From the present state of knowledge of <sup>experimental</sup> results on irrigated cotton crop at the research centres, it appears to be difficult to judge, even approximately, what the input-output relationship will be like when it is grown as a dry irrigated crop on the farmers' own fields. It is probable that, in the long run, good varieties of cotton can be profitably grown under irrigated conditions on the left canal side. Then its input-output pattern may change favourably enough for appearing in the optimal programme.

(vii) Even by the end of the 10 year period, the <sup>about 400 percent - and</sup> results of 500 per cent as the value added (which is the remuneration to human labour, land and fixed capital) may not be fully achieved due to the various limitations. But it is certainly indicative of the attainable potential if effective steps are taken

for developing the ayacut rapidly.

In conclusion, it should be emphasised that it is essential to review the position from time to time, and carry out fresh programming work, using the latest input-output data and incorporating into the work the changes in the relative price structure, and then pass on the results to the farmers by effective extension service.

RESEARCH

INPUTS PER ACRE OF IRRIGATED CROPS FROM VARIOUS SOURCES

S. No.	Crop	Human labour (in 8 hr. days)	Bullock labour (in 8 hr. pair days)	Source
(1)	(2)	(3)	(4)	(5)
1. Irrigated Paddy		55.5	28.4	F.M.S. West Bengal, (Hooghly and
		48.6	21.5	24 Faraganas)
		37.4	8.8	F.M.S. (Uttar Pradesh).
		139.8	147.7	F.M.S. (Madras) (well irrigation)
		47.5	8.1	F.M.S. (Andhra Pradesh)
		85.0	11.0	T.E.S. (Andhra Pradesh).
		40.7	6.1	N.S.P. (S <sub>1</sub> -Tank irrigation)
		67.6	7.1	N.S.P. (S <sub>2</sub> -Tank irrigation)
		71.8	13.3	N.S.P. (S <sub>3</sub> -Tank irrigation)
		79.6	25.0	N.S.P. (S <sub>3</sub> -Canal irrigation)
		81.3	34.6	N.S.P. (S <sub>3</sub> -Well irrigation)
	45.9	7.3	(Wet villages (canals) irrigation)	
	62.4	6.2	(Wet villages - (Tank) irrigation)	
2. Cotton		43.0	5.0	F.M.S. (Uttar Pradesh)
		41.3	18.7 (American Coin)	F.M.S. (Punjab)
		39.6	16.2 (Pesi Coin)	F.M.S. (Punjab)
		48.0	5.0	T.E.S. (Andhra Pradesh)
3. Jowar (Dry Irrigated)		61.5	45.1	F.M.S. (Madras - Well irrigation)
		37.0	7.0	T.E.S. (Andhra Pradesh)
		41.7	13.4	N.S.P. (S <sub>2</sub> -Well irrigation)

(Contd.)

TABLE NO. 1 (Contd.)

INPUTS PER ACRE OF IRRIGATED CROPS FROM VARIOUS SOURCES (CONTD.)

S. No.	Crop	Human labour (in 8 hr. days)	Bullock labour (in 8 hr. pair days)	Source
(1)	(2)	(3)	(4)	(5)
4.	Bajra (Cumla)	31.5 36.9	19.8 14.8	F.M.S. (Madras) + 1 N.S.P. (S <sub>2</sub> -Well irrigation)
5.	Groundnut	50.0	8.0	T.E.S. (Andhra Pradesh)
6.	Chillier	92.0	6.0	T.E.S. (Andhra Pradesh)
7.	Ragā	87.9	28.8	N.S.P. (S <sub>2</sub> -Well irrigation)
8.	Korra	36.4	12.8	N.S.P. (S <sub>2</sub> -Well irrigation)

Note:- 1) F.M.S. stands for Farm Management Studies  
 2) T.E.S. stands for Techno-Economic Survey  
 3) N.S.P. stands for the Intensive Farm Surveys  
 in the Nagarjunasagar Project Area.

YIELDS PER ACRE OF CROPS FROM VARIOUS SOURCES

S.No.	Crop	Bureau of Economics and Statistics A.P. Andhra Pradesh.	Farm Management Studies sponsored organized by the R.P.C. (Planning Commission) and the Ministry of Food and Agriculture, Govt of India.		Techno-Economic Survey of Andhra Pradesh	
			Unirrigated	Irrigated	Unirrigated	Irrigated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Jowar (Cholam)		684.4 lbs	1180.5 lbs Madras	650 lbs	1550 lbs
2.	Paddy		13.04 mds	24.54 mds (Madras) Andhra (20.19 lbs) (Andhra)	-	2466 lbs
3.	Korra		-	-	-	-
4.	Bajra		250.0 lbs	623.6 (Madras) 54.55	-	-
5.	Coriander		-	-	-	-
6.	Greengram		-	-	500 lbs	-
7.	Bengal gram		-	-	-	-
8.	Horsegram		-	-	-	-
9.	Black Paddy		13.04 mds (1073 lbs)	24.54 Andhra 1957-58 (2019 lbs) to 1959-60	-	2466 lbs
10.	Variga		-	-	-	-
11.	Chillies		-	-	32 mds. (2633 lbs)	50 mds. (4114 lbs)
12.	Groundnut		795.4 lbs	not available	586 lbs	859 lbs.
13.	Ragi		583.3 lbs	964.2 lbs (Madras Madras 1964-54-55)	-	-
14.	Virginia tobacco		580 lbs	-	-	-
15.	Country tobacco		-	-	-	-
16.	Cotton	439.3 lbs 115.6 lbs	176.5 lbs	585 lbs Madras	167 lbs	500 lbs.
17.	Fodders		-	Desi 561 mds Punjab (420 lbs) (Punjab)	-	-

82 2/7 lbs = 1 md.

(Contd.)

YIELDS PER ACRE OF CROPS FROM VARIOUS SOURCES (Contd.)

S. No.	Crop	Intensive Farm Surveys conducted in the Nagarjunasagar Project Area 1959-60 (Andhra University)		Season and Crop year report, Guntur <del>Dist.</del>	
		Unirrigated	Irrigated	Standard	Actual 1958-59.
(1)	(2)	(8)	(9)	(10)	(11)
1.	Jewar (Cholam)	5.92 sl <i>maund</i>	11.5 mds.	664 lbs	440 lbs
2.	Paddy	6.18 sl	21.24 sl	1377	1515
3.	Korra	1.99 sl 164 lbs	10.35 sl 852 lbs	600	570
4.	Bajra	-	-	437	331
5.	Coriander	-	577 lbs 475 lbs	not available	not available
6.	Greengram	3.81 sl (314 lbs)	-	185	168
7.	Bengal gram	2.89 sl (238 lbs)	-	500	450
8.	Horsegram	4.00 sl (329 lbs)	-	200	170
9.	Black Paddy	6.18 sl (509 lbs)	21.24	not available	not available
10.	Variga	7.72 sl (635 lbs)	-	500	450
11.	Chillies	3.82 sl (314 lbs)	-	809 1725	728 (Nellore where 80% crop is irrigated) 1552
12.	Groundnut	6.54 sl (538 lbs)	-	1120	1008
13.	Ragi	8.34 sl (686 lbs)	15.82 sl (1274 lbs)	775	780
14.	Virginia tobacco	8.01 sl (659 lbs)	-	750	712
15.	Country tobacco	5.09 sl (419 lbs)	-	1000	950

(Contd.)

Ans - 1 maund = 82  $\frac{2}{5}$  lbs. S<sub>1</sub> = Standard 1, S<sub>2</sub> = Standard 2

1959-60 (1952)

YIELDS PER ACRE OF CROPS FROM VARIOUS SOURCES (Contd.)

S.No.	Crop					Intensive Farm Surveys conducted in the Nagarjunasagr Project Area 1959-60 (Andhra University)		Season and crop year report, Guntur	
		(3)	(4)	(5)	(6)	Unirrigated (8)	Irrigated (9)	Standard (10)	Actual 1958-59 (11)
						maund		lbs	lbs
16.	Cotton	-	-	-	-	1.72 slt (142 lbs)	-	90	72
17.	Fodders	-	-	-	-	-	-	-	-
18.	Vegetables	-	-	-	-	-	-	-	-
19.	Castor	-	-	-	-	-	-	250	200
20.	Gingelly	-	-	-	-	-	-	280	250
21.	Varagu (Arika)	-	-	-	-	-	-	700	553

N. B:- 82.2/7 lbs. = 1 md.



## PER ACRE INPUT REQUIREMENTS AND VALUES OF OUTPUT (INCLUDING VALUE OF BY PRODUCT) ASSUMED AFTER IRRIGATION

S.No.	Name of crop	8 hr. mandays	3 hr. bullock-pair days required			Value @ Rs. 2.68 per 8 hr bullock pair day (in Rs.)	Value of other inputs (in Rs.)	Value of material inputs (in Rs.)	Yield		Value of by product (in Rs.)	Value of total put at 59-60 prices (in Rs.)	Gross value added (in Rs.) Col. (14) - Col. (9)
			June/ July	Sept/ Octo	Total				Weight (in mds)	Price per md. (in Rs)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)
1.	Paddy 58	50	4	-	8	37.04	50	87.04	24.00	13.12	314.88	45.00	272.84
2.	Black Paddy	37	3	-	6	27.78	40	67.78	14.00	11.70	163.80	26.00	122.02
3.	Ragi	30	-	3	6	27.78	40	67.78	16.00	13.36	213.76	45.00	190.93
4.	Jowar	25	3.5	-	7	32.41	30	62.41	12.00	13.86	166.32	60.74	164.65
5.	Variga	25	4	-	8	37.04	45	82.04	12.00	12.08	144.34	28.07	90.20
6.	Bajra	30	2	-	4	18.52	20	38.52	9.00	13.63	122.67	25.00	109.15
7.	Korra	25	2	-	4	18.52	20	38.52	12.00	10.16	121.89	25.00	108.28
8.	Varagulu	22	3	-	6	27.78	10	37.78	12.00	8.73	104.76	30.00	96.98
9.	Coriander	20	3	-	6	27.78	35	62.78	6.00	27.79	166.74	5.81	109.77
10.	Chillies	60	-	3.5	7	32.41	120	152.41	1600 lbs	0.90	1446.72	2.00	1296.31
11.	Country tobacco	30	-	4	8	37.04	60	97.04	6.00	39.73	238.38	-	141.34
12.	Cotton	30	3	-	6	27.78	18	45.78	400 lbs	0.60	238.38	34.67	88.89
13.	Groundnut	50	2	-	4	18.52	50	68.52	11.00	19.18	210.93	7.00	115.43
14.	Castor	15	2.5	-	5	23.15	10	33.15	4.00	15.68	62.72	-	29.67
15.	Gingelly	15	2	-	4	18.52	10	28.52	5.00	30.94	154.70	-	126.18
16.	Fodders	21	-	-	2	9.26	11	20.26	-	-	-	-	19.41
17.	Vegetables	70	-	-	2	9.26	78	87.26	-	-	-	128.88	36.62
18.	Jowar-Redgram	37	2	-	4	18.52	10	28.52	-	149.90	37.24	187.14	158.62
19.	Other mixtures	28	2.5	-	5	23.15	16	39.15	-	-	121.56	27.00	109.41

RESOURCE AVAILABILITY PER FARM

(AS OBTAINED FROM THE CENSUS SURVEY)

Size group (in acres)	Size of typical farm or Average size (in acres)	Land (in acres)					Bullock labour (In 8 hr. pair days)					
		Areas set apart for selected crops			Balance availa- ble for progra- mming	Availa- ble at present (for 30 days)	June - July		September-October			
		Chill- ies	Country toba- cco	Paddy			Assumed availa- ble for 30 days*	Set apart as requi- rement for Paddy	Balance availa- ble for progra- mming	Set apart for sele- cted crops	Chillies	Country tobacco
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0.01 - 2.50	1.23	0.17	0.11	0.42	0.56	1.89	2.84	1.68	1.16	0.66	0.44	1.74
2.51 - 7.50	4.83	0.64	0.43	1.61	2.15	10.14	15.21	6.44	8.77	2.24	1.72	11.25
7.51 -15.00	10.65	1.42	0.95	3.55	4.73	19.17	28.76	14.20	14.56	4.97	3.80	19.99
Above 15.00	24.81	3.31	2.21	8.27	11.02	44.66	66.99	33.08	33.91	11.59	8.84	46.56

N.B:- In the Right Canal area human labour is not found to be a limitational factor.

\* The increase assumed over the present level of availability of this resource is 50 per cent.

(Contd.)

RIGHT CANAL AREA (S<sub>1</sub> + S<sub>2</sub>)

RESOURCE AVAILABILITY PER FARM  
RESOURCE AVAILABILITY PER FARM (OTHER VARIABLE INPUTS: IN Rs.)

( AS OBTAINED FROM INTENSIVE FARM SURVEYS )

Size group (in acres)	Average size	Resource at present ava- ilable	Assumed available *	Set apart for selected crops			Balance available for programming
				Chillies	Country tobacco	Paddy	
	(14)	(15)	(16)	(17)	(18)	(19)	(20)
0.01 - 2.50	1.26	45.76	64.82	20.40	6.60	21.50	16.32
2.51 - 7.50	4.83	129.01	245.34	76.80	25.80	82.50	60.24
7.51 -15.00	10.63	380.52	449.59	176.40	57.00	132.50	89.69
Above 15.00	24.81	632.41	1385.73	397.20	132.60	425.00	430.93

\* The increase assumed over the present level of availability of this resource ranges from 40 to 125 percent in different size groups.

RIGHT CANAL AREA (S<sub>1</sub> + S<sub>2</sub>)

RESOURCE REQUIREMENTS OF DIFFERENT ACTIVITIES CONSIDERED IN LINEAR PROGRAMMING TO OBTAIN

Rs. 100 of THE GROSS VALUE ADDED

S.No.	Crop	Land (in acres)	June/July Bullock labour (in 8 hr. pair days)	September / October Bullock labour (in 8 hr. pair days)	Other variable inputs (in Rs.)
(1)	(2)	(3)	(4)	(5)	(6)
1.	*Cotton	1.12	3.37	-	20.25
2.	*Groundnut	0.67	1.34	-	33.41
3.	Ragi-I	0.52	1.57	-	20.94
4.	Other cereals	0.89	2.66	-	22.15
5.	Black Paddy	0.82	2.46	-	32.80
6.	Coriander	0.91	-	2.73	28.68
7.	*Oil seeds-I	1.32	3.31	-	13.20
8.	*Fodders	5.15	-	-	56.65
9.	*Vegetables	2.73	-	-	213.00
10.	*Jowar+Redgram	0.63	1.26	-	6.30
11.	Other mixtures	0.91	2.28	-	14.56
12.	*Ragi-II	0.52	-	1.57	20.94
13.	Pulses other than <del>Neu</del> gram	2.50	-	2.75	37.43
14.	Oil seeds - II	0.89	-	2.66	22.15

N.B.:- (i) Crops marked with an asterisk have turned out to be efficient crops; (ii) Other cereals are Jowar, Bajra, Variga, Korra; (iii) Oil seeds-I are those oil seed crops sown in June/July; (iv) Other mixtures are raised; (v) Ragi-I is the ragi crop during June and September; (vi) Ragi-II is the ragi crop raised during September and December; (vii) Oil seeds-II are those oil seed crops sown in September or October; (viii) Human labour is not considered here.

→ Jowar + green gram + redgram and Korra + Cotton.

Table No. 6

PT - 6

RIGHT CANAL AREA (S<sub>1</sub>+S<sub>2</sub>) SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION  
 Size group: 0.01-2.50 acres  
 Typical farm size is 1.26 acres

				0	0	0	0	88.89	149.64	190.98	75.56	19.41	36.62	158.62	
C s	Resource or activity	Suppl. level	Unit	Disposal activities				Real activities							R
				Land	J.B.L.	O.B.L.	O.V.I.	Cotton	G'nut	Ragi-II	Other oil seeds	Fodders	Vege- tables	J+ Rg.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
0	Land	0.56	Acres	1	0	0	0	1	1	1	1	1	1	1	0.56
0	J.B.L.	1.16	3 hr. pair day	0	1	0	0	3	2	0	2.5	0	0	2	
0	O.B.L.	1.74	"	0	0	1	0	0	0	3	0	0	0	0	0.56
0	O.V.I.	16.32	Rs.	0	0	0	1	18	50	40	10	11	78	10	0.4
	Z	0		0	0	0	0	0	0	0	0	0	0	0	
	Z - C	0		0	0	0	0	-88.89	-149.64	-190.08	-75.56	-19.41	-36.62	-153.62	
0	Land	0.152		1	0	0	-0.025	0.550	-0.25	0	0.75	0.725	-0.95	0.75	0.25
0	J.B.L.	1.16		0	1	0	0	3	2	0	2.5	0	0	2	0.53
0	O.B.L.	0.54		0	0	1	-0.075	-1.350	-3.75	0	-0.75	-0.825	-5.350	-0.750	
100.93	Ragi-II	0.408		0	0	0	0.025	0.450	1.250	1	0.25	0.275	1.95	0.25	
	Z	77.920		0	0	0	4.775	85.941	238.725	190.98	47.745	52.520	372.411	47.745	
	Z - C	77.920		0	0	0	-4.775	-2.949	89.085	0	-27.815	33.11	335.701	-110.3	
158.62	J+Rg.	0.203		1	0	0	-0.033	+0.733	-0.333	0	1	0.067	-1.267	1	
0	J.B.L.	0.754		0	1	0	+0.066	1.534	2.666	0	0.500	-1.934	+2.534	0	
0	O.B.L.	0.608		0	0	1	-0.100	-0.800	-4.000	0	0	-0.100	-6.800	0	
190.98	Ragi-II	0.357		0	0	0	0.033	0.267	+1.333	1	0	0.033	2.267	0	
	Z	100.380		0	0	0	1.063	167.260	201.756	190.98	158.62	150.638	231.980	158.62	
	Z - C	100.380		0	0	0	1.063	78.370	52.116	0	83.06	140.278	195.360	0	

N.B:- J.B.L.= June bullock labour; O.B.L.= October bullock labour; O.V.I.= Other variable inputs;  
 G'nut = Groundnut; J+Rg. Jowar+ Redgram.

(Contd.)

RIGHT CANAL AREA (S<sub>1</sub>+S<sub>2</sub>) SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: 2.51 - 7.50 acres  
Typical farm size is 4.33 acres

C <sub>s</sub>	Resource or activity	Supply level	Unit	Disposal activities				Real activities							R
				Land	J.B.L.	O.B.L.	O.V.I.	Cotton	G'nut	Ragi-II	Other oil seeds	Fodd-ers	Vege-tables	J+Rg.	
				(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
				0	0	0	0	88.89	148.64	190.93	75.56	19.41	36.62	153.62	
0	Land	2.15	Acre	1	0	0	0	1	1	1	1	1	1	1	2.15
0	J.B.L.	3.77	3 hr. pair day	0	1	0	0	3	2	0	2.5	0	0	2	...
0	O.B.L.	11.25	"	0	0	1	0	0	0	3	0	0	0	0	3.05
0	O.V.I.	60.24	Rs.	0	0	0	1	18	50	40	10	11	78	10	1.51
Z		0		0	0	0	0	0	0	0	0	0	0	0	
Z - C		0		0	0	0	0	-88.89	-149.64	-190.93	-75.56	-19.41	-36.62	-153.62	
0	Land	0.644		1	0	0	-0.025	0.550	-0.250	0	0.750	0.725	-0.950	0.750	1.36
0	J.B.L.	8.77		0	1	0	0	3	2	0	2.5	0	0	2	4.33
0	O.B.L.	6.73		0	0	1	-0.075	-1.350	-3.750	0	-0.75	-0.325	-5.350	-0.750	6.02
>190.93	Ragi-II	1.506		0	0	0	0.025	0.450	1.250	1	0.250	0.275	1.950	0.250	6.02
Z		287.616		0	0	0	4.775	85.941	238.725	190.93	47.745	53.520	372.411	47.745	
Z - C		287.613		0	0	0	4.775	-2.940	89.035	0	-27.815	33.11	335.791	-110.375	
>153.62	J+Rg.	0.350		1.333	0	0	-0.033	0.733	-0.333	0	1	0.957	-1.267	1	
	J.B.L.	7.052		-2.666	1	1	+0.066	1.534	2.566	0	0.500	-1.934	+2.531	0	
	O.B.L.	7.08	7.376	1.000	0	1	-0.100	-0.300	-4.000	0	0	-0.100	-6.800	0	
190.93	Ragi-II	1.291		-0.333	0	0	0.033	0.267	1.333	1	0	0.033	2.267	0	
Z		332.838		147.844	0	0	1.068	167.260	201.756	190.93	153.62	159.683	231.930	153.62	
Z - C		332.858		147.844	0	0	1.068	73.370	52.116	0	33.06	140.273	195.360	0	

N.B:- J.B.L.= June bullock labour; O.B.L.= October bullock labour; O.V.I.= Other variable inputs  
G'nut = Groundnut; J+Rg. = Jowar + Redgram.

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(Contd.)

TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: 7.51-15.00 acres  
Typical farm size is 10.65 acres

C <sub>s</sub>	Resource or activity	Supply level	Unit	Disposal activities				Real activities					R		
				Land	J.B.L.	O.B.L.	O.V.I.	Cotton	Groundnut	Ragi-II	Other oil seeds	Fodders		Vegetables	J+Rg.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
0	Land	4.73	Acres	1	0	0	0	1	1	1	1	1	1	1	4.73
0	J.B.L.	14.56	8 hr/	0	1	0	0	3	2	0	2.5	0	0	2	...
0	O.B.L.	19.99	13.28 pair day	0	0	1	0	0	0	3	0	0	0	0	6.00
0	O.V.I.	39.69	Rb.	0	0	0	1	18	50	40	10	11	78	10	2.24
	Z	0		0	0	0	0	0	0	0	0	0	0	0	
	Z - C	0		0	0	0	0	-33.69	-149.64	-190.98	-75.56	-19.41	-36.62	-153.62	
0	Land	2.436		1	0	0	-0.025	+0.550	-0.25	0	0.75	0.725	-0.950	0.750	3.32
0	J.B.L.	14.56		0	1	0	0	3	2	0	2.50	0	0	2	7.23
0	O.B.L.	11.554	13.26	0	0	1	-0.075	-1.35	-3.75	0	-0.75	-0.825	-5.85	-0.75	...
100.93	Ragi-II	2.242		0	0	0	0.025	0.45	1.25	1	0.25	0.275	1.950	0.25	3.97
	Z	423.177		0	0	0	4.775	85.941	233.725	190.98	47.75	52.520	372.411	47.75	
	Z - C	423.177		0	0	0	4.775	-2.949	89.085	0	-27.81	33.11	335.791	-110.37	
153.62	J+Rg.	3.317		1.333	0	0	-0.033	0.733	-0.333	0	1	0.967	-1.267	1	
0	J.B.L.	7.926		-2.666	1	0	0.066	1.534	2.666	0	0.500	-1.934	2.534	0	
0	O.B.L.	14.042	15.752	1.000	0	1	-0.100	-0.300	-4.000	0	0	-0.100	-6.300	0	
190.98	Ragi-II	1.413		-0.333	0	0	0.033	0.267	1.333	1	0	0.033	2.267	0	
	Z	796.00		147.844	0	0	1.063	167.26	201.756	190.98	153.62	159.688	231.93	153.62	
	Z - C	796.00		147.844	0	0	1.063	73.37	52.12	0	83.06	140.28	195.36	0	

N.B:- J.B.L. =June bullock labour; O.B.L.= October bullock labour; O.V.I.= Other Variable inputs;

J+Rg.= Jowar + Redgram.

(Contd.)

SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: Above 15.00 acres  
Typical farm size is 24.81 acres

C S	Resource or activity	Supply level	Unit	Disposal activities				Real activities						R	
				Land	J.B.L.	O.B.L.	O.V.I.	Cotton	G'nut	Ragi-II	Other oil seeds	Fodders	Vege- tab- les		J+Rg.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
				0	0	0	0	88.89	149.64	190.98	75.56	19.41	36.62	153.62	
0	Land	11.02	Acre	1	0	0	0	1	1	1	1	1	1	1	11.02
0	J.B.L.	33.91	3 hr.	0	1	0	0	3	2	0	2.5	0	0	2	...
0	O.B.L.	46.56	pair day	0	0	1	0	0	0	3	0	0	0	0	15.57
0 ←	O.V.I.	430.83	hrs.	0	0	0	1	18	50	40	10	11	78	10	10.77
	Z	0		0	0	0	0	0	0	0	0	0	0	0	
	Z - C	0		0	0	0	0	-38.89	-149.64	-190.98	-75.56	-19.41	-36.62	-153.62	
0 ←	Land	0.247		1	0	0	-0.025	0.550	0.250	0	0.750	0.725	-0.050	0.750	.33
0	J.B.L.	33.91		0	1	0	0	3	2	0	2.5	0	0	2	16.96
0	O.B.L.	46.56	14.241	0	0	1	-0.075	-1.350	-3.750	0	-0.750	-0.325	-5.850	-0.750	...
190.98	Ragi-II	10.773		0	0	0	+0.025	0.450	1.250	1	0.250	0.275	1.950	0.250	43.09
	Z	2057.423		0	0	0	4.775	35.941	233.725	190.98	47.745	52.520	372.411	47.745	
	Z - C	2057.423		0	0	0	4.775	-2.949	80.035	0	-27.815	33.110	335.791	-110.875	
153.62	J+Rg.	0.320		1.333	0	0	-0.033	0.733	-0.333	0	1	0.967	-1.267	1	
0	J.B.L.	33.252		-2.666	1	0	+0.066	1.534	2.666	0	0.500	-1.934	+2.534	0	
0	O.B.L.	46.273		1.000	0	1	-0.100	-0.800	-4.000	0	0	-0.100	-6.800	0	
190.98	Ragi-II	10.601		-0.033	0	0	+0.033	0.267	1.333	1	0	0.033	2.267	0	
	Z	2093.953		147.844	0	0	1.063	167.260	201.756	190.98	153.62	159.639	231.930	153.62	
	Z - C	2093.953		147.344	0	0	1.063	73.37	52.116	0	83.06	140.279	195.360	0	

N.B.: - J.B.L.= June bullock labour; O.B.L.= October bullock labour; O.V.I.= Other variable inputs

G'nut. = Groundnut; J+Rg.= Jowar + Redgram.



RIGHT CANAL AREA ( $S_1+S_2$ )

OPTIMAL CROP PATTERN FOR INDIVIDUAL FARMERS OF DIFFERENT SIZE GROUPS

Size group (in acres)	Average size of farm	Adhoc allotments of area (in acres) to selected crops			Balance of farm available for programming	Area allocations arrived at for efficient crops considered in programming (in acres)					
		Chillies	Country tobacco	Paddy		Ragi II	Jowar+ Redgram	Cotton	Groundnut	Fodders	Vegetables
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0.01 - 2.50	1.26	0.17	0.11	0.42	0.56	0.36	0.20	-	-	-	-
2.51 - 7.50	4.83	0.64	0.43	1.61	2.15	1.29	0.86	-	-	-	-
7.51 -15.00	10.65	1.42	0.95	3.55	4.75	1.41	3.32	-	-	-	-
Above 15.00	24.81	3.31	2.21	8.27	11.02	10.69	0.33	-	-	-	-

RIGHT CANAL AREA ( $S_1 + S_2$ )

OPTIMAL CROP PATTERN OBTAINED FOR 11.24 LAKHS OF ACRES OF

Size-group (in acres)	Total acreage	No. of farms	Chillies	Country tobacco	Paddy	Ragi-II	Jowar+Redgram
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0.01 - 2.50	59,572.00	47,279	7,950.00	5,3000.00	19,853.61	17,014.07	9,454.32
2.51 - 7.50	2,26,710.00	46,933	30,255.00	20,170.00	75,485.58	60,483.66	40,316.56
7.51 - 15.00	5,31,390.80	31,893	44,625.00	29,750.00	1,11,468.43	44,280.55	1,04,266.02
Above 15.00	5,03,327.20	20,917	67,170.00	44,780.00	1,67,783.41	2,16,901.24	6,692.55
Total	11,24,000.00	1,47,022	1,50,000.00	100,000.00	3,74,591.03	3,38,679.52	1,60,729.45

RIGHT CANAL AREA (  $S_1 + S_2$  )

RESOURCE AVAILABILITY AND REQUIREMENTS FOR ADOPTING THE OVERALL OPTIMAL CROP PATTERN

S.No.	Description of the resource	Available at present (in 59-60) Total.	Available for crop production only.	Actual requirement as per the optimal crop pattern	Requirement for virginia tobacco and other unirrigated crops	Total requirement	Shortage	Percentage increase required over the actual
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Bullock labour in June/July (in 8 hr pair days)	22,34,573.47	20,66,980.46	18,19,823.02	Nil	18,19,823.02	-	-
2.	Bullock labour in Sept/Octo. (in 8 hr. pair days)	22,34,573.47	20,66,980.46	19,41,038.56	4,21,942.17	23,62,980.73	2,96,000.27 <del>20,407.26</del> 10,000 OR (4,280 pairs) approx.	14.32
3.	Other variable inputs (in Rs)	3,55,62,625.95	3,55,62,625.95	5,78,84,026.80	1,19,90,282.53	6,98,74,309.33	3,43,11,683.38	96.48

RIGHT CANAL AREA (S<sub>1</sub>+S<sub>2</sub>)

ACTUAL REQUIREMENTS OF BULLOCK LABOUR AND OTHER VARIABLE INPUTS FOR ADOPTING THE PROPOSED OPTIMAL CROP PROGRAMME (EXCLUDING BULLOCK LABOUR)

S. No.	Crop	Bullock labour (in 8 hr. pair days)			Other variable inputs (in Rs.)
		Total	Of which		
(1)	(2)	(3)	June/July (4)	September/ October (5)	(6)
1.	Chillies	10,50,000.00	-	5,25,000.00	1,30,00,000.00
2.	Country tobacco	8,00,000.00	-	4,00,000.00	60,00,000.00
3.	Paddy	29,96,723.24	14,93,364.12	-	1,87,29,551.50
4.	Ragi	20,32,077.12	-	10,16,033.56	1,35,47,180.80
5.	Jowar + <del>Ragi</del> <sup>Yedgram</sup>	6,42,917.80	3,21,453.90	-	16,07,294.50
Total		75,21,723.16	18,19,823.02	19,41,033.56	5,78,84,026.80

RIGHT CANAL AREA (S<sub>1</sub>+S<sub>2</sub>)

AT PRESENT  
GROSS VALUE ADDED PER FARM BEFORE AND AFTER IRRIGATION FOR THE FOUR  
TYPICAL FARMERS

Size group (in acres)	Average size of farm	Gross value added at present	Gross value added after irrigation*	Percentage in- crease
(1)	(2)	(3)	(4)	(5)
0.01 - 2.50	1.26	92.13	450.99	390
2.51 - 7.50	4.83	256.96	1712.46	566
7.51 - 15.00	10.66	905.04	3739.52	313
Above 15.00	24.81	2154.75	3953.46	316

Gross value added at present 7,43,10,330.00

Farms 430

\* Gross value added after irrigation is calculated on the assumption that the intensity of cropping is unity.

RIGHT CANAL AREA (S<sub>1</sub> + S<sub>2</sub>)

VALUE OF OUTPUT, MATERIAL INPUTS AND GROSS VALUE ADDED IF THE OPTIMAL CROP PATTERN IS ADDED

S.No.	Crop	Acreage	Main Product		Value of by-product (in Rs.)	Value of the total output (in Rs.)	Cost of material inputs (in Rs.)	Value added (in Rs.)
			Yield in tonnes	Value in Rs.				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Chillies	1,50,000.00	1,08,864.00	21,70,08,000.00	3,00,000.00	21,73,08,000.00	2,28,61,500.00	19,44,46,500.00
2.	Country tobacco	1,00,000.00	22,395.00	2,38,38,000.00	--	2,38,38,000.00	97,04,000.00	1,41,34,000.00
3.	Paddy	3,74,591.03	3,35,558.65	11,79,51,223.53	1,68,56,596.35	13,48,07,819.88	3,26,04,403.25	10,22,03,416.63
4.	Ragi	3,38,679.52	2,02,259.41	7,23,96,134.20	1,52,40,578.40	8,76,36,712.60	2,29,55,697.87	6,46,81,014.73
5.	Jowar + Redgram	1,00,729.45	65,990.69	2,40,93,344.55	59,85,564.72	3,00,78,909.27	45,84,003.91	2,54,94,905.36
Total			11,24,000.00	45,52,86,702.28	3,83,82,739.47	49,36,69,441.75	9,27,09,605.03	40,09,59,836.72 + 2,69,37,909.82*

Value added at present in Rs. 10,12,78,540.28

Increase in value added Rs. 32,66,19,206.26

% increase 322

\* This amount of value added will arise from the unirrigated crops on the extent of nearly 87 thousand acres. No allowance is, however, made for intensity of cropping greater than unity in the irrigated area after irrigation.

DEVI CANAL AREA (S<sub>3</sub>)

## PER ACRE INPUT REQUIREMENTS AND VALUES OF OUTPUT (INCLUDING VALUE OF BY PRODUCT) ASSUMED AFTER IRRIGATION.

S.No.	Name of crop	3 hr. mandays	8 hr. bullock-pair days required			Value @ Rs.3.66 per 8-hr bullock pair day (in Rs.)	Value of other inputs (in Rs.)	Value of material inputs (in Rs.)	Yield		Value of inputs maintained (in Rs.)	Value of by-product (in Rs.)	Value of total output 59-60 (in Rs.)	Gross value added (in Rs.) Col. (14) - Col. (9)
			June/ July	Sept/ Oct.	Total				Weight (in mds)	Price (in Rs.)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1.	Irrigated Paddy	30	4	-	8	29.28	50	79.28	24.00	12.50	300.00	55.00	355.00	275.72
2.	Chillies	60	-	3.5	7	25.62	120	145.62	1600 lbs	69.49	1350.89	3.00	1353.89	1208.27
3.	Country Tobacco	30	-	4	8	29.28	60	89.28	6.00 lbs	36.68	220.08	2.00	222.08	132.80
4.	Cotton	30	3	-	6	21.96	18	39.26	100 lbs	24.50	119.07	-	119.07	79.81
5.	Groundnut	50	2	-	4	14.34	50	64.64	11.00	17.85	196.35	3.00	199.35	134.71
6.	Other cereals	25	-	3	6	21.96	40	61.26	11.25	12.05	135.58	15.00	150.58	89.32
7.	Castor	15	2.5	-	5	18.30	10	28.30	4.00	13.16	52.64	-	52.64	24.34
8.	Jowar + Cucumber	25	-	3.5	7	25.62	30	55.62	11.00	12.89	141.74	20.00	161.74	106.12
9.	Groundnut + Redgram	55	2	-	4	14.64	50	64.64	12.00	17.25	206.96	5.00	211.96	147.32
10.	Other mix- tures.	28	2.5	-	5	18.30	16	34.30	10.50	13.59	142.74	12.50	155.24	120.94
11.	Vegetables	-	-	-	2	7.32	78	85.32	-	-	-	-	138.10	52.78

LEFT CANAL AREA (S<sub>3</sub>)

RESOURCE AVAILABILITY PER FARM  
(AS OBTAINED FROM OUR CENSUS SURVEY)

Size group (in acres)	Average size (in acres)	Land (in acres)				Balance of land available for progra- mming. (res.)	Human labour in 8 hr. man day				
		Area set apart for selected crops					June - July				
		Chillies tobacco	Country	Paddy	Vegetables		At present available for 30 days	Assumed available *	Set apart require- ment for paddy	Balance availa- ble for progra- mming.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
0.01 - 2.50	1.47	0.02	0.01	1.19	0.02	0.23	--	11.7	--	--	--
2.51 - 7.50	5.00	0.06	0.03	4.06	0.06	0.79	--	--	--	--	--
7.51 -15.00	10.69	0.13	0.07	8.69	0.13	1.67	83.40	116.76	103.63	8.13	
Above 15.00	27.62	0.35	0.17	22.44	0.35	4.31	99.30	317.76	280.50	37.26	

N.B:- In the first two size groups of farms, human labour is not considered to be a limitational factor during June/July.

\* The percentage increases assumed over the availability at present in the size groups 7.51-15.00 and Above 15.00 are 40 and 220 respectively.



LEFT CANAL AREA (S<sub>3</sub>)

RESOURCE AVAILABILITY PER FARM  
(AS OBTAINED FROM OUR CENSUS SURVEY)

Size group (in acres)	June - July Bullock labour (in 8 hr. pair days)			
	Available at present (for 30 days)	Assumed availability for 30 days*	Set apart as requirement for paddy	Balance available for programming.
	(12)	(13)	(14)	(15)
0.01 - 2.50	6.83	10.25	4.76	5.49
2.51 - 7.50	16.50	24.75	16.24	8.51
7.51 - 15.00	28.86	43.29	34.76	8.53
Above 15.00	58.00	92.80	89.76	3.04

N.B:- Human labour and Bullock labour in September /October are not found to be limitational factors and so are not considered.

\* The percentage increased assumed over the availability at present is 50 in all the size groups except in the size group Above 15.00 where it is 60.

LEFT CANAL AREA (J<sub>3</sub>)

RESOURCE AVAILABILITY PER FARM (OTHER VARIABLE INPUTS IN Rs.)

( AS OBTAINED FROM INTENSIVE FARM SURVEYS )

Size groups (in acres)	At present available	Assumed available *	Set apart for selected crops				Balance available for programming
			Chillies	Country tobacco	Paddy	Vegetables	
	(16)	(17)	(18)	(19)	(20)	(21)	(22)
0.01 - 2.50	61.41	92.12	2.40	0.60	59.50	1.56	28.06
2.51 - 7.50	120.65	241.30	7.20	1.80	203.00	4.63	24.62
7.51 - 15.00	236.14	590.36	15.60	4.20	434.50	10.14	125.92
Above 15.00	496.88	1490.65	42.00	10.20	1122.00	27.30	289.15

\* The percentage increase assumed over the availability at present range from 50 to 200 in the different size groups.

LEFT CANAL AREA (S<sub>3</sub>)

RESOURCE REQUIREMENT OF DIFFERENT ACTIVITIES CONSIDERED IN LINEAR PROGRAMMING TO OBTAIN Rs. 100  
FOR THE GROSS VALUE ADDED.

S. No.	Crop	Land (in acres)	June/July Bullock labour (in 8 hr. pair days)	September/ October Bullock labour (in 8 hr. pair days)	Other variable inputs (in Rs.)
(1)	(2)	(3)	(4)	(5)	(6)
1.	*Groundnut	0.74	9.28	1.48	37.12
2.	*Cotton	1.25	-	-	22.55
3.	*Castor	4.11	15.41	10.71	41.10
4.	*Jowar+Greengram	0.94	-	-	28.27
5.	Other cereals	1.12	7.00	-	44.78
6.	*Groundnut+ Redgram	0.68	9.33	1.36	33.92
7.	*Other-mixtures	0.83	5.29	2.07	12.23

N.B:- i) Crops marked with an asterisk have turned out to be efficient crops.

- ii) Other cereals are Jowar, Variga, Bajra and Korra
- iii) Other mixtures are Bajra + Cotton, Jowar+Redgram+Greengram
- iv) Human labour is not considered here.

LEFT CANAL AREA (S<sub>3</sub>)

SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: 0.01-2.50 acres  
Typical farm size is 1.47 acres

				0	0	0	134.71	106.12	147.32	120.04		
				Disposal activities			Real activities					
C <sub>s</sub>	Resource or activity	Supply level	Unit	Land	J. B.L.	O.V.I.	G'nut	J+Cu.	G'nut+ Rg.	Other mixtures	R	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
0	Land	0.23	Acre	1	0	0	1	1	1	1	0.23	
0	J.B.L.	5.40	8 hr. pair day	0	1	0	2	0	2	2.5	2.745	
0	O.V.I.	23.03	hs	0	0	1	50	30	50	16	0.551	
	Z	0		0	0	0	0	0	0	0		
	Z - C	0		0	0	0	-134.71	-106.12	-147.32	-120.04		
-147.32	G'nut+Rg.	0.23		1	0	0	1	1	1	1		
0	J.B.L.	5.03		-2	1	0	0	-2	0	0.50		
0	O.V.I.	16.56		-50	0	1	0	-20	0	-34		
	Z	53.884		147.32	0	0	147.32	147.32	147.32	147.32		
	Z - C	33.884		147.32	0	0	12.61	41.20	0	26.33		

N.B:- J.B.L. = Jume bullock labour; O.V.I. = Other Variable inputs; G'nut = Groundnut; Rg. = Redgram;  
J+Cu. = Jowar + Cucumber

(Contd.)

LEFT CANAL AREA (S<sub>3</sub>)

SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: 2.51-7.50 acres  
Typical farm size is 5.00 acres

C <sub>s</sub>	Resource or activity	Supply level	Unit	Disposal activities			Real activities				R
				Land	J.B.L.	O.V.I.	G'nut	J+Cu.	G'nut+Rg.	Other mixtures	
				(5)	(6)	(7)	(8)	(9)	(10)	(11)	
				0	0	0	134.71	106.12	147.32	120.94	
0	Land	0.79	Acre	1	0	0	1	1	1	1	0.79
0	J.B.L.	8.51	8 hr.	0	1	0	2	0	2	2.5	4.255
0 ←	O.V.I.	24.62	pair day	0	0	1	50	30	50	16	0.492
	Z		Rs.	0	0	0	0	0	0	0	0
	Z - C	C		0	0	0	-134.71	-106.12	-147.32	-120.94	0
0 ←	Land	0.293		1	0	-0.02	0	0.40	0	0.63	0.438
	J.B.L.	7.326		0	1	-0.04	0	-1.20	0	1.36	5.046
→147.32	G'nut+Rg.	0.492		0	0	0.02	1	0.60	1	0.32	1.538
	Z	72.431		0	0	2.946	147.32	88.292	147.32	47.142	
	Z - C	72.481		0	0	2.946	12.61	17.728	0	-73.793	
→120.94	Other mixtures	0.438		1.471	0	-0.029	0	0.538	0	1	
0	J.B.L.	6.733		-2.736	1	+0.014	0	-2.204	0	00	
147.32	G'nut+Rg	0.352		-0.471	0	+0.029	1	0.412	1	0	
	Z	104.823		103.515	0	0.765	147.32	131.800	147.32	120.94	
	Z - C	104.328		103.515	0	0.765	12.61	25.688	0	0	

N.B:- J.B.L. = June Bullock labour; G'nut = Groundnut; Rg. = Redgram; J+Cu. = Jowar + Cucumber.

(Contd.)

SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: 7.51-15.00 acres  
Typical farm size is 10.69 acres

Cs	Resource or activity	Supply level	Unit	Disposal activities				Real activities					R
				Land	J.H.L.	J.B.L.	O.V.I.	Cotton	J+Cu.	G'nut	G'nut+Rg.	Other mix-tures	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
							79.81	106.12	174.71	147.32	120.94		
0	Land	1.67	Acre	1	0	0	0	1	1	1	1	1	1.67
0	← J.H.L.	3.13	3 hr. manday	0	1	0	0	0	0	12.50	<u>13.75</u>	27.5	0.591
0	J.B.L.	3.53	3 hr. pair day	0	0	1	0	3	0	2	2.2	2.5	4.265
0	O.V.I.	125.92	Rs.	0	0	0	1	13	30	50	50	16	2.513
	Z	0		0	0	0	0	0	0	0	0	0	
	Z-C	0		0	0	0	0	-79.81	-106.12	-134.71	-147.32	-120.94	
→ 147.32	← Land	1.079		1	-0.073	0	0	1	<u>1</u>	0.091	0	0.491	1.070
0	G'nut+Rg.	0.591		0	0.073	0	0	0	0	0.909	1	0.509	
0	J.B.L.	7.343		0	-0.146	1	0	3	0	0.132	0	1.432	
0	O.V.I.	96.370		0	-3.650	0	1	13	30	4.550	0	-9.450	3.212
	Z	87.066		0	10.754	0	0	0	0	133.91	147.32	74.980	
	Z - C	37.066		0	10.754	0	0	-79.81	-106.12	-0.81	0	-45.951	
→ 106.12	J+Cu.	1.079		1	-0.073	0	0	1	1	0.091	0	0.491	
147.32	G'nut+Rg.	0.591		0	0.073	0	0	0	0	0.909	1	0.509	
0	J.B.L.	7.343		0	-0.146	1	0	3	0	0.132	0	1.432	
0	O.V.I.	64.000		-30	-1.460	0	1	-12	0	1.800	0	-24.130	
	Z	201.570		106.12	3.008	0	0	106.12	106.12	143.57	147.32	127.001	
	Z - C	201.570		106.12	3.008	0	0	26.31	0	8.86	0	6.151	

N.B:- J.H.L. = June Human Labour; J.B.L.= June bullock labour; O.V.I. = Other Variable inputs;  
G'nut+Rg. = Groundnut+Redgram; J+Cu.= Jowar + Cucumber

(Contd.)

LEFT CANAL AREA (S<sub>3</sub>)

SIMPLEX TABLE FOR COMPUTING THE OPTIMAL CROP COMBINATION

Size group: Above 15.00 acres  
Typical farm size is 27.62 acres

				79.81 134.71 106.12 147.32 120.94									
C <sub>s</sub>	Resource or activity	Suppl. level	Unit	Disposal activities			Real activities					R	
				Land	J.H.L.	J.B.L.	O.V.I.	Cotton	G'nut	J+Cu.	G'nut+Rg.		Other mixtures
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
0	Land	4.31	Acre	1	0	0	0	1	1	1	1	1	4.31
0	J.H.L.	37.26	8 hr. manday	0	1	0	0	0	12.50	0	13.75	7	2.710
0 ←	J.B.L.	3.04	3 hr. pair day	0	0	1	0	0	2	0	2	2.5	1.520
0	O.V.I.	230.15	Rs.	0	0	0	1	13	50	30	50	16	5.733
	Z	0		0	0	0	0	0	0	0	0	0	
	Z - C	0		0	0	0	0	-79.81	-134.71	-106.12	-147.32	-120.94	
0 ←	Land	2.70		1	0	-0.5	0	-0.5	0	1	0	-0.25	2.70
0	J.H.L.	16.36		0	1	-6.375	0	-20.625	-1.25	0	0	-10.133	
147.32	G'nut+Rg.	1.520		0	0	0.5	0	1.5	1	0	1	1.25	
0	O.V.I.	213.15		0	0	-2.5	1	-57	0	30	0	-46.50	7.105
	Z	223.926		0	0	73.660	0	220.930	147.32	0	147.32	134.15	
	Z - C	223.923		0	0	73.660	0	141.17	12.61	-106.12	0	63.21	
-106.12	J+Cu.	2.70		1	0	-0.5	0	-0.5	0	1	0	-0.25	3.54
0	J.H.L.	16.36		0	1	-6.375	0	-20.625	-1.25	0	0	-10.133	-20.323
147.32	G'nut+Rg.	1.520		0	0	0.5	0	1.5	1	0	1	1.25	5.77
0	O.V.I.	120.45		-30	0	-10	1	-42	0	0	0	-30.00	9.45
	Z	520.001		106.12	0	2.06	0	167.920	147.32	106.12	147.32	157.62	
	Z - C	520.001		106.12	0	2.06	0	83.11	12.61	0	0	36.63	

N.B;- J.H.L= June human labour; J.B.L. = June bullock labour; O.V.I.= Other varibale inputs;  
G'nut+ Rg.= Groundnut+Redgram; J+Cu.= Jowar+Cucumber.

LIN A PROGRAMMING ( )

Table No. 7

LEFT CANAL AREA (S<sub>3</sub>)

OPTIMAL CROP PATTERN FOR INDIVIDUAL FARMERS OF DIFFERENT SIZE GROUPS

Size group (in acres)	Average size of farm	Ad hoc allotments of area (in acres) to selected crops				Balance of farm available for programming	Area allocations arrived at for efficient crops considered in programming (in acres)						
		Chillies	Country tobacco	Paddy	Vegetables		Cotton	G'nut	other cereals	Castor	Jowar+ Cucumber	G'nut+ Redgram	Other mixtures
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
0.01 - 2.50	1.47	0.02	0.01	1.19	0.02	0.23	-	-	-	-	-	0.23	-
2.51 - 7.50	5.00	0.06	0.03	4.06	0.06	0.79	-	-	-	-	-	0.35	0.44
7.51 - 15.00	10.69	0.13	0.07	8.69	0.13	1.67	-	-	-	-	1.03	0.59	-
Above 15.00	27.62	0.45	0.17	22.44	0.45	4.31	-	-	-	-	2.79	1.52	-



LEFT CANAL AREA (S<sub>3</sub>)

OPTIMAL CROP PATTERN OBTAINED FOR 8,00 LAKHS OF ACRES

Size group (in acres)	Total acreage	Chillies	Country tobacco	Paddy	Vegetables	G'nut+Redgram	Jowar+Cucumber	Other mixtures
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0.01 - 2.50	24,160	302.00	151.00	19,630.00	302.00	3,775.00	-	-
2.51 - 7.50	1,47,200	1,840.00	920.00	1,19,600.00	1,840.00	10,139.00	-	12,811.00
7.51 - 15.00	2,07,360	2,592.00	1,296.00	1,68,430.00	2,592.00	11,447.00	20,953.00	-
Above 15.00	4,21,200	5,266.00	2,633.00	3,42,290.00	5,266.00	23,215.00	42,610.00	-
<b>Total</b>	<b>8,00,000</b>	<b>10000.00</b>	<b>5000.00</b>	<b>6,50,000.00</b>	<b>10,000.00</b>	<b>48,626.00</b>	<b>63,563.00</b>	<b>12,811.00</b>

LEFT CANAL AREA (S<sub>3</sub>)

RESOURCE AVAILABILITY AND REQUIREMENTS FOR ADOPTING THE OVERALL OPTIMAL CROP PATTERN

S.No.	Description of the resource	Available at present (in 59-60)	Available for crop production only	Actual requirement as per the optimal crop pattern	Shortage	Percentage increase required over the actual
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Human labour in June/July (in 8 hr. days)	73,79,324	36,89,662	88,83,285	51,93,623 (or 1,73,121 workers)	140.76
2.	Bullock labour in June/July (in 8 hr. pair days)	15,90,119	14,31,107	27,29,280	12,98,173 (or 43,272 pairs)	90.71
3.	Other variable inputs (in Rs.)	1,30,16,330.78	1,30,16,330.78	3,93,23,166.00	2,63,06,835.22	202.11

LEFT CANAL AREA (S<sub>3</sub>)

ACTUAL REQUIREMENTS OF HUMAN-LABOUR BULLOCK LABOUR AND OTHER VARIABLE INPUTS  
FOR ADOPTING THE PROPOSED OPTIMAL CROP PATTERN

S. No.	Crop	Human labour (in 8 hr. mandays)		Bullock labour (in 8 hr. pair days)		Other variable inputs (in Rs.)
		Total	Of which June/July	Total	Of which June/July	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Chillies	6,00,000	-	70,000	-	12,00,000
2.	Country tobacco	1,50,000	-	40,000	-	3,00,000
3.	Paddy	3,25,00,000	81,25,000	52,00,000	26,00,000	3,25,00,000
4.	Vegetables	7,00,000	-	20,000	-	7,30,000
5.	Groundnut+ Redgram	36,74,430	6,63,603	1,94,504	97,252	24,31,300
6.	Jowar + Cucumber	15,39,075	-	4,44,941	-	19,06,890
7.	Other mixtures	3,43,703	89,677	64,055	32,023	2,04,976
Total		3,85,72,213	83,83,285	60,33,500	27,29,230	3,93,23,166

LEFT CANAL AREA (S<sub>3</sub>) GROSS VALUE ADDED PER FARM BEFORE AND AFTER IRRIGATION FOR THE  
FOUR TYPICAL FARMERS

Size group (in acres)	Average size of farm	Gross value added at present	Gross value added after irrigation *	Percentage increase
(1)	(2)	(3)	(4)	(5)
0.01 - 2.50	1.47	55.26	338.54	603
2.51 - 7.50	5.00	181.25	1303.85	619
7.51 - 15.00	10.69	531.51	2770.77	421
Above 15.00	27.62	1762.71	7171.10	307

\* This is calculated on the assumption that the intensity of cropping after irrigation is unity.

LEFT CANAL AREA (S.)<sup>3</sup>

VALUE OF OUTPUT, MATERIAL INPUTS AND GROSS VALUE ADDED IF THE OPTIMAL CROP PATTERN IS ADOPTED

S.No.	Crop.	Acreage	Main yield in <del>of 1000S</del> <sup>GRAMS</sup>	Value of Product (in Rs.)	Value of by product (in Rs.)	Value of the total output (in Rs.)	Cost of material inputs (in Rs.)	Gross value added (in Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Chillies	10,000.00	7257.60	13508900.00	30,000.00	13538900.00	1456200.00	1208272.00
2.	Country tobacco	5,000.00	1119.75	1100400.00	10,000.00	1110400.00	446400.00	664000.00
3.	Paddy	6,50,000.00	582270.00	195000000.00	35750000.00	230750000.00	51532000.00	179218000.00
4.	Vegetables	10,000.00	2885.20	1331000.00	-	1331000.00	853200.00	527800.00
5.	Groundnut + Redgram	48,626.00	21779.59	10063636.96	2,43,130.00	10306766.96	3143184.64	7163572.32
6.	Jowar + Cucumber	63,563.00	26097.06	9009419.62	12,71,260.00	10280679.62	3535374.06	6745305.56
7.	Other mixtures	12,811.00	5020.76	1828642.14	1,60,137.50	1988779.64	439417.30	1549362.34
Total		8,00,000.00	.	231891993.72	3,74,64,527.50	269356526.22	61405776.00	20790750.22

Gross value added at present is Rs. 3,38,67,232.92

Percentage increase, <sup>assuming the</sup> intensity of ~~cropping~~ <sup>cropping</sup> ~~to be unit~~ <sup>to be unit</sup> after irrigation. } 513

## APPENDIX - I

### OUTLINE OF A SCHEME OF INVESTIGATION INTO THE ECONOMIC ASPECTS OF THE NAGARJUNA SAGAR PROJECT

#### SOCIAL ASPECTS OF PROJECT PLANNING:

It is common experience that, while much attention is paid to engineering detail in planning a big public utility project to provide water for irrigation or power or railway transport for a wide region, the social and economic aspects of the project do not receive the attention due to them, either before or after the project is completed. It is of course vitally important that the engineering details of construction, maintenance and operation should be thoroughly examined; but a scientific study of the social and economic consequences of the project is as important. Too often the benefits of the project are taken for granted; and proper assessment of net benefit and its distribution among the different classes of beneficiaries are not emphasised as important problems for investigation. This attitude is basically inconsistent with any scheme of planned utilisation of national resources. Survey of social and economic conditions existing in the region which a project is intended to serve, both before the project is completed and after, objective study of the project's impact on the social and economic life of the region during the stages of construction and later, and assessment of results with reference to the social aims of the project - these also should form essential elements in a project plan. Further, each project must be considered as part of a general plan for the development of the region which it serves. Maximum benefit from the project can be realised only when it is treated as one of the instruments for an integrated development of the region. It is also necessary to constantly bear in mind that development is essentially a dynamic process. It must be pursued according to a well-conceived plan as an unending drive to raise the productivity of land and labour by various means of which water or power forms a part.

It cannot be said that project planning in our country fully recognises the importance of the above considerations. Social and economic engineering does not receive equal attention with the engineering of the physical plant. The government and the people are, however, becoming increasingly aware of the social implications of project planning and the need for objective study of the social and economic aspects of projects. In this connection the Nagarjuna Sagar Project, recently undertaken, provides us with a great opportunity to view it in the proper perspective by paying due attention to the economic aspects of the project. We are advantageously placed in respect of this in that steps can now be taken to undertake basic economic survey and studies during the construction phase of the project. In organizing these surveys we can also draw on the valuable experience gained by the Reserve Bank of India, the Programme Evaluation Organization and other Institutions in conducting large scale economic surveys.

## 2. MAIN FEATURES OF THE NAGARJUNA SAGAR PROJECT:

Nagarjuna Sagar Project is rightly claimed as one of the major multi-purpose River Valley Projects in India. The project is a unit for large scale storage and use of the water of the river Krishna for purposes of irrigation and generation of Hydel power. The project also serves the purposes of flood control and navigation. Irrigation was however given the highest priority in planning the multipurpose scheme. The total estimated cost of the Dam at Nagarjuna Sagar and of the Right and Left Bank canals worked out ~~to~~ to a sum of Rs.122 crores, and it will take nine years to complete the project. When the project is completed, and when full development of the ayacut under the Dam has taken place, it is expected to bring under irrigation about <sup>31.83</sup> ~~2~~ lakhs of acres of land, lying mostly in the dry and arid zones of Andhra Pradesh, and to assure water supply to the existing ayacut under the Krishna Anicut System. In respect

— of irrigation the project is thus planned to achieve within a short period of sixteen years, more than what was achieved during the past hundred years under the Krishna and Godavari Anicut Systems. The construction of the Dam and storage of water at Nagarjuna Sagar will also reduce the incidence and fear of floods. The network of canals will facilitate navigation over a wide region. Moreover, 75,000 K.W. of Hydel power will be generated for the benefit of the region.

Thus, broadly speaking, the benefits expected from the project are a considerable increase in the area of irrigated land and production of food-grains, additional generation of Hydel power, prevention of losses from floods in the river Krishna, and additional navigational facility in the canals. It is not possible to make a more detailed and precise statement about the benefits of the Project or its full significance in relation to the regional and national economy for want of necessary statistical information. The benefits also depend on how rapidly the ayacut under the dam is developed and what extra cost have to be borne by the farmers and the local governments, the extent to which the project activates the economy of the region directly and indirectly, and the measures which the state and the local governments take to aid the process of economic development in the region.

### 3. CERTAIN IMPORTANT QUESTIONS:

Some of the important questions which arise in the study of the social and economic aspects of the project may be stated as follows:

(1) What are the extra capital costs to be borne by the cultivators in order to bring water into their lands or to bring new land under cultivation for the first time.

(2) What are the extra capital costs to be borne by the state and local governments in promoting the development of the ayacut, in erecting road bridges or providing ferries on the canals, etc.



(3) What is the attitude of farmers to irrigation in dry areas which are now used for growing commercial crops and whether there will be any opposition to irrigation based on economic or non-economic considerations. Economic considerations are important when the farmers feel that change from dry cultivation of crops like virginia tobacco; chillies or groundnut, to wet cultivation of paddy may not bring net monetary benefit. Non-economic considerations are important when the cultivators are reluctant to adopt wet cultivation due to lack of irrigation experience, etc.

(4) What shifts are likely to take place in land utilization and crop pattern (that is, in the distribution of dry and wet food crops, wet commercial crops and dry commercial crops) and how they effect the economy of the region. It is interesting to find that in the Krishna, Guntur and Nellore Districts 76 per cent of the area under dry crops is under cereals and pulses; while ~~whether~~ value comes to only 39 per cent of the total value of dry crops. The area under Tobacco is 7 per cent of the area under dry crops while its value comes to about 33 per cent. The area under chillies, groundnut, cotton and castor comes to 17 per cent and their value is 28 per cent. As regards irrigated crops paddy takes, of course, nearly 95 per cent of acreage as well as value. (These are rough estimates based on data in the Season and Crop Reports).

(5) What price should be charged for water, and what will be the economic justification for imposing additional tax burdens on land:

(6) What will be the extra demand for trade and transport facilities taking into account the possible changes in the crop pattern and expansion of agricultural production How will the canal navigation affect the present distribution of such facilities

(7) What new opportunities for the development of processing or other manufacturing industries will arise (for rice mills, sugar mills etc.). What will be the effect on some of the important existing industries like the tobacco ~~fact~~ factories and oil mills. How does the generation of power help the establishment of new industries in the region.

(8) What are the employment potentialities in the project during the stages of construction and later. How is employment related to investment. What peculiar problems of recruitment and migration of labour and its organization arise in the important work centers of the project.

(9) What are the governmental measures required regarding the rapid development of irrigation, extension of credit facilities, and provision of better seed and manures in addition to water for raising agricultural production. What are the measures needed, speaking in a general way, for sustaining the stimulus<sup>m</sup> that the project would impart to the region, and for mobilising the economic surplus arising from the project for productive purposes.

(10) What will be the overall effect on the incomes and living standards of the people in the region.

#### 4. NEED FOR ECONOMIC SURVEYS AND STUDIES:

The questions posed above are very important for any rational scheme of project planning; but, it is obvious that no satisfactory answers can be given to the above questions without adequate ~~in~~ knowledge of the existing social and economic conditions of the region, how they will change in the course of the development of the project, and what the government policy is regarding the utilisation of water and power, (i.e., regarding shifts in land use and crop pattern and the establishment of new industries) and what other measures the government propose to undertake for the general development of the region. It is therefore necessary to emphasise the need for starting immediately economic surveys and studies covering the whole region, some of which will have to be repeated during the stage of the development of the ayacut under the Dam and also after the stage of complete utilisation of the new water and power resources is reached.

## 5. MAIN OBJECTS OF PROPOSED ECONOMIC SURVEYS AND STUDIES:

The main objects of the proposed economic surveys and studies may be stated as follows:

(1) Estimating possible changes in crop pattern, agricultural production, trade, incomes etc., in the ~~x~~ different parts of the Project region on certain assumptions regarding the use of water and other investment by the cultivators, while the Project is still under construction.

(2) Preparation of plans regarding the use of water and power on the basis of objective economic information in order to secure maximum gain from the project, and for the organisation of complementary resources such as supply of credit to the farmers and local governments, transport facilities, services of Government Agriculture and Health Departments, and community development <sup>e</sup> schemes for sustaining and stimulating the new dynamic factors brought into existence by the Project.

(3) Assessment of results of the Project and the developments following the Project as contrasted with the economic conditions existing at present in the region.

(4) Study of the impact of the Project and the developments following the Project on the finances of the governments, particularly in relation to tax revenues.

## 6. TYPES OF SURVEYS NEEDED:

The types of economic surveys and studies required for the above purposes will be the following:

(1) Systematic collection of historical and factual data about the Project region from the available records, relating to land area, topography, geology and soils, hydrology, population, existing land use and crop pattern, land tenures and tenancy, organisation of markets and credit, development of urban centers, trade and industry, communications, government revenues and expenditures, etc.

(2) Field surveys and enquiries in selected villages, urban areas, markets and industries in order to gather comprehensive economic information for purposes of estimating possible economic changes and assessment of results. These surveys may be classified as follows:

(a) Village surveys covering both agricultural and non-agricultural activities, landholdings and fragmentation, output, income and employment, indebtedness, investment, consumption habits, etc.

(b) farm surveys (including the study of model or experimental farms set up for the purpose) for the study of farm-size, costs of cultivation, crop-rotation, agricultural practices etc.

(c) urban area surveys including survey of cottage and small-scale industries (selected important trading and industrial centres, railway stations and semi-urban areas likely to develop rapidly as trading or industrial centres).

(d) marketing surveys (of the principal food and commercial crops).

(e) employment surveys (with particular reference to the work centres of the project).

#### 7. TIME AND OTHER ASPECTS OF THE SURVEYS:

As regards the time aspect of the above surveys we have to distinguish three stages of development of the Project, i.e., the construction stage, the transition stage and the mature stage. The construction stage is spread over nine years and it is essential that different kinds of investigations should commence during this stage. Employment surveys have to be commenced at the earliest time as the work on the Project has already been taken up. The investigation of the employment problem under the Bakranangal Project by the Delhi School of Economics, and Dr. D.L. Narayana's study of the problems of labour organisation under the Machkund Tydel Project (to be shortly published by the Andhra University) will be found very useful in the connection. Reports on employment and labour ~~and~~ surveys are to be made available even as the construction work is going on. Village and farm surveys ~~are~~ have of

course to be given the top priority. Reports based on these surveys, dealing with the existing economic conditions, estimates of investment which the cultivators have to undertake, changes in crop pattern, production, etc. and the organization of complementary resources, have to be made available before the Project is completed. It will be also necessary to get reports of studies on the marketing of principal commodities and industrial potentialities in the region. The construction stage of the project is thus a crucial one both from the point of view of engineering and that of economic investigation.

The transition stage is spread over six years again after the construction of the project is completed, and during this stage the process of conversion of dry cultivation to wet cultivation, land reclamation etc. will go on. It will become necessary for some of the village and farm surveys mentioned above to be repeated for limited purposes during this stage, i.e., for the study of transitional problems. During the mature stage, when the new resources of water and power are fully utilised, the surveys have to be repeated again for an overall assessment of the results.

Further, as regards the selection of villages and farms for purposes of survey, due attention must be paid to the problem of proper stratification of the whole region or population. For instance, in the selection of villages or groups of villages the following five categories may be considered. (1) Villages growing Virginia tobacco as a predominant crop, (2) villages growing other commercial crops like groundnut, chillies and cotton as predominant crops, (3) villages growing predominantly other <sup>dry</sup> ~~by~~ crops, (4) villages having wet cultivation under non-canal sources of water, (5) and villages which lie within the project region or in the adjacent region but in which dry cultivation will continue.

With regard to the selection of farms for the study of farm-size, costs, output, and incomes, and agricultural practices, due attention must be similarly paid to the important dry and irrigated crops that are now raised in the Project region. Details of design of

sample surveys will have to be worked out carefully with the assistance of competent economists and statisticians.

### 8. ORGANIZATION AND COST OF THE SURVEYS:

The organization of the economic surveys and studies suggested above will be an enormous and responsible task. It would be necessary to entrust it to a body of experienced and competent persons. The cost of the whole scheme would come to a few lakhs of rupees; but, the surveys would be absolutely worth while undertaking. A tentative and rough estimate of the cost of surveys during the construction stage, covering a total period of three years, can be given as follows:

1. Head-quarters organization (staff and office expenses, at Rs. 2,500 per month, for three years)	...	Rs. 72,000
2. Village and farm surveys - (field survey with five Research Officers for the five districts, and five investigators to cover about 200 villages in two years, including travelling expenses of officers and Directors.)	...	Rs. 2,00,000
3. Employment surveys (for two years confined to the work centres)	...	Rs. 50,000
4. Tabulation, Analysis and preparation of Reports	...	Rs. 1,50,000
		Rs. 4,72,000

Repeat surveys may cost about Rs. 1½ lakhs during the transition stage and about 2½ lakhs during the mature stage. The cost of survey of an urban area may be placed at an average figure of Rs. 25,000, and if ten centres are selected for survey in the construction stage or in the transition stage, the total cost would be Rs. 2,50,000. The cost of repeat survey of the selected urban areas may be placed at Rs. 1,50,000.

ANDHRA UNIVERSITY,  
WALTAIR,  
D/24th Sept. 1956.

Sd. B. SARVESWARA RAO,  
HEAD OF THE DEPARTMENT OF ECONOMICS

## APPENDIX - II

### METHODS OF EVALUATING FARM ASSETS, OUTPUTS AND INPUTS, AND ESTIMATING COSTS

#### A. Evaluation of Farm assets:

1. Farm lands: : Self cultivated lands have been evaluated at the rates prevalent in the village at the time of enquiry, taking into account the individual differences with regard to type of soil, distance from village, source of irrigation available etc.,
2. Dwelling houses, cattle sheds, storage sheds, wells etc., : These have been evaluated at the market prices prevailing at the time of enquiry.
3. Implements and Machinery: : Evaluated at market <sup>prices</sup> ~~value~~ prevailing at the time of enquiry.
4. Live-stock : Evaluated at market price. Even if the age of the animal exceeds 13 years the prevailing market value of the animal at the time of enquiry is taken.

#### B. Evaluation of farm output:

1. Crops: : Both main products and by-products have been evaluated at the prevailing prices at the time of harvest.
2. Fodders other than crops : Fodders have been evaluated at the rates prevailing in the villages.
3. Milk : Valued at current prices prevailing in the village.

#### C. Evaluation of Farm inputs :

##### 1. Human Labour:

- a. Casual hired labour: Actual amounts paid in cash and/or value of kind payments evaluated at harvest prices.
- b. Permanent hired labour (Annual servant) : Actual amounts paid in cash and/or the value of payments made in kind estimated at the harvest prices has been taken to be the total wage paid to the servant. Payments in kind include meals, clothes, chappals etc., consumption of food grain (Paddy) has been estimated at 6 maunds per meal per year, and evaluated at harvest price.

: 100:

As regards the other perquisites like clothes, chappals, etc., amounts actually incurred on these things have been taken. The wage rate per annual servant per labour-day is arrived at by dividing the total wages paid to the servant in cash and/ or kind by the total number of 8 hr. working days, irrespective of type of work. The wage rates for servant mainly engaged ~~employed for~~ in crop production and mainly employed for live-stock maintenance have been calculated.

c) Family labour:

i) Men

: The cost of labour days has been evaluated at the village average wage rate for annual servants. ~~For wage rates refer Appendix.~~

(ii) Women & Children

: Wage rates prevailing in the village for hired women and children (Casual labour) have been used for family labour.

d) Exchange or Gratis labour:

: Evaluated at family labour rates.

e) Supervision:

: Supervision charges have not been included:

Conversion

: All human labour hours have been converted into man-hours on the basis of following ratios.

One woman hour =  $\frac{4}{5}$  man-hour  
One child hour =  $\frac{1}{2}$  man-hour

The above ratios have been arrived at on the basis of average rates during the year. All man hours have again been converted into man-days (8 man-hours = 1 man-day).

2) Bullock labour:

(a). Hired Bullock labour: Actual amount paid-out for hiring in bullocks in cash and or the value of kind payments estimated at harvest prices.

(b) Owned bullock labour: Bullock labour includes work done by all draught cattle. The cost of maintenance of bullocks includes the following items:

- (i) Cost of green and dry fodders;
- (ii) Cost of concentrates;
- (iii) Depreciation and interest on the value of animals;
- iv) Depreciation and interest on the value of cattle sheds;
- v) Shoeing veterinary ~~charges~~ charges, repairs;
- vi) Upkeep labour charges.



Receipts:

- i) Value of farm yard manure including dung is estimated at the prevailing village price.
- ii) Amount received for hiring/out bullocks.

Net cost of maintenance:

Total cost of maintenance minus receipts.

The cost of Bullock pair labour days is arrived at by dividing the total net cost of maintenance per pair in the year by total number of 8 hour work days of a bullock pair in the year.

- 3) Seed : For crops which are generally transplanted with seedlings such as paddy, tobacco etc., the cost of raising seedlings is taken into account. For other crops which are sown with seed, actual cost of seed if purchased, or the value estimated at the village price at the time of sowing, if home produced.
- 4) (a) Depreciation on Farm Buildings: : Evaluated <sup>at</sup> 5 per cent in the case of kuccha and 2 per cent in the case of pucca buildings per year.
- (b) Depreciation on implements and machinery excluding irrigation equipment. : Depreciation according to expected life of the implement plus cost of repairs if less than Rs.10/- depreciation on added value of implement if cost repair exceeds Rs.10/- plus rent paid for hiring in implements, minus rent received for hired-out implements, if any.
- 5) Irrigation charges:
  - i) Depreciation on irrigation implements and wells according to principles cited above.
  - ii) Working expenses such as fuel, oil, engine oil, lubricants etc.,
  - iii) Hire paid for using water from other sources.
- 6) Manures and fertilisers: : Under this head the following items are included:
  - i. Home produced farm yard manure has been valued at market price prevailing in the village.
  - ii. Actual cost of purchased farm yard manure and fertilisers.
- 7) Land Revenue, Cesses and Water rates: This item includes the land revenue and water rates for irrigated crops and special taxes for certain crops paid to the Government.

- 8) Rental value of owned land : The rent has been estimated for the land owned by the cultivators on the basis of prevalent rents in the ~~lands~~ *village for similar lands.*
- 9) Interest on Fixed capital: Interest on agricultural assets excluding land have been calculated at 3 per cent per annum in all cases.
- 10) Miscellaneous: : Miscellaneous items include items which have not been included under any of the above heads.

D. Estimation of cost of production of individual crops:

1) Human Labour:

- (a) Casual hired labour: Actual amount paid for hired labour in cash and/or kind for different crops.
- (b) Permanent hired labour (annual servant) : In proportion to labour-days put in for different crops.
- (c) Family labour:
- (i) Men: : In proportion to days of labour put in for different crops.
- (ii) Women & Children: : Actual labour days evaluated at wage rates prevalent in the village.
- (iii) Exchange or Gratis labour: : In proportion to labour days put in and evaluated at family labour days rates.

(2) Bullock Labour:

- (a) Hired Bullocklabour: Actual amount paid for hiring bullocks utilised for different crops.
- (b) Owned Bullock Labour: In proportion to Bullock pair labour days utilised for different crops.

- (3) ~~xxx~~ Seed : Cost of seed used or cost of seedlings raised.

(4) Depreciation:

- (a) Depreciation on Farm Buildings: : In proportion to acreage under the crop. In the case when it is used for only a certain crop the whole amount has been debited to the concerned crop.

- 4(b) Depreciation on implements and Machinery excluding irrigation equipment: : <sup>to</sup> Proportion to bullock pair labour days put in for different crops if they are bullock drawn implements. With regard to specific implements the ~~cost~~ <sup>amount</sup> has been debited to the crop for which they have been used.
- 5) Irrigation charges : In proportion to irrigation days for crops which require irrigation by the help of implements.
- 6) Manures and fertilisers : Values of quantities applied for different crops. Residual effect have been ignored.
- 7) Rent Paid : Proportional to acreage under the crop to total cropped area of each fragment of leased-in lands.
- 8) Rental value : Proportional to acreage under the crop to total cropped area of each fragment of owned land.
- 9) Land Revenue : Proportional to acreage under the crop to total cropped area in each fragment.
- 10) Interest on fixed capital (excluding ~~on~~ land) : Proportional <sup>to</sup> acreage under the crops to total cropped area.
- 11) Miscellaneous : Actual amounts spent for different crops.
- 12) Cost of Fuel for flue-curing tobacco : This is only for tobacco crop.
- 13) Special taxes and cesses: : Respective crops.

E. Estimating cost of Maintenance of cattle (Draught, milch, and other cattle)

1. Fodders : Fodders jointly fed to the total live-stock have been allocated to different cattle on the following basis:
- (i) Bullock, cow, Buffalo, above 2 years in age : One adult animal unit
- (ii) Youngstock between 1 & 2 years in age :  $\frac{1}{2}$  adult animal unit
- (iii) Young-stock below one year :  $\frac{1}{4}$  adult animal unit.

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- 2) Concentrates : Costs of actual amounts fed to different cattle.
- 3) Depreciation on livestock : For the purpose of calculating depreciation on livestock, the life of an animal is assumed to be 13 years in age. Its value has been taken to appreciate during the first three years in the ratio of 1:3:5, constant upto 5 years and depreciated thereafter upto the age of 13 years at the rate of 12½ per cent annum. In a straight line method. If the age of animal exceeds 13 years, no depreciation is accounted for, if the animal died during the year, total remaining value has been debited to the depreciation account.
- 4) Depreciation on cattle sheds: : Calculated at 5 per cent for kaccha sheds and at 2 per cent for puccasheds and has been allocated in proportion to the number of cattle in each category.
- 5) Up-keep labour charges: Allocated in proportion to number of cattle in each category. Family man labour has been evaluated at the wage rate of an annual servant mainly engaged for tending of cattle in the village.
- 6) Interest on cattle sheds: : Apportioned in proportion to number of cattle in each category.
- 7) Interest on the value of live-stock : Calculated at 3 per cent on the value of different categories of cattle separately.
- 8) Ropes, veterinary charges etc., : Actual amounts spent for different categories of cattle.

RECEIPTS:

- i) Farm Yard manures (dung etc.,) : Apportioned on the basis of the ratios adopted for allocating fodders fed jointly.
- ii) Amount received for hiring out : This only occurs in the case of draught cattle.
- 9) Net maintenance cost : Total cost minus income from dung, and amount received for hiring out in the case of draught cattle.

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