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Water management to maximise farm income from irrigated dry crops — A field study in Tamil Nadu*

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सार — इस क्षेत्रीय अध्ययन का उद्देश्य एक ऐसी अनुकूल विधि/प्रयास की खोज करना है जिससे सिंचित शुष्क फसलों से होने वाली कृषि आय को अधिकतम किया जा सके। यह सिंचित शुष्क फसल तमिलनाडु में एक वृहद् सिंचाई प्रणाली के अन्तर्गत एक क्षेत्र में बढ़ाई जाएगी।

यहां सिंचाई के लिये जल की उपलब्धता एक बाधा है। इसलिये जल के इस अत्यल्प संसाधन का प्रभावी उपयोग बहुत आवश्यक है। जल की इस सीमित मात्रा का इच्छानुसार अधिकतम उपयोग इस क्षेत्र के बहुत से निवासियों को लाभान्वित करेगा।

लाभों को अधिकतम सीमा तक बढ़ाने के लिये खेतों के पूर्ण विभव के उपयोग हेतु एक "इष्टतम फसल प्रारूप" का विकास करना परमावश्यक है ताकि अत्यल्प जल संसाधन का प्रभावी उपयोग किया जा सके। एक अनुकूल इष्टतमीकरण तकनीक को अपना कर ही इस, "इष्टतम फसल प्रारूप" का विकास किया जा सकता है। किसी भी इष्टतमीकरण तकनीक को विभिन्न प्रकार की फसलों के लिये संसाधन आवश्यकताओं पर विस्तृत तथा विश्वसनीय जानकारी की आवश्यकता होती है। इस अध्ययन के लिये यह आधारभूत जानकारी आमतौर पर उपलब्ध नहीं होती और इसे प्राप्त करना भी बहुत मुश्किल है। इन सीमाओं के बावजूद एक "इष्टतम फसल प्रारूप" का विकास करने का एक प्रयास किया गया है।

अध्ययन के उद्देश्य को ध्यान में रखते हुए "रैखिक प्रोग्रामन" को एक इष्टतमीकरण तकनीक के रूप में चुना गया है तथा अपनाया गया है सिंचाई प्रणाली से पानी सामान्यतः वर्ष में केवल एक ही फसल, खरीफ या रबी के मौसम में, के लिये दिया जाता है। इसलिये फसल प्रारूप के विकास के लिये वार्षिक फसल गतिविधियों पर विचार किया गया है।

निदर्श में सम्मिलित संसाधन संबंधी बाधाएं इस प्रकार हैं: भूमि, जल (भूमिगत तथा सतही), कार्यरत पूंजी तथा कृषि-मजदूरी जिन सम्भावित फसल विकल्पों पर विचार किया गया है, वे संख्या में बहुत अधिक है तथा इस प्रकार समस्याओं के समाधान हेतु और एक इष्टतम समाधान पर पहुंचने के लिये कम्प्यूटर का उपयोग आवश्यक हो जाता है।

प्रारंभिक इष्टतम समाधानों ने "जल तथा मजदूरी" की ओर नियन्त्रक संसाधनों के रुप में संकेत दिया है जो भूमि संसाधनों (जिनका उपयोग इस प्रणाली में अनिवार्य होता है) के पूर्ण उपयोग में बाधा पहुंचाते हैं। जल एवं मजदूरी की उपलब्धता को (उसकी कुल उपलब्धता तथा अतिरिक्त मात्रा के लिये सम्भाव्य संचालन के भीतर ही) आवश्यकतानुसार संशोधित किया गया था ताकि सिंचाई के दौर में अधिक से अधिक क्षेत्र में फसल लगाई जा सके और संशोधित इष्टतम समाधान प्राप्त किए जा सकें।

किसानों से पूछने से पता चला कि फसल संबंधी उनकी वरीयताएं नवविकसित 'इष्टतम फसल प्रारुप' की वरीयताओं से भिन्न हैं। इससे कार्यान्वियन संबंधी कुछ समस्याएं उठ सकती हैं। संसाधन उपलब्धता तथा आवश्यकताओं के विषय में अधिक विस्तृत सूचना सहित इसमें उनके विभिन्न फसलों संबंधी दृष्टिकोण एवं व्यवहार के अध्ययन की आवश्यकता है।

ABSTRACT. The field study is to evolve a suitable method/approach to 'maximise farm income' from irrigated dry crops that could be raised in an area under a Major Irrigation System in Tamil Nadu.

Availability of water for irrigation is a constraint here. Effective utilisation of this scarce resource is therefore essential. Optimal utilisation of this limited quantity of water will enable to spread the benefits to a larger group of people of the region.

Developing an 'optimal crop pattern' to achieve effective utilisation of the scarce resources is a pre-requisite to tap the full potential of the farm's for maximising the benefits. Evolving this optimal crop pattern' is possible only with the adoption of a suitable optimization technique. Any optimization technique requires detailed and reliable information on resource requirements of different crop types. These basic information is not generally available for this study and is also difficult to acquire. With this limitation an attempt had been made here to evolve an 'optimal crop pattern'.

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Considering the objectives of the study 'Linear Programming' had been chosen as the optimization technique and adopted. 'Annual Crop Activities' were considered for developing the crop pattern since water from the irrigation system is generally allowed for one crop only in a year either in kharif or in rabi season.

The resource constraints included in the model are : Land, Water (both ground and surface), Working capital and agricultural labour. The possible crop alternatives handled are large in number and hence warrented the use of computer to solve the problems and arrive at optimal solutions.

Preliminary optimal solutions indicated 'water and labour' as the controlling resources restricting the full utilisation of the land resource which is mandatory under this irrigation system. Availability of water and labour had been suitably modified (within the total availability and possible mobilisation for additional quantities) as to cover the maximum area with crops during an irrigation spell and revised optimal solutions obtained. The optimal solution with maximum benefit is recommended for implementation.

Field enquiry with the farmers had indicated that their crop preferences are different from that of the 'optimal crop pattern' evolved which is likely to result in some implementation problems. This requires the study of their attitudes and behaviours on crop varieties, with more detailed information on the resource availability and requirements.

1. Introduction

The objective of this field study is to evolve a mathematical model for designing a suitable cropping pattern, not only to efficiently use the irrigation water resources available in the area, but also to maximise the farmer's income.

The study area covers about 400 hectares and forms part of the major irrigation command under "Parambikulam Aliyar Project" in Coimbatore district of Tamil Nadu. The project works have been mostly completed by 1970 and the system is in operation since then. It covers an area of about 1.0 lakh hectares and provides assured irrigation water supplies for raising irrigated dry crops.

The study area has been chosen as a "sample area" from the brown soil region, which accounts for a major portion of the project command (more than 50%). This area is served by a suitable water distribution network, *viz.*, a distributory* taking off from main canal and number of water courses**. The entire canal system upto 10-20 hectares block is lined with cement concrete to reduce the percolation losses to a minimum.

Prior to the project, only rain-fed dry crops were cultivated in the command area. Irrigated dry crops *viz.*, Cotton, Sorgham, Groundnut etc have been raised in the Garden lands developed adjoining the valleys. This constitutes only a very small percentage of the total command area.

However, after the advent of the irrigation project, irrigated dry crops are being raised in the uplands also. Few shallow dug wells fitted with electrically operated pump sets are also functioning in the study area, with more concentration in the valleys. These wells are mostly owned by the big farmers. With the functioning of the irrigation project, more number of shallow wells (upto 30 metre) have been dug by the farmers including medium and small farmers, taking advantage of the increase in the ground watertable year after year, consequent to the use of surface water from the irrigation system for raising crops.

Due to the limitations in the availability of surface water supplies and with the Government's policy to extend the benefits to more area, only irrigated dry crops are allowed to be raised in the command area. Growing of paddy is however permitted only in the valleys which are likely to be affected by seepage from upland irrigation.

As per the design of the irrigation project, assured water supplies for irrigation are to be made available for "one spell of 4½ months in a year", for raising dry crops only. Since the catchment areas of the reservoirs are receiving a major portion of the normal annual rainfall during southeast monsoon, water for irrigation is being made available during the period June-July to March-April in two spells. Therefore, the area may get water supply either in kharif or in rabi based on a tentative turn system of water distribution being followed now.

The aim of this study is, therefore, restricted to the better use of irrigation water and maximize the farm-income, once "assured water supply" is made available at the "head of the distribution channel" which serves the study area.

2. Soil suitability

Based on the pre-project soil survey, the project command area has been classified broadly as :

Red soil area	32,000	hectares
Black soil area	11,000	,,
Brown soil area	57,000	,,
Total	1,00,000	,,

* Distributory - Channels benefiting area upto 1600 hectare.

** Water Courses - Channels branch off from Distributories to benefit area up to 60 hectare.

The study area is a sample area from the brown soil region of the command. Since the rainfall in this area is much lower than that of occurring in red soil region, the summers are extremely hot. The parent material is formed from granites and gneisses which are more basic in composition than that obtaining in red soil region.

The soil structure of the brown soil is described below:

Depth below ground level	*Description of the soil*
0-15 cm	Brown to reddish brown, sandy to sandy loam, aggregated loss with broken pieces of quartz and felspar, abrupt boundry.
15-30 cm	Brown sandy loam, friable with big pieces of tuffacious limestone sometimes cemented. Irregular boundry.
Below 30 cm	Bluish green weathered genesis, giving violent effervesance with HCL and veins of white to pale brown tufa layer.

Due to the presence of a limited soil cover (mostly upto 30 cm) and light textureness of the soil only light irrigated crops are recommended. Land development work is emphasised for the better use of the irrigation water supplies.

For the purpose of developing a suitable crop pattern, the land in the study area has been divided into two categories, *viz.*, grade-I and grade-II, based on field inspection and enquiry. Grade-I land is spread over 135 hectares and grade-II land covers 265 hectares.

A 30% reduction in the yield for different crops has been effected to arrive at the net-income from crops raised in grade-II lands. The working expenses to raise different crops and the requirement of other resources (except water) have been kept the same for both the grade of lands. In the case of grade-II lands 50% more water consumption is assumed.

3. Water availability

The quantity of water that would be allocated from the project system to the study area for raising crops is known. Data on the availability of ground water is not available. Since quite a good number of wells are operating in the area pumping ground water for raising crops, it is essential to take into consideration, the use of ground water also in developing a "suitable crop pattern". The problem of quantifying the ground water consumption has been over come by making use of the information on "monthly power consumption" by each of the pumpset operating in the area, available with the Tamilnadu Electricity Board and indirectly computing the quantity of water pumped out. The average monthly groundwater consumption have been estimated considering the data for the period 1968-78.

4. Crop water requirement

Since no field studies were carried out in the command area to find out the actual crop water requirement for different crops that could be raised, the findings of the studies made in the adjoining areas of the command have been made use of for the purpose of this study.

5. Labour requirement

Agricultural research stations functioning in the Coimbatore district have observed actual labour requirements for different operations involved in raising crops. This information have been used in this study.

6. Labour availability

The study area partially covers two villages only. To estimate the local labour availability for carrying out agricultural operations, the information available from 1971 census have been suitably updated.

7. Cost of production and credit facilities

A field enquiry has been conducted and approximate cost of producing different irrigated dry crops have been computed. The cost of production is partially met by the farmers from their personal savings (which is considered as Rs. 1250 hectare) and the balance amount is to be received as "short term crop loan" from the village cooperative societies. Crop loans are advanced, according to the nature of the crops to be grown.

An interest rate of 10% on the loan advanced has been considered for arriving at the "net maximum income" from different crops grown in the study area.

8. Evolving a suitable crop pattern

It is proposed to use "Linear Programming Model" to develop the "cropping pattern" which will not only enable to maximise the farm-income but will also allow the efficient use of water that is available for irrigating the crops.

The general L.P. Model is discussed below :

Obj. function

$$\text{Max.} \sum_{i=1}^{p} \sum_{j=1}^{m} \sum_{t=1}^{n} Cijt\ Xijt - rCRP - rCRK - RCRR$$

where,

i=Variety of crops ranging from 1,2,.....l

j=Grade of land ranging from 1,2,.....m

t=Month of the crop period ranging from 1,2,.....n

subject to the following constraints :

(1) *Land constraint*

(*i*) $Xijt \leqslant A_{jt}$ where i represents growing of paddy only for all t.

$$(ii) \quad \sum_{i=1}^{p} Xijt \leqslant \sum_{j=1}^{m} Ajt$$

(*iii*) Since the availability of land for growing crops depends upon the crop period of different variety of crops, this crop seasonal constraint should also be taken into consideration.

For example

$*Xijt_1 = Xijt_2 = Xijt_3 = Xijt_4$ in case the *i*th crop grown over *j*th grade land is paddy or ragi.

$*Xijt_1 = Xijt_2 = Xijt_3 = Xijt_4 = X_ijt_5 = Xij_{t6} = Xijt_7$ in case the *i*th crop grown over *j*th grade land is cotton. However, to avoid high computer time in solving number of equality constraints while formulating the specific problem only one nomenclature may be used for all the crop periods.

(2) *Water constraint*

Ground and surface water for irrigation

$$(i) \sum_{i=1}^{l} \sum_{j=1}^{m} Wijt\ Xijt \leqslant W\text{t} \quad \text{for all } t$$

$$(ii)\ Wt \leqslant Wst + WGt \quad \text{for all } t$$

$$(iii)\ Wst \leqslant Dc \quad \text{for all } t$$

$$(iv) \sum Wst \leqslant Ws$$

$$(v) \sum_{t \epsilon k}^{t \epsilon k} Wst \leqslant 0$$

$$(vi) \sum Wst \leqslant Ws$$

$$(vii) \sum_{t \epsilon R}^{t \epsilon R} Wst \leqslant 0$$

$$(viii) \sum_{t=1}^{n} WGt \leqslant WG \quad \text{for all } t$$

(3) *Working capital*

$$(i) \sum_{i=1}^{l} \sum_{j=1}^{m} \sum_{t \epsilon p} Eijt\ \ Xijt\ \ - CRP \leqslant Sp;$$

$$Sp \sum_{t \epsilon p} St$$

$$(ii) \sum_{i=1}^{l} \sum_{j=1}^{m} \sum_{t \epsilon k} Eijt\ Xijt - CRK \leqslant Sk;$$

$$Sk \sum_{t \epsilon k} St$$

$$(iii) \sum_{t=1}^{l} \sum_{j=1}^{m} \sum_{t \epsilon r} Eijt\ \ Xijt - CRR \leqslant SR;$$

$$SR \sum_{t \epsilon r} St$$

$$(iv)\ CRP \leqslant \text{CAP}$$

$$(v)\ CRK \leqslant CAK$$

$$(vi)\ CRR \leqslant CAR$$

(4) *Labour constraint*

$$(i) \sum_{i=1}^{l} \sum_{j=1}^{m} LRijt\ Xijt \leqslant LAt \quad \text{for all } t$$

and non-negativity constraint
all $X_i \geqslant 0$

where,

(*i*) *Cijt* : Net-income from *i*th crop grown over *j*th grade land during t^{th} month/season.

(*ii*) *Xijt* : area in hectare under *i*th crop gorwn over *j*th grade land during *t*th month/season.

(*iii*) *r* : rate of interest charged on the short term crop loan.

(*iv*) *CRP* : Credit used for crops grown in pre-kharif period.

(*v*) *CRK* : Credit used for crops grown in kharif period.

(*vi*) *CRR* : Credit used for crops grown in rabi period.

(*vii*) *Avj* : The area of all grades of lands available in hectares located adjoining the valley portion of the command area over which paddy only can be grown.

(*viii*) *Ajt* : the area available in *j*th grade land for growing different crops during *t*th month.

(*ix*) *Wijt* : monthly crop water requirement of *i*th crop standing over *j*th grade land during *t*th month. (crop season to be divided into different stages of growth of the crop and crop water requirement for each stage to be computed)

(*x*) *Wt* : total surface and ground water available during *t*th month for irrigating all the standing crops on different grades of land during *t*th month.

(*xi*) *Wst* : total surface water available from the irrigation system for irrigating crops in the region during *t*th month.

(*xii*) *WGt* : total ground water available in the region for irrigating crops during *t*th month.

(*xiii*) *Dc* : maximum monthly water carrying capacity of the canal system-surface water only.

(*xiv*) *Ws* : total quantity of surface water made available for the region from the irrigation system during the irrigation spell which may be either in kharif or in rabi season.

(*xv*) *WG* : annual quantity of available ground water in the region for raising crops during different seasons.

(*xvi*) $t \in k$: time period within kharif season when water from canal system will be available for irrigation.

(*xvii*) $t \in R$: time period within rabi season when water from canal system will be available for irrigation.

(*xviii*) $t \notin k$: time period within kharif season when water from canal system *will not be* available for irrigation.

(*xix*) $t \notin R$: time period within rabi season when water from canal system *will not be* available for irrigation.

(*xx*) *Eijt* : funds required for raising *i*th crop over *j*th grade land during *t*th season.

(*xxi*) *Sp* : amount of personal savings available with the farmers for raising different crops during pre-kharif season.

(*xxii*) *Sk* : amount of personal savings available with the farmers for raising different crops during kharif period.

(*xxiii*) *SR* : amount of personal savings available with the farmers for raising different crops during rabi period.

(*xxiv*) $t \in p$: crop periods within pre-kharif season.

(*xxv*) $t \in k$: crop periods within kharif season.

(*xxvi*) $t \in R$: crop periods within rabi season.

(*xxvii*) *CAP*: funds available as credit for raising crops during pre-kharif season.

(*xxviii*) *CAR* : funds available as credit for raising crops during rabi season.

(*xxix*) *CAK*: funds available as credit for raising crops during kharif season.

(*xxx*) *LRijt*: monthly labour required for growing *i*th crop on *t*th grade land standing during *t*th month.

(*xxxi*) *LAt* : monthly labour available in mandays for raising differents crops in the region during the *t*th month.

The above model takes into consideration the only resources that are in short supply and hence likely to impose restrictions on growing different crops for maximizing the net income from the farms.

For instance though fertilizers and pesticides are very important agricultural inputs necessarily required to increase the crop yield, since sufficient quantity of them are readily available in the region for use, they have not been taken into the model for developing a suitable crop pattern.

However, the impact of the use of fertilizers and pesticides in increasing the crop yield have been taken into consideration while working out the maximum expected yield and its corresponding net income.

The crops that are feasible and considered for developing a suitable crop pattern are

(*i*) Paddy,

(*ii*) Ragi,

(*iii*) Sorghum,

(*iv*) Cotton,

(*v*) Maize, and

(*vi*) Groundnut.

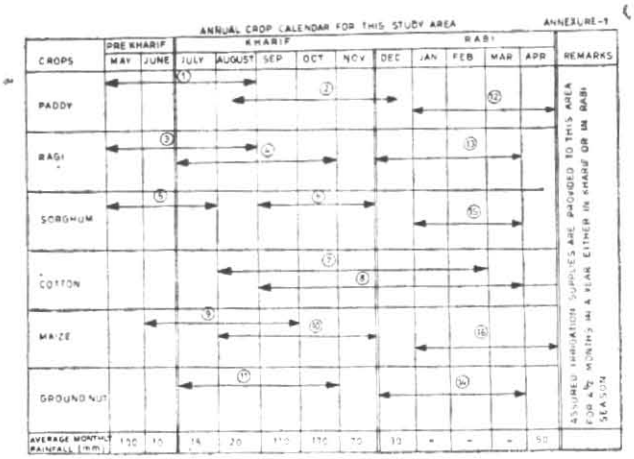
The above crops are currently being grown in the command area under study in varied extent and hence considered for working out an optimal crop mix to maximise farm income.

Since assured irrigation facilities are made available either in kharif or in rabi season only, for the purpose of maximizing the farm income, "annual crop activities" are considered. The annual crop calender developed for this study area is made available *vide* Annexure-I.

9. Out-come of the study

Based on the above general model, the detailed L.P. problem has been formulated and the optimal values have been computed using ICL 1900 Computer package. The resources availability (mainly water and labour) have been varied to arrive at a suitable "crop combination" which maximises the farm income.

The results obtained are tabulated *vide* Table 1 – Table 7 and discussed.



Annexure-I

TABLE 1

Crop Season	Optimal crop mix: Crop	Code	area (ha)	Controlling resource restrictions	Remarks
(A)	Paddy	X011	15	May Ground water	Net annual income
Pre-kharif (May-June)			15	(4% of the command)	Rs.12,57,000
(B)	Paddy	X021	52	Aug & Sep canal water	
Khafif (Canal irrigation spell)	sorgham	X062	13		
(July-November)	Cotton	X071	68		
	Cotton	X072	32		
	Cotton	X081	15	Aug Labour	
	Cotton				
	Groundnut	X112	35		
	Cotton	X082	46		
			261	(65% of the command)	
(C)					
Rabi	Cotton	X071	68	Dec & Jan Ground water	
(No canal irrigation)	Cotton	X072	32		
	Cotton	X081	15		
	Cotton	X082	46		
		X161	37		
			198	(50% of the command)	

Note : *Resources availability* :

Land : (*a*) Grade-I - 135 ha, (b) Grade - II - 265 ha.

Water (*a*) Ground water - Pre-kharif - 2900 units Kharif - 22,000 units, Rabi - 20,000 units.

(*b*) Surface water - from irrigation system.
Month 1 = 15,000 units
Months 2-4 = 12,000 units each
Month 5 = 8,000 units
Total 59,000 units

Capital :

(*a*) personnel savings - Rs. 5,50,000 per crop season

(*b*) Credit available - Rs. 12,00,000

Labour :

12,000 - mandays per month available for all the crop seasons.

* *xij* : where $i = 1,2,\ldots\ldots,$ 16 according to the variety of the crop and

$j = 1$ or 2 according to the grade of land.

TABLE 2

Crop season	Optimal crop mix: Crop	Code	Area (ha)	Controlling resource restrictions	Remarks
A	Ragi	X031	25	June - Ground water	Net annual income
			25	(12% of the command)	Rs. 10,64,000
B	Ragi	X041	53	July, Sep, Oct } Ground water	
	Cotton	X071	19		
(No irrigation spell)	Cotton	X081	51		
	Cotton	X082	47		
			170	(42% of the command)	
C	Paddy	X121	67	Dec, Mar } Labour	
	Paddy	X122	16		
(Canal irrigation spell)	Cotton	X071	19		
	Cotton	X081	51		
	Cotton	X082	47		
	Maize	X162	42		
		Total	242	(60% of the command)	

Note : No change has been made in the resources availability. Water from the canal system is made available only during rabi, and hence crop activities in other seasons fully depend upon the ground water.

TABLE 3

Crop season	Optimal crop mix: Crop	Code	Area (ha)	Controlling resource restrictions	Remarks
A	Paddy	X011	15	May — Ground water	Net annual income
			15	(4% of the command)	Rs. 13,97,000
B	Paddy	X021	52		
	Cotton	X071	68	Canal water fully used	
(Canal irrigation spell)	Cotton	X072	63		
	Cotton	X081	15		
	Cotton	X082	16		
	Groundnut	X112	90		
			304	(75% of the command)	
C	Cotton	X071	68	Dec, Jan } Ground water	
	Cotton	X072	63		
(No irrigation spell)	Cotton	X081	15		
	Cotton	X082	16		
	Maize	X161	52		
			214	(55% of the command)	

Note : *The total quantity of canal water available for irrigation is kept as 60,000 units and the monthly water availability is restricted to the canal carrying capacity of 27,500 units.

*The monthly labour availability has been increased from 12,000 *to* 20,000 *man days.*

TABLE 4

Crop season	Optimal crop mix			Controlling resource restrictions	Remarks
	Crop	Code	Area (ha)		
A	Paddy	X011	15	May—Ground water (4% of the command)	Net annual income Rs. 15,32,638
			15		
B	Paddy	X021	52	Capital fully used.	*this gives the maximum income from the study area.
	Paddy	X022	19		
	Cotton	X071	68	canal water fully used.	
(canal irrigation spell)	Cotton	X072	67		
	Cotton	X081	15	Oct — Labour	
	Groundnut	X112	146		
			367	(92% of the command)	
C	Cotton	X071	68	Dec, Jan } Ground water	
	Cotton	X072	67		
(No irrigation spell)	Cotton	X081	15		
	Ground nut	X142	5		
	Maize	X161	52		
			207	(52% of the command)	

NOTE : *The total quantity of canal water availability has been increased from *60,000 units to 80,000 units* keeping the monthly restriction according to the canal carrying capacity :—

TABLE 5

Crop season	Optimal crop mix			Controlling resource Restrictions	Remarks
	Crop	Code	Area (ha)		
A	Ragi	X031	25	June — Groundwater (6% of the command)	Net annual income Rs. 12,81,206
			25		
B	Ragi	X041	53	July, Sep, Oct } Ground water	
	Cotton	X071	19		
	Cotton	X081	49		
	Cotton	X082	47		
	Ragi	X031	24		
			192	(48% of the command)	
C	Paddy	X121	67	Canal water fully used	
	Paddy	X122	23		
(canal irrigation spell)	Groundnut	X142	97		
	Cotton	X071	19	March — Labour	
	Cotton	X081	49		
	Cotton	X082	47		
			302	(76% of the command)	

Note : Total canal water water availability is kept as 60,000 units and monthly restrictions relaxed, subject to canal carrying capacity.

All the other resources are kept as the same.

TABLE 6

Crop season	Optimal crop mix			Controlling resources restrictions	Remarks
	Crop	Code	Area (ha)		
A	Ragi	X031	25	June – Ground water (6% of the command)	Net annual income is Rs. 10,83,000
			25		
B	Ragi	X031	25	Aug \ Ground Sep / water	
(No canal water)	Paddy	X012	184		
			213	(53% of the command)	
C (canal irrigation) spell)	Paddy	X121	67		
	Paddy	X122	140	Canal water fully used	
	Maize	X161	68		
	Maize	X162	12		
	G. Nut	X142	16		
			303	(76% of the command)	

Note : The only change effected in the resource availability is increasing the canal water availability from *60,000* units to *80,000* units.

TABLE 7

Crops	Area covered during irrigation spells (ha)				Remarks
	Kharif-1	Kharif-2	Rabi-1	Rabi-2	
Paddy	71	75	90	38	Crop season
Sorgham	—	21	—	90	1-designed crop mix
Cotton	150	60	115	58	2-Actual crop mix
G. Nut	146	67	97	11	
Maize	—	—	—	4	
Ragi	—	—	—	7	Kharif max-Table-4
Other crops	—	38	—	45	Rabi max-Table-5
Total	367	261	302	253	

5.1. *Comparison of designed optimal crop mix and actual crop mix*

The area under cotton and groundnut is much more than what is actually being grown in the field using canal water.

A detailed enquiry with the farmers indicate the following preferences :

(1) Only paddy and ground nut is preferred to be grown using canal water. Though *cotton* is an important cash crop being grown in this area, the area under cotton crop is presently restricted to the availability of ground water.

The reasons for this attitude is the belief that canal water does not contain any micro-nutrients just like well water and hence is not suitable for raising any other crop except, paddy and ground nut. Though canal water is found to be free from any injurious salts, (as per the laboratory analysis of the water samples), only well water is preferred for cotton and other crops.

Since every one of the farmers of this area was expressing the same view during my interview with them to examine the validity of their belief, water samples from the canal as well as from a number of randomly selected wells spread over the entire study area have been collected and tested. The results of the analysis indicate that canal water is free from any injurious salts and is quite suitable for raising any crop. Whereas, in the case of well waters, varying degree of injurious salts were found to be present. However, as on date, the total quantity of salts present now is within the tolerable limits. This only indicates that there exists a *psychological fear* in the minds of the farmers of this area regarding the use of canal water for raising different dry crops like cotton etc.

This fear is to overcome by taking up suitable and intensive "Demonstration Farms" in the farmer's fields and also by "intensive extension work".

The next step before we accept the "crop mix" evolved by using L.P. Model to maximise farm income from the study area, is to probe into more details to find out the feasibility of implementing this "crop mix" for adoption.

Since, no detailed informations are available on the "soil suitability" and its productive potential for different crops, further examination of its suitability is to be carried out with more field information on soil characteristics. The other factors, *viz.* price variations, risk involved in raising certain crops like cotton, uncertainities in the assured water supplies for irrigation are to be taken care of with further studies.

In this case, it is proposed to continue the field study with more detailed information before making a final recommendation.

Work has already been started in this direction and detailed soil surveys have been carried out. Based on this, the study area has been classified into nine soil types and its crop production potentials are being assessed.

Further study in this direction is being continued.

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