Original Research Article

Determining optimal solution of short term loan use to maximize net farm return in Jorhat District of Assam

Abstract: The present study of **Determining optimal solution of short term loan use to maximize net farm return in Jorhat District of Assam** was undertaken to examine the possibilities and prospects of increasing net return through optimal allocation of resources under existing financial environment. The study was carried out through collection of data by interview method and linear programming technique was used to develop optimum plans for different farms of the study area. The results of the study brought out that there was a tremendous scope to shift the resource allocation to more revenue generating high value crops. The analysis of the results shows that the farmer's optimal cropping pattern was sugarcane, pea, potato, cauliflower and cabbage in all the farm groups. The operation wise labour use was also increasing significantly in optimal plan. The results showed that in order to obtain an optimum farm credit farm plan, the short term farm credit were used. The optimum farm credit was reached when the net revenue were maximum in all the farm groups. Credit played an important role in increasing net farm return. The effect of credit on income was inversely related with the size of the farm whereas the credit needs were directly related to the farm size.

Keywords: Linear Programming, Optimum allocation, Farm credit

1. INTRODUCTION

Comment [S1]: No citations included in this section.

Despite the focus on industrialization, agriculture remains a dominant sector of the Indian economy both in terms contribution to Gross Domestic Product (GDP) as well as a source of employment to millions across the country. Agriculture plays a vital role in the Indian economy. Over 70 per cent of the rural households depend on agriculture as their principal means of livelihood. Finance in agriculture is as important as other inputs being used in agricultural production. Technical inputs can be purchased and used by farmer only if he has money but in India, one of the major problems facing by small and marginal farmers is poor access to adequate capital. The agrarian Structure of an economy assumes a key part in upgrading agricultural profitability and raising financial proficiency of farm. Agricultural growth and development cannot be achieved against the background of farmer's poor financial position. Good lending principles include that farmers should be given sufficient credit for their needs so as to make

effective use and avoid diversion. It is therefore necessary to answer the question of what is the level of credit need of the farmers. Thus, the need for this study arises because of the conflicting information about the real credit need of small scale farmers in India. The study focuses on describing in detail the existing agrarian structure and determining the economic efficiency of different farms, applying the Linear Programming. Lack of knowledge about the recommended farm practices also has a direct bearing on the efficient utilization of resources. It could be argued that it is not enough to know about the constraints only. It would be useful to know which of the constraints have had binding and limiting effects on the farm efficiency. As regards credit, in most of the cases, it was not in adequate quantity as also not received in time when it was needed. Various techniques for optimization have been developed for making the most efficient use of the available resources. Among these different models, Linear Programming (LP) has been found to be one of the best and simple techniques for optimizing net farm return with limited quantity of land, labour and capital. In the study area it was observed that farmers, who are growing Boro paddy, vegetables, cash crops and commercial crops like Tea, Orange, etc., are more interested for bank loan. But farmers, who are growing mostly Sali paddy, do not feel credit is very important. This is because of the fact that the farmers are using seed of their own stock and rate of seed replacement is very slow. Further, the use of fertilizer and pesticides are also at relatively low dose. Most of the farmers in the study, who have Kisan Credit Card expressed that the limit was insufficient and need to be increased. Under these circumstances, the present study was conducted to derive an optimal solution of short term loan use to maximize net farm return in Jorhat District of Assam**.**

2. METHODOLOGY

The field investigation was started in the second week of March and completed by the middle of May 2016. The data collected pertains to the year 2016. The sampling design followed for the study is three stage random sampling design. Blocks formed the first stage unit, villages were the second and the sample farmers were the third and ultimate stage of units of sampling. A list of the eight development blocks (undivided) in Jorhat district was prepared. From eight development blocks three blocks were purposively selected for the study. Thus, Jorhat North west Development Block, Titabor Development Block and Kaliapani Development Block were selected as first units of sampling. In the next stage, all the villages in the above mentioned three

selected blocks three villages were selected from each block by consulting the respective Block Development Offices. The village thus selected for drawing the sample were:

Table 1. List of blocks and villages selected for sample collection

Blocks	Villages
Jorhat North West Development Block (Dhekorgorah)	Eporia
	Maloukhat
	Baligaon
Kaliapani Development Block	Bamunpukhuri
	Boloma
	Balijan
Titabor Development Block	Bekajan
	Ekorani
	Rajabahar

Comment [S2]: This table was not mentioned in the text.

After selection of villages, the entire household from each villages were listed and thirty household from each selected villages were selected at random. Thus, total 270 households were finally selected for the study. The sample households were stratified in to three size groups, on the basis of their area under cultivation. As only few farmers were found to have more than 3 ha of land hence, the stratification was done as follows:

Group I : Less than 1 ha.
Group II : Between 1 - 2 ha
Group III : Above 2 ha

Table 2. The distribution of sample households according to the stratification

Stratification of sample household	No. of household per groups	Percentage of total sample household
Group I (Less than 1 ha)	119	44
Group II (Between 1 - 2 ha)	110	41

Comment [S3]: This table was not mentioned in the text.

Group III (Above 2 ha)	41	15
Total	**270**	**100**

The study was based on primary data. Primary source were the farmer borrowers. The primary data were collected with the help of pre-tested schedule and questionnaire through personal interview.

The different analytical tools used in the study were as follows:

Linear Programming: The general deterministic Linear Programming model of the study was a gross margin maximization model designed to find out the optimum solutions of short term loan use. Thierauf and Klekamp (1975) described linear programming as term that covers a whole range of mathematical techniques that aim to optimize performance in term of combinations of resources. The algebraic expression of the linear programming model developed for this study with the objective to determine the optimum credit need was expressed as follows:

$$\text{Maximize } Z = \sum_{j=1}^{n} C_j X_j$$

Subject to

$$\sum_{j=1}^{m} a_{ij} X_j \leq b_i \; (j = 1 \ldots m)$$

$$X_j \geq 0$$

Where,

Z: Total net revenue from all the activities

Cj: Net revenue/farm from each activity

aij: Level of inputs

bi: Amount of farm credit available

n: Number of possible activities

m: Number of constraints

Activities of the model:

Activities included in the model were crop activities and borrowing activities.

Crop activities: the crops grown by the farmers of the study area were categorized as *kharif* Crops and *Rabi* crops.

The *kharif* crops are:

X1: Sali Rice

X2: Blackgram

X3: Sugarcane

X4: Ahu Rice

The *rabi* crops included are

X5: Toria

X6: Pea

X7: Potato

X8: Cauliflower

X9: Cabbage

Borrowing activity: This activity was included in the model to meet the capital required for crop production when the farmers do not have adequate owned capital. Though short term borrowing, the farmers can obtain needed capital for crop production.

Resource constraints/ restrictions of the model:

.**1. Land:** The land area was classified according to two crop seasons namely; Kharif and Rabi. In Kharif season the crops like sali rice, blackgram, and sugarcane were grown in the study and in the Rabi season crops like toria, ahu rice, potato, pea, cauliflower and cabbage were considered. Sali Rice is the most important crop in the cropping system. It is largely grown during rainy (*kharif*) season. Other crops cover negligible area in the production system. toria, sugarcane, blackgram, vegetables are commonly grown. After harvest of paddy, most of the land kept fallow during post rainy (*Rabi*) season.

2. Labour: Two sources of labour open to the farmer are considered in this study, namely: human labour and animal labour. Human labour is of two types; one is the family farm labour which includes the sum of man-days a farm family can directly engage in farm operations, and the other is hired labour which the farm operator employs whenever the family farm labour is not enough to meet the man labour needed in farm operations.

3. Capital: The farm operator is generally confronted with two types of capital investments, viz.; owned capital and borrowed capital. The owned capital included cash on hand

or revenue gained from farm return and the borrowed capitals were short term loan or crop loan from credit agencies.

As a constraint, capital/credit constraints was linearly constructed keeping owned capital constant in each category of farms allowing short term borrowing through borrowing activity.

Minimum area constraints:

To ensure inclusion of some non remunerative crops in the optimal plan, minimum area restrictions was put for some of the crops which is shown in tTable 3.

Table 3. Minimum area under nine crops across different farm size groups (Area in ha)

Crops	Minimum area		
	Group I	Group II	Group III
Sali Rice	0.30	0.39	1.13
Blackgram	0.08	0.27	0.32
Sugarcane	0.11	0.32	0.55
Ahu Rice	0.06	0.09	0.29
Toria	0.04	0.26	0.25
Pea	0.09	0.13	0.14
Potato	0.05	0.13	0.22
Cauliflower	0.05	0.05	0.23
Cabbage	0.07	0.05	0.15

Existing cropping pattern in the study area

The existing cropping pattern across different farm size groups in the study area was presented in Ttable 4. It was observed from the table that sali rice dominated the cropping pattern occupying 39.22 per cent area in the study area. The share of Sali rice in the gross cropped area varied from 36.59 per cent in Group II to 46.91 per cent in Group I. Sali rice is largely grown during rainy (Kharif) season. Besides rice, black gram occupied 19.36 per cent of gross cropped area followed by Ahu rice (11.21 per cent) and sugarcane (6.58 per cent) as kharif season crops. Similar trend was also observed across the farm size groups. Among the rabi season crops, highest share in gross cropped area was occupied by toria (11.21 per cent) followed by potato (4.97 per cent), cauliflower (3.73 per cent), cabbage (3.62 per cent) and pea (2.76 per cent). After harvest of paddy, most of the land kept fallow during post rainy (*Rabi*) season. Although some crops like Pea and *Rabi* vegetables are grown in the post rainy season but

their area was not catching up. The most pre dominant cropping pattern followed by the farmers in the study area is Rice + fallow, Rice + Toria, Rice + Pea and Sugarcane as sole crop. The cropping intensities of Group I, Group II and Group III were 147.14 per cent, 147.29 per cent and 149.11 per cent respectively.

Existing labour utilization pattern in the study area

Labour utilization pattern in the existing production plan across different farm groups presented in T~~t~~able 5. Existing labour utilization was found to vary between 165.84 mandays in Group I to 201.39 mandays in Group III with an average of 183.74 mandays. Operation wise breakup of labour utilization revealed that labour intensive operations were transplanting (24.70 per cent), post harvest operations (22.36 per cent), intercultural operations (12.31 per cent) and land preparation (10.64 per cent) respectively. Operation wise labour utilization was more or less similar in all the farm size groups.

Existing capital and credit utilization pattern across different farm groups

Table 6 showed the existing capital and credit utilization pattern across various farm sizes. The capital used in the production programme were owned capital and crop loan or short term loan borrowed from different credit agencies. The share of borrowed capital to the total capital used was significant in case of Group I (80.88 per cent), it indicates Group I farmers were mainly dependent on borrowed capital for production of crops. On the other hand, nearly 55.42 per cent and 41.89 per cent of capital was borrowed by Group II and Group III farmers respectively for production of crops.

Table 4. Existing cropping pattern across different farm size groups

Crops	**Area (ha)**			
	Group I	**Group II**	**Group III**	**All groups**
Sali Rice	0.38	0.78	1.37	0.69
	(46.91)	(36.45)	(38.59)	(39.22)
Blackgram	0.11	0.49	0.62	0.34
	(13.58)	(22.90)	(17.46)	(19.36)
Sugarcane	0.06	0.17	0.14	0.12

	(7.41)	(7.94)	(3.94)	(6.62)
Ahu Rice	0.06	0.28	0.38	0.20
	(7.41)	(13.08)	(10.70)	(11.21)
Toria	0.08	0.19	0.25	0.15
	(9.87)	(8.88)	(7.04)	(8.52)
Pea	0.03	0.05	0.10	0.05
	(3.70)	(2.34)	(2.82)	(2.76)
Potato	0.03	0.09	0.25	0.09
	(3.70)	(4.21)	(7.04)	(4.97)
Cauliflower	0.03	0.04	0.24	0.07
	(3.70)	(1.87)	(6.76)	(3.73)
Cabbage	0.03	0.05	0.20	0.06
	(3.70)	(2.34)	(5.63)	(3.62)
Gross Cropped Area	0.81 (100.00)	2.14 (100.00)	3.55 (100.00)	1.77 (100.00)
Net Cropped Area	0.55	1.45	2.37	1.19
Cropping Intensity	147.27	147.59	149.11	148.57

Note: Figures in parentheses indicates percentage to gross cropped area

Table 5. Labour Utilization pattern in existing plan across different farm groups

Activities	**Labour (mandays)**			
	Group I	**Group II**	**Group III**	**All groups**
Land preparation	19.81 (11.94)	17.22 (8.76)	25.01 (12.42)	19.54 (10.64)
Manuring and Fertilization	8.55 (5.16)	18.40 (9.36)	14.32 (7.11)	13.44 (7.31)
Transplanting	41.23 (24.86)	48.97 (24.92)	47.87 (23.77)	45.39 (24.70)

Sowing	7.20 (4.34)	17.25 (8.78)	14.27 (7.09)	12.37 (6.73)
Intercultural operation	17.23 (10.39)	27.82 (14.16)	24.25 (12.04)	22.61 (12.31)
Harvesting	30.21 (18.22)	28.71 (14.61)	28.24 (14.02)	29.30 (15.95)
Post harvest operation	41.61 (25.09)	38.15 (19.41)	47.43 (23.55)	41.08 (22.36)
Total	**165.84 (100.00)**	**196.52 (100.00)**	**201.39 (100.00)**	**183.74 (100.00)**

Note: Figures in parentheses indicates percentage to total labour

Table 6. Existing plan showing own capital and short term credit use pattern

(Amount in Rs.)

Particulars	Group I	Group II	Group III	All groups
Owned capital	4981.93 (19.12)	15948.86 (44.58)	30298.78 (58.11)	13294.35 (39.13)
Borrowed capital	21070.44 (80.88)	19824.79 (55.42)	21837.37 (41.89)	20679.41 (60.87)
Total capital	**26052.37 (100.00)**	**35773.65 (100.00)**	**52136.15 (100.00)**	**33973.76 (100.00)**

Note: Figures in parentheses indicates percentage change to total capital

Optimum Cropping Patterns across different farm size

The optimum cropping patterns for the sampled farmers are presented in Table 7. From the table it was found that the in Group I, the area under Sali rice and blackgram and were decreasing by 21.05 per cent and 9.71 per cent respectively in kharif season but the area under Sugarcane was increased by 150 per cent in optimal solution. However the area under ahu rice

was remained same in optimal plan. In Rabi season the area under pea, potato, cauliflower and cabbage were increased by 266.67 per cent, 200.00 per cent, 133.33 per cent and 233.33 per cent respectively but area under toria was decreased by 37.50 per cent in the optimal plan by 33.33 per cent and 25.55 per cent respectively. In case of Group II, the area under sali rice was declined by 10.26 per cent and blackgram and toria by 28.57 per cent respectively but the area under sugarcane increased by 135.00 per cent. In rabi season area under toria was decreased by 21.05 per cent and area under pea, potato, cauliflower and Cabbage increased by 60.00 per cent, 44.44 per cent, 125 per cent and 180.00 per cent respectively in optimal plan. In case of Group III, it showed that the area under sali rice, blackgram, ahu rice were decreasing by 8.76 per cent, 27.42 per cent and 21.05 per cent respectively whereas in rabi season all the rabi crops like toria, pea, potato, cauliflower and cabbage were increased by 12.00 per cent, 70.00 per cent, 40.00 per cent, 29.17 per cent and 25.00 per cent respectively.

From the table, the comparison between existing and optimal pattern at Group I, Group II and Group III farm showed that the area under Sugarcane in kharif season and pea, potato, cabbage and cauliflower were increased substantially in optimal solution but the area under Sali rice and blackgram decreased in all the farm groups. The area under Ahu Rice in Group I was remained same in the optimal cropping pattern. There was a tremendous scope to shift the resource allocation to more revenue generating high value crops. The analysis of the results shows that the farmer's optimal cropping pattern was sugarcane, pea, potato, cauliflower and cabbage in all the farm groups

Optimum labour utilization pattern across different farm groups

Table 8 showed the optimal labour utilization pattern across various farm sizes. From the table it was found the labour utilization was simultaneously increased in all the farm operations in the optimal plan. Average labour use in Group I, Group II and Group III were increased from 165.84 mandays to 195.66 mandays, 196.52 mandays to 212.87 mandays and 201.39 mandays to 246.52 mandays. The operation wise labour use was also increasing significantly in optimal plan. The increase in labour utilization may be due to more area was incorporated in the optimal production plan.

Optimum capital and credit utilization pattern across different farm groups

Table 9 showed the optimal capital and credit utilization pattern across various farm sizes. The results showed that in order to obtain an optimum farm credit farm plan, the short term farm

credit were used. The optimum farm credit was reached when the net revenue were maximum in all the farm groups. That is, an increase in the level of farm credit can no longer bring further improvement on the net revenue. With the existing capital i.e; owned and short term loan net revenue of Rs. 23q641.10, Rs.27396.56 and Rs. 26959.80 in Group I, Group II and Group III respectively were obtained. The major limiting constraints in the model were credit. When the average farm credit was increased by 16.31 per cent in all the farm groups there was increased in net revenue by 23.13 per cent. This goes to confirm that the optimum farm credit for the farm plan is Rs. 23557.37, Rs. 23544.12 and Rs. 26850.33 for Group I, Group II and Group III respectively. It indicated that the farmer's requirement of the farm credit in the study area was not met. One of the major problems confronting Indian farmers is lack of farm planning. This model was designed to assist farmers in getting optimum farm credit as well as planning for adequate use of farm credit. This implies that with the level of resources available in this model which represent the true farm conditions of the farmers, a farm credit of about Rs. 23557.37, Rs. 23544.12 and Rs. 26850.33 in Group I, Group II and Group III respectively would be adequate to meet the extra financial needs on the farm. From the above discussion, it may be noted that credit played an important role in increasing income. Further it was clear that the potentiality of increasing net farm returns through borrowing adequate capital was more on Group I compared to Group II and Group III. This could be due to higher productivity of capital under recommended technology on Group I than on Group II and Group III. These similar findings were reported by Jayashree Handigol and R. A. Yeledhalli (2011), Sharma and Prasad (1971), Singh and Ramanna (1981), Gajanana and Sharma (1990), Sastry and Venkataram (1993) and Deoghare (1997). The optimum farm credit determined for this model was subject to influence by some socio-economic variables such as farm size and credit. Labour and capital for a farmer who meets the resource conditions of the farm model were the major binding constraints in the plan, which implies that farmers cannot increase their production unless they are addressed. Therefore, for farmers to demand for more than the optimum farm credit recommended, they must be ready to increase their hectare of land in order to accommodate the additional labour needed for the production of the farm enterprises. The results of the optimal solution was in line with the study conducted by Abu *et.al* (2001) that credit level was raised to N30, 000.00. The net revenue further increased to N422, 271.27. This shows that the addition of N10, 000.00 farm credit to the former level yielded additional revenue of N27.032.00. S. Osamama *et al.* (2017)

also found that the gross net benefit is increased by an average of 6:44% _ 0:84 during the five years after optimization compared to the existing cropping pattern in Egypt.

Table 7. Optimum cropping pattern of across different farm size

(Area in ha)

Crops	**Existing**	**Optimal**	**% change**	**Existing**	**Optimal**	**% change**	**Existing**	**Optimal**	**% change**
	Group I	**Group I**		**Group II**	**Group II**		**Group II**	**Group II**	
Sali Rice	0.38 (46.91)	0.30 (29.13)	-21.05	0.78 (36.45)	0.70 (28.57)	-10.26	1.37 (38.59)	1.25 (31.02)	-8.76
Blackgram	0.11 (13.58)	0.10 (9.71)	-9.09	0.49 (22.90)	0.35 (14.29)	-28.57	0.62 (17.46)	0.45 (11.17)	-27.42
Sugarcane	0.06 (7.41)	0.15 (14.56)	150.00	0.17 (7.94)	0.40 (16.33)	135.00	0.14 (3.94)	0.67 (16.63)	378.57
Ahu Rice	0.06 (7.41)	0.06 (5.83)	0.00	0.28 (13.08)	0.20 (8.16)	-28.57	0.38 (10.70)	0.30 (7.44)	-21.05
Toria	0.08 (9.87)	0.05 (4.85)	-37.50	0.19 (8.88)	0.28 (11.43)	-21.05	0.25 (7.04)	0.28 (6.95)	12.00
Pea	0.03 (3.70)	0.11 (10.68)	266.67	0.05 (2.34)	0.15 (6.12)	60.00	0.10 (2.82)	0.17 (4.22)	70.00
Potato	0.03 (3.70)	0.09 (8.74)	200.00	0.09 (4.21)	0.20 (8.16)	44.44	0.25 (7.04)	0.35 (8.68)	40.00
Cauliflower	0.03 (3.70)	0.07 (6.80)	133.33	0.04 (1.87)	0.07 (2.86)	125.00	0.24 (6.76)	0.31 (7.69)	29.17
Cabbage	0.03 (3.70)	0.10 (9.71)	233.33	0.05 (2.34)	0.10 (4.08)	180.00	0.20 (5.63)	0.25 (6.20)	25.00
GCA[1]	**0.81 (100.00)**	**1.03 (100.00)**	**27.16**	**2.14 (100.00)**	**2.45 (100.00)**	**4.67**	**3.55 (100.00)**	**4.03 (100.00)**	**13.52**
NCA[2]	**0.55**	**0.55**		**1.45**	**1.45**		**2.37**	**2.37**	
CI[3]	**147.27**	**187.27**	**27.16**	**147.59**	**168.97**	**4.67**	**149.11**	**170.04**	**13.52**

Note:

[1] Gross Cropped Area; [2] Net Cropped Area; [3] Cropping Intensity

Figures in parentheses indicates percentage to gross cropped are

Table 8. Optimal plan showing labour utilization pattern across different farm size

(Figures in Mandays)

Activities	**Existing Plan**			**Optimal Plan**		
	Group I	**Group II**	**Group III**	**Group I**	**Group II**	**Group III**
Land preparation	19.81 (11.94)	17.22 (8.76)	25.01 (12.42)	25.12 (12.84)	21.26 (9.99)	27.29 (11.07)
Manuring and Fertilization	8.55 (5.16)	18.40 (9.36)	14.32 (7.11)	12.41 (6.34)	21.52 (10.11)	19.21 (7.79)
Transplanting	41.23 (24.86)	48.97 (24.92)	47.87 (23.77)	52.33 (26.75	71.41 (33.55)	61.26 (24.85)
Sowing	7.20 (4.34)	17.25 (8.78)	14.27 (7.09)	11.42 (5.84)	16.25 (7.63	17.11 (6.94)
Intercultural operation	17.23 (10.39)	27.82 (14.16)	24.25 (12.04)	27.65 (14.13)	29.44 (13.83)	31.74 (12.88)
Harvesting	30.21 (18.22)	28.71 (14.61)	28.24 (14.02)	29.17 (14.91)	33.58 (15.77)	32.25 (13.08)
Post harvest operation	41.61 (25.09)	38.15 (19.41)	47.43 (23.55)	37.56 (19.20)	19.41 (9.12)	57.66 (23.39)
Total	**165.84 (100.00)**	**196.52 (100.00)**	**201.39 (100.00)**	**195.66 (100.00)**	**212.87 (100.00)**	**246.52 (100.00)**

Note: Figure in parentheses indicates the percentage to total labour

Table 9. Effect of farm credit on net revenue and farm output

Plans	**Level of Farm credit use (Rs.)**				**Net Revenue (Rs.)**			
	Group I	**Group**	**Group**	**All**	**Group I**	**Group**	**Group**	**All Groups**

		II	III	Groups		II	III	
Existing Plan	21070.44	19824.79	21837.37	20679.41	23641.10	27396.56	26959.80	25675.05
Optimal Plan	23557.37	23544.12	26850.33	24052.01	29415.17	33232.76	33652.25	31613.89
% change over existing plan	11.80	18.76	22.96	16.31	24.42	21.30	24.82	23.13

Recommendations

Based on the findings the following policy measures are suggested as means to increase agricultural credit system and efficient use of agricultural credit.

1. Extension unit of Agricultural Development Project should advise farmers on how to use the surplus farm labour resources identified in this study to grow crop with low land requirements in order not to waste them.
2. Banks should provide more credit to farmers with the view to enable them increase production. The credit volume should be large enough to take charge of both production and consumption needs of farmers.

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Comment [S4]: This section needs to be revised according to the Journal format

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Comment [S5]: Revise according to the journal format