Impact of Custom Hiring Centers on Cost, Profitability, and Efficiency in Crop Production in Anantapur District of Andhra Pradesh

ABSTRACT

This study examines the impact of custom hiring centers (CHCs) on agricultural mechanization and productivity of groundnut of cultivation in Anantapur District of Andhra Pradeshin 2021. CHCs, established under the Submission on Agricultural Mechanization (SMAM) scheme, aim to address challenges faced by small-scale farmers in accessing improved machinery. Through farm business analysis, data envelopment analysis (DEA), and binary logistic regression, the study evaluates the adoption of improved farm machinery, changes in costs, profitability, and efficiency in crop production due to CHCs. Utilizing purposive sampling, data was collected from 160 beneficiary and non-beneficiary farmers in villages. Cost concepts were used to compare costs and returns in groundnut cultivation among CHC beneficiaries and non-beneficiaries. Findings indicate that CHC beneficiaries demonstrate lower input costs and higher net returns, signaling improved efficiency and profitability. DEA analysis reveals higher technical, allocative and cost efficiency among beneficiary farms compared to non-beneficiary ones. Additionally, binary logistic regression identifies significant factors influencing farmers' decisions to hire machinery from CHCs, including machine labor, net income, hired human labor, irrigation, and yield. Overall, the study underscores the pivotal role of CHCs in enhancing agricultural productivity and efficiency, particularly among small-scale farmers. It suggests that policymakers prioritize expanding CHCs and promoting mechanization to further improve agricultural outcomes and address challenges faced by marginalized farmers.

Keywords: Custom Hiring Centers, Data Envelopment Analysis, Binary logistic Regression, Submission on Agricultural Mechanization, Technical efficiency, Allocative efficiency and Cost efficiency

1. INTRODUCTION

Mechanization has been acknowledged as a pivotal factor in augmenting land productivity by facilitating timely execution ofagricultural tasks, enhancing labor efficiency through reduced exertion, and upgrading the overall quality of farm activities [13]. It leads to savings of approximately 15–20 percent on inputs such as seeds and fertilizers, 20–30 percent on labor and operational time, 5–20 percent on cropping intensity, and 10–15 percent on crop productivity [5].Numerous challenges accompany the adoption of farm mechanization, including economic hurdles like high initial and maintenance costs, inadequate access to institutional credit, exorbitant custom hire charges, escalating production costs, limited availability of service centers, situational constraints such as small and fragmented land holdings, unsuitability of certain machines for various soil types, and technological limitations such as a lack of proficiency in operating machinery and implements [8].

Custom hiring centers (CHCs) serve as crucial facilitators in introducing advanced agricultural machinery to small-scale and marginalized farmers in India, thereby addressing the hurdles associated with mechanization and fostering increased productivity[10]. To promote agricultural mechanization, the Indian government has initiated various schemes and programs such as the Rashtriya Krishi Vikas Yojana (RKVY), the National Food Security Mission (NFSM), and the National Horticulture Mission (NHM). Notably, prior to 2014, the Government of India did not introduce specific schemes or programs for the promotion of agricultural mechanization. However, in the fiscal year 2014-15, the Submission on Agricultural Mechanization (SMAM) was launched to assist small-scale and marginalized farmers by establishing custom hiring centers (CHCs), farm machinery banks (FMBs), and high-tech hubs to facilitate access to farm machinery. The proliferation of CHCs, high-tech hubs, and FMBs at the grassroots level has ensured that small-scale and marginalized farmers have access to modern agricultural machinery for various field operations[9].

The state of Andhra Pradesh has emerged as a frontrunner in establishing CHCs under the SMAM scheme, with Agriculture being the mainstay of the economy of the Ananthapuram district, with 85 percent of the farmers being small and marginal farmers[1]. In light of this backdrop, this study has been undertaken to assess thechanges in cost of operations, profitability and efficiency in crop production due to theadoption of improved farm machinery owing to CHCs in the Anantapur District of Andhra Pradesh.

2. MATERIALS AND METHODS

2.1 Data

Andhra Pradesh state was chosen purposively to study the performance of custom hiring centers established with government support. It is because Andhra Pradesh is the leader in the establishment of CHCs with the highest number of CHCs established under the SMAM scheme. Rayalseema region was selected purposively because most of the farmers belong to small and marginal categories in this region and the objective of the government scheme is to cover small and marginal farmers. Anantpur district from the Rayalseema region was intentionally selected as it is one of the largest districts and most of the farmers are small and marginal farmers. Government subsidy support in establishing CHCs plays an important role in such areas. In the district, 2 taluks were selected randomly namely Anantapur and

Dharmavaram and from each of the selected taluks, 2 clusters of villages, one having formal CHCs established with government support and another without formal CHC and away from the first one so that custom hire services are not available in the villages fromthe formal CHC, were selected. From each of the selectedvillages, 40 farmers were selected randomly. Thus a total sample of 160 constituting 80 CHC farmers and 80 non-beneficiaries farmers were selected. The Primary data was collected using the personal interview method with the aid of a pre-tested schedule designed for the study.

2.2 Farm Business Analysis

Farm business analysis was performed to estimate different costs and returns in crop cultivation on sample farms. For this purpose cost concepts of the Commission on Agricultural Costs and Prices (CACP)[6] were used to estimate profitability and different costs to compare across farm size categories for both the beneficiaries and non-beneficiaries of CHCs to assess the changes due to mechanization through CHCs. The various cost concepts used to analyze the costs and profitability of Groundnut production are discussed below:

Cost Concepts:

- Cost A_1 = Wages of hired labor, cost of input, hired machinery charges, Imputed value of owned machine power, depreciation on implements and farm buildings, land revenue, and interest on working capital.
- Cost A_2 = Cost A_1 + Rent paid for leased in land
- Cost B_1 = Cost A_1 + interest on the value of owned fixed capital (excluding land).
- Cost B_2 = Cost B_1 + rental value of owned land.
- Cost C_1 = Cost B_1 + imputed value of family labour.
- Cost C_2 = Cost B_2 + imputed value of family labour.
- Cost C_3 = Cost C_2 + 10 percent of Cost C_2 accounting for managerial input

Farm Returns

- Farm business income = Gross income – Cost A_1
- Family labour income = Gross income – Cost B_2
- Net income over Cost C_1 = Gross income – Cost C_1
- Net income over Cost C_2 = Gross income – Cost C_2
- Net income over Cost C_3 = Gross income – Cost C_3

2.3 Dataenvelopment analysis approach(DEA):

DEA is anon-parametriclinearprogrammingmethod forevaluatingtheperformanceofasetofpeerentitiescalleddecision-makingunits(DMUs). In this case, the individual farm was considered as a decision-making unit.It measuresthetechnicalefficiencybased onestimatedbest-practiceorefficientfrontierorenvelopmentsurfacemadeupofasetofPareto-efficientDMUs(efficiencyscore=1).Theefficiencyofthefarmswascalculatedaboutthisandtheefficiencyscorew a s

between0and1.Technicalefficiencycorrespondingtoconstantreturnstoscale(CRS)assumptionisknownasOverallTechnicalEfficiency(OTE)whichcapturesefficiencyduetobothmanagerialandscaleeffects.

ConsideringNDMUs,i=1,…, NandassumingthatthereareM outputs andN inputs.Letyiandxi denote,respectively,theoutputandinputvectorsforthei-thDMU.TheK*NinputmatrixXandtheM*NoutputmatrixY,representthedataofallNDMU‟s.

Toestimatethetechnicalefficiency,theenvelopmentformofthelinearprogrammingproblem usingthe dualitywasused as

$$\boldsymbol{min_{\theta,\lambda}\ \theta},$$

$$\boldsymbol{st -\ y_i + Y\lambda \geq\ 0},$$

$$\boldsymbol{\theta x_i - X\lambda \geq 0},$$

$$\boldsymbol{\lambda \geq 0},$$

Where θ is a scalar and λ is an N× 1 vector of constants. The value of θ is the efficiency score for the ith firm[3]. Table 1 shows the description of variables along with their unit of measurement which were used to perform DEA analysis.

Table 1. Description of the input and output variables used in the DEA analysis

S. No.	Variables	Units (per acre)
I	Output variable	
1	Profit	Rupees
II	Input variables	
1	Seed material cost	Rupees
2	Fertilizer cost	Rupees
3	Human labour	Total hours
4	Machine labour	Total hours

2.4Binary Logistic Regression Model

A logit model was used to identify the factors influencing farmers to hire machinery from CHCs. Using the maximum likelihood estimation method, the model predicts the probability of a binary outcome. It deals with situations in which the outcome for a target variable can have only two possible ways. Logistic regression model output helps to identify the factors (Xi) impacting the dependent variable (Y) and also shows the nature of the relationship between dependent variable and explanatory variables.

The logistic function can be represented as,

$$Y=\ln (P_i/1-P_i) = \alpha + \beta_1 X_1 + \ldots + \beta_n X_n + U_i$$

Where Y is the dependent variable that takes value 1 if a farmer hired machinery from CHC and otherwise it takes 0.

α= the constant of the equation;

β= the coefficient of predictor variables

Xi= the predictor variables

U_i =error term

In this particular case,nine (9) independent variables were used as shown in Table 2- The logistic function for this study was thus rendered as

$Y=\ln (P_i/1-P_i) = \alpha + \beta_1$Age + β_2 Education+ β_3 machine labour hours+ β_4Net income + β_5Animal labour hours+ β_6 Human labour hours+β_7 Irrigation+β_8 yield+β_9 total seed cost +U_i

Marginal effects (dy/dx): These reflect the change in probability of Y=1 given a unit change in independent variable X.

Table 2. Description and units of variables used in the models

	Variables	**Units of measurement**
	Dependent variable	
Yi	Whether Farmer is hiring machineries from CHC or not	1=yes,0=no
	Independent variable	
X_1	Age	years
X2	Education	Illiterate=1, Primary=2, Secondary=3, PUC=4, Degree=5
X_3	Machine labour	Hours
X_4	Net income	Rupees
X_5	Animal labour	Hours
X_6	Human labour	Hours
X_7	Irrigation	Yes=1,No=0
X_8	Yield	q/ha
X_9	Seed cost	Total cost

3. RESULTS AND DISCUSSION

3.1 Costs and return in groundnut cultivation on sample farms

Farm business analysis was performed to understand the economics of groundnut production in both the CHC adopted villages and non-adopted villages. The costs and returns over different costs have been estimated and presented in the Table 3 for both the CHC and non-neneficiaries farmers across farm sizecategories. Perusal of the table indicates that all the input cost excepting irrigation and plant protection cost was higher on non-beneficiary farmers in comparison to beneficiary farmers. However, yield was marginally higher by 0.51 percent on beneficiary farms in comparison to Non-Beneficiary farmers.Singh et al.,(2004) also found that state having highest mechanization index incurred lower cost of cultivationper quintal of the wheat crop due to increased yield.

The Cost C2 was 4.8 percent lower on CHC farms as compared to non-beneficiaries faarms on overall basis and also the pattern of beneficiary and non-beneficiary farms in case of cost reduction was similar across farm size categories. The net returns over Cost C_2 of CHC beneficiaries was 20.8 percent more in comparison to non-beneficiaries and the net return over Cost C1of CHC beneficiarieswas 14.73 percent higher than non-beneficiaries.This indicates thatincreased use of farm machinery on beneficiary farms has led to an increase in better use of inputs and hence reduction in the cost of cultivation.Verma (2006) concluded that farm mechanization enhances the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs

Table 3. Costs and returns in groundnut cultivation at beneficiaries and non-beneficiaries of CHC farms (Rs /ha)

Particulars	Beneficiary farmers			Non-beneficiaries farmers			Change over Non-beneficiaries farms (%)
	Marginal	Small	Overall	Marginal	Small	Overall	
Human labour	16720	16480	16600	17507	18327	17917	-6.68
Animal labour	6856	6644	6750	8015	7835	7925	-13.49
Machine labour	15123	17172	16148	20146	21152	21152.5	-28.50
Seed	14800	14450	14625	14910	14790	14850	-0.34
Manures & Fertilizers	5682	5777	5715	5815	6010	5955	-4.58
Irrigation charges	542.5	543.5	543	496	498.5	497.5	9.05
Plant Protection Chemicals	1455.5	1544.5	1500	1411.5	1489.5	1450.5	0.34
Miscellaneous	1435	1621	1528	1538	1553.5	1557.5	-7.87
Cost A_1	60633	59900	60267	65900	65200	65550	-7.50
Cost A_2	61591	60859	61225	66783	66083	66433	-7.29
Cost C_1	67886	67155	67521	73078	72268	72673	-6.59
Cost C_2	82883	80905	81894	88075	86048	87061.5	-4.80
Yield (q)	19.6	19.8	19.7	19.2	19.7	19.5	0.51
Price (Rs/q)	5600	5620	5610	5560	5580	5580	0.36

Gross return	112958	114459	113709	110958	112957	111958	0.89
Farm Business Income	51367	53600	52484	44175	46874	45525	12.83
Family labour Income	34164	38054	36109	28630	31309	29969.5	14.00
Net Returns over C_1	45072	47304	46188	37880	40689	39284.5	14.73
Net Returns over C_2	30075	33554	31814.5	22883	26909	24896	20.80

Source: Compiled from field survey, 2021

3.2 Efficiency in groundnut production across CHC and Non-Beneficiaries farmers

DEA was used to determineefficiency (TE), allocative efficiency (AE) and economic efficiency (EC) in groundnut production for both the CHC farmers and non-CHC farmers and to know the status of efficiency of groundnut farms, farms of both the CHC and non-beneficiaries villages were classified into four categories based on their technical ,allocative and economic efficiency score into (i) Efficient if score is equal to one; (ii) Less efficient if score is more than 0.8 but less than 1; (iii) Moderately efficient if score is more than 0.6 but less than 0.8 and (iv) Inefficient if score less than 0.6. The results are summarized in table 4.A perusal of the table reveals that out of a total of 80 sample farms, 18.8 percent of beneficiaries and 13.8 percent of non-beneficiaries of CHC were technically efficient; 50 percent of beneficiaries and 40 percent of non-beneficiaries were less efficient; 31.2 percent of beneficiaries and 46.2 percent of non-beneficiary were moderately efficient and none of the farms either in CHC or non-beneficiaries villages were technically inefficient. The overall technical efficiency of beneficiaries was high compared to non-beneficiary's farms.Chinnappa et al., (2018) also observed that farmers hiring machineries from private individual were less efficient compared to those hiring machineries from formal custom hire service providers.

Only 2.5 percent of beneficiaries and none of the non-beneficiaries of CHC had an allocative efficiency score 1 . However, 57.5 percent of beneficiaries and 75.0 percent of non-beneficiaries were inefficient in allocating their resources and had an allocative efficiency score of less than 0.6. Overall results convey that allocative inefficiency was ofgreater on non-beneficiary farms of CHC compared to beneficiary farms.

Economic Efficiency was also lower for non-beneficiaries of CHC as compared to beneficiaries, and more than 72.5 percent of farms had cost efficiency scores less than 0.6 and hence inefficient in both cases. Hiremath et al., (2015) also found that the successof CHCs in the district of Raichur has substantially assisted small and marginal farmers to carry out farmscores operations on time at low cost.

Table 4. Distribution of farms (%) according to Technical (TE), Allocative (AE) and Economic efficiency (CE) in groundnut production

Efficiency level	TE	AE	EC

	Beneficiaries	Non-beneficiaries	Beneficiaries	Non-beneficiaries	Beneficiaries	Non-beneficiaries
Efficient (E=1)	18.8	13.8	2.5	0.0	2.5	0.0
Less efficient (E> 0.8 <1)	50.0	40.0	13.8	7.5	11.3	0.0
Moderately efficient (E> 0.6 <0.8)	31.2	46.2	26.2	17.5	13.8	27.5
Inefficient (E <0.6)	0.0	0.0	57.5	75.0	72.5	72.5

Source: Compiled from field survey(N=160), 2021

The above discussion indicates that the technical, allocative and cost efficiency were higheramong farms covered by formal CHC in comparison to farms in villages not covered by formal CHCs. However, these also indicates the existence of ample room for improvement in all the technical, allocativeand cost efficiency in the entire study area irrespective of whether villages are covered by CHC or not. This may be due to low mechanization in the area. In addition to all other efforts, mechanization of farms can play an important role in improving technical efficiency and hence greater emphasis is required on mechanizing the less mechanized farms.

3.3 Factors influencing farmers to hire machinery from CHC

ABinary logit model was used to identify the factors affecting the decision by farmers to choose services from CHC. The results of the logit model presented in the Table 5 show that machine labor, net income, hired human labour, yield and seeds were observed to be significant at 1 percentlevel of understanding of significance while age and irrigation were found to be significant at 5 percent level of significance. The factors like age, machine labor, net income, irrigation and yield were positively related to the participation. The animal labour and seeds were found to negatively influence the farmer’s decision to hire machinery from CHC. The marginal effect of age, machine labour, net income, irrigation and yield had negatively influenced the farmer’s decision to hire machinery from CHC. With increase in age by one year the probability of hiring farm machinery from CHC by the farmer increases by 0.13 percent keeping the other things constant. Similarly, if the farmer wants to increase machine labor hours by 1 hour the probability that farmers will go to hire machinery from CHC increases by 0.09 percent. If farmers want to increase animal labour hours by 1 percent, then the probability to hire machineries by farmers from CHC decreases by 0.00002 percent. To overcome the problem faced by marginal and small farmers in India during the peak season, use of farm machinery will solve the issue.

Table 5.Binary logit estimates for factors influencing farmers to hire machinery from CHC

Parameter	Coefficient	Marginal effect (dy/dx)	Z value	P >|z|
Age(Years)	0.06602**	0.13**	2.07	0.04
Education (Illiterate=1,Primary=2,Secondary=3, PUC=4,Degree=5)	0.2498	0.52	0.77	0.44
Machine labour (Total hrs.)	0.4636***	0.0973***	3.69	0
Net income(Rs/ha)	0.00053***	0.00011***	4.49	0
Animal labour (Total hours)	0.000102	0.0000215	0.44	0.87
Hired human labour (Total hrs.)	-0.05053***	-0.00218***	-3.16	0.002
Irrigation (1=yes,0=no)	1.35005**	0.307**	1.99	0.04
Yield (Qtl/Ha)	1.4897***	0.312***	2.67	0.008
Seeds(Total cost)	-0.000745***	-0.0001***	-3.49	0
Pseudo-R-squared	0.58			
LR chi2(10)	125.72			
Prob> chi2	0			

Note: *** significant at 1% level, ** significant at 5% level

4. CONCLUSION

The study highlights the positive impact of CHCs on agricultural mechanization in Anantapur District, Andhra Pradesh. Beneficiary farmers experienced lower input costs, higher profitability, and greater efficiency compared to non-beneficiaries. Factors such as machine labor, net income, and yield influenced farmers' decisions to hire machinery from CHCs positively. Overall, the findings emphasize the importance of CHCs in promoting mechanization and suggest the need for further expansion to enhance agricultural productivity and sustainability in the region. To further promote agricultural mechanization and the effectiveness of Custom Hiring Centers (CHCs), policymakers should focus on expanding CHC networks, providing financial support and subsidies, offering training programs for farmers, investing in rural infrastructure, promoting information and awareness campaigns, fostering collaboration with the private sector, and implementing robust monitoring and evaluation mechanisms.

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