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A PRAGMATIC STUDY FOR ENHANCING AGRICULTURAL EFFICIENCY THROUGH LABOR FREEDOM

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ABSTRACT
The study aims to explore labor freedom in the agricultural sector for enhancing the efficiency of farming through policy change towards assigning property rights, rental contracts, and better wage-employment options to rural workers. Labor freedom emphasizes land reform and development policy for improving the economic status and capabilities of rural workers. The paper assessed the labor freedom index, weighted through agricultural property rights, labor wage contracts, and rural development policy. Data envelopment analysis is used to assess farm-level efficiency under the framework of Tobit regression for different size-based farm categories. Farm-level information was collected through a primary survey of 336 rural households of an advanced agricultural state in India. The study found a positive association between farm size and intensity of labor freedom, although the extent of freedom differs among farms. Size-specific variation was also observed for allocative efficiency such that marginal and medium-sized farms are more efficient than smaller ones. Tobit regression indicated labor freedom to be positively and significantly related to the efficiency of marginal, small and overall farms with enhancing efficiency of 25, 17 and nearly 20%, respectively; however, estimates of labor freedom insignificantly increased the efficiency of mediums farms, by 4.8%. This result suggests that labor freedom positive and significantly affects the efficiency of farms in general, and marginal and small farms in particular. Of course, the elasticity estimate of enhancing efficiency through labor freedom for medium farmers is found at a lower level.

Contribution/Originality: The study contributes to the existing literature of enhancing efficiency of farms through labor freedom options and opportunities, thereby building capabilities among rural workers. Labor freedom can be enhanced through property rights, wage contracts, and region-specific development policy reform. The study findings will be further used to develop allocative efficiency at the farm-level.

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1. INTRODUCTION

The existing literature on land reform, property rights, and rural wage-employment policy stating allocative inefficiency in the rural labor market found that, the smaller the farm size the higher the labor efficiency and vice-versa (Ahmad, 2003; Bardhan, 1979; Bardhan, 1977; Besley & Burgess, 2000; Green, 1987; Hoque, 1993; Moschini & Hennessy, 2001; Sen, 1981; Taslim, 1990); examples from previous literature introduced rural development and migration policy to minimize rural–urban wage and employment gaps to enhance labor efficiency (Boyer & Hatton, 1997; Deshingkar & Akter, 2009; Li, 1976; Miller, 1966; Renkow, 2003; Rhoda, 1983; Todaro, 1969; Wouterse, 2010). This paper introduces the concept of labor freedom in the agricultural sector to resolve inefficiency issues through assessing the intensity of land reform, wage contracts, labor market reform, off-farm wages, and labor mobility, thereby evaluating its impact on agricultural efficiency. The purpose of labor freedom is to explain building capability among groups of rural laborers (namely, farm-labor, hired, forced, tenants, landlords, migrants, etc.) for enhancing the allocative farm efficiency[1]. Labor freedom is specified to offer better wages and job options to rural workers in the process of economic transformation, thereby deploying resources from one use to another for development and efficiency (Mellor, 2017). Thus, labor freedom involves structural, institutional, and economic changes for enhancing agricultural efficiency (Carraro & Karfakis, 2018).

Labor freedom is an opportunity given to workers for getting better access to the labor market. It offers 'voluntary exchange' to both workers and employers sanctioned by labor laws. The concept of labor freedom is widespread and includes personal freedom, willingness and ability to work, along with legal rights to do so (Baum, 2016). In the rural labor market, land inequality and market imperfections are found due to its monopsonic features and thus there are limited options and opportunities for workers to enhance efficiency (Ezeala-Harrison, 2004). Besides, farm operations are seasonal and usually occur with involuntary job losses. In short, allocative inefficiency exists when an inadequate level of labor is working at a fluctuating wage rate (Benjamin & Brandt, 2002).

Land reform is considered as the first component of labor freedom that redistributes property rights among small and marginal farms for resolving inverse farm size and labor productivity relations; small-sized farms are more efficient in the use of labor resources as they are focused on intensive farming, irrigation improvements, and land quality (Mendola & Simtowe, 2015). Likewise, tenancy reform provides possession of property on lease to 'tenant' laborers (Deininger, Jin, & Nagarajan, 2009) for enhancing the efficiency and incentives to work. Land rental contracts increase labor freedom with larger incentives and bargaining power, thereby giving an opportunity to register in rental contracts (Banerjee, Gertler, & Ghatak, 2002). Land rental activities were enhanced among rural households after the inclusion of tenancy reform in rural China, which allowed farmers to lease out their land (Chari, Liu, Wang, & Wang, 2017). In this way, the reform has provided freedom to 'tenant' laborers to develop their skills and talents. Over a period of time, economic status will improve and tenants will be able to spend more on training, education, and health and, hence, the position of tenants will be upgraded from 'ladders' to 'trained cultivators'. Thus, tenancy reforms identified significant freedoms to rural laborers for earning income and investing in human and physical capital (Tarisayi, 2014).

Next, wage contracts are interlinked transactions or commitments that landlords have made with workers for employment. Minimum wage laws can measure the cost of labor in monetary terms, being suitable for both the skilled and unskilled worker (Eswaran & Kotwal, 1985). Labor wage contracts and minimum wage laws motivate workers to be more liable to contribute their best, and landowners are also bound to pay higher wages, maintaining the consistency for enhancing efficiency of farms (Ezeala-Harrison, 2004). This enables landlords to engage farm labor during the peak season for attaining optimal employment at an efficient wage rate. There is a marked rise found in real wage payments of hired labor in days relative to hours during the recent years of institutional reform (Chari et al., 2017). Thus, reforms positive and significantly have affected rural wages and employment options.

Likewise, rural development policy boosts freedom of labor and efficiency of farms. A favorable development policy opens off-farm jobs for workers and creates opportunities for high rural wages and employment (Lanjouw, Shariff, & Rahut, 2007). Development policy affects the labor mobility of workers within rural to rural and rural to urban areas for better wages and job options; these movements towards efficient regions are considered as an alternative choice of labor (Pingali, 2007). In-migration and out-migration of workers improve labor freedom with greater commuting to nearby residences and, besides, remittances have increased the productive capacity and efficiency of farming (Nonthakot & Villano, 2008). Thus, labor mobility is a tool for balancing the knowledge, skills, and structure of both local and national labor markets facing the productivity challenges of globalized farming (Chand, 2019).

A rural development policy aims to promote investment in technology, agro-based industries, cooperative farming, and infrastructure, thereby providing off-farm job opportunities to farm workers. Such inclusions are benefitable for both residential workers and those from nearby regions. A favorable rural development policy can induce migrant workers to settle for longer in the farm-job-receiving community (Nori & Farinella, 2020). Labor freedom changes migration decisions positively (Agbonlahor & Phillip, 2015), whereas wage rigidities may limit rural labor market stabilizing at an under-employment situation (Bardhan & Mookherjee, 2008). Nevertheless, the high pressures of population, scarcity of land, and insufficient growth of the off-farm sector reduce rural wages (Hossain, 2008). Thus, policy has endorsed labor mobility, commuting and incentive to move for migrant workers by reducing the rural/urban income and employment gaps (Todaro & Smith, 2006).

Subsequently, sociocultural gaps among rural and urban areas diminished (Taylor, 2010) through retrieving options of upgrading abilities, knowledge, and attitudes. The average wage rate for farm wotk improved after implementing a rural employment program[2] analyzing the total factor productivity of labor (Nagaraj, Bantilan,

[1]Allocative efficiency refers to the ability to produce a given level of output using cost-minimizing input ratios. In other words, allocative inefficiency denotes inadequate levels of input showing an ambiguous effect on output and production costs.
[2]After implementation of MGNREGA based on field survey data of the villages of Maharashtra state of India.

Pandey, & Roy, 2016). In developing countries, employment-orientated programs in the agro-based industries have been established at the village level for increasing the income and employment opportunities of the rural laborer. There is a significant positive relation among investment in the growth of agro-processing units and the rural employment. The study of Kumar, Dixit, Kumar, and Singh (2016) examined the impact of agro-processing units on the employment growth rate, taking into account all categories of agro-processing industries in India.

A section of the literature reported positive and significant impact of agricultural productivity and efficiency on rural wages (Kundu, 2016; Nagaraj et al., 2016). In the surplus labor developing countries, rural wages have responded towards productivity and efficiency of the agricultural sector (Hossain, 2008). Rural wages and agricultural efficiency increased due to technical and institutional reforms following rural inventions and investments, thereby improving the marginal productivity of labor (Chamberlin, Jayne, & Sitko, 2020). In this way, wage payments are positively related to labor freedom, labor productivity, and efficiency (Venkatesh, 2013). Thus, higher wage payments and better working conditions engaged labor in crucial farm activities.

The study therefore attempts to explore first a comprehensive framework to measure labor freedom in an empirical perspective. The second objective is to offer an analytical perspective to determine its impact on the allocative efficiency of farms. The remainder of the article is organized as follows. The next section describes the data sources and methodology used to measure labor freedom and efficiency at the farm level. Thereafter, the empirical findings are presented. Conclusions and policy implications are specified in the last section.

2. MATERIALS AND METHODS

2.1. Dataset

The study collected information through a primary survey conducted in the reference year 2020–21 using a multistage stratified sampling technique from different categories of farmers[3]. A total of 336 rural households were surveyed from randomly selected villages in the state of Haryana in India. The cross-sectional data were compiled for estimation of allocative efficiency using the DEA technique. For analyzing the impact of labor freedom on farm efficiency, a qualitative framework was designed for response analysis through measurable indicators from a sample of rural households.

2.2. Area of Research

The northern zone of the state of Haryana was selected for the primary survey as it is one of the most suitable areas for cereal production in India. The major crops being wheat, rice, and sugarcane. Haryana is one of the developed states in regard to agriculture, where the green revolution has increased land productivity, and this state appears to be a technically efficient agricultural system. A recent study by Coventry et al. (2015) revealed that the state achieved significant improvement in agricultural growth, especially in wheat production, since the green revolution. This state is a significant contributor of another staple crop, rice (Sihmar, 2014). Notably, the state in terms of geographical location falls under the category of major agro-climatic zones on the basis of rainfall, terrain, temperature, and soil characteristics, as defined by the Haryana Kisan Ayog (Government of Haryana). The study area covers three randomly selected districts in the northern zone (Figure 1).

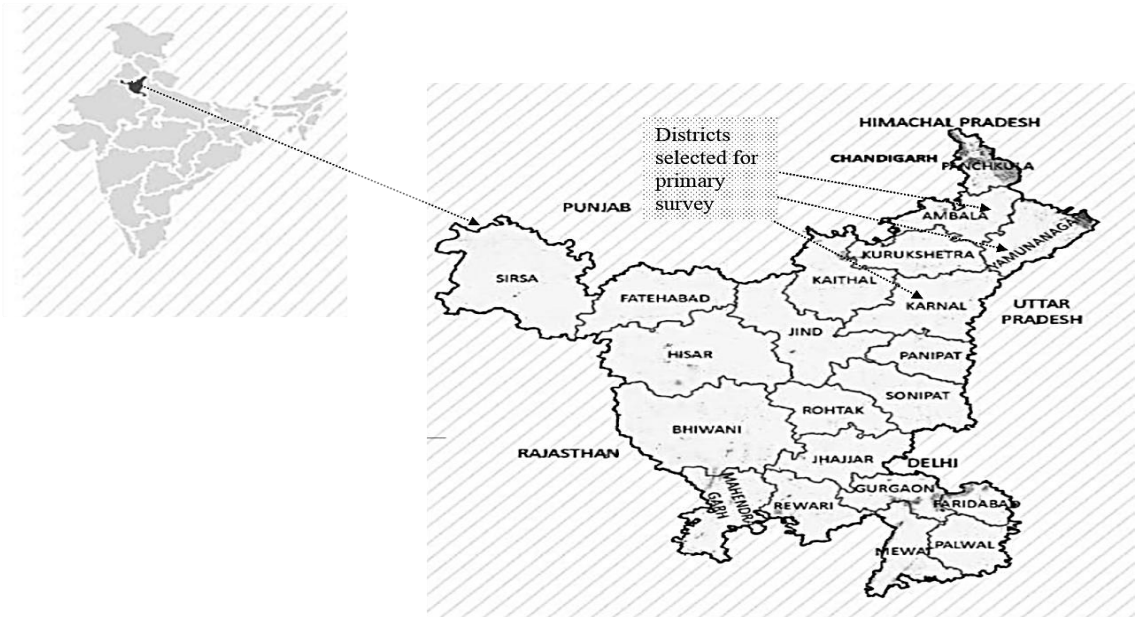

Figure-1. District map of Haryana State, India.

Source: Haryana State Agricultural Policy.

[3] Landless (0 acre), marginal (0 > 2.5 acres), small (2.5 > 5 acres), and medium (5 >10 acres).

2.3. Framework of Assessing Labor Freedom

Labor freedom was assessed through three-dimensional variables, namely agricultural property rights, labor wage contracts, and rural development policy as may be observed in the agricultural sector. The scheduled questionnaire was designed to obtain responses for each of the measurable indicators under those variables on a four-point scale (never, very little, little, and high) ranging from 1 to 4, thereby indicating high or full freedom (4), little or moderate freedom (3), very little or low freedom (2), or never or no freedom (1). The respondents were asked open-ended questions regarding each specific indicator with a discrete choice: yes/no, indicating a negligible freedom score for no (1), if yes, the intensity further evaluates into next three points of the assessment scale. Qualitative scores were then quantified to arrive at a weighted index using the principal component (PCA) framework (see Chart-1).

Chart-1. Indicators and qualitative reviews used to assess labor freedom from respondents.

1. Agricultural property rights:
   - *(a) Land reform:* Whether have benefitted with any piece of land from land reform? If yes, have had larger land before getting from land reform /had little land / had very little land.
   - *(b) Land rental contracts*: Whether have made any kind of legal/formal land registration with the land rental contracts? If yes, have the land rental contracts disregarded the security of tenure / provided the security of tenure / provided the security of tenure and improved the bargaining capacity both.
2. Labor wage policy
   - *(c) Labor wage contracts:* Whether have ever employed on regular/contractual basis in farm job? If yes, has farm job disregarded the security and benefits of real wages / has farm job provided the security / has farm job provided the security and benefits of real wages?
   - *(d) Minimum wage laws*: Whether have ever paid wages as per the minimum wage laws? If yes, have wage payments lesser than the work capacity? /have wage payments equal to the work capacity /have wage payments as per the work capacity and skills?
   - *(e) Labor market reform*: Whether have benefitted with labor market reform? If yes, have these reforms disregarded the working conditions /have reforms provided good working conditions /have reforms provided good working conditions as well improved the wage rate?
3. Rural development policy
   - *(f) Off-farm wage/income:* Whether have ever benefitted with higher wage and employment from off-farm works? If yes, have had wage & employment before getting from off-farm? / Had little wage & employment / had very little wage & employment?
   - *(g) Off-farm job:* Whether have accessed off-farm job easily? If yes, have found lack of complete information about off-farm jobs? / found limited availability / found irregular jobs?
   - *(h) In-migration of labor:* Whether have found in-migration of workers for wage and employment in the rural area? If yes, have had larger wage & employment benefits before in-migration? / had little / had very little?
   - *(i) Out-migration of labor:* Whether have found out-migration of workers for wage and employment from the rural area? If yes, have had facilitated larger commuting? /had facilitated little commuting /had facilitated very little commuting?

2.4. Indexing Approach to Measurement of Labor Freedom

The first principal component is considered to estimate the weight for each indicator of the labor freedom. The principal component technique uses a correlation coefficient between dimension-wise indicators of labor freedom, described as the latent[4] variables, which further depended on other observed variables. Thus, the results are discussed in terms of component scores by transforming the variables and loading of the weights by each standardized original variable multiplied to obtain the average weighted index (Wooldridge, 2015).

For the same, PCA weights (factor loadings l_{ij}) are estimated by dividing the column sum of covariance $\Sigma r_{x_i x_j}$ of each sub-components/indicator to the square root of column sum of covariance $\sqrt{\Sigma\Sigma r_{x_i x_j}}$, i.e.

$$l_{ij} = \frac{\Sigma r_{x_i x_j}}{\sqrt{\Sigma\Sigma r_{x_i x_j}}}$$

Principal component weights (λ) is estimated by adding the square sum of covariance of each indicator, i.e.

$$\lambda = l_1^2 + l_2^2 + l_3^2 + \cdots \ldots \ldots \ldots \ldots \ldots + l_r^2$$

Estimated model to measure labor freedom indices

Labor freedom index $(Lf_i) = \Sigma C_i W_{ri}$, i = observations and r = set of indicators

In the contemporary empirical literature, the principal component method is a widely used approach for extracting the significant determining factor through obtaining PCA weights (factor loadings), solving the problem of multicollinearity and assessing reliability in the field of indices.

[4] These latent variables are called components used in multivariate analysis comprises of a set of techniques dedicated to analyze data with more than one response variable (Abdi, 2003).

2.5. DEA Framework for Allocative Efficiency

Allocative efficiency can be measured using the cost-minimization DEA model (Charnes, Cooper, & Rhodes, 1978) analyzing with multi-input and single-output, constant returns to scale (CRS) input oriented DEA model. The input-oriented model represents the input to be proportionally reduced without changing the quantity of the output produced, following Coelli, Rahman, and Thirtle (2002). Let us assume that there are 'n' decision making units (DMUs) each producing output using 'm' different inputs. A cost minimization linear programming problem is solved for each DMU and for qth DMU is given below:

Objective function: $Min_{\lambda x_q} z_q' x_q^*$ Subject to;

$$\sum_{q=1}^{N} \lambda_q x_{jq} - x_{jq}^* \leq 0,$$

$$\sum_{q=1}^{N} \lambda_q y_{iq} - y_{iq} \geq 0$$

$N1\lambda_q = 1, \lambda_q \geq 0$

where, z_q = vector of unit price of inputs utilized by DMUq, x_q^* = vector of input quantities of DMUq with respect to production cost minimization, y_{iq} = Amount of output i produced by DMUq, x_{jq} = amount of j utilized by DMUq, $N1$ = an Nx1 vector of one, λ = dual variables.

A measure of cost efficiency is the ratio of minimum feasible cost to actual cost, it requires input prices. If the value is unity, then the farmers are cost efficient and if a value is less than unity indicates degrees of cost inefficiency. Input-allocative efficiency is the ratio of the measure of cost efficiency to the measure of input-oriented measure of technical efficiency.

If input prices are $z = (z_1, \ldots, z_n) \in R_{++}^n$ objects to minimize costs,

Minimum cost function is: $c(x_{jq}, z_q') = min_x \{z_q' x_q^* : N1(y_{iq}, x_{jq}) \geq 1\}$

A measure of cost efficiency is the ratio of minimum cost to actual cost: $CE(x, y, z) = \frac{c(z_q' x_q^*)}{z_q' x_q}$

A measure of input-allocative efficiency is: $AE_1(x, y, z) = CE(x, y, z)/TE_1(y, x)$

2.6. Tobit Regression

Tobit regression is a second-stage econometric analysis using DEA efficiency VRS DEA (TE_q^{VRS}) and in the CRS DEA (TE_q^{CRS}) of qth farm regressed against some institutional factors suggested by Tobin (1958). It is used to estimate determinants of agricultural efficiency when the observed dependent variable lies between 0 and 1. Tobit regression is an alternate to the OLS regression estimate and is applied when the dependent variable is bounded with specific positive range, as in DEA allocative efficiency is either 0 or some positive figure from 0 to 1. It is reviewed that the estimation of OLS is inconsistent and inefficient, which is why the Tobit Model is used replacing OLS. The efficiency measurement is censored with the value between 0 and 1 known as censored regression to analyze the role of farm-specific factors in determining efficiency in the cultivation of crops, first analyzed in the econometric literature by Maddala and Lahiri (2009).

In this study, the two-limit Tobit model is used with a random effect assuming that the farm-specific individual effect of identified factors is not correlated with the observed experimental variables. The empirical Tobit model for ith observation is given as:

$$y_i^* = \beta_m \Sigma x_{im}' + \epsilon_i, \qquad i = 1, 2, 3, \ldots .252$$

Where, y_i^* = latent variable representing DEA allocative efficiency of farm i used as a dependent variable in the model, ϵ_i/x_i is $N(0, \sigma_0^2)$. $\{y_i, x_i\}(i = 1, 2, \ldots n)$, β_m is the vector of independent variables (m =1, 2…..k) and are known parameters associated with farm-specific factors. ϵ_i is normally distributed error term with zero mean and constant variance $\epsilon_i \sim N(0, \sigma_0^2)$. y_i is observed variable,

$y_i = 1$, if $y_i^* \geq 1$

$y_i = y_i^*$, if $0 < y_i^* < 1$

$y_i = 0$, if $y_i^* \leq 0$

Tobit regression model is used to apply the maximum likelihood approach to estimate the model.

$$L = \prod_{y_i=0} (1 - F_i) \prod_{y_{i>0}} \frac{1}{(2\prod \sigma^2)^{1/2}} e[\frac{1}{2\sigma^2}](y_i - \beta x_i)^2$$

Where,

$$F_i = \int_{-\infty}^{\beta^i xi/\sigma} \frac{1}{(2\Pi^{\frac{1}{2}})} e^{-i^2/2} \partial_i$$

F_i is normally scattered in the $\beta^i xi/\sigma$. In this way, farm level allocative efficiency scores are used in the Tobit regression model to represent relation among the measurement of efficiency and socio-economic indicators of farmers. It is reviewed in the literature that there are several variables identified to examine allocative efficiency level among farmers, such as age, education, family labor, year of farming experience and farm size; information is collected based on surveys and interviews.

3. RESULTS AND DISCUSSION

3.1. Farm-wise Intensity of Labor Freedom Index

The survey results depict the farm-wise intensity of labor freedom represented in Table 1, which reveals that around 60 per cent of the landless have low scores and approximately 40 per cent have a moderate score of labor freedom. It is observed that although landless farmers are working as hired, farm or contractual laborers; land and labor market reforms has improved their working conditions, wages, and job tenure because landowners have made some kind of explicit or implicit contract with them. Likewise, the study of Eswaran and Kotwal (1985) mentioned that labor wage contracts were required to confirm the supply of farm labor for completing agricultural works.

Besides, migrant workers have benefitted with rural development policies; it is observed that a development policy has provided off-farm job opportunities to in-migrants and local laborers. Consequently, migrant workers are engaged in off-farm work within the rural area staying at the farm-job-receiving community. Nevertheless, Rhoda (1983) found that rural-urban migration of labor was reduced by increasing cultivatable land and equalizing the size of landholding. Figure 2 is the representation of Table 1 for a better understanding (see Figure 2). It is also observed that development policy is positively related to commuting, incentives to move, and labor mobility and, in this way, employment rate is observed to be better in rural areas. Similar observations have been specified by Renkow (2003) in North Carolina, that commuting flows of workers and employment growth rate were found positively related to each other.

Table 1 depicts that nearly 40 per cent of marginal farmers have low scores of labor freedom and above 50 percent have a moderate score, and it was observed that a couple of marginal farmers are largely benefitted more than landless because a larger proportion of marginal farmers have used land rental contracts and labor wage laws, besides land has been redistributed among weaker classes within the village, and community lease-in land found available for farming at lowest rent. Herein the study it is observed that rental contracts provided possession of land to the marginal farmers/tenants and has improved their bargaining capacity, tenure security, and production rights. Nevertheless, a group of marginal farmers is found in a very low range of labor freedom because they are not from the main profession of farming and hence have not received direct benefits from freedom.

Table-1. Farm-wise intensity of labor freedom index.

Labor Freedom level	Landless		Marginal		Small		Medium		Overall	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
$1 \geq f_L > 2$ (Very low)	0	0	9	10.71	3	3.57	1	1.19	19	5.66
$2 \geq f_L > 2.5$ (Low)	49	58.33	31	36.9	25	29.76	13	15.48	100	29.76
$2.5 \geq f_L > 3$ (Moderate)	35	41.67	44	52.38	46	54.76	57	67.86	202	60.12
$3 \geq f_L > 3.99$ (High)	0	0	0	0	10	11.9	13	15.48	15	4.46
Total Sample	84	100	84	100	84	100	84	100	336	100

Next, Table 1 also reveals that around 30 per cent of small farmers have low scores and 55 percent have a moderate score of labor freedom. The results suggest that small farmers have enjoyed the considerations of labor freedom more than marginal farmers. Figure 2 shows that more than 10 percent of small farmers have high scores of labor freedom. It indicates that freedom improved when contract farming, whether in the form of sharecropping or fixed rent benefitted small farmers through increasing the number of land registrations. Similarly, the study of Banerjee et al. (2002) on Indian agriculture has reported that small landholders secured tenureship and bargaining capabilities in tenancy reform. Thus, results are expected. Table 1 depicts that around 15 per cent of medium farmers have low scores and nearly 70 percent have a moderate score. It is observed that development policy has explored the options for them to work as technical personnel. It is also found that in the farming process, medium-sized farms have coordinated the exchange activities with tenants for mutual benefit. In contrast, Powell (2002) reported that medium-sized farms that have diversified crops have greater harvesting options to choose the best with well-defined property rights.

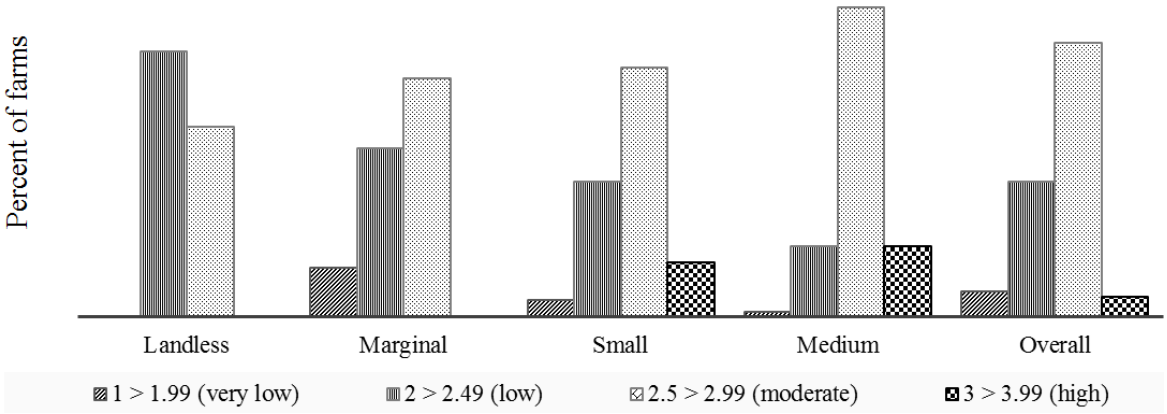

Figure-2. Farm-wise intensity of labor freedom index.

We observe that around 15 percent of medium farmers have higher scores of labor freedom (see Figure 2) because they have greater incentives to move with better wages and employment and have used remittances as inputs to

improve farm management. Likewise, Taylor and Wyatt (1996) analyzed migrant households of rural Mexico and has found that remittances enhanced household farm income indirectly by reducing their financial constraints, whereas one respondent from a medium rural household was found in a very low category. It suggests that out-migration has placed a negative effect on farming and has reduced the quality and intensity of farm work. Migrant households have the 'labor loss' effect owning to insufficient farm laborers in the initial years of migration (Gubert, 2002; Mochebelele & Winter-Nelson, 2000), and the process of optimizing labor input continued till replacing labor intensity with non-labor inputs or machines (Yang et al., 2016).

3.2. Components/Indicators of Labor Freedom

Labor freedom index is the composite average of the weights assigned to each individual indicator (see Table 2), which reveals that, on average, landless farmers have benefitted with off-farm jobs, labor market reform, and minimum wage laws as a mean estimate of these indicators are found 3.08, 2.99 to 2.84, respectively, and the standard deviation of off-farm jobs (0.45) is a minimum specifying that data points are inclined to be very close to the mean. Whereas, the standard deviation of labor market reform (0.68) found a maximum for landless indicating that data points spread out over a large range of values. On the other hand, landless have the lowest mean (0.71) in land reform and estimated with the lowest standard deviation (0.003), meaning that landless workers have not been provided significant land from the land reform.

Table-2. Summary statistics: weighted average scores of labor freedom indicators.

Indicators	Landless	Marginal	Small	Medium	Total
Land reform (LDR)	0.71 (0.003)	1.49 (0.78)	0.80 (0.29)	0.89 (0.38)	0.98 (0.54)
Land rental contracts (LRC)	2.69 (0.52)	*2.80* *(0.96)*	2.66 (0.58)	2.70 (0.44)	2.91 (0.69)
Labor wage contracts (LWC)	2.28 (0.49)	2.54 (0.56)	2.83 (0.71)	*3.13* *(0.48)*	*2.94* *(0.65)*
Minimum wage laws (MWL)	*2.99* *(0.67)*	*2.97* *(0.73)*	2.83 (0.68)	2.62 (0.45)	2.54 (0.57)
Labor market reform (LMK)	*2.84* *(0.68)*	*2.86* *(0.73)*	*2.99* *(0.74)*	*3.63* *(0.44)*	*3.07* *(0.71)*
Off-farm jobs (OFW1)	*3.08* *(0.45)*	2.04 (0.49)	2.42 (0.71)	2.92 (0.53)	2.83 (0.72)
Off-farm wages (OFW2)	2.42 (0.42)	*2.75* *(0.81)*	2.91 (0.77)	2.69 (0.77)	2.56 (0.66)
In-migration of labor (LMB1)	2.78 (0.62)	2.43 (0.75)	*2.97* *(0.73)*	*3.26* *(0.70)*	*2.96* *(0.74)*
Out-migration of labor (LMB2)	2.32 (0.62)	2.29 (0.64)	*3.02* *(0.75)*	2.98 (0.72)	2.43 (0.64)
Labor freedom (LFI)	2.45 (0.16)	2.47 (0.33)	2.60 (0.34)	2.76 (0.26)	2.58 (0.30)
Observations	84	84	84	84	336

Next, marginal farmers have good scores for minimum wage laws, labor market reforms, land rental contracts, and off-farm wages as a mean estimate of these indicators are 2.97, 2.87, 2.80 to 2.75. respectively. Small farmers are found to be more inclined towards out-migration and in-migration, as mean scores of these indicators are 3.02 to 2.97, respectively. The mean estimate of labor market reform (3.63) is maximum for medium farmers. Furthermore, in-migration of labor (3.26) and wage contracts (3.13) have increased the freedom of medium households. Thus, Table 2 depicts a positive relation between farm size and weighted average scores of labor freedom indicators. That is why the mean value of labor freedom index is estimated as high (2.76) for medium farms and low (2.45) for landless.

3.3. Input-Output Summary in Cereal Production

The major inputs used in cereal production (rice and wheat) are land, seeds, fertilizers, pesticides, electricity, machinery, and labor. The natural logarithm of input-output data is represented in Table 3.

Table 3 shows that land is an important input in the cereal production. The results indicate farm-wise increase in expenditure on land, on an average, mean estimate of land (10.66) is minimum for marginal farmers'. There is a positive relation found between farm size and expenditure on seeds also, the results exclude medium farmers. A similar kind of result observations have been reported by Amaechina and Eboh (2017).

It is observed that large-size farms spend more on fertilizers. The application of fertilizer varies across farms due to lack of capital and proper knowledge of using it. Table 3 depicts extensive expenditure on pesticide as farm size increases. It suggests that medium farms have spent more on pesticides. The mean estimate of electricity consumption varies across farms. It indicates that, on an average, marginal farmers have spent least on electricity. The expenditure pattern reveals that marginal farmers are more rational in their expenditure on inputs. It is found that marginal and small farmers have almost equal expenditure in hiring machinery such as tractors, combines, or threshers used during harvesting and cultivation; however, medium farmers paid slightly more than others. Nevertheless, labor requirements

of marginal and medium farmers were low, although small farmers spent more on labor. It is reported that marginal and medium farmers enjoyed the highest output using adequate proportion of inputs in farming, whereas small farmers misused their resources and produced the lowest output. The results are consistent with the findings of Nasrin, Bauer, and Arman (2018).

Table-3. Summary statistics of input-output data used in cereal production (expenditure/land).

Input	Output	Seed	Fertilizer	Pesticide	Electricity	Machine	Labor	Land
Marginal farms, DMUs=84								
Mean	11.78	7.47	8.57	7.96	7.90	8.64	8.60	10.66
SD	10.41	6.38	6.40	6.53	6.78	6.78	7.24	8.94
Min	10.61	6.68	8.01	7.09	6.91	8.13	8.01	10.31
Max	12.44	8.29	8.74	8.34	8.49	8.91	9.20	10.97
Small farms, DMUs= 84								
Mean	11.74	7.64	8.60	8.10	8.01	8.64	8.77	10.69
SD	10.52	6.67	6.23	6.41	6.90	6.70	7.29	8.76
Min	11.16	7.00	8.34	7.60	7.31	8.29	8.27	10.31
Max	12.44	8.52	8.74	8.52	8.59	8.99	9.20	10.97
Medium farms, DMUs= 84								
Mean	11.82	7.49	8.61	8.15	8.18	8.67	8.64	10.72
SD	10.14	6.51	6.17	6.48	7.49	6.83	6.84	8.73
Min	11.38	7.00	8.34	7.55	7.17	8.29	8.19	10.31
Max	12.30	8.52	8.80	8.61	9.21	9.04	8.94	10.97
All farms, DMUs= 252								
Mean	11.78	7.54	8.59	8.07	8.04	8.65	8.68	10.69
SD	10.39	6.55	6.28	6.55	7.19	6.77	7.21	8.82
Min	10.61	6.68	8.01	7.09	6.91	8.13	8.01	10.31
Max	12.44	8.52	8.80	8.61	9.21	9.04	9.20	10.97

Note: SD=standard deviation, Min=minimum, Max=maximum value.

3.4. Allocative Efficiency of Farms

In order to determine the cause of inefficiency across different size-based farm categories, the study estimated allocative efficiency scores using DEA methodology. A farmer having an allocative efficiency score between 0.7 and >0.9 is treated as highly efficient, less than 0.5 is inefficient, between 0.5 and >0.7 is moderate and between 0.9 and >1 is extremely efficient. Farm-wise allocative efficiency scores are represented in Figure 3, which reveals that allocative efficiency scores varied across farm category ranges from inefficient to extremely efficient. It is found that more than 45 per cent of marginal farms are moderately, around 12 percent are extremely and 25 percent are highly efficient. The study suggests that marginal farms have used a suitable quantity of inputs. Nevertheless, nearly 20 percent are inefficient because this group may be primarily associated with off-farm jobs. The implication of the observation is that a larger proportion of marginal farms have efficiently allocated resources.

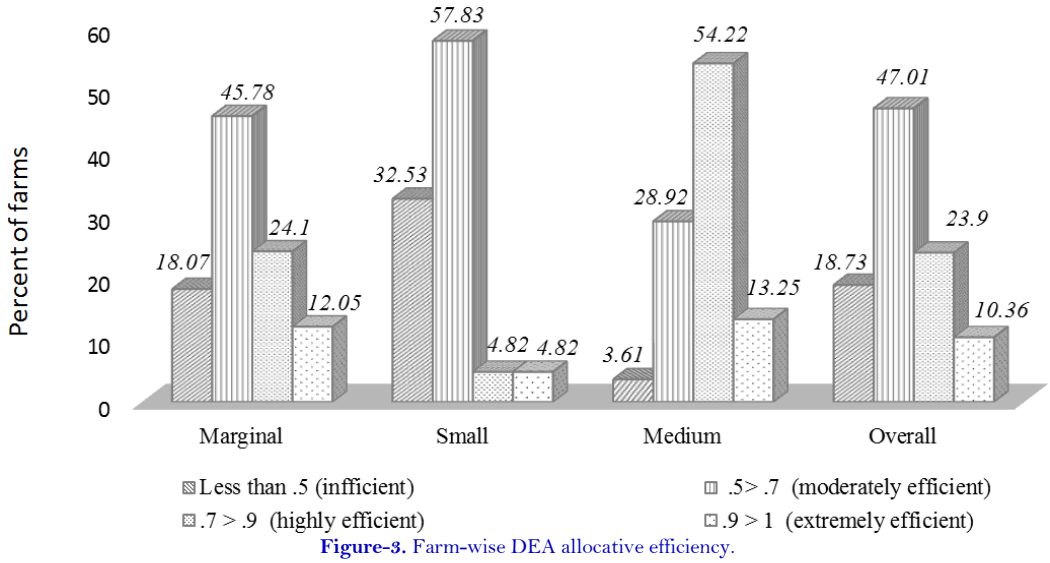

Figure-3. Farm-wise DEA allocative efficiency.

Figure 3 reveals that around 60 per cent of small landholders are moderately efficient, more than 30 percent are less than 0.5 and a couple of small-size farms are extremely efficient. It is observed that the majority of the small farms are inefficient relative to the best-practised farms that are producing the same output at the given technology. On the other hand, around 55 percent of medium farms are highly, nearly 15 percent are extremely (0.9 >1) and around 30

percent are moderately efficient, however, a couple of them are inefficient. The results indicate that the majority of medium landholders (70 percent) have utilized resources efficiently. This would provide an opportunity to them to increase farm revenue through equalizing marginal revenue product of inputs to their marginal costs (Umanath & Rajasekar, 2013). The results are consistent with the findings of Coelli, Rao, O'Donnell, and Battese (2005).

3.5. Impact of Labor Freedom on Allocative Efficiency of Farms

The estimated model of Tobit regression can be written as:

$$AE_i = \beta_0 + \beta_1 LFI_i + \beta_2 AGE_i + \beta_3 EDU_i + \beta_4 NFI_i + \beta_5 DUMI_i + U_i \quad (1)$$

where AE = allocative efficiency of ith no of observations, $i = 252$, Ui = error term, DUMI=1……..3 (for marginal, small, and medium farms). AE is latent variable ranges from $0\ to\ 1$, $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ and β_5 are the coefficients of labor freedom index, age of head of the family, education level, non-farm income, and farm-size dummy, respectively; in this study, four Tobit regression models operated in STATA@ 14.0 were used to examine the impact of labor freedom and socio-economic variables on allocative efficiency. The five given explanatory variables are assumed as a cause of inefficiency across farms. The econometric results of Tobit regression model estimated from Equation 1 are shown in Table 4. The results reveal that all models are statistically significant at the 1% level as p-value>F-statistics(0.000). The selected five variables {namely, labor freedom index (LFI), age of farmers (AGE), education (EDU), non-farm income (NFI), and dummy of farm-size (DUMI)} have significantly contributed to farm-level efficiency.

Table-4. Impact of labor freedom on allocative efficiency of farms.

Variables	Tobit regression results				
	Parameters	Marginal	Small	Medium	Overall
Constants	β_0	0.084 (0.620)	0.248 (1.750)	0.572*** (3.820)	0.231*** (2.76)
Labor freedom Index	β_1	0.249*** (6.12)	0.170*** (4.830)	0.048 (1.18)	0.189*** (8.21)
Age	β_2	-0.004*** (-0.300)	-0.011 (0.015)	0.007 (0.510)	-0.004 (-0.48)
Education	β_3	0.017** (1.770)	0.002 (0.210)	0.012 (1.32)	0.010** (1.8)
Non-farm income	β_4	-0.019** (-1.940)	0.002 (0.160)	0.014 (0.97	-0.004 (0.537)
Farm-size dummy	β_5	na	na	na	-0.018 (2.76)
p-value > F		0.000***	0.000***	0.000***	0.000***
LR Chi²		33.12	23	4.43	65.97
Log likelihood estimates		59.859	67.106	76.337	180.316
No of observations		84	84	84	252

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

Table 4 reveals that the coefficient of labor freedom is positively and significantly related to allocative efficiency at the 1% level of significance. The results indicate that an increase in the option and opportunities of labor freedom such as property rights, miniumum wage laws, and land rental contracts improve allocative and resource-use ability among marginal farmers by 25%. The results are consistent with the study of Nagaraj et al. (2016), whereas age and non-farm income of marginal farmers show negative and significant effect on efficiency. The implication of the result is that an increase in the age and non-farm income of marginal farms has reduced the resource-use efficiency by 0.4% and 0.19% respectively. It is observed that aged farmers and those with other sources of income are found less efficient than the younger farmers with farming as their primary profession. Similar conclusions are specified in Bhatt and Bhat (2014). Education is found to be positive and significantly related to efficiency of marginal landholders. This implies that an increase in the year of schooling of marginal farms enhanced farm efficiency by 0.17%. The study suggests that education has assisted marginal farmers in making better allocation of resources.

For small farmers, the coefficient of labor freedom is found positive and significant at 1%. The results indicate that an increase in the freedom of labor such as migration with commuting services enhanced efficiency by 17%. The age of small landholders was found to be negative and insignificantly related to efficiency. The results suggest that an increase in the age of small farmers reduced resource-use efficiency by 1.1%. It is observed that aged farmers are less efficient than younger farmers. Similar observations are confirmed in the findings of Houngue and Nonvide (2020). Education is positively related to efficiency, but the relationship is not significant. The estimated results suggest that an increase in the years of schooling will improve efficiency of small farms by 0.2%. It is observed that knowledge, skills, and ability helped them to access and allocate resources in a better way. Similar results have specified by Bravo-Ureta and Pinheiro (1997).

Next, labor freedom estimates of medium-size farms are positive and insignificantly related to allocative efficiency. Moreover, the extent of efficiency increased by 4.8%. It is observed that a very smaller proportion of labor freedom options and opportunities such as labor market reform, wage contracts, and migrants' remittances are used to allocate and access resources. Similar results were reported by Benjamin and Brandt (2002). Age of the head of medium

households was also found positive but insignificantly associated with farm efficiency. The results indicate that a 1% increase in the age of farmers will increase efficiency by 0.07 %. This implies that older farmers have allocated resources more efficiently than younger producers at their counterparts. The results are consistent with the findings of Coelli et al. (2002). Moreover, education is also positive but insignificant. The results suggest that a one percent increase in years of schooling improved efficiency by 0.12 %. The coefficient of non-farm income was found positive, but insignificant. It means that a one percent increase in income from other sources increased the resource-use efficiency of medium farms by 0.14%. This implies that income from other professions (secondary jobs) has created an assured and continuous supply of extra disposable income for fulfilling farming requirements. Similar findings were reported by Sibiko et al. (2013).

Furthermore, the coefficient of labor freedom of farms overall was found positive and significant at 1%. This implies that efficiency increased by 18.9%. The results indicate that greater options given to rural laborers built capabilities to allocate resources efficiently and effectively. Similar results were found by Kundu (2016). Age, on average, was found to be negative and insignificant. It suggests that a one percentage increase in the age of the sampled farmers decreased efficiency by 0.04%. Likewise, non-farm income was also found to be negative and insignificant (see Table 4), implying that the extent of efficiency reduced by 0.04%. It is also observed that farmers whose main occupation continued to be farming are expected to have higher efficiency than those engaged in any other income-generating activity. Next, farm size was found to be negative and significantly related to efficiency at the 1% level of significance. Farm size is a dummy variable of different farm categories. The study reveals that membership of a farm group reduced efficiency by 1.8% compared to non-member counterparts. In contrast, the findings of Tchale (2009) in Malawi showed that farmers who had been members of any group not only benefitted with knowledge, resource use and input price, but were also credited with economies of scale.

4. CONCLUSIONS

It is concluded that labor freedom in agriculture is empowered with property rights, legal approvals, autonomy of choices, and making changes in development policy. Consequently, this paper emphasizes ownership rights, tenancy reform, wages, and rental contracts. Moreover, the paper specifies rural development policy exploring off-farm work to enhance labor freedom, rural wage employment, and the mobility of workers. In this way, the paper has determined a farm-wise labor freedom index using weights of nine sub-components/indicators for enhancing agricultural efficiency. The outcomes show a positive relation between farm size and intensity of labor freedom. It is found that the mean value of labor freedom index ranges from 2.76, 2.60, and 2.47 to 2.45 for medium, small, marginal, and landless farmers, respectively. However, indicators of labor freedom are found different farm-wise: on average, labor market reform, wage contracts and minimum wage laws, off-farm jobs and in-migration of labor significantly contributed to development of the freedoms and options of rural laborers.

The study found that labor requirement by marginal and medium farmers is estimated as low, but small farmers spent more on labor. The observations suggest that marginal and medium farmers have enjoyed the highest output using an adequate proportion of inputs in farming; on the other hand, small farmers have misused resources and produced a lower output than others. Allocative efficiency scores varied across farm size, implying that marginal and medium farms are more efficient relative to small farms. Tobit regression estimated labor freedom to be positively and significantly related to the efficiency of marginal, small, and overall farms, with the extent of enhancing efficiency by 25, 17 and nearly 20%, respectively, although elasticity estimates of labor freedom increased the efficiency of medium farms by 4.8%.

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