



Livelihood Implications of Pulse in an Operating Cropping System

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Authors' contributions

This work was carried out in collaboration among all authors. Author SM collected data, performed the statistical analysis. Author KM managed the literature searches and wrote the first draft of the manuscript.

Authors SG and DP helped in preparation of manuscript. Authors SKA and AB designed the study, managed the interpretation of the analyses and supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To delineate the general status of pulse cultivation and enterprise in West Bengal and estimate the nature, level and direction of interactive relationships among the dependent variables, wages and man-days required in pulse crop cultivation, a set of economic and ecological variables were selected for the study.

Study Design: The locale was selected by purposive sampling technique and the respondents, pulse cultivators, were selected by the simple random sampling method.

Place of Study: Dhanara and Manara GP of the Manbazar-1 and Purulia-1 block of Purulia district in West Bengal were purposively selected for the study.

Methodology: In this study 75 respondents, following pulse cultivation, were selected by the simple random sampling method. A preliminary interview schedule was administered to understand the knowledge, perceptions and attitudes of the people towards climate changes concept, communication and extension system, effect of climate change on pulse production.

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The gathered data were analysed with multivariate analysis. Statistical Package for the Social Sciences V20.0 (SPSS) of IBM was used for analyzing the Coefficient of Correlation, Multiple Regression followed by Stepwise Regression.

Results: Education (X2), Size of holding(x6), Cropping Intensity(x8), Distance From Market(x12) and Crop Biodiversity(x16) variables were found to exert strong and determining contribution to estimate dependent variables wages (y1) and man-days (y2) required in pulse crop cultivation and the set of economic and ecological variables as selected for the study.

Conclusion: The present study has uniquely landed on the value of some important empirical revelation. It can be concluded that pulse as a new intern crop enterprise has been responsive to crop biodiversity, soil health management, and distributive nature of land-resource in the form of fragments and also other ecological and economical aspects. This crop has got a big role for stabilizing national economy by putting up a deterrent to export expenditure in procures pulses from outside India.

Keywords: Cropping intensity; family labor; income; man-days; marketable surplus; pulse; wages..

1. INTRODUCTION

Unpredictable climatic changes jeopardize food production and food security globally and, in the poorer countries especially in India. Being a tropical country, India is more vulnerable to this frequently changing pattern characterized by irregular and untimely rainfalls along with extended summers and winters. Introducing pulse crops that adapt to climate change and mitigate its effects, in the intercropping system, can be pivotal to increase climate resilience in farming [1]. Pulses themselves are, however, very sensitive to torrential rain, especially in the early vegetative stage and at flowering as well as a high quantity of rainfall can cause disease infestations in crops [2,3]. One of the main objectives in National Food Security Mission (Pulses) was creation of employment opportunities because the most important source of income for agricultural labour is wages earned from works in both crop cultural practises and marketing operations. Some income is generated from the cultivation of small plots of land owned or held on lease by the agricultural labour families. Intercropping is a systematic way to increase diversity in an agricultural ecosystem as an example of sustainable agricultural systems following objectives like maintaining ecological balance, more utilization of resources, increasing the quantity and quality of produces and reduce yield damage from pests, diseases and weeds. Success of intercropping in comparison with pure cropping can be determined by a series of agronomic operations which interacts between the species grown in-situ condition [4]. Soil fertility conservation in intercropping is a form of rotation that is done in each season on land. Rhizobium bacteria are able to have a symbiotic relationship with plants of leguminosae family,

and thereby can fix atmospheric nitrogen into available nitrogen for plants uptake. Several reports indicate that there is an increase in the nitrogen content in non-leguminous plants due to the intercropping with the plants of leguminosae family [5]. Pulse crop is the most important source of natural protein to millions of people across the world. The amount of protein in pulses is 17 percent to 35 percent on a dry weight basis [6]. In India pulses have been described as "poor man's meat and rich man's vegetable". The role of pulse is not only confined to our dietary composition but also contributes to soil health, moisture retention, livelihood generation and unshaking important ecological function [7]. Pulses like mungbean, groundnut, lentil etc. extract water from a shallower depth, thereby preventing the use of water at the deeper levels and increasing water use efficiency of the entire crop rotation. Pulses, therefore, facilitate microbial life to flourish through increasing their diversity, breaking diseases, weeds and insect cycles. Ultimately it helps other main crops to access nutrients. While the conventional cultivation practices always included a pulse crop either in intercropping or in crop rotation, the commercialization of agricultural sector has encouraged the practice of sole-cropping of pulse. However, India accounts for about 25 percent of global production, 27 percent of consumption, and 34 percent of food use [8,9].

Family labour is the dominant source of labor input, while farmers may also hire labour during the peak season. Family labour may be allocated to on-farm crop production and off-farm employment [10]. Labour is a central category in many social systems, and it is central in social ecology because the process of colonization consists of physical interventions into nature and

requires human labour. Throughout human history, socio-ecological transitions strongly affected human labour. Previous transition into the prevailing fossil-fuel-based socio-metabolic regime fundamentally changed labours' characteristics in terms of physical power, knowledge and empathy. Lifetime spent on labour was reduced, and a new form of institutional organization became dominant i.e. wage labour [11,12]. The increased wage rate may be a reason for the fluctuation in the prices of agricultural crops. The increase in agricultural prices may also be the reason behind increasing wage because cost of living of the people also increases [13]. This situation reflects an inequilibrium between demand for and supply of labour and the resultant, labour shortage, in the farm sector is pushing the wage rate persistently and perceptibly upwards. The new farm technology is not only capital intensive but also energy intensive involving most farm activities like cultivation, transplantation, weeding, crop cuttings & carrying, thrashing, harvesting, processing and distribution [14]. The wages, in some extent reflect the productivity of labour in different energy sectors / sub-sectors of modern economy. Agriculture accounts for almost 60 percent of aggregate employment in India, out of which 97 percent employment in agriculture is rural-based; but it is depressing to note that in the rural sector the rate of growth of agricultural employment is abysmally low [15]. Pulse crops require less water and nutrient, and less cost of investment as well. Global-warming being a harsh reality and returns from conventional crops such as rice and wheat dwindling very fast; the importance of pulse crop, in both economic and ecological terms is generating both promises and critical acceptance.

2. METHODOLOGY

The deliberation on the methodology has been made to understand the concept, methods and

techniques which are utilized to design the study, collection of information, analysis of data and interpretation of the findings for revelation of truths and formulation of theories. This section deals with the methods and procedures used in the study.

2.1 Locale of Research

Dhanara and Manara GP of the Manbazar-1 and Purulia-1 block of Purulia district in West Bengal were purposively selected for the study. The villages namely Dhanara and Sidpur, were selected by random sampling. The blocks were selected for the study because a) there was ample scope for collecting relevant data for the concerned aspect, b) acquaintance with the local people as well as local language, c) the concerned area was very easily accessible to the researcher in terms of place of residence and transportation.

2.2 Pilot Study

Before taking up actual field work a pilot study was conducted to understand the area, its people, institution, communication and extension system and the knowledge, perception and attitude of the people towards pulse intercropping system.

2.3 Sampling Design

Purposive as well as simple random sampling techniques were adopted for the study (Table 1).

2.4 Construction of Interview Schedule

On the basis of finding pilot study a preliminary schedule was formed with the help of literature and by the assistance of supervisor and members of advisory committee. The interview schedule consisted of three major parts according to the specific objective of the study.

Table 1. Sampling techniques and sampling design

Step	Items	Level	Approach
1	State	West Bengal	Purposive
2	District	Purulia	Purposive
3	Subdivision	Puruliasadar	Purposive
4	Block	Manbazar-1 & Purulia-1	Purposive
5	Gram Panchayat	Dhanara & Manara	Purposive
6	Village	Dhanara & Sidpur	Simple Random
7	Respondents	75	Simple Random

2.5 Pre-testing of Interview Schedule

It's the process of advance testing of the study design after the schedule has been prepared. The object of pretesting is to detect the discrepancies that have emerged and to remove them after necessary modification in the schedule. After conducting pretesting appropriate changes and modification of the interview schedule have been made. The individuals who responded in pretesting have been excluded in the final sample selected for the study.

2.6 Statistical Tools Used for Analysis of Data

Statistical Package for the Social Sciences V20.0 (SPSS) of IBM was used for analyzing the Coefficient of Correlation, Multiple Regression and Stepwise Regression Analysis. Appropriate operationalization and measurement of the variables helped the researcher to land upon the accurate conclusion. Therefore, the selected variables for this study are operationalized and measured in the following manner: (1) Independent variables and (2) Dependent Variables.

2.6.1 Independent variables

2.6.1.1 Age(x_1)

In all societies, age is one of the most important determinants of social status and social role of the individual. In the present study, age of the respondent was measured on the basis of their chronological age (years) at the time of investigation.

2.6.1.2 Education(x_2)

Education is instrumental in building personality structure and helps in changing one's behavior in social life. Education was conceptualized as the amount of formal schooling literacy acquired by the responded. The unit is year.

2.6.1.3 Exposure unit(x_3)

The Participation in meeting measured by number of time meeting was attended per year.

2.6.1.4 Family size(x_4)

Number of family members of an individual farmer.

2.6.1.5 Family labour(x_5)

Family farming is a means of organizing agricultural, forestry, fisheries, pastoral and aquaculture production which is managed and operated by a family and predominantly reliant on family labour, including both women and men. Here the number of family members attached with the farming was taken as family labour.

2.6.1.6 Size of holding(x_6)

The amount of land owned by a person is an important parameter to access the economic status of the person in the society.

2.6.1.7 No of fragments(x_7)

It's the number of fragmented lands (plots) of an individual farmer.

2.6.1.8 Cropping intensity(x_8)

The proportion of total annual cropped area to the size of holding expressed in percentage. It's calculated as = (Gross Cropped Area \times 100)/Net sown Area.

2.6.1.9 Home stead land(x_9)

The area of land owned by a person is an important parameter to assess the economical status of the person in the society.

2.6.1.10 Marketable surplus(x_{10})

Marketable surplus is a term that agriculturalists use to refer to a specific type of surplus that farmers and ranchers deal with. It was taken on the basis of per bigha of the individual farmer.

2.6.1.11 Marketed surplus(x_{11})

Marketed surplus as compared to marketable surplus is a practical ex-post concept and refers to that part of the marketable surplus which is marketed by the producer i.e., not only the part which is available for disposal but that part which is made available to the market or to the disposal of the non-farm rural and urban population. It was taken on the per bigha basis of the individual farmer.

2.6.1.12 Distance from market(x_{12})

The distance between market and field of a farmer in terms of meter (m).

2.6.1.13 Cost of fuel(x_{13})

It is the ratio of consumption of diesel/petrol/electricity in a year to the size of the family.

2.6.1.14 Family expenditure(x_{14})

It is the ratio of family income in a year to family size.

2.6.1.15 Total cost(x_{15})

Total cost was determined by the following formula i.e. (Total cost of fuel + fuel expenditure + expense in pulse production)/Size of the family.

2.6.1.16 Crop biodiversity(x_{16})

It is the ratio of total no of all crops to size of holding.

2.6.1.17 Animal resource(x_{17})

It is the ratio of total no of animals to family size.

2.6.2 Dependent variables

Wages (y_1) and man days (y_2) required in pulse crop cultivation were selected as dependent variables for the present experiment.

3. RESULTS AND DISCUSSION

3.1 Result and Discussion of Coefficient of Correlation

Coefficient of correlation between wages (y_1) and man-days (y_2) required in pulse crop cultivation and 17 independent variables are presented in Table 2. The following variables have been found to register a significant correlation with wages required in pulse crop cultivation(y_1) viz, education (x_2), family labour (x_5), size of holding (x_6), number of fragments and average size (x_7), home-stead land (x_9), marketable surplus (x_{10}), marketed surplus (x_{11}) and crop biodiversity (x_{16}). On the basis of correlation analysis wages required in pulse crop cultivation has gone better for those having more family labour, higher size of holding land with more number of fragments. A highly unequal distribution means a large demand for paid labour while a less skewed distribution calls for a smaller demand. The more number of fragments distributed over various topography has offered better opportunity for wages required in pulse

crop cultivation. The respondents having bigger size of home-stead land, more marketable and marketed surplus pulse production have contributed to higher wages required in pulse crop cultivation. Here, though institutional education is better, they may lack professional skills which lower their wage. Since pulse is followed in a rice-fallow cropping sequence, it is readily preferred by farmers in diversified cropping system. The demand for hired workers is high in newly adopted technology oriented cropping systems i.e. multiple cropping, intense inter-culture [16,17].

On the other hand, the variables education (x_2), size of holding (x_6), number of fragments and average size (x_7), home-stead land (x_9), marketable surplus (x_{10}), marketed surplus (x_{11}) and crop biodiversity (x_{16}) have been found to register a strong significant correlation with man-days required in pulse crop cultivation (y_2). Man days required in pulse crop cultivation will go up if the educational status of labours is lower. As such, more number of labours will work. Man days required in pulse crop cultivation has gone better for those having higher size of holding land. The more number of fragments distributed over various topography, better opportunity for man days is generated in pulse crop cultivation. The respondents having bigger size of home-stead land, more marketable and marketed surplus in pulse production, have contributed higher man days requirement in pulse crop cultivation.

Agriculture, and more specifically, crop diversification, has been pointed out as a pathway for wage development and labour involvement [18,19,20,21] and consequently, to sustainable development. Mukherjee (2015) [22], however, found that the aggregate per capita net earnings from cultivation of high value crops in West Bengal in India was lower in the more diversified villages and those farmers in these villages ended up with considerably less income compared with farmers in the less diversified villages.

3.2 Result and Discussion of the Multiple and Stepwise Regression Analysis

Multiple regression analysis followed by stepwise regression analysis was depicted in Tables 3 and 4. Table 3 presents that 17 causal variables together have explained 44.0 per-cent of variance of the dependent variable i.e. wages required in pulse crop cultivation (y_1).

Table 2. Coefficient of correlation between wages (y1) and man days (y2) required in pulse crop cultivation and 17 independent variables (x1-x17)

Independent Variables	Wages		Man days	
	"r" value	significance (2-tailed)	"r" value	significance (2-tailed)
Age(x1)	-0.107		-0.122	
Education(x2)	-0.301	**	-0.258	*
Exposure Unit(x3)	0.041		0.064	
Family Members(x4)	0.185		0.178	
Family Labour(x5)	0.237	*	0.186	
Size of holding(x6)	0.431	**	0.467	**
Number of Fragments and average size(x7)	0.353	**	0.403	**
Cropping Intensity(x8)	0.071		0.036	
Home-stead Land(x9)	0.335	**	0.378	**
Marketable Surplus(x10)	0.344	**	0.386	**
Marketed Surplus(x11)	0.307	**	0.355	**
Distance From Market(x12)	0.212		0.038	
Cost of fuel(x13)	-0.069		-0.163	
Family Expenditure(x14)	-0.106		-0.107	
Total cost(x15)	-0.113		-0.133	
Crop Biodiversity(x16)	-0.286	*	-0.314	**
Animal Resources(x17)	-0.138		-0.136	

** Correlation is significant at the 0.01 level (2 tailed); *Correlation is significant at the 0.05 level (2 tailed)

Table 3. Multiple regression analysis: Wages required in pulse crop cultivation (y1) with 17 causal variables

Sl. no	Independent Variables	Reg. Coeff. (B)	Std. Error	β	t-value	sig.
1	Age(x1)	-7.469	5.271	-.154	-1.417	.162
2	Education(x2)	-4.179	15.278	-.034	-.274	.785
3	Exposure Unit(x3)	44.711	24.955	.207	1.792	.078
4	Family Members(x4)	-39.848	62.221	-.161	-.640	.524
5	Family Labour(x5)	1.387	60.898	.004	.023	.982
6	Size of holding(x6)	71.607	36.151	.591	1.981	.052
7	No. of Fragments & average size(x7)	-13.544	25.978	-.146	-.521	.604
8	Cropping Intensity(x8)	6.084	2.472	.286	2.461	.017
9	Home-stead Land(x9)	16.852	34.842	.079	.484	.630
10	Marketable Surplus(x10)	7.386	4.499	1.104	1.642	.106
11	Marketed Surplus(x11)	-6.337	4.847	-.902	-1.307	.196
12	Distance From Market(x12)	32.690	17.768	.289	1.840	.071
13	Cost of fuel(x13)	-.218	.740	-.069	-.295	.769
14	Family Expenditure(x14)	-.154	.242	-.317	-.637	.526
15	Total cost(x15)	.083	.240	.202	.346	.731
16	Crop Biodiversity(x16)	22.972	147.798	.023	.155	.877
17	Animal Resources(x17)	-55.352	77.796	-.075	-.711	.480

R² = 44.0%

It indicates that selection of variables for this study has been fairly relevant. The stepwise regression analysis elicits that three variables i.e. size of holding (x6), cropping intensity (x8) and

distance from market (x12) have come out with stronger determining character on wages required in pulse crop cultivation (y1). The causal effect of higher size of holding land on wage

required in pulse crop cultivation (y1) is well discernible. Higher value of cropping intensity(x8) and distance from market(x12) here also offer a better indicator for assessing wages required in pulse crop cultivation. These three variables together have interpreted 30.1 percent of variance, embedded with wages required in pulse crop cultivation (y1). Table 5 and 6 display the multiple regression analysis followed by stepwise regression analysis. Table 5 presents that 17 causal variables together have explained 41.1 percent of variance of the dependent variable, man days required in pulse crop cultivation (y2). It indicates that selection of

variables for this study has been fairly relevant. The stepwise regression analysis shows that two variables, size of holding (x6) and cropping intensity (x8), have come out with stronger determining characters on man days required in pulse crop cultivation (y2). The causal effect of higher size of holding land on man days required in pulse crop cultivation (y2) is well discernible and higher value of cropping intensity (x8) here also offers a better indicator for assessing man days required in pulse crop cultivation. These two variables have together interpreted 26.5 percent of variance, embedded with man days required in pulse crop cultivation (y2).

Table 4. Stepwise regression analysis: Wages required in pulse crop cultivation (y1) with 17 causal variables

Sl. no	Independent Variables	B	Std. Error	β	t	sig.
1	Size of holding(x6)	65.095	12.889	0.537	5.050	.000
2	Cropping Intensity(x8)	5.555	2.260	0.261	2.458	.016
3	Distance From Market(x12)	27.298	11.228	0.242	2.431	.018

R² = 30.1%

Table 5. Multiple regression analysis: Man days required in pulse crop cultivation (y2) with 17 causal variables

Sl. no	Independent Variables	Reg. Coeff.(B)	Std. Error	β	t-value	sig.
1	Age(x1)	-.038	.032	-.133	-1.196	.237
2	Education(x2)	-.030	.092	-.042	-.331	.742
3	Exposure Unit(x3)	.257	.150	.204	1.715	.092
4	Family Members(x4)	-.318	.373	-.220	-.853	.397
5	Family Labour(x5)	-.010	.365	-.005	-.027	.978
6	Size of holding(x6)	.402	.217	.567	1.855	.069
7	No. of Fragments & average size(x7)	-.052	.156	-.097	-.337	.737
8	Cropping Intensity(x8)	.032	.015	.256	2.150	.036
9	Home-stead Land(x9)	.099	.209	.080	.472	.639
10	Marketable Surplus(x10)	.044	.027	1.127	1.633	.108
11	Marketed Surplus(x11)	-.038	.029	-.929	-1.313	.195
12	Distance From Market(x12)	.100	.107	.151	.935	.354
13	Cost of fuel(x13)	-.003	.004	-.166	-.693	.491
14	Family Expenditure(x14)	-.001	.001	-.331	-.649	.519
15	Total cost(x15)	.001	.001	.240	.400	.691
16	Crop Biodiversity(x16)	.102	.886	.017	.115	.909
17	Animal Resources(x17)	-.330	.466	-.076	-.707	.483

R² = 41.1%

Table 6. Stepwise regression analysis: Man days required in pulse crop cultivation (y2) with 17 causal variables

Sl. no	Independent Variables	B	Std. Error	Beta	t	sig.
1	Size of holding(x6)	.389	.077	.549	5.081	.000
2	Cropping Intensity(x8)	.029	.013	.231	2.139	.036

R² = 26.5%

4. CONCLUSION

The present study has uniquely depicted the value of some important empirical revelations. We have found that being a new intern crop enterprise; pulse has been responsive to crop biodiversity, soil health management, distributive nature of land-resource in the form of fragments and livelihood generation. Wage required in pulse crop cultivation has gone better for those who have more family labourers and higher size of land holding. The small and marginal farmers having more marketable and marketed surplus of pulse production can contribute to higher income. Man days required in pulse crop cultivation will be increased if the educational status of labourers will be lower and more number of labourers will be required. This crop has got a big role for stabilizing national economy by putting up a deterrent to export expenditure in procuring pulses from outside India.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per the international standards, respondents' written consent have been collected and preserved by the author(s).

ETHICAL APPROVAL

All experiments have been examined and approved by the appropriate ethics committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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