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Determinants of adoption of BDN-716 pigeon pea variety in Maharashtra's Parbhani district

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Abstract
This study examines the socio-economic and agronomic determinants influencing the adoption of the BDN-716 pigeon pea variety in Parbhani district of Maharashtra. Using a logistic regression model, data were analyzed from a sample of 120 farmers to identify key factors associated with adoption decisions. The analysis revealed that variables such as age, education, income, seed rate, manure application, and chemical fertilizer use significantly influenced adoption. Specifically, age and education showed a positive impact and were significant at 5% and 1% levels, respectively, while income had a highly significant positive effect. Seed rate and chemical fertilizer use exhibited significant negative relationships with adoption, indicating the importance of balanced input use. Manure application had a weakly positive effect, significant at the 10% level.

Keywords: Determinants, BDN-716, significant, logit or logistic regression

Introduction
Pigeon pea ranks as the fifth most important pulse crop globally and holds the second position in India in terms of significance. It serves as a crucial source of food and livestock feed, being rich in carbohydrates, proteins, essential amino acids, dietary fiber, vitamins, and minerals. Due to its nutritional content, pigeon pea is consumed in various forms such as split dal, mature and immature seeds and contributes significantly to both human diets and animal nutrition through its seeds and by-products. In the Marathwada region of Maharashtra, pigeon pea stands as the second most cultivated leguminous crop after soybean. Among the varieties promoted in this region is BDN-716, developed in 2016 by the Agricultural Research Station (ARS), Badnapur. This variety is particularly suited irrigated conditions and performs well in heavy soils, especially in drought-prone areas. At least one irrigation is recommended to achieve optimal yields, which typically range from 18 to 22 quintals per hectare. The BDN-716 variety is characterized by its yellow flowers and Bold Red mature seeds, with a maturity duration of approximately 160-165 days. The recommended seed rate is 10-12 kg per hectare, which aids in maintaining optimal plant density and improving productivity. Importantly, this variety exhibits resistance to major diseases such as wilt and sterility mosaic disease (SMD), making it a resilient choice for farmers in the region.

Methodology Logit or Logistic model
To examine the factors influencing the adoption of the BDN-716 variety of pigeon pea, the objective was addressed using logistic regression analysis. This statistical method models the relationship between a binary dependent variable and multiple independent variables, estimating the probability of an event occurring based on predictor variables. The logistic regression model is expressed as:

$$\text{Logit} = Li = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \ldots. + \beta 8X8 + \mu$$

Where,
Y = Dependent variable
β_0 = Intercept
β_1, β_2, β_3……. β_8 = Regression coefficients. With respect to…….
X_1, X_2, X_3…….X_8 = Explanatory variables.

Sr. No.	Dependent Variable (Y)	Particular	Independent Variable (X)	Particular
1	Adopter	1	Age	X_1
2	Non-Adopter	0	Education	X_2
3			Income	X_3
4			Seed	X_4
5			Sowing Time	X_5
6			Spacing	X_6
7			Manure	X_7
8			Chemical Fertilizer	X8

The basic model of Logit estimation (Gujrati, 2004) -

$$Pi = E(Y = 1/Xi) = 1/ 1+e^{-(\beta 1+\beta 2xi)} \quad (1)$$

For ease of exposition, we right (1) as

$$Pi = 1/1+e^{-z} \; i = e^{z}/1+e^{z} \quad (2)$$

Where, $Zi = \beta 1+\beta 2Xi$

Where Pi is the probability that farmers are BDN-716 Pigeon pea variety adopter then (1-Pi) is the probability that farmers are non-adopter and „e" is the exponential constant. Equation (2) represents a cumulative logistic distribution function. Which it is easy to verify that Zi ranges from -∞ to +∞, pi ranges between 0 to 1 and the logit goes from -∞ to +∞.

Dependent variable: (Y)

Adopter: adopter of BDN-716 Pigeon pea variety taken '1' as a particular.

Non-adopter: Non-adopter of BDN-716 Pigeon pea variety taken '0' as a particular.

Independent Variable: (X)

Socio-economic determinants

Age: As per the study findings, the average age of adopters of the BDN-716 pigeon pea variety was higher compared to non-adopters. This suggests that adopters typically possess greater farming experience, which may enhance their ability to evaluate and adopt improved agricultural technologies.

Education: The illiteracy rate was higher among non-adopters compared to adopters, whereas a greater number of adopters had completed higher education than non-adopters.

Yield: The yield of Pigeon pea is classified into two components: the main produce and the by-produce. According to the study, farmers who adopted BDN-716 variety achieved a higher yield compared to those who did not adopt it.

Income: The annual income of farmers who adopted the BDN-716 variety was higher than that of non-adopters.

Recommended Determinants

Seed Rate: According to recommendations, the seed rate for the BDN-716 pigeon pea variety is 10-12 kg per hectare. This rate helps ensure an optimal plant population is maintained on the pigeon pea farm.

Sowing Time: The recommended sowing period for the BDN-716 pigeon pea variety is between 15th June and 15th July.

Spacing: The recommended spacing for the BDN-716 pigeon pea variety is 90×20 cm, which ensures proper plant growth and facilitates better field management.

Manure: Application of 15 tonne per hectare of farmyard manure (FYM) is recommended to enhance the production of pigeon pea.

Chemical Fertilizer: The recommended application rate of chemical fertilizers for pigeon pea is 25:50:30 kg/ha of Nitrogen (N), Phosphorus (P), Potash (K) respectively, to support optimal crop growth and yield.

Results and Discussion

The results of the Logit (logistic) model analysis examining factors influencing farmers' adoption of the BDN-716 variety are presented. The explanatory variables included a range of socio-demographic and economic characteristics such as age, education, farm size, income and yield. Additionally, several recommended agronomic practices were considered, including seed quality, sowing time, spacing, manure application, use of chemical fertilizers and intercultural operations.

Table 1: Determinants for Adoption of BDN-716 Pigeon pea Variety

Determinants of Adoption of BDN-716 Pigeon pea Variety					
Sr. No.	**Variable**		**Estimate Coefficient**	**Standard error**	**Z Value**
1	Intercept		-7.045*	3.856	-1.827
2	Age	X1	0.1565**	0.06704	2.335
3	Education	X2	0.4637***	0.1546	3.000
4	Income	X3	0.0001948***	0.00004394	4.432
5	Seed rate	X4	-1.666***	0.6029	-2.763
6	Sowing time	X5	-0.466	0.6894	-0.676
7	Spacing	X6	-0.1641	0.6749	-0.243
8	Manure	X7	0.2226*	0.1145	1.943
9	Chemical fertilizer	X8	-0.1121**	0.04984	-2.248

(**Dependent variable**: Adoption of BDN-716 variety (Yes=1; No=0)

Note: '*' '**'** and **'*'** represent significance at '1' percent, '5' percent and '10' percent levels, respectively.

The analysis revealed that among various social factors, Manure was significant at the 10 percent level, exhibiting a positive influence on the adoption of the BDN-716 pigeon pea variety. These factors appear to enhance a farmer's experience and capacity for sound decision-making, which are critical for improving farm productivity. Educated and older farmers are more likely to choose high-yielding crop varieties, apply inputs such as fertilizers and plant protection chemicals effectively and carry out essential farming practices at the appropriate time and location. Additionally, age, chemical fertilizer demonstrated a positive and statistically significant effect at the 5 percent level. This suggests that farmers with larger landholdings are more inclined to adopt improved crop varieties, likely due to their better access to resources and greater potential to benefit from economies of scale in pigeon pea cultivation.

Other variables including seed rate, income, Education, were examined to assess their influence on pigeon pea production. Seed rate, income, education was found to be significant at the 1 percent level, but with a negative coefficient, indicating an inverse relationship with yield. This may be attributed to the characteristics of the BDN-716 variety, which is resistant to Sterility Mosaic Virus (SMV) and possesses high yield potential. The improved genetic makeup of this variety reduces the need for excessive seed quantities and plant protection measures, thereby lowering input costs and enhancing productivity for farmers.

The use of chemical fertilizers specifically Nitrogen, Phosphorus, Potash and Micronutrients was found to be statistically significant at the 5 percent level, but with a negative coefficient. However, when applied in recommended quantities and at the appropriate time and place, these fertilizers contribute significantly to increased productivity. For adopters of the BDN-716 variety, the recommended application rates Nitrogen (25 kg/ha), Phosphorus (50 kg/ha), Potash (30 kg/ha) have been shown to optimize production outcomes. These findings emphasize the importance of balanced and timely nutrient management in maximizing the yield potential of improved pigeon pea varieties.

According to Table 1, the variables age, education, income, seed rate, manure and chemical fertilizer use were found to have a statistically significant influence on the adoption of the BDN-716 pigeon pea variety. These factors appear to play a critical role in shaping farmers' decisions regarding the adoption of improved crop technologies. In contrast, variables such as sowing time, spacing, did not show a statistically significant effect on the adoption decision, indicating that they may not directly influence the choice to adopt the BDN-716 variety.

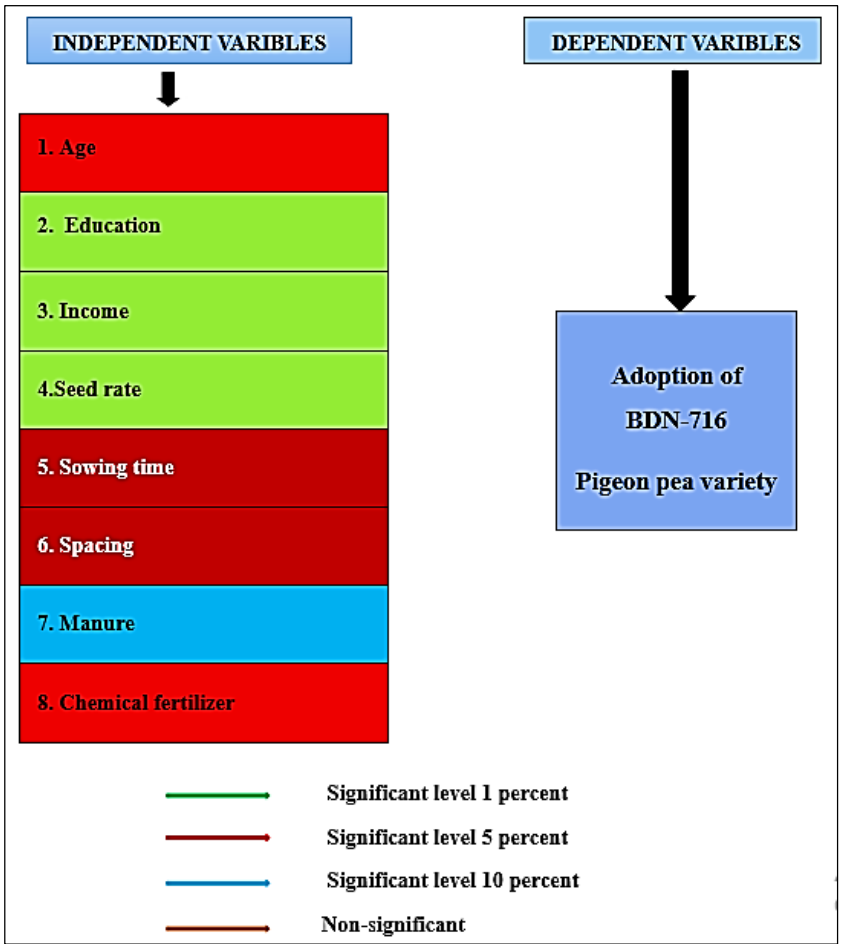

Fig 1: Determinants for adoption of BDN-716 Pigeon pea variety

Conclusion

The Logit (logistic regression) model was employed to assess the factors influencing the adoption of the BDN-716 pigeon pea variety. The analysis revealed that Income, education and Seed rate had a positive and significant influence at the 1% level, while Age and chemical fertilizer was positively significant at the 5% level, Manure significant at 10% level indicating these factors encourage

adoption. In contrast, seed rate use showed a negative and significant effect at the 1% level. suggesting that improper seed rate and high chemical input use may deter adoption.

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