Chapter VIII
RESULTS AND INTERPRETATIONS - III
Determinants of Cotton Productivity

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DETERMINANTS OF COTTON PRODUCTIVITY

8.1. Productivity function

Based on the information collected on various aspects of cotton cultivation from 240 sample farmers in the two districts, a set of factors under each of the broad categories of human capital, financial capital and infrastructure were hypothesised to determine the productivity. Although, a large number of factors were considered under each set, by repeated estimations, those variables that could explain the yield differential better were only retained in the model.

Under human capital variables, education of the farmer, visit by the extension officer and adoption was retained in the final model. Various measures of education variable was used in different equations such as education of the farmer (decision maker) in number of years, average education of all the members in the farm household in number of years and highest education attained by anyone member of the farm household. Further, education variable was used as a dummy variable to examine the effect of various levels of education such as primary (4 years and below), secondary (4 to 10 years) and 10 years and above. Visit by the extension officer to the farm at least once in the reference crop season was included as dummy variable, variable taking the value 1 if the farm is visited by the extension officer and 0 if not. Similarly, adoption of the recommended package of practices for cultivation by the farmer was included as dummy variable, taking value 1 if farmer is categorised as adopter and 0 otherwise.

Financial capital variables retained in the model were quantity of NPK plant nutrients used per hectare of cotton cultivated, quantity of organic manure per hectare and amount of crop loan taken per hectare of the gross cropped area.

Among various infrastructure variables considered, percentage of irrigated area and road variable were retained. Road variable was used as dummy to test whether the connectivity of farms with all weather roads influence productivity. Summary statistics of the variables used to estimate the cotton productivity in Amaravati district and Nagpur district are given in tables 8.1 and 8.2, respectively.

Table 8.1 Summary statistics of the variables used to estimate the cotton productivity function - Amaravati

Variable name	Variable description	Mean	Max	Min	SD	Exp. Sign
YLD	Yield of cotton (Qtls per hectare)	9.5	15.0	2.5	162.9	
EDHD	Education of the farmer (years)	7	12	0	4.8	+
EDAVE	Average education of all members in the household (years)	6	7.5	0.5	3.5	+
EDHI	Highest education in the household (years)	13	15	5	2.8	+
IRR	Percentage of irrigated area in NSA (%)	30.5	100	0	39.3	+
CRED	Crop loan (Rs. per ha. Of GCA)	968	5000	0	1179	+
OM	Organic manure (tons/ha)	8.1	45	0	12.0	+
NPK	Fertiliser nutrients (kg/ha)	42.1	211.1	0	36.8	+

Table 8.2 Summary statistics of the variables used to estimate the cotton productivity function - Nagpur

Variable name	Variable description	Mean	Max	Min	SD	Exp. sign
YLD	Yield of cotton (Qtls/hectare)	10.1	17.5	2.5	160.7	
EDHD	Education of the farmer (years)	10	17	0	3.9	+
EDAVE	Average education of all members in the household (years)	8	10.4	0	2.6	+
EDHI	Highest education in the household (years)	13	18	0	3.5	+
IRR	Percentage of irrigated area in NSA (%)	36.6	100	0	43.9	+
CRED	Crop loan (Rs. per ha. Of GCA)	1879	5000	0	1960.5	+
OM	Organic manure (tons/ha)	6.0	50	0	9.8	+
NPK	Fertiliser nutrients (kg/ha)	54.4	153.6	0	39.5	+

8.1.1. Dependent variable – Productivity

Yield of cotton in quintals per hectare (qtl/ha) was defined as the dependent variable for the productivity function. The average yield of cotton for the sample farmers was 9.5 qtl/ha. in Amaravati and varied from a minimum of 2.5 Qtl/ha. to a maximum of 15 qtl/ha. The average yield of cotton in Nagpur was 10.1 qtl./ha. and varied from a minimum of 2.5 Qtl./ha. to a maximum of 17.5 Qtl/.ha.

8.1.2 *Independent variables –Human capital*

Based on the theoretical model, the explanatory variables considered for the empirical productivity model were human capital, financial capital and *infrastructure*.

The human capital variables included in the model was education of the farmer (EDHD) in number of years. Education of the sample cotton farmers varied from 0 year (illiterate) to 12 years with average of 7 years in Amaravati. It varied from 0 year (illiterate) to 17 years in Nagpur with average education of the cotton farmer at 10 years. The education-productivity relationship have been found to be positive and significant in several studies cited earlier. This variable has also been defined differently in various studies. Therefore, apart from education of the farmer himself (decision maker) in Equation No.1 of the productivity function, average education of all the members of the household (EDAVE), maximum number of years of schooling attained by anyone member of the farm household (EDHI) and 3 dummy variables of education such as EDUM1, EDUM2 and EDUM3 were used in Equation Nos. II, III, IV, V and VI, respectively. The dummy variable EDUM1 takes the value 1 if the farmer had education less than 4 years and 0 otherwise, EDUM2 takes the value 1 if the farmer had education between 4-10 years and 0 otherwise and EDUM3 takes the value 1 if the farmer had education more than 10 years and 0 otherwise.

Age of the farmer (AGE) and experience of the farmer in cotton farming (FEXP) were two demographic characteristics considered under human capital for the analysis. Experience of the farmer in cotton farming was later excluded due to

its high correlation with the age. Age of the farmer also did not emerge to indicate any significant relationship with productivity of cotton and therefore was excluded from the model.

Other variables that were considered under human capital were the 14 sources of technical information received by the farmer. These variables were tried as dummy variables taking the value 1 if the farmer had received technical information from that source and 0 otherwise. They included farm daily (FRMDAILY), farm journal (FRMJRL), farm radio (FRMRADIO), farm television (FRMTV), farmer training (FARTRG), visit by extention officer (VISBYE), visit to extension office (VISTOE), contact with progressive farmers (CONTFAR), contact with other farmers (OTHFAR), proximity to agricultural department (AGDEPT), proximity to office of cotton development (COTOFF), family members having employment with agricultural related service (FRMFLY) and conduct of minikit trials in the farm (MINIKIT). Among these variables, only visit by extension officer was found to have significant and positive impact on cotton productivity and hence retained in the model. Adoption of recommended package of practices was used as dependent variable to study adoption behaviour of the farmers but was also included as an independent variable in the productivity model as a variable related to human capital.

8.1.3 Independent variables – Financial capital

The explanatory variables for productivity of cotton considered under financial capital related to the resource endowments of the farmer. They included farm size, level of input use, supplementary sources of income and availability of credit. Net sown area of the farmer (NSA) measured in hectares, quantities of fertiliser nutrients used per hectare (NPK), quantity of organic manure per hectare (OM), number of plant protection sprays given for the reference crop, income from other crops in the farm (OFINCME), income from dairy (DIAINCME), non-farm income (NFINCME),

total income of the farm household (TOTINCME), crop loan taken from institutional sources (CRED) and credit dummy (CREDUM) were the variables considered in the analysis. Dummy variable for credit was used to test whether there is any significant difference in productivity due to use of credit.

Among the variables, except farm size (NSA) all other variables were expected to have positive relationship with cotton productivity and the sign for farm size was left for analysis. In the analysis, however, only three variables emerged to significantly influence productivity. They were the use of fertilizer nutrients (NPK) per hectare of cotton cultivation, use of organic manure (OM) and use of institutional credit for cotton cultivation (CRED) and were retained in the model.

8.1.4 Independent variables – Infrastructure

Infrastructural variables that were hypothesised to influence cotton productivity were irrigation availability of the farm, connectivity of the farm with all weather roads, electricity availability in the farm and distance to the nearest market from the farm. Percentage of irrigated area in the farm (IRR) was hypothesized to have positive influence on productivity. Connectivity of the farm with all weather roads was defined as a dummy variable (ROADUM) taking value 1 if the farm is connected by all weather road and 0 otherwise. Similarly, electrification of the farm was also defined as a dummy variable taking the value 1 if the farm has electricity connection and 0 otherwise. Distance to the nearest market in kilometers (DIST) was hypothesised to have an inverse relationship with productivity as it would act as a constraint to input availability in the farm as also for marketing of the produce. In the analysis, two variables under this category emerged to have significant relationship with productivity of cotton, viz. irrigation and road connectivity and were retained in the model.

8.1.5. Parameter Estimates - Amaravati

The parameter estimates from the productivity function of cotton for Amaravati district are presented in Table 8.3.

Table 8.3. Parameter estimates from the cotton productivity functions for Amaravati district

Source	Equations					
	I	II	III	IV	V	VI
Intercept	5.533***	5.387***	5.417***	5.600***	5.707***	5.524***
	(0.045)	(0.244)	(0.081)	(0.050)	(0.057)	(0.054)
Education	0.017***	0.052	0.059	0.237	0.348	0.012***
	(0.006)	(0.096)	(0.040)	(0.074)	(0.064)	(0.004)
Visit by ext. officer	0.060*	0.090*	0.082*	0.050*	0.051*	0.091*
	(0.035)	(0.053)	(0.043)	(0.026)	(0.026)	(0.053)
Adoption	0.469***	0.470***	0.472***	0.466***	0.435***	0.470***
	(0.056)	(0.058)	(0.056)	(0.055)	(0.056)	(0.046)
NPK	0.023***	0.024***	0.023***	0.020***	0.027***	0.024***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Organic Manure	0.016***	0.016***	0.016***	0.015***	0.025***	0.017***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)
Credit	0.021***	0.021***	0.020***	0.021***	0.021***	0.021***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Irrigation	0.004	0.004	0.005	0.005*	0.003	0.004
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)
Road	0.096**	0.126***	0.116**	0.096**	0.143***	0.128***
	(0.048)	(0.047)	(0.047)	(0.046)	(0.046)	(0.046)
R^2	0.78	0.77	0.78	0.79	0.77	0.77

Figures in brackets are standard errors ** *indicate significant at 5 % level*
* *indicate significant at 10 % level* *** *indicate significant at 1 % level*

It is evident that the years of education of the head of the household has a statistically significant effect at 1 per cent level. This confirms the positive education-productivity hypothesis. However, other education variables such as the average number of

years of education of all members of the household (Equation II), maximum number of years of schooling attained by anyone member of the farm household (Equation III), education of the head of the household upto 4 years (Equation IV) and education of the head of the household from 4 to 10 years (Equation V), although had expected positive signs, were not significant even at 10 per cent level. Education of the head of the household above 10 years (Equation VI) had a statistically significant effect at 1 per cent level. The findings implies that the education productivity relationship is significant with respect to the education level of the farmer himself (decision maker). Education level of 10 years and above is required to have a significant education-productivity relationship.

Visit by Extension Officer to the farm had a positive influence on cotton productivity statistically significant at 10 per cent level, that too consistently in all the equations specified. It is also worth understanding that the effect of visit of Extension Officer is higher than the effect of education. This implies the importance of extension visits on making the farmers understand and utilize new information in an effective way.

Adoption of recommended package of practices for cotton cultivation has a positive influence on productivity statistically significant at 1 per cent level in all the equations specified. This implies the importance of following the specifications of technology in increasing the productivity level.

Use of fertiliser nutrients, use of organic manure and crop loan from institutional sources have, as could be expected, strong positive effect on cotton productivity, all statistically significant at 1 per cent level. This implies the direct relationship between productivity and use of important inputs like fertilisers and manures. Influence of credit from institutional sources on cotton productivity could be through higher input use. Irrigation, though had expected positive sign, effect on productivity was not significant even at 10 per cent level.

The other infrastructural variable, i.e. road dummy variable had a positive effect on productivity statistically significant at 5 per cent level in 2 specified equations and statistically significant at 1 per cent level in the rest 4 specifications. Implications of the non-significance of irrigation variable, as against expectations, could be the absence of assured irrigation facility for the crop in general. The importance of infrastructure like road in influencing farm productivity positively is implied by the significance of road variable.

8.1.6. Parameter Estimates - Nagpur

The parameter estimates from the productivity function of cotton for Nagpur district are presented in Table 8.4.

The results of the study in Nagpur district were similar with respect to human capital variables. Education of the head of the household had a positive effect on productivity statistically significant at 1 per cent level. Other specifications of education variable like average education of all members of the household and highest education of any one member of the household, although had expected positive signs, were not significant. Education of the head of the household from 4 to 10 years was significant at 5 per cent level and above 10 years was significant at 10 per cent level. Also, the impact of education variable on productivity was higher in Nagpur compared to Amravati. This implies that the education productivity relationship is strong in an environment of better infrastructure. The impact of visit by Extension Officer, another human capital variable, was also higher in Nagpur district compared to Amravati district. This results corroborates the hypothesis that the education productivity relationship is stronger in a dynamic setting.

Table 8.4. Parameter estimates from the cotton productivity models for Nagpur district

Source	Equations					
	I	II	III	IV	V	VI
Intercept	5.61***	5.58***	5.59***	5.76***	5.74***	5.59***
	(0.078)	(0.088)	(0.086)	(0.105)	(0.106)	(0.087)
Education	0.036***	0.018	0.030	0.177	0.144**	0.137*
	(0.006)	(0.012)	(0.020)	(0.140)	(0.066)	(0.082)
Visit by ext. officer	0.338***	0.344***	0.341***	0.320***	0.300***	0.323***
	(0.067)	(0.074)	(0.073)	(0.073)	(0.075)	(0.074)
Adoption	0.273***	0.325***	0.306***	0.315***	0.334***	0.360***
	(0.075)	(0.082)	(0.083)	(0.081)	(0.080)	(0.081)
NPK	0.013**	0.015**	0.017**	0.015**	0.016**	0.016**
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Organic Manure	-0.003	0.001	0.001	-0.002	-0.002	-0.001
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Credit	0.002	0.003	0.003	0.002	0.003	0.002
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
Irrigation	0.008*	0.006	0.006	0.004	0.005	0.005
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)
Road	0.030	0.003	0.012	0.085	0.066	0.013
	(0.076)	(0.083)	(0.083)	(0.088)	(0.088)	(0.083)
R^2	0.67	0.59	0.60	0.61	0.60	0.59

Figures in brackets are standard errors ** *indicate significant at 5 % level*

* *indicate significant at 10 % level* *** *indicate significant at 1 % level*

8.2. Demand for crop credit

The demand for credit from institutional sources by the sample farmers was hypothesised to be influenced by the education of the farmer, the size of land holding operated by the farmer, the quantities of NPK nutrients, or-

ganic manure and plant protection chemicals used and the connectivity of the farm with all weather roads. Among these factors, all factors were expected to have positive sign. The summary of parameter estimates for the credit demand model is given in Table 8.5.

Table 8.5. Parameter estimates for the credit demand model

Source	Amaravati		Nagpur	
	Coefficient	S.E.	Coefficient	S.E.
Intercept	1.1395	1.5897	3.8053	2.6013
EDHD	0.0712*	0.0426	0.3532**	0.1715
NSA	0.3098	0.6259	0.9690	1.0705
NPK	0.3120**	0.1451	0.3421*	0.1869
Organic Manure	0.4670***	0.1208	0.5196***	0.1451
Pesticides	0.8891***	0.2842	0.7181*	0.3977
ROADUM	1.4312	1.1112	4.9747	3.316
R^2	**0.5010**		**0.5812**	

** indicate significant at 10 % level* *** indicate significant at 5 % level*
**** indicate significant at 1 % level* *S.E. is standard error*

The model specified for demand for crop credit could explain 50 per cent variation in Amaravati. Among the variables, education of the head of the household was having a positive effect on demand for credit statistically significant at 10 percent level. This result is in confirmation with the hypothesis that education has positive and significant influence on demand for credit facilities. The farm size although had positive sign, was not significantly influencing the demand. But the positive sign disproves the notion that large farmers may not avail credit facilities on account of their surplus. The use of fertiliser nutrients affects the credit demand

positively and statistically significant at 5 per cent level. This result is rather direct as the farmers' demand for crop credit is for enhancing his input use. The result is true for the use of organic manures and pesticides as well. The effect quantity of organic manure used on credit demand was stronger than the impact of fertilisers. The co-efficient was also significant of 1 per cent level. This was expected from the feedback got from the sample farmers regarding the non-availability of organic manure easily in large quantities. The effect of number of spray applications to the cotton crop on demand for credit was even larger and stronger than organic manure. The co-efficient was almost double the coefficient of organic manure and more than double the coefficient of fertilizser nutrients (NPK) and was statistically significant at 1 per cent level. This result should be expected as the pesticide spray applications to cotton crop is one of the important components of cotton cultivation and its cost. The effect of infrastructural variable like road, as expected was positive, but not significant.

The results of demand for crop credit by sample farmers in Nagpur were comparable to that of Amaravati. Here again, the effect of education level of the head of the household on demand for credit was strong. The coefficient was statistically, significant at 5 per cent level also. The coefficient of farm size (NSA), as expected had a positive sign implying that the demand for credit would be larger for larger farm sizes. The coefficient of fertiliser nutrients was significant at 10 per cent level, again implying direct and significant relationship between input use and credit. However, this association between input use and credit raises the issue whether demand for credit is a causal factor due to increased input use or one merely associated with increased input use. According to the canons of causality, the supposed cause (increased input use) must precede the supposed effect (demand for credit). But, as could be judged from the sample farmers the demand for crop credit for

cotton cultivation was both a cause and an effect.

All the variables considered in the credit model had positive influence on credit demand. The quantities of NPK nutrients, organic manure and plant protection chemicals used by the sample farmers was positively and significantly influencing the demand for crop credit. The infrastructure variable although had positive influence on demand for credit in both the districts, the coefficient was significant in Nagpur only. The extent of land holding held by the farmers, similarly, had positive signs in relation to demand for credit, but the influence was not significant in both the districts.

8.3. Logistic regression of adoption behaviour of cotton farmers

Logistic regression is a form of regression which is used where the dependent is a dichotomy and the independents are continuous variable. Here in this case, adoption of recommended package of practices is the dependent variable and it is a dichotomy in the sense it takes value 1 for adoption and 0 for non-adoption. Logistic regression applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of the dependent occurring or not). In this way, logistic regression calculates changes in the log odds of the dependent, not changes in the dependent itself as Ordinary Least Square (OLS) regression does.

The dependent variable ADOPTION was evaluated using a logistic regression model. A value of 1 was assigned to farmers who were identified as adopters and value of 0 was assigned farmers who were not adopters. The characteristics of these two groups of farmers are summarised in Table 8.6 and table8.7 for the two districts.

Table 8.6. Comparison of the characteristics of adopters and non-adopters in Amaravati district

Characteristic	Adopters (35)		Non-adopters (85)		t statistic
	Mean	S.D.	Mean	S.D.	
Cotton productivity	14.4	127.3	7.45	102.9	13.55***
Age	47	12.3	48	11.9	0.660NS
Education (Head)	9	3.4	5	4.9	4.370***
Education (average)	6.8	2.7	5.4	3.8	1.09NS
Education (high)	13	3.1	12	3.1	2.03**
Visit by extension officer	1	0	0	0	7.558***
NSA	5.88	11.8	5.91	13.9	-0.32NS
Irrigation	43.5	42.9	25	36.4	2.36**
Crop credit	904	1158.3	994	1193.8	-0.38NS
Organic manure	14.65	5.7	5.44	5.2	4.03***
NPK	56.78	19.5	36.08	20.2	2.88***
PP sprays	3.08	8.5	7.44	8.3	-5.66***

Figures in brackets are number of adopters and non-adopters

**** indicates significance at 1 % level , ** significant at 5 % level, and NS – non significant.*

Table 8.7. Comparison of the characteristics of adopters and non-adopters in Nagpur district

Characteristic	Adopters (54)		Non-adopters (66)		t statistic
	Mean	S.D.	Mean	S.D.	
Cotton productivity	13.4	159.2	7.48	93.2	11.68***
Age	55	15.2	55	11.7	0.265NS
Education (Head)	10	3.1	9	4.0	5.459***
Education (average)	8.5	2.7	7.8	2.5	3.042***
Education (high)	14	4.0	13	3.7	2.432**
Visit by extension officer	1	0	0	0	3.556***
NSA	4.69	8.3	3.76	6.4	1.731*
Irrigation	50.6	45.8	25.2	37.9	3.292***
Crop credit	1878	1970.4	1880	1943.3	-0.005NS
Organic manure	8.89	13.8	3.68	4.4	3.0006***
NPK	72.49	46.1	39.62	26.5	4.959***
PP sprays	5.27	2.2	8.34	3.1	-6.444***

Figures in brackets are number of adopters and non-adopters
*** *indicates significance at 1 % level ,*
** *significant at 5 % level, and*
NS – non significant.

The adoption of recommended package of practices for cotton cultivation by the sample households were dependent on their benefit expected out of its adoption. The decision to adopt a practice/technology was dependent on several factors such as human capital characteristics (education, extension contacts, age, etc.) financial capital characteristics such as availability of credit and infrastructural characteristics like availability of irrigation, connectivity of the farm, etc.

The productivity of cotton in Amaravati was higher for adopters (14.4qtl/ha) compared to non adopters (7.45 qtl/ha) and the difference was statistically significant at 1 per cent level. Age of the farmer did not differ significantly between the adopters and non-adopters. Education of the head of the household was 9 years for adopters and 5 years for non-adopters and the difference was statistically significant at 1 per cent level. Average education of all members of household was 6 years for adopters and 5.4 years for non-adopters, but the difference was not statistically significant. Highest education attained by any one member of the farm household was 13 years for adopters as compared to 12 years for non-adopters and the difference was statistically significant at 5 per cent level. Extension contact as measured by number of visits made by the extension officer during the reference crop season, averaged to 1 for adopters and 0 for non-adopters and the difference was statistically significant at 1 per cent level. The farm size was slightly lower for adopters but the difference was not significant. Percentage of irrigated area (43.5 per cent for adopters and 25 per cent for non-adopters), application of organic manure (14.65 tons per ha for adopters and 5.2 tons/ha for non-adopters) and application of fertilizer nutrients (56.78 kg/ha for adopters 36.08 kg/ha for non-adopters) were higher for adopters and statistically significant at 5 per cent, 1 per cent and 1 per cent, respectively. Use of institutional credit per hectare was slightly lower for adopters (Rs.904 per ha.) compared to non-adopters (Rs. 994 per ha.) but the difference was not statistically significant. Number of pesticide sprays by adopters was lower and statistically significant at 1 per cent level.

8.3.1. Adoption behaviour - Amaravati

The maximum likelihood coefficient estimates of the parameters used in the logit model for Amaravati district are presented in Tables 8.8.

Table 8.8. Parameter estimates and the statistical relationship of the logit model used to evaluate the adoption behaviour of cot ton farmers in Amaravati District

Variable name	Equations		
	I	II	III
Intercept	-5.556** (2.525)	-6.228** (3.114)	-5.285** (2.202)
AGE	1.228 (0.9148)	1.2969 (0.9051)	1.1004 (0.9191)
Education	0.3205** (0.1282)	0.1258 (0.4796)	1.2236 (1.1008)
Visit by Extension officer	0.889*** (0.0841)	0.811*** (0.0423)	0.867*** (0.0280)
Crop credit	0.312*** (0.1162)	0.320*** (0.1187)	0.334*** (0.1182)
Irrigation	0.3250*** (0.0330)	0.2296*** (0.0456)	0.3214*** (0.0674)
Road dummy	0.1592* (0.0884)	0.2023* (0.1190)	0.2666* (0.1517)
Electricity dummy	0.2326 (0.558)	0.2876 (0.5584)	0.3129 (0.5543)
Log likelihood	-47.96	-48.15	-45.05
Percentage of correct predictions	71.0	70.0	70.0
Value of Chi-square (Significant at 1%)	16.81		
Estimated average probabilityof adoption	0.26		

Equations I, II & III differ only in the specification of the education variable. In equation I it is the education of the farmer, in II avarage education of the household and in III the highest education attained in the family. However, equation I with maximum number of significant variables is only used for further discussion and analysis.

*** *indicates significance at 1 % level*

** *significant at 5 % level*

* *significant at 10% level*

Figures in brackets are standard errors

The logit regression model gave a good fit to the adoption behaviour of the sample farmers in Amaravati as suggested by the Chi-square[1] value significant at per cent level. Among the 7 independent variables 5 variables emerged significant. Education in years of the head of the household influences the adoption decision positively and significant at 5 per cent level. Other specification of the education variable namely average education in number of years of all the members of the household (equation II) and the highest education attained by anyone member of the farm household (equation III) although had positive signs, were not significantly influencing the adoption decision.

The adoption of recommended package of practices, was influenced positively by visit by extension officer and the influence was statistically significant at 1 per cent level. The highly significant coefficient of the extension variable implies the strong relationship between extension visit and adoption decisions. Other variables that emerged to affect adoption decision positively were crop credit and irrigation each significant at 1 per cent level. It implies that availability of credit is a factor that helps the farmers' adoption decisions positively as adoption decision obviously involve higher level of input use and consequent higher out lay of money.

Similarly availability irrigation influences adoption decisions positively as some of the recommendations like quantity of NPK, to be followed fully, availability of irrigation could be a prerequisite.

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[1] For the log likelihood test, the model was run with and without the variables and the difference in -2 log likelihood between the two models is assessed as a Chi-square distribution with degrees of freedom k-1, where k is the number of variables.

Infrastructure variable like road also emerged as positively influencing adoption decision, coefficient statistically significant at 10 per cent level. This implies that the connectivity of the farm with all weather road helps the farmer to adopt the recommended package of practices through easy availability of inputs. It also implies that even extension visits to a farm would be favoured by the single fact of good road and the visit not be made for the reason of a bad road.

Another infrastructural variable, electricity, as could be expected did have positive sign in influencing productivity but was not significant. This could be due to the fact that electricity connection was not a constraint in the area and electricity alone would not ensure irrigation. The model, as could be expected by the good fit, could predict 71 per cent of the cases correctly. The average probability of adoption of recommended package of practices of sample favoures in Amaravati was 0.26. The marginal impact of the individual independent variables on the average probability of adoption is discussed subsequently.

8.3.2. Adoption behaviour - Nagpur

The parameter estimates of logit regression for adoption behaviour of sample farmers in Nagpur were similar to that of Amaravati. With the only exception that the infrastructure variable road, although had positive sign did not emerge significant in Nagpur. The model gave good fit as indicated by the Chi- square value significant at 1 per cent level.

The maximum likelihood coefficient estimates of the parameters used in the logit model for Nagpur are presented in Table 8.9.

Table 8.9. Parameter estimates and the statistical relationship of the logit model used to evaluate the adoption behavior of cot on farmers in Nagpur District

Variable name	Equations		
	I	II	III
Intercept	-5.403**	-5.511**	-5.141**
	(2.25)	(2.396)	(2.336)
AGE	1.020	1.215	1.206
	(0.8184)	(0.8850)	(0.8161)
Education	0.194*	0.125	1.223
	(0.1028)	(0.4796)	(1.1008)
Visit by Extension	0.855***	0.812***	0.867***
	(0.0393)	(0.0423)	(0.0280)
Crop credit	0.092***	0.103***	0.103***
	(0.0338)	(0.0317)	(0.0330)
Irrigation	0.225***	0.326**	0.231***
	(0.0233)	(0.1552)	(0.0674)
Road dummy	0.179	0.103	0.186
	(0.6005)	(0.4805)	(0.4389)
Electricity dummy	0.326	0.307	0.213
	(0.6611)	(0.6041)	(0.6533)
Log likelihood	-44.19	-46.29	-45.05
Percentage of correct predictions	80.0	78.0	78.0
Value of Chi-square	16.81		
(Significant at 1%)			
Estimated average			
probability of adoption	0.33		

Equations I, II & III differ only in the specification of the education variable. In equation I it is the education of the farmer, in II avarage education of the household and in III the highest education attained in the family. However, equation I with maximum number of significant variables is only used for further discussion and analysis.

**** indicates significance at 1 % level* *Figures in brackets are standard errors*

*** significant at 5 % level* ** significant at 10% level*

Age variable, as observed in Amaravati, had positive sign contrary to the expectation that older farmers may be slower in adoption. This may be implying that the farmers cultivating cotton could have some commercial characteristics which could be retained even with age. Education of the head of the household in years was positively influencing adoption decision and the coefficient was significant at 10 per cent level. Extension visit, crop credit and irrigation were the other variable influencing the adoption decisions positively and statistically significant at 1 per cent level.Infrastructural variables, both road and electricity, had positive signs but not statistically significant. The model could predict 80 per cent of the cases correctly. The average probability of adoption of recommended package of practices by the sample farmers was 0.33.

8.3.3. Marginal Impact of explanatory variables on adoption behaviour

The marginal impact[2] of each of the independent variable on the adoption behaviour is calculated and given in table 8.10

Table 8.10. Marginal impact of factors influencing adoption

Variable	Amaravati	Nagpur
Education	0.11	0.19
Visit by extension officer	0.31	0.42
Irrigation	0.11	0.11
Road connectivity	0.05	0.08

The marginal impact of different variables indicate that one extra visit by the extension officer increases the probability of adoption by 31 per cent and 42 per cent. Similarly, one year of additional education of the farmer

[2] *Marginal impact* $(\partial P_i / \partial X) = \hat{a}_x(Pi/(1- Pi)$, *where* $\hat{a}_x$ *is the coefficient of independent* variable X and Pi is the probability of adoption of recommended package of practices calculated at the mean values of the independent variables (Pindyck and Rubenfeld, 1981).

increases the probability of adoption of the recommended package of practices by 11 per cent and 19 per cent. It could also been seen that the marginal impact of each of the variables are more in district (Nagpur) which is infrastructurally better developed.

The results lead to the conclusion that education of the farmer (decision maker), irrigation availability in the farm, the visit by the extension officer to the farm and the infrastructure variable of road are significant variables influencing adoption of recommended package of practices for cotton cultivation. While the education of the head of the household was significant, other specifications of the education variable such as average education or highest education achieved in the family were not significant. The highly significant coefficient of visit by the extension worker indicates the strong influence of the variable on adoption.