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Genetically Modified Crops: A Pre-Introductory Assessment of Farmer Readiness, Its Determinants and Extent of Support in India

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ABSTRACT India has become the focal point of biggest debates on GM Crops and their Risk benefit analysis. The present study reveals extent of farmer readiness and support for Genetically Modified crops and biotechnology applications in Indian agriculture. A set of new indices developed could reveal farmers' readiness towards GM Crops, willingness to pay for GM seeds, to trial in time, to invest additionally and to substitute available area. 5 factors namely Biotechnology awareness, innovativeness, extension participation and cosmopoliteness were found to determine farmer readiness towards GM crops. A model was developed for predicting GM readiness which explained up to 78.4 per cent variation. A set of 14 biotechnology applications were rated for their farmer acceptability. Farmer support for ongoing GM research was found highest for crops requiring lesser chemical fertilizers followed by crops requiring less water for growth, crops having longer shelf life periods, drought tolerant crops and saline tolerant crops. The findings will serve researchers, industry and Government in developing biotech communication strategies, pricing, production and timing of market entry as well as development of GM crops based on farmer needs in future.

INTRODUCTION

Over the past decade, India has become the focal point of one of the biggest GM debate. Politicians, lobbyists, farmers, environmentalists and major corporations have all joined in the debate, on whether to fully introduce GM crops into the nation's agriculture (GreenBio 2009). But much of this debate lacks science or the voice of scientists. The media in India has also exhibited an irresponsible approach by continuously publishing poorly researched articles.

Bt Cotton is the first and only transgenic crop approved for commercial cultivation in India from 2002. Of the 6.3 million hectares of hybrid cotton in India in 2006, which represents 70% of all the cotton, 60% or 3.8 million hectares was Bt cotton - a remarkably high proportion in a fairly short period of five years (APCoAB 2006). Also, India has doubled its production in the last five years and has crossed the US last year to become the second largest cotton producer in the world. It is expected to overtake China in 2009 to become the biggest producer (Gurcharan 2007).

With the phenomenal success of Bt cotton, India is looking forward to the introduction of Bt Brinjal. India is currently experimenting with GM mustard, cabbage, cauliflower, brinjal (aubergine/egg plant), potato, tomato, ground nut and rice (Sajeev 2006). According to Swaminathan (2005), among the frontier technologies relevant to the next stage in our agricultural revolution, the foremost is agricultural biotechnology. The work already performed in India has revealed the potential for breeding new GM crop varieties possessing tolerance to salinity, drought and some major pests and diseases, together with improved nutritive quality. However GM foods are predicted to have many disastrous effects on the economy and society of such a struggling nation (Paarlberg 2002).

Past research has shown that there is an inverse association between consumers' perceived risks and perceived benefits (Alhakami and Slovic 1994 and Siegrist 1999), and it has been suggested that the negative correlation shows that people fail to consider the dimensions of risks and benefits separately (Alhakami and Slovic 1994). In other words, those that perceive high risks would tend also to perceive low benefits from GM.

According to Hoban (1999) majority of American and Japanese population remain positive about the use of biotechnology. About three quarters of the Japanese consumers support the use of biotechnology in agriculture. In an extensive international study of public perceptions of biotechnology conducted by Environics International (2000), almost three-fifths of the people surveyed in the Americas, Asia and Oceania agreed that the benefits of the use of biotechnology outweigh the risks.

Following the psychometric paradigm, risk researchers analyzed the cognitive structure underlying the risk perception of the lay public with respect to potential hazards containing different risk characteristics (Fischhoff et al. 1978). According to findings based on empirical research, qualitative risk characteristics like personal control, voluntariness, familiarity, expected consequences of potential hazards; etc determines the public perception of risk (Slovic et al. 1985). Level of education also results in a better capacity to identify risks as well as benefits (Berrier 1987). It has been argued that ability to process information also influences risk and benefit perception; this ability is presumed to be related to level of education (Steenkamp 1997) although the direction of the effect is somewhat ambiguous.

The major influences on biotechnology acceptance seem to be knowledge level, awareness of benefits, confidence and trust (Hoban 1996). Global differences in support for specific applications of agricultural biotechnology are based on a country's culture and history, economic conditions, and government initiatives or responses related to the issue. Media coverage and activist opposition has been most pronounced in those countries where survey respondents were more negative (Hoban 1998).

Perceived knowledge about GM crops is also expected to have an influence on risk-benefit perceptions. It is hypothesized that people perceive risks that are familiar to them as lower than those that are unfamiliar (Miller 1998), suggesting a negative association between perceived knowledge and perceived risk.

Semantic images associated with the meaning of technological risks (e.g. pending danger, slow killers, cost/benefit ratio, avocational thrill, etc.) (Rohrmann and Renn 2000) and immediate affect (Finucane et. al. 2000) also determines the perception.

One of the emerging themes in risk perception research is the importance of trust. The key idea is that risk perception is not just a perception of inherent dangers of the technology; the actions taken by those who use and regulate the technology also ultimately determine risk (CAST, 1995). Several surveys in North America and the U.K. have found that perceptions of trust in government regulation (and industry), regarding either pesticides or the products of agricultural biotechnology, are the strongest predictors of consumer support (Dittus and Hillers 1993).

Ravenswaay (1995) concluded that trust in government and industry may be a more important influence on risk perception than the inherent safety or the danger of a particular agrichemical. This view holds true and is reflected by the American consumer's continued positive attitudes toward biotechnology. Several surveys have shown that trust in regulatory authorities is higher in the United States than in Europe. In contrast, Europeans trust the government regulatory system less than Canadians or Americans, preferring international regulatory agencies (Einsiedel 1997).

In another survey by Einsiedel (1997), two segments among the Canadian public emerged from the various attitude measures relating to regulatory processes. Some Canadians are predisposed to the use of modern biotechnology alongside traditional breeding methods (traditionalists) and some Canadians (technocrats) exhibit high trust in the technology and its surrounding institutions (including the regulatory institutions and the industry).

Risk-benefit perceptions are hypothesized to be related to people's trust in the source of information also. It can be anticipated that because government and the food industry promote a generally positive message about GM technology (FAO 2000), people who trust these information sources will perceive lower risks and higher benefits. By contrast, environmental groups tend to paint a bleak picture of GM technology, so trust in these organizations should lead to higher risk and lower benefit perceptions (Verdurme et al. 2001).

In India, not much scientific studies have been conducted on farmer support towards GM Crops. In a study conducted by Sajeev and Gangadharappa (2006) in villages of Karnataka, a meager 2.5 per cent of farmers showed awareness regarding biotechnology and its applications in agriculture. Being that Indian government is on the verge of making many key decisions regarding GM crops, it is imperative that the farmers' support towards various biotechnology applications in agriculture be studied.

METHODOLOGY

Locale, Survey Instrument and Data Collection

The Bangalore rural district of Karnataka state of India was sensitized towards the concept of GM food crops and other biotechnology applications in agriculture. The work was done under the project; 'Improving nutritional quality of food through biotechnology approaches' as a partnership between Purdue University, USA and University of Agricultural Sciences, Bangalore, India and funded by USAID-ALO. Three villages from this district namely Heggadehalli, Venketanahalli and Shettihalli were selected after initial survey and PRA exercises by the international project team. Extensive biotechnology awareness programmes (focusing mostly on Bt Brinjal and Bt Tomato) were conducted in these villages till completion of first phase of project in early 2008. For the present study data was collected randomly from 120 farm families out of the 256 families living in these villages. An original simple survey instrument was developed in consultation with social science and life science experts of University of Agricultural Sciences, Bangalore, India and Purdue University, USA. Respondents were asked to recall the biotechnology awareness programmes conducted in their village before introducing them to the questions on biotechnology awareness and GM readiness.

Contingent Valuation Method (CVM) was used to study the farmers' willingness to pay (WTP) for GM seeds. We have used or rather modified the CVM to develop three more willingness indices namely Willingness to Substitute available area (WTS), Willingness to Invest additionally (WTI) and Willingness to Trial in Time (WTT). An elaborate explanation regarding Contingent Valuation Method (CVM) and its scoring methods (FAO 2002) was given to each respondent before their biddings were asked for. Also, respondents were asked to recall the biotechnology awareness programmes conducted in their village before introducing them to the questions on GM readiness (dependent variable measuring the farmer readiness towards GM crops) and support towards GM crops.

RESULTS AND DISCUSSION

1. Socio-personal Profile of the Farmers

The socio personal profile of farmers is compiled in Table 1 and the major findings are explained below:

The mean age of the respondents in the study area was found to be 42 to 43 years (42.7) with middle age group dominating with 71.7 per cent. The mean family size in the study area was found to be of 5 to 6 members. Medium sized families dominated with three fourth of the population (75%).

Respondents seemed evenly distributed with respect to education level with almost two fifth (19.2%) illiterate, one eighth can only read and write (11.7%), two fifth having primary education, 18.3 per cent having secondary education, 17.5 per cent with SSLC, one eighth passing PUC and only a meager 4.2 per cent having a degree or higher qualifications.

Mean farming experience (in years) was found to be 21 to 22 years with majority (67.5%) having medium farming experience. Mean area under cultivation was found to be 2 to 3 acres with a great majority (90%) having medium sized farm land, followed by the remaining 10 per cent having large holdings.

Slightly less than two third of the population recorded medium trust in agencies followed by high (22.5%) and low (15.0%) trust leading to a vast majority (81.7%) having only low level of extension participation. This is due to the fact that public research and extension system in India has put up a poor performance in recent times.

A majority (61.7%) of the population had medium aspiration level followed by others. In case of Cosmopoliteness, a four fifth majority of the population had only medium cosmopoliteness. Subsistence farming calls for medium cosmopoliteness only thereby explaining the result.

A two third majority of the farmers had medium risk taking ability followed by around 30 percent of the farmers having high risk taking ability and a meager portion registering low risk taking ability. Mass media usage was found to be medium in a vast majority (71.7%) and high among one fifth of the population followed by low in a meager 8.3 per cent of the population.

Table 1: Socio-personal profile of the farmers (n=120)

Independent variables	*Mean*	*SD*	*Category*	*Respondents*	
				f	*%*
Age	42.70	11.03	Young	15	12.5
			Middle age	86	71.7
			Old	19	15.8
Family size	5.83	1.93	Small	13	10.8
			Medium	90	75.0
			Large	17	14.2
Level of Education	3.62	1.77	Illiterate	23	19.2
			Can read and write only	10	8.3
			Primary School	24	20.0
			Secondary School	22	18
			High School	21	17.5
			Pre University Course	15	12.5
			Bachelor Degree and above	5	4.2
Experience in farming	21.27	10.64	Low	24	20.0
			Medium	81	67.5
			High	15	12.5
Area under agriculture	2.64	2.48	Small	0	0.0
			Medium	108	90.0
			Large	12	10.0
Extension participation	4.63	3.78	Low	98	81.7
			Medium	0	0.0
			High	22	18.3
Level of aspiration	2.19	1.12	Low	32	26.7
			Medium	74	61.7
			High	14	11.6
Cosmopoliteness	5.62	5.67	Low	0	0.0
			Medium	97	80.8
			High	23	19.2
Risk taking ability	4.23	2.68	Low	4	3.33
			Medium	81	67.5
			High	35	29.2
Trust in agencies	21.61	7.36	Low	18	15.0
			Medium	75	62.5
			High	27	22.5
Mass media usage	1.49	3.66	Low	10	8.3
			Medium	86	71.7
			High	24	20.0
GM awareness	1.15	0.90	Not Aware at all	14	11.7
			Low	8	6.66
			Moderate	79	65.8
			High	19	15.8

Moderate GM awareness was found among two third of the population (65.8%) while 15.8 per cent had high and a meager 6.66 per cent reported low GM awareness. It was noted that around one tenth (11.7%) of the population didn't report any GM awareness. The only channel through which these villagers could gather information and awareness about GM technology or biotechnology was through their participation in the focus group meetings and lecture classes conducted by USAID ALO project scientists. Since this has not happened much in reality as seen in the case of low extension participation it in turn has lead to the moderate GM awareness.

2. Economic Profile and Willingness Indices of Farmers

Mean annual investment in agriculture was found to be Rs. 8495.83/- with almost all farmers belonging to medium investment category (Table 2). Mean long term investment in agriculture was found to be Rs. 44495.83/-.

Economic motivation was found to be medium among great majority (85.8%) of the population followed by others. Through generations the farmers in the study area have resorted to subsistence farming which yields only modest results. Hence; the farmers are tuned towards medium economic motivation.

Table 2: Economic profile and willingness indices of farmers (n=120)

Independent variables	*Mean*	*SD*	*Category*	*Respondents*	
				f	*%*
Annual investment in agriculture	8495.83	15124.21	Low	0	0.0
			Medium	112	93.3
			High	8	6.7
Long term investment in agriculture	44495.83	83736.85	Low	0	0.0
			Medium	25	20.8
			High	95	79.2
Economic motivation	13.49	1.73	Low	12	10.0
			Medium	103	85.8
			High	5	4.2
Willingness To Pay (WTP)	Mean WTP for GM seeds above the ordinary seed price (%) 59		No WTP	17	14.2
			Low (‹50%)	68	56.7
			Medium (51-100%)	20	16.7
			High (›100%)	15	12.5
Willingness To Substitute available area (WTS)	Mean area available for substitution (%) 59		No WTS	8	6.66
			Low	8	6.66
			Medium	71	59.1
			High	33	27.5
Willingness To Invest additionally (WTI)	Mean WTI for GM crop cultivation above the ordinary variety (%) 99		No WTI	6	5
			Low (‹50%)	24	20
			Medium (51-100%)	72	60
			High (›100%)	18	15
Willingness To Trial in Time (WTT)			Not willing	14	11.6
			Undecided	2	1.66
			Third season	8	6.66
			Second season	69	57.5
			First season	27	22.5

Willingness to Pay (WTP) was found to be low among more than half of the respondents while 16.7 per cent had medium and one eighth of the farmers had high WTP. More than one eighth of the population had no willingness to pay. The mean WTP above the price of the ordinary seed varieties was found to be 59 per cent. The results show the poor financial condition prevailing in the farm families as well as their aversion to take risk in investing more.

The above findings augur badly for any agency aiming at high profit business through sale of GM seeds in future. It calls upon the public sector to rise to the occasion to provide cheaper and affordable varieties of GM food crops to the Indian farmers. Public or private, the agencies involved in development and marketing of GM crops in future can price their seeds based on the price ranges that the farmers are willing to pay as revealed by this study.

Willingness to Substitute available area (WTS) was found to be medium among nearly three fifth of the respondents while the remaining 27.5 and 6.66 per cent of the population had high and low WTS respectively. Mean WTS for the prospective GM crop was found to be 59 per cent. The results show the aversion of farmers to take risk by substituting their available farm area for a GM alternative.

The significance of the above results lies in the fact that on a broad scale, agencies will be able to quantify the demand for GM seeds based on the willingness to substitute available area reported by farmers. Accordingly, agencies can go for rough estimates of seed replacement rates expected and can augment their production pertaining to the trends made available here. The results give a preliminary idea of what level of initial response agencies can expect for their GM seeds.

Mean Willingness to Invest additionally (WTI) for GM crop cultivation above the ordinary variety was found to be 99 per cent with three fifth of the population reporting medium WTI. While one fifth of the respondents reported low WTI, 15 per cent had high WTI and a meager 5 per cent reported a complete 'NO WTI'.

Although WTP for GM seeds was found moderate (59%), farmers have recorded very high WTI on management costs (99%). This reflects the farmer readiness to cultivate GM crops confirming to the prescribed package of practices for these crops. It should also be noted that they are willing for the same upon the hope that their choice of a GM alternative should reap success at any cost. Hence, the findings call for increased *technology performance assurance* on part of public and private sector agencies.

Regarding Willingness to Trial in Time (WTT), nearly three fifth of the farmers were ready to trial a GM crop only in the second season/opportunity while around one fourth plans to try it in the first season/opportunity itself. While 6.66 per cent were willing to take up GM in the third season, 11.6 per cent were not at all willing to cultivate it and the remaining 1.66 per cent was undecided.

It should be noted that a striking proportion (25%) of the farming population have identified themselves as '*innovators*' with respect to readiness in adopting GM technologies. These innovators are followed by a majority (60%) who belong to the 'early adopter' category. This is contrast with the classical 'adopter category' classification by Rogers in which generally we find only 3.5 percent and 13.5 percent of farmers in falling under 'innovator' and 'early adopter' categories respectively. The findings hold good for public as well as private research institutions who aim for mass popularization of GM crops in future.

3. Determinants of Farmer Readiness (GM Readiness) and Their Individual Contribution

Relationship between GM Readiness and Independent Variables

A cursory look at Table 3 reveals the relationship between GM readiness and the independent variables used in the study. Eight variables namely GM awareness, WTP, WTT, and WTS, annual investment in agriculture, extension participation, cosmopoliteness and mass media usage had a significant relationship with GM readiness of the farmers.

Willingness to adopt any technology requires awareness regarding the technology and its working and application. Without proper awareness no farming population can move towards adoption of a technology. In case of a high end application like GM, this awareness becomes a highly important factor deciding their GM readiness and hence the significant relationship.

Table 3: Relationship between GM readiness and independent variables (n=120)

Independent variables	*Correlation coefficient 'r'*
GM awareness	0.842**
Willingness To Pay (WTP)	0.540**
Willingness To Trial in time (WTT)	0.534**
Willingness To Substitute available area (WTS)	0.299**
Willingness To Invest additionally (WTI)	0.106
Age	-0.119
Family size	0.021
Level of education	0.160
Experience in farming	0.014
Area under agriculture	0.112
Annual investment in agriculture	0.210*
Long term investment in agriculture	0.143
Extension participation	0.311**
Level of aspiration	0.112
Cosmopoliteness	0.343**
Risk taking ability	0.176
Trust in agencies	0.157
Economic motivation	0.088
Mass media usage	0.276**

**= Significant at 1% level
* = Significant at 5% level

The WTP, WTT and WTS are the quantitative parameters which act as clear indicators of the farmer interest in adopting GM crops and hence their GM readiness. In our study, it was hypothised that if the farmers are not having the sufficient WTP, WTT and WTS it will negatively affect their GM readiness. The results undoubtedly proved the same thus justifying the development and application of these new variables. Annual investment in agriculture is another quantitative variable which in monitory terms has high influence on readiness to adopt any new technology and hence the result.

Participation in extension programmes, cosmopoliteness and mass media usage are the variables which promote the GM awareness of farmers which in turn contributes to increased GM readiness thereby explaining the significant correlation with the dependent variable.

Extent of Contribution of Independent Variables Towards GM Readiness

Table 4 reveals the extent of contribution of the independent variables used in this study towards GM readiness. Out of the 19 independent variables selected and used for the study four variables namely, GM awareness, WTT, extension participation and cosmopoliteness had positive and significant contribution towards GM readiness. This shows that these are the variables contributing significantly to the variation in GM readiness. The R^2 value shows that all the 19 independent variables together could explain up to 80.6 per cent variation in GM readiness. This also proves that the choice of independent variables used for measuring GM readiness of Indian farmers was fairly good and result yielding.

Table 4: Extent of contribution of independent variables towards GM readiness (n=120)

Independent variables	*Standardized Regression coefficient 'b'*
GM awareness	0.776**
Willingness To Pay (WTP)	0.129
Willingness To Trial in time (WTT)	0.163**
Willingness To Substitute available area (WTS)	0.053
Willingness To Invest additionally (WTI)	0.005
Age	-0.007
Family size	0.013
Level of education	-0.026
Experience in farming	-0.016
Area under agriculture	-0.060
Annual investment in agriculture	0.221
Long term investment in agriculture	-0.206
Extension participation	-0.200**
Level of aspiration	0.070
Cosmopoliteness	0.135*
Risk taking ability	-0.086
Trust in agencies	0.021
Economic motivation	-0.043
Mass media usage	-0.014

Model	*R*	*R^2*	*Adjusted R^2*	*Std. Error of the Estimate*
1	0.898	0.806	0.769	4.5090

**= Significant at 1% level
* = Significant at 5% level

The results recommend that any agency involved in research, development and outreach of GM crops/biotechnology applications should concentrate mostly on building GM awareness, measuring and analyzing their clients' WTT, make them participate in extension programmes aimed at GM awareness and make efforts to improve and build cosmopoliteness. Dedicated efforts towards building up of these variables can lead to greater GM readiness among farmers.

Step-wise Regression Model Predicting GM Readiness

Table 5 reveals the results of step wise regression analysis which yielded 7 models explaining the variation in GM readiness. The model 7 explained up to 78.4 per cent variation in GM readiness with the predictors: constant, GM awareness, WTT, extension participation, cosmopoliteness and WTP. But considering the fact that model 5 had the lowest standard error of 4.5168 and that the further models 6 and 7 couldn't explain much more significant variation in GM readiness, the model 5 was selected as the best model to predict GM readiness of farmers. The regression model 5 which was found best suited to predict GM readiness is given below:

GM readiness = $17.847 + 0.804X_1 + 0.222X_2 - 0.063X_3 - 0.148X_4 + 0.117X_5$

Where, X_1 = GM awareness, X_2 = WTT, X_3 = Risk taking ability, X_4 = Extension participation and X_5 = Cosmopoliteness

The above model shows that any agency whether public or private; willing to measure or predict the willingness of their target clients towards new GM applications, the variables GM awareness, WTT, risk taking ability, extension participation and cosmopoliteness holds the key for them. Also, the model can be used for prediction of GM readiness under similar conditions.

4. Extent of Farmer Support for Biotechnology Applications in Agriculture

The extent of farmer support for ongoing biotechnology research in agriculture is depicted in Table 6.The support was highest for crops requiring lesser chemical fertilizers with 92.5 per cent of the farmers supporting it. This is due to the fact that fertilizer costs are not affordable by small and marginal farmers and hence research on GM crops requiring less chemical fertilizers was widely supported.

Applications like crops requiring less water for growth, crops having long shelf life periods, drought tolerant crops and saline tolerant crops garnered support from 91.7 per cent of the farmers and stood second. This is due to the fact that water has become a scarce resource and also farmers in India don't have an institutionalized cold chain support there by incurring huge losses

Table 5: Stepwise regression analysis of independent variables with GM readiness (n=120)

Model	*R*	*R^2*	*Adjusted R^2*	*Std. Error of the Estimate*
1	0.842	0.709	0.706	5.0867
2	0.865	0.748	0.743	4.7541
3	0.871	0.758	0.752	4.6769
4	0.877	0.768	0.760	4.5951
5	0.882	0.778	0.768	4.5168
6	0.880	0.775	0.767	4.5276
7	0.886	0.784	0.775	4.5515

Models	*Predictors*
Model 1	(Constant), GM awareness.
Model 2	(Constant), GM awareness, WTT.
Model 3	(Constant), GM awareness, WTT, Risk taking ability.
Model 4	(Constant), GM awareness, WTT, Risk taking ability, Extension participation.
Model 5	(Constant), GM awareness, WTT, Risk taking ability, Extension participation, Cosmopoliteness.
Model 6	(Constant), GM awareness, WTT, Extension participation, Cosmopoliteness.
Model 7	(Constant), GM awareness, WTT, Extension participation, Cosmopoliteness, WTP.

every time perishable crops suffer a price crash. Salinity has rendered much area in India uncultivable and hence the wide support for that application.

Research on crops requiring lesser pesticides and herbicide tolerant crops were closely supported by 89.2 per cent of the farmers while nutritionally enhanced cereals (77.5%) and nutritionally enhanced vegetables and fruits (72.5%) also got wide support. Pesticide applications take a major chunk of the farming expenses incurred by the poor farmers in this village and the idea of crops requiring fewer pesticide applications was readily accepted and supported. Herbicide tolerance was supported as an 'utility idea' while the promises of nutritional enhancement through biotechnology has fascinated the imagination of the villagers contributing to the excellent support. The same principle worked in case of support for protein enriched tubers and cereals.

Crops containing hormones were supported by only 46.7 per cent and crops containing vaccines by only a mere 38.3 per cent. In the above two cases, the idea of inserting genes producing hormones and vaccines in to edible crops was viewed with suspicion and fear which has resulted in low support.

Crops with terminator seeds were not supported by any farmer with almost all farmers (92.5%) fully opposing research and development of that application. This is due to the fact that terminator application was viewed as a threat to the basis of agriculture itself where a farmer who cultivates a crop is not allowed to take the seeds of his crop for raising the next crop. This is part of a global agenda of multinational seed giants to cheat the poor farmers of the developing countries there by making them dependent on the companies for seeds in every subsequent cropping season. Hence, research on this application was vehemently opposed by the farmers by using their commonsense.

CONCLUSION

The present study attempted to draw an initial picture regarding farmer readiness towards GM technologies. The antecedents of 'GM readiness' revealed by this study will serve as guide-

Table 6: Extent of farmer support for ongoing biotechnology research in agriculture (n=120)

S. No.	*Ongoing biotechnology research in agriculture*	*Support*		*Neutral*		*Oppose*	
		f	*%*	*f*	*%*	*f*	*%*
1.	Nutritionally enhanced cereals like Golden rice	93	77.5	14	11.7	13	10.8
2.	Nutritionally enhanced vegetables and fruits	87	72.5	23	19.2	10	8.3
3.	Crops requiring less water for growth	110	91.7	2	1.6	8	6.7
4.	Crops requiring lesser pesticides	107	89.2	13	10.8	0	0
5.	Crops requiring lesser chemical fertilizers	111	92.5	9	7.5	0	0
6.	Crops containing hormones for better human health	56	46.7	19	15.8	45	37.5
7.	Crops containing vaccines against human diseases	46	38.3	3	2.5	71	59.2
8.	Crops having long shelf life periods	110	91.7	2	1.6	8	6.7
9.	Protein enriched tubers	88	73.3	27	22.5	5	4.2
10.	Protein enriched cereals	88	73.3	27	22.5	5	4.2
11.	Drought tolerant crops	110	91.7	2	1.6	8	6.7
12.	Saline tolerant crops	110	91.7	2	1.6	8	6.7
13.	Herbicide tolerant crops	107	89.2	13	10.8	0	0
14.	Crops with terminator seeds	0	0	10	7.5	110	92.5

line for GM researchers. The willingness indices measured can be used for chalking out strategies with respect to pricing, production and release of GM crop varieties in the future. Extension implications from these findings are likely in the areas of developing dedicated 'biotech outreach' towards improved education about the potential of new GM technologies. The stepwise regression model developed will provide help in predicting the GM readiness of farmers under similar conditions. Concerted efforts at developing dedicated *'biotech-outreach'* strategies involving policy makers, researchers and extension agencies only will work for GM crops in developing countries like India. The study reveals that contrary to popular belief and media projections, farmers are highly supportive of biotechnology applications in Indian agriculture. Orchestrated bashing of scientific institutions and their findings by NGOs and media has pushed the scientific facts to background. Policy makers have to take note of scientific studies by reputed agencies and their results so as to reorient the current research and policies with respect to GM crops in the larger interest of Indian agriculture and farmers.

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