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A STUDY ON SCHOOL TEACHERS' ATTITUDES TOWARDS GENETICALLY MODIFIED ORGANISMS

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ABSTRACT

Genetically modified crops GMCs, GM crops, or biotech crops are plants used in agriculture, the DNA of which has been modified using genetic engineering techniques. In most cases, the aim is to introduce a new trait to the plant which does not occur naturally in the species. This paper deals with school teachers' attitude towards genetically modified organisms. It outlines the various dimensions of attitude on genetically modified organisms and such attitudes are measured with help of 5 point rating scale. This paper concludes with some interesting findings.

KEYWORDS: ***Genetically modified crops, agriculture, organisms***

INTRODUCTION

The World Health Organization (WHO) defines GMOs as those organisms in which the genetic material has been altered in a way that does not occur naturally. As genetically modified (GM) foods are starting to be present in our diet concerns have been expressed regarding GM food safety. Although the WHO declares that the GM products that are currently on the international market have all gone through risk assessment by national authorities, the risk assessment of GM foods in general, and crops in particular for human nutrition and health, has not been systematically performed as indicated in the scientific literature. Evaluations for each GM crop or trait have been conducted using different feeding periods, animal models, and parameters. The most common result is that GM and conventional sources induce similar nutritional performance and growth in animals. However, adverse microscopic and molecular effects of some GM foods in different organs or tissues have been reported to a certain extent. Diversity among the methods and results of the risk assessments reflects the complexity of the subject. Among the different GMOs, in recent years GM plants have attracted a large amount of media attention. However, the general public remains largely unaware of the real notion of GM plants or what advantages and disadvantages the technology has to offer, particularly with regard to the range of applications for which they can be used. From the first

generation of GM crops, two main areas of concern have emerged, namely risk to the environment and risk to human health. As GM plants are gradually being introduced into the European Union it is likely that public concern regarding potential health issues will arise. Although it is now commonplace for the press and media to adopt 'health campaigns', the information they publish is often unreliable and unrepresentative of the available scientific evidence. Approximately 15 years have passed after the introduction of genetic modifications in food, and new GM products are currently added to the existing list of foods. However, 10 years ago we already noticed that there was no sufficient published information concerning safety of GM foods in general, and GM plants, in particular. Specifically, the lack of published toxicological studies on adverse health effects was evident.

A global food security crisis is underway. Grain reserves are critically depleted, environmental extremes are compromising productivity, and cereal prices continue to rise. Although the causes of this crisis are complex, they are disclosing the Achilles' heel of a prolonged underinvestment in agricultural research and controversial agricultural policies. One of the most significant innovations in agriculture since the Green Revolution is the development of transgenic crops and this technology offers great opportunities to sustainably tackle some of the major agricultural productivity challenges of our time caused by arable land shortage, population growth, urbanisation and climate change. Modern plant biotechnology has been widely and repeatedly acknowledged by the major intergovernmental agencies in recent years; indeed innovation through plant biotechnology is viewed to be of major importance in our efforts to achieve the objectives of the Millennium Development Goals. Still, the progress towards pro-poor GM innovations is slow, due in part to limited interest of the private sector, intellectual property, regulatory considerations and last but not least, strong globally organized opposition. This has driven an escalation in the cost of biosafety regulations with the result that the ability of the public sector to conduct field trials is restricted, and public sector institutions in the developing countries are unable to bring their innovations to the farmer. Field trials are the only way for the societal, environmental and biological benefits to be assessed, and their continuation – particularly in developing countries – must be lobbied for at the highest levels. It is ironic that many of the GM crop varieties blocked in development that would lead to lower pesticide applications, nutritional benefits and general environmental protection, are of direct interest to those who oppose their deployment. Policy makers should keep in mind that regulatory compliance and biosafety regulations must be brought in line with appropriate scientific evidence, regarding risk benefit, and reduce the costs of these procedures. The risk of not doing so is to have a powerful innovation in agriculture only in the hands of big multinational agribusiness industries, while SMEs, public research sector and developing countries that need it most will be unable to participate in – and contribute to – this emerging bio-economy.

A REVIEW OF STUDIES ON GENETICALLY MODIFIED FOOD

According to Larson (1999), GMO technology could play a critical role in developing a sustainable agriculture in our world by minimizing use of natural resources, reducing environmental impacts and protecting the earth's productive capacity for future generations. GMO technology offers increased biological resistance to ever-present pests and diseases, thereby reducing the need for chemical pesticides, decreasing the risk of crop failure, and increasing yields. It improves plants adaptability to harsh growing conditions such as drought, saline soils, and temperature extremes and tolerance to environmentally safe herbicides that discourage weeds but leave the desired plant unaffected.

NABC (2000) states that GMO technology brings desirable functional characteristics such as faster ripening, increased starch content, longer shelf life or better flavor and color, and desirable nutritional characteristics such as altered protein or fat content and increased phytochemical or nutrient content. Hodgson (2000) notes that GMO had been applied on livestock breeding, microbial

production of substances used in food processing and human medicines as well as numerous pharmaceutical applications including the mass production of pure human insulin for diabetes management.

U.S. Census Bureau (2002) reports an important contribution of GMO technology is to satisfy the global need for increased food production, driven by the still growing population. The world's current population is approaching 6.2 billion people. Out of that number, about 1 million of them are chronically under-nourished. Global population is estimated to grow a minimum of 2 billion in the next 25 years. At the same time land and water resources, biodiversity, and the ecology continue to be depleted. In order to feed the growing population, a solution to grow more food on less land needs to be put in place. GMO technology may provide a solution to this dilemma.

According to Kerr (1999) the rapid rates of technological improvements possible using modern biotechnology, the product life cycle of new genetically modified organisms (GMO) is likely to be short and, hence, those investing in their development will desire access to the widest possible international market. However, new technologies like GMO will be subjected to intense public scrutiny. Therefore, consumer perception and technological understanding are very important to GMO developers, government and GMO-using firms who are near the consumer end of the supply chain.

May, et al., (2001) reported that Americans have shown little of mass rejection of genetically modified (GM) foods seen in Europe. Results of recent studies by The Wirthlin Worldwide survey indicate that about 62 percent of Americans would likely buy produce that is biotechnology-enhanced to taste better or fresher. If biotechnology were used to protect produce from insect damage resulting in fewer pesticide applications, about 77 percent said that they would likely buy the biotechnology-enhanced produce.

Petty and Cacioppo (1981) view that it is important to provide consumers and the public with objective information based on scientific evidence about genetically modified organisms (GMO) to help them make informed choices. The public needs to recognize the benefits, future promises, and tradeoffs that GMOs provide.

According to Frewer, Howard, and Shepherd (1998), there are two general ways or routes central and peripheral in which attitudes are formed. When people are motivated to understand an issue and have the ability and opportunity to do so, their attitudes will form through a central route. When they are not motivated, lack the technical or cognitive ability to understand or the opportunity to think about it, any message will be peripherally processed. In this framework, a person's values, beliefs, and information processing style all contribute to how he or she understands the benefits and risks of the biotechnology process and of specific biotechnology foods. These factors, in turn, combine to form a person's attitude toward biotechnology.

Gaskell et al. (2006) reported from their study that Hawaii, its diverse population is quite different from US mainland and other regions. Therefore, results from a Hawaii study could be quite different than those done on the US mainland. It is necessary to analyze the sociodemographic determinants that influence public opinion toward GMO technology, and to understand how the different attitudes are influenced by ethnicity.

According to The European Commission (2005) present, there is a dearth of information on consumer attitude toward GMO technology in Hawaii. When looking at the literature, one can find a huge number of studies that generally explore consumers' opinions and attitudes towards genetically modified (GM) food, for example, regularly conducts representative surveys on biotechnology. The most recent survey, conducted in 2005, comes to the conclusion, that medical and industrial biotechnologies are broadly supported by the general public, whereas a strong opposition to agricultural biotechnologies exists.

Saba et al. (1998) and Lusk and Rozan (2008) try to explain the differences in consumer attitudes across countries and to explore determinants of attitudes towards genetically

modified foods. Hallman et al. (2002) and Lusk et al. 2003) reported from their study that in the United States, the International Food Information Council and the Food Policy Institute carried out comprehensive surveys on this issue, which indicate that American consumers have more positive attitudes towards the application of genetic engineering than Europeans.

Springer et al. (2004) viewed that consumer attitudes are directly formed by the perceived risks and benefits of genetically modified food, which in turn are affected by general consumer attitudes, with reference to attitudes towards the environment, consumer knowledge and trust in regulation bodies, as well as by sociodemographic characteristics.

Wachenheim, C.J. and T. Vanwechel (2004) investigated the impact of subjective and objective knowledge as well as the level of information and trust in risk regulation on consumer acceptability and demand for GM food. that national labelling policies might have an impact on the acceptance of GM food, too, as the actions of government will change individuals' beliefs about the safety of GM food. Furthermore, most consumers and organisations pushing for labelling want the process instead of the product labelled. This is because there are other concerns besides the desire for product safety for health reasons, like the effect of GMOs on the environment or ethical considerations.

Gruere and Rao (2007) argue that product based labelling benefits consumers by causing an increased variety of 'GMO-free' products on the shelves. This is due to the fact that product-based labelling standards are easier both to comply with and to control compared to process-based labelling standards, which in turn prevent producers from launching 'GMO free' labelled products because normally it is to expensive and complicated to control the whole production chain, especially for animal products. Opponents, on the other hand, argue that consumers expect from a 'GMO-free' labelled product that it has been produced without any form of genetic engineering throughout the whole production process. Accordingly, 'GMO-free' labels are only supportive for consumers if they provide this kind of expected information.

Miles et al. (2005) conducted a consumer survey in Italy, Norway and England, where more than 78% of the participants wanted processed food ingredients from a genetically modified food labelled, even if there is no genetically modified material in the final product. In another survey of the National Consumer Council (2001) in the United Kingdom in August 2001 notes that about 79% of consumers thought that meat and other products from GM feed should be labelled as such. This proportion is substantially higher than the number of people in this survey who were concerned about labelling food from GM plants.

Gaskell et al. (2003), found higher acceptance of genetic engineering in the fields of pharmaceutical development and hereditary illnesses compared to genetic engineering of plants and animals for food production purposes. This is not surprising, since other studies about the public acceptance of several branches of biotechnology also showed higher acceptance of genetic engineering in the fields of medicine and industry compared to agriculture.

METHODS AND MATERIALS

This paper examines the school teachers' attitudes towards genetically modified organisms. In this study samples are selected from the four groups of schools in Cuddalore district. They are CBSC schools, Matriculation schools, Government schools and Municipal schools. From each group of schools 50 teachers are selected sample under simple random sampling method. In total 200 teachers are selected sample under simple random sampling method. The relevant data collected from the teacher respondents with the help of questionnaire method. The questions relating to attitudes towards genetically modified organisms are collected from the respondents with the help of 5 point rating scale. The data interpretation is done with the help of average analysis, ANOVA two way method and t test.

RESPONDENTS' ATTITUDES TOWARDS GENETICALLY MODIFIED ORGANISMS

This section deals with respondents' rating on attitudes towards genetically modified organisms. It can be assessed with the help of 30 factors on a 5 point rating scale. These include GMO consumption increases number of allergies, chocolate containing fats from GM soya, cultivation of GMO requires less application of spray for pests and pathogens, GMO plants are more accepted than GMO animals, education about GMOs should be organized for all school teachers irrespective of the subject they teach, GMO apples are not accepted, beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food, cultivation of GMO plants in garden, buying food stuff containing GMOs, teaching about GMOs inculcates values and a moral and ethical component, GMO food are healthier than conventional food, GMO research should be additionally stimulated, GMO research should be prohibited until it is clear that it is entirely safe, researchers working on GMOs conceal data about their harmful effects, preparation of school meal with GMOs affects the health of the children, GMO could cross into the environment, effects of GMO consumption could show up after a long time period, worrying about farmers' cultivate the GMO crops, bacterial resistance to antibiotics may increase because of GMOs, students are not capable of creating their own system of values about GMOs and need to be guided by teacher, food stuff produced from GMO are marketed without labeling system, production of GMOs is against the laws of nature and should be forbidden, GMO should be a topic in subjects such as biology and home economy and not in other school subject, Buying GM ornamental house plants out of curiosity, transferring, genes from animals to plants is scientifically possible, eating GM foods will not modify a person's gene, creating GM plants and animals is morally wrong, human have a duty to respect nature and animal welfare, genetic modification is like playing God and genetic modification violates the basic principles regarding the relationship between human and nature.

Table 1 School Wise Respondents' Rating on Attitudes towards Genetically modified organisms

Variables	Matriculation schools	Municipal schools	Government schools	CBSC schools	Mean
GMO consumption increases number of allergies	2.68	2.49	2.86	3.05	2.77
Chocolate containing fats from GM soya	3.12	2.93	3.30	3.49	3.21
Cultivation of GMO requires less application of spray for pests and pathogens	3.52	3.33	3.70	3.89	3.61
GMO plants are more accepted than GMO animals	2.16	1.97	2.34	2.53	2.25
Education about GMOs should be organized for all school teachers irrespective of the subject they teach	3.71	3.52	3.89	4.08	3.80
GMO Apples are not accepted	2.59	2.40	2.77	2.96	2.68
Beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food	3.07	2.88	3.25	3.44	3.16
Cultivation of GMO plants in garden	2.06	1.87	2.24	2.43	2.15
Buying food stuff containing GMOs	4.16	4.11	4.20	4.23	4.15
Teaching about GMOs inculcates values and a moral and ethical component	3.45	3.26	3.63	3.82	3.54
GMO food are healthier than conventional food	2.10	1.91	2.28	2.47	2.19
GMO research should be additionally stimulated	3.75	3.56	3.93	4.12	3.84
GMO research should be prohibited until it is clear that it is entirely safe	2.80	2.61	2.98	3.17	2.89
Researchers working on GMOs conceal data about their harmful effects	3.18	2.99	3.36	3.55	3.27
Preparation of school meal with GMOs affects the health of the children	2.93	2.74	3.11	3.30	3.02
GMO could cross into the environment	3.65	3.46	3.83	4.02	3.74
Effects of GMO consumption could show up after a long time period	2.55	2.36	2.73	2.92	2.64
Worrying about farmers' cultivate the GMO crops	2.27	2.08	2.45	2.64	2.36
Bacterial resistance to antibiotics may increase because of GMOs	4.05	3.76	4.13	4.22	4.04
Students are not capable of creating their own system of values about GMOs and need to be guided by teacher	2.38	2.19	2.56	2.75	2.47
Food stuff produced from GMO are marketed without labeling system	2.86	2.67	3.04	3.23	2.95
Production of GMOs is against the laws of nature and should be forbids	3.26	3.07	3.44	3.63	3.35
GMO should be a topic in subjects such as biological and home economy and not in other school subjects	3.40	3.21	3.58	3.77	3.49
Buying GM ornamental house plants out of curiosity	3.80	3.61	3.98	4.17	3.89
Transferring, genes from animals to plants is scientifically possible	4.10	3.91	4.18	4.17	4.09
Eating GM foods will not modify a person's gene	2.33	2.14	2.51	2.70	2.42
Creating GM plants and animals is morally wrong	3.85	3.66	4.03	4.22	3.94
Human have a duty to respect nature and animal welfare	3.90	3.81	4.08	4.17	3.99
Genetic modification is like playing god	2.50	2.31	2.68	2.87	2.59
Genetic modification violates the basic principles regarding the relationship between human and nature	3.33	3.14	3.51	3.70	3.42
Average	3.12	2.56	2.96	3.46	3.20

Source: Computed from the primary data

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*F crit*
Variation due to attitude components	47.22594	29	1.628481	764.6824	1.597822
Variation due to schools	4.567823	3	1.522608	714.9679	2.709402
Error	0.185277	87	0.00213		
Total	51.97904	119			

Data presented in table 1 indicate the school wise respondents' rating on attitudes towards genetically modified organisms. It could be noted that out of the 30 attitudes towards genetically modified organisms, the respondents rate the buying food stuff containing GMOs as their first level attitude towards genetically modified organisms and it is evident from their secured a mean score of 4.15 on a 5 point rating scale. Transferring, genes from animals to plants is scientifically possible is rated at second level attitude towards genetically modified organisms and it is estimated from the respondents' secured a mean score of 4.09 on a 5 point rating scale. The respondents have attitude towards genetically modified organisms by citing the situation of bacterial resistance to antibiotics may increase because of GMOs as their third level observed event. It is evident from their secured a mean score of 4.04 on a 5 point rating scale. The respondents possess the fourth level attitude towards genetically modified organisms by citing the event of human have a duty to respect nature and animal welfare and it is observed from the respondents' secured a mean score of 3.99 on a 5 point rating scale. Creating GM plants and animals is morally wrong is rated at fifth level attitude and it could be known from the respondents' secured a mean score of 3.94 on a 5 point rating scale.

The respondents rate the buying GM ornamental house plants out of curiosity as their rated sixth level attitude towards genetically modified organisms and it is revealed from their secured a mean score of 3.89 on a 5 point rating scale. GMO research should be additionally stimulated is rated at seventh level attitude towards genetically modified organisms and it observed from the respondents' secured a mean score of 3.84 on a 5 point rating scale. The respondents rate the attitude towards genetically modified organisms by citing the fact that education about GMOs should be organized for all school teachers irrespective of the subject they teach and it is their eighth level ranking. It is evident from their secured a mean score of 3.80 on a 5 point rating scale. The respondents hold the ninth level attitude towards genetically modified organisms by citing the event that GMO could cross into the environment as per their secured a mean score of 3.74 on a 5 point rating scale. Cultivation of GMO requires less application of spray for pests and pathogens is rated at tenth level attitude towards genetically modified organisms and it is evident from the respondents' secured a mean score of 3.61 on a 5 point rating scale.

The respondents rate the teaching about GMOs inculcates values and a moral and ethical component as their eleventh level attitude towards genetically modified organisms and it could be known from their secured a mean score of 3.54 on a 5 point rating scale. GMO should be a topic in subjects such as biology and home economy and not in other school subjects is rated at twelfth level attitude towards genetically modified organisms and it is reflected from the respondents' secured a mean score of 3.49 on a 5 point rating scale. The respondents rank the thirteenth level attitude towards genetically modified organisms by citing the event that genetic modification violates the basic principles regarding the relationship between human and nature. It is evident from their secured a mean score of 3.42 on a 5 point rating scale. The respondents rank the fourteenth level attitude towards genetically modified organisms by citing the fact that production of GMOs is against the laws of nature and it should be forbidden and it is clear from their secured a mean score of 3.35 on a 5 point rating scale. Researchers working on GMOs conceal data about their harmful effects is rated at fifteenth level attitude towards genetically modified organisms as per the respondents' secured a mean score of 3.27 on a 5 point rating scale.

The respondents rate the chocolate containing fats from GM soya as their sixteenth level rated attitude towards genetically modified organisms and it is revealed from their secured a mean score of 3.21 on a 5 point rating scale. Beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food is rated at seventeenth level attitude towards genetically modified organisms and it is revealed from the respondents' secured a mean score of 3.16 on a 5

point rating scale. The respondents hold the attitude towards genetically modified organisms by citing the event that preparation of school meal with GMOs affects the health of the children and it is evident from their eighteenth level ranking of attitude towards genetically modified organisms. It is known from their secured a mean score of 3.02 on a 5 point rating scale. The respondents rank the nineteenth level attitude towards genetically modified organisms by citing the event of food stuff produced from GMO are marketed without labeling system as per their secured a mean score of 2.95 on a 5 point rating scale.

The respondents rate the GMO research should be prohibited until it is clear that it is entirely safe as their rated twentieth level attitude towards genetically modified organisms and it is revealed from their secured a mean score of 2.89 on a 5 point rating scale. GMO consumption increases number of allergies is rated at twenty first level attitude towards genetically modified organisms and it observed from the respondents' secured a mean score of 2.77 on a 5 point rating scale. The respondents rate the attitude towards genetically modified organisms by citing the fact that GMO apples are not accepted and it is their twenty second level ranking. It is evident from their secured a mean score of 2.68 on a 5 point rating scale. The respondents hold the twenty third level attitude towards genetically modified organisms by citing the fact that effects of GMO consumption could show up after a long time period as per their secured a mean score of 2.64 on a 5 point rating scale. Genetic modification is like playing God is rated at twenty fourth level attitude towards genetically modified organisms and it is evident from the respondents' secured a mean score of 2.59 on a 5 point rating scale.

The respondents' rate the students are not capable of creating their own system of values about GMOs and need to be guided by teacher as their twenty fifth level attitude towards genetically modified organism and it could be known from their secured a mean score of 2.47 on a 5 point rating scale. Eating GM foods will not modify a person's gene is rated at twenty sixth level attitude towards genetically modified organisms and it is reflected from the respondents' secured a mean score of 2.42 on a 5 point rating scale. The respondents rank the twenty seventh level attitude towards genetically modified organisms by citing the event of worrying about farmers' cultivate the GMO crops. It is evident from their secured a mean score of 2.36 on a 5 point rating scale. The respondents rank the twenty eighth level attitude towards genetically modified organisms by citing the event that GMO plants are more accepted than GMO animals and it is clear from their secured a mean score of 2.25 on a 5 point rating scale. GMO food are healthier than conventional food is rated at twenty ninth level attitude towards genetically modified organisms as per the respondents' secured a mean score of 2.19 on a 5 point rating scale. The respondents rate the cultivation of GMO plants in garden as their thirtieth level rated attitude towards genetically modified organisms and it is revealed from their secured a mean score of 2.15 on a 5 point rating scale.

The CBSC school teacher respondents' rank the first positions in their overall rated attitudes towards genetically modified organisms as per their secured a mean score of 3.46 on a 5 point rating scale. The matriculation school teacher respondents' record the second position in their overall rated attitudes towards genetically modified organisms and it is known from their secured a mean score of 3.12 on a 5 point rating scale. The government school teacher respondents' register the third position in their overall rated attitudes towards genetically modified organisms and it is computed from their secured a mean score of 2.96 on a 5 point rating scale. The municipal school teacher respondents' come down to the last position in their overall rated attitudes towards genetically modified organisms and it is estimated from their secured a mean score of 2.56 on a 5 point rating scale.

The anova two way model is applied for further discussion. The computed anova value 764.68 is greater than its tabulated value at 5 percent level significance. Hence, the variation among the overall rated attitudes towards genetically modified organisms is statistically identified as

significant. In another point, the computed anova value 714.96 is greater than its tabulated value at 5 percent level significance. Hence, the variation among the schools is statistically identified as significant as per the respondents rating on attitudes towards genetically modified organisms.

Table 2 Education Wise Respondents' Rating on Attitudes towards Genetically modified organisms

Variables	Post graduate science degree	Post graduate social science degree	Under post graduate science degree	Under graduate social science degree	Mean
GMO consumption increases number of allergies	3.12	2.88	2.66	2.42	2.77
Chocolate containing fats from GM soya	3.56	3.32	3.10	2.86	3.21
Cultivation of GMO requires less application of spray for pests and pathogens	3.96	3.72	3.50	3.26	3.61
GMO plants are more accepted than GMO animals	2.50	2.36	2.14	2.00	2.25
Education about GMOs should be organized for all school teachers irrespective of the subject they teach	4.15	3.91	3.69	3.45	3.80
GMO Apples are not accepted	3.03	2.79	2.57	2.33	2.68
Beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food	3.51	3.27	3.05	2.81	3.16
Cultivation of GMO plants in garden	2.40	2.26	2.04	1.90	2.15
Buying food stuff containing GMOs	4.20	4.16	4.14	4.10	4.15
Teaching about GMOs inculcates values and a moral and ethical component	3.89	3.65	3.43	3.19	3.54
GMO food are healthier than conventional food	2.44	2.30	2.08	1.94	2.19
GMO research should be additionally stimulated	4.19	3.95	3.73	3.49	3.84
GMO research should be prohibited until it is clear that it is entirely safe	3.24	3.00	2.78	2.54	2.89
Researchers working on GMOs conceal data about their harmful effects	3.62	3.38	3.16	2.92	3.27
Preparation of school meal with GMOs affects the health of the children	3.37	3.13	2.91	2.67	3.02
GMO could cross into the environment	4.09	3.85	3.63	3.39	3.74
Effects of GMO consumption could show up after a long time period	2.99	2.75	2.53	2.29	2.64
Worrying about farmers' cultivate the GMO crops	2.71	2.47	2.25	2.01	2.36
Bacterial resistance to antibiotics may increase because of GMOs	4.19	4.15	4.03	3.89	4.04
Students are not capable of creating their own system of values about GMOs and need to be guided by teacher	2.82	2.58	2.36	2.12	2.47
Food stuff produced from GMO are marketed without labeling system	3.30	3.06	2.84	2.60	2.95
Production of GMOs is against the laws of nature and should be forbids	3.70	3.46	3.24	3.00	3.35
GMO should be a topic in subjects such as biological and home economy and not in other school subjects	3.84	3.60	3.38	3.14	3.49
Buying GM ornamental house plants out of curiosity	4.21	4.03	3.78	3.54	3.89
Transferring, genes from animals to plants is scientifically possible	4.20	4.10	4.08	3.94	4.09
Eating GM foods will not modify a person's gene	2.77	2.53	2.31	2.07	2.42
Creating GM plants and animals is morally wrong	4.19	4.05	3.83	3.69	3.94
Human have a duty to respect nature and animal welfare	4.14	4.10	3.98	3.74	3.99
Genetic modification is like playing god	2.94	2.70	2.48	2.24	2.59
Genetic modification violates the basic principles regarding the relationship between human and nature	3.77	3.53	3.31	3.07	3.42
Average	3.50	3.30	3.10	2.89	3.20

Source: Computed from the primary data

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*F crit*
Variation due to attitude components	47.13295	29	1.625274	329.0871	1.597822
Variation due to educational level	6.26843	3	2.089477	423.0793	2.709402
Error	0.42967	87	0.004939		
Total	53.83105	119			

Table 2 presents data on the education wise respondents' rating on attitudes towards genetically modified organisms. The post graduate science degree level educated respondents rank the first position in their overall rated attitudes towards genetically modified organisms and it is evident from their secured a mean score of 3.50 on a 5 point rating scale. The post graduate social science degree level educated respondents record the second position in their overall ranked attitudes towards genetically modified organisms and it is revealed from their secured a mean score of 3.30 on a 5 point rating scale. The under graduate science degree level educated respondents register the third position in their overall rated attitudes towards genetically modified organisms and it isreflected from their secured a mean score of 3.10 on a 5 point rating scale. The under graduate social science degree level educated respondents come down to the last position in their overall rated attitudes towards genetically modified organisms and it is estimated from their secured a mean score of 2.89 on a 5 point rating scale.

The anova two way model is applied for further discussion. The computed anova value 329.08 is greater than its tabulated value at 5 percent level significance. Hence, the variation among the overall rated attitudes towards genetically modified organisms is statistically identified as significant. In another point, the computed anova value 423.07 is greater than its tabulated value at 5 percent level significance. Hence, the variation among the educational groups is statistically identified as significant as per the respondents rating on attitudes towards genetically modified organisms.

Table 3 Caste Wise Respondents' Rating on Attitudes towards Genetically modified organisms

Variables	Forward caste	Backward caste	Most backward caste	Scheduled caste	Mean
GMO consumption increases number of allergies	2.99	2.90	2.64	2.55	2.77
Chocolate containing fats from GM soya	3.43	3.34	3.08	2.99	3.21
Cultivation of GMO requires less application of spray for pests and pathogens	3.83	3.74	3.48	3.39	3.61
GMO plants are more accepted than GMO animals	2.47	2.38	2.12	2.03	2.25
Education about GMOs should be organized for all school teachers irrespective of the subject they teach	4.02	3.93	3.67	3.58	3.80
GMO Apples are not accepted	2.90	2.81	2.55	2.46	2.68
Beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food	3.38	3.29	3.03	2.94	3.16
Cultivation of GMO plants in garden	2.37	2.28	2.02	1.93	2.15
Buying food stuff containing GMOs	4.22	4.18	4.12	4.07	4.15
Teaching about GMOs inculcates values and a moral and ethical component	3.76	3.67	3.41	3.32	3.54
GMO food are healthier than conventional food	2.41	2.32	2.06	1.97	2.19
GMO research should be additionally stimulated	4.06	3.97	3.71	3.62	3.84
GMO research should be prohibited until it is clear that it is entirely safe	3.11	3.02	2.76	2.67	2.89
Researchers working on GMOs conceal data about their harmful effects	3.49	3.40	3.14	3.05	3.27

Preparation of school meal with GMOs affects the health of the children	3.24	3.15	2.89	2.80	3.02
GMO could cross into the environment	3.96	3.87	3.61	3.52	3.74
Effects of GMO consumption could show up after a long time period	2.86	2.77	2.51	2.42	2.64
Worrying about farmers' cultivate the GMO crops	2.58	2.49	2.23	2.14	2.36
Bacterial resistance to antibiotics may increase because of GMOs	4.16	4.07	4.01	3.92	4.04
Students are not capable of creating their own system of values about GMOs and need to be guided by teacher	2.69	2.60	2.34	2.25	2.47
Food stuff produced from GMO are marketed without labeling system	3.17	3.08	2.82	2.73	2.95
Production of GMOs is against the laws of nature and should be forbids	3.57	3.48	3.22	3.13	3.35
GMO should be a topic in subjects such as biological and home economy and not in other school subjects	3.71	3.62	3.36	3.27	3.49
Buying GM ornamental house plants out of curiosity	4.11	4.02	3.76	3.67	3.89
Transferring, genes from animals to plants is scientifically possible	4.21	4.12	4.06	3.97	4.09
Eating GM foods will not modify a person's gene	2.64	2.55	2.29	2.20	2.42
Creating GM plants and animals is morally wrong	4.16	4.07	3.81	3.72	3.94
Human have a duty to respect nature and animal welfare	4.20	4.12	3.86	3.78	3.99
Genetic modification is like playing god	2.81	2.72	2.46	2.37	2.59
Genetic modification violates the basic principles regarding the relationship between human and nature	3.64	3.55	3.29	3.20	3.42
Average	3.41	3.32	3.08	2.99	3.20

Source: Computed from the primary data

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*F crit*
Variation due to attitude components	47.01388	29	1.621168	1102.987	1.597822
Variation due to caste status	3.464002	3	1.154668	785.5956	2.709402
Error	0.127873	87	0.00147		
Total	50.60576	119			

Table 3 presents data on the caste wise respondents' attitudes towards genetically modified organisms. The forward caste respondents rank the first position in their overall revealed attitudes towards genetically modified organisms and it is evident from their secured a mean score of 3.41 on a 5 point rating scale.The backward caste respondents' record the second position in their overall rated attitudes towards genetically modified organisms and it is learnt from their secured a mean score of 3.32 on a 5 point rating scale. The most backward caste respondents register the third position in their overall reflected attitudes towards genetically modified organisms and it is revealed from their secured a mean score of 3.08 on a 5 point rating scale. The schedule caste respondents come down to the last position in their overall experienced attitudes towards genetically modified organisms as per their secured a mean score of 2.99 on a 5 point rating scale.

The anova two ways model is applied for further discussion. The computed anova value 1102.98 is greater than its tabulated value at 5 percent level significance. Hence, the variation among the overall attitudes towards genetically modified organisms is statistically identified as significant. In another point, the computed anova value 785.59 is greater than its tabulated value at 5 percent level significance. Hence, the variation among the caste groups is statistically identified as significant as per the respondents rating on attitudes towards genetically modified organisms.

Table 4 Sex Wise Respondents' Rating on Attitudes towards Genetically modified organisms

Variables	Male	Female	Mean
GMO consumption increases number of allergies	3.16	2.38	2.77
Chocolate containing fats from GM soya	3.60	2.82	3.21
Cultivation of GMO requires less application of spray for pests and pathogens	4.00	3.22	3.61
GMO plants are more accepted than GMO animals	2.44	2.06	2.25
Education about GMOs should be organized for all school teachers irrespective of the subject they teach	4.19	3.41	3.80
GMO Apples are not accepted	3.07	2.29	2.68
Beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food	3.55	2.77	3.16
Cultivation of GMO plants in garden	2.25	2.06	2.15
Buying food stuff containing GMOs	4.24	4.06	4.15
Teaching about GMOs inculcates values and a moral and ethical component	3.93	3.15	3.54
GMO food are healthier than conventional food	2.38	2.00	2.19
GMO research should be additionally stimulated	4.23	3.45	3.84
GMO research should be prohibited until it is clear that it is entirely safe	3.28	2.50	2.89
Researchers working on GMOs conceal data about their harmful effects	3.66	2.88	3.27
Preparation of school meal with GMOs affects the health of the children	3.41	2.63	3.02
GMO could cross into the environment	4.13	3.35	3.74
Effects of GMO consumption could show up after a long time period	3.03	2.25	2.64
Worrying about farmers' cultivate the GMO crops	2.55	2.77	2.36
Bacterial resistance to antibiotics may increase because of GMOs	4.23	3.85	4.04
Students are not capable of creating their own system of values about GMOs and need to be guided by teacher	2.86	2.08	2.47
Food stuff produced from GMO are marketed without labeling system	3.34	2.56	2.95
Production of GMOs is against the laws of nature and should be forbids	3.74	2.96	3.35
GMO should be a topic in subjects such as biological and home economy and not in other school subjects	3.88	3.10	3.49
Buying GM ornamental house plants out of curiosity	4.18	3.60	3.89
Transferring, genes from animals to plants is scientifically possible	4.18	4.00	4.09
Eating GM foods will not modify a person's gene	2.81	2.03	2.42
Creating GM plants and animals is morally wrong	4.13	3.75	3.94
Human have a duty to respect nature and animal welfare	4.18	3.70	3.99
Genetic modification is like playing god	2.98	2.20	2.59
Genetic modification violates the basic principles regarding the relationship between human and nature	3.81	3.03	3.42
Average	3.51	2.90	3.20

Source: Computed from the primary data

T Statistical Value 12.73, df 29, T Critical Value 1.69

Data presented in table 4 indicate the sex wise respondents' rating on attitudes towards genetically modified organisms. The male respondents' ranks the first position in their overall rated attitudes towards genetically modified organisms as per their secured a mean score of 3.51 on a 5 point rating scale. The female respondents hold the second position in their over all rated attitudes towards genetically modified organisms as per their secured a mean score of 2.90 on a 5 point rating scale.

The T test is applied for further discussion. The computed t value 12.73 is greater than its tabulated value at 5 per cent level significance. Hence there is a significant difference between male respondents and female respondents in their overall rated attitudes towards genetically modified organisms.

Table 5 Area Wise Respondents' Rating on Attitudes towards Genetically modified organisms

Variables	Rural	Urban	Mean
GMO consumption increases number of allergies	2.31	3.23	2.77
Chocolate containing fats from GM soya	2.75	3.67	3.21
Cultivation of GMO requires less application of spray for pests and pathogens	3.15	4.07	3.61
GMO plants are more accepted than GMO animals	2.09	2.41	2.25
Education about GMOs should be organized for all school teachers irrespective of the subject they teach	3.34	4.26	3.80
GMO Apples are not accepted	2.22	3.14	2.68
Beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food	2.70	3.62	3.16
Cultivation of GMO plants in garden	1.99	2.31	2.15
Buying food stuff containing GMOs	3.69	4.61	4.15
Teaching about GMOs inculcates values and a moral and ethical component	3.08	4.00	3.54
GMO food are healthier than conventional food	2.03	2.35	2.19
GMO research should be additionally stimulated	3.38	4.30	3.84
GMO research should be prohibited until it is clear that it is entirely safe	2.43	3.35	2.89
Researchers working on GMOs conceal data about their harmful effects	2.81	3.73	3.27
Preparation of school meal with GMOs affects the health of the children	2.56	3.48	3.02
GMO could cross into the environment	3.28	4.20	3.74
Effects of GMO consumption could show up after a long time period	2.18	3.10	2.64
Worrying about farmers' cultivate the GMO crops	2.12	2.62	2.36
Bacterial resistance to antibiotics may increase because of GMOs	3.88	4.20	4.04
Students are not capable of creating their own system of values about GMOs and need to be guided by teacher	2.01	2.93	2.47
Food stuff produced from GMO are marketed without labeling system	2.49	3.41	2.95
Production of GMOs is against the laws of nature and should be forbids	2.89	3.81	3.35
GMO should be a topic in subjects such as biological and home economy and not in other school subjects	3.03	3.95	3.49
Buying GM ornamental house plants out of curiosity	3.63	4.15	3.89
Transferring, genes from animals to plants is scientifically possible	4.06	4.17	4.09
Eating GM foods will not modify a person's gene	2.26	2.58	2.42
Creating GM plants and animals is morally wrong	3.71	4.17	3.94
Human have a duty to respect nature and animal welfare	3.83	4.15	3.99
Genetic modification is like playing god	2.38	2.80	2.59
Genetic modification violates the basic principles regarding the relationship between human and nature	3.06	3.78	3.42
Average	2.84	3.55	3.20

Source: Computed from the primary data

T Statistical Value 13.77, df 29, T Critical Value 1.69

Data presented in table 5 indicate the area wise respondents' rating on attitudes towards genetically modified organisms. The urban respondents' ranks the first position in their overall rated attitudes towards genetically modified organisms as per their secured a mean score of 3.55 on a 5 point rating scale. The rural respondents hold the second position in their overall rated attitudes towards genetically modified organisms as per their secured a mean score of 2.84 on a 5 point rating scale.

The T test is applied for further discussion. The computed t value 13.77 is greater than its tabulated value at 5 per cent level significance. Hence there is a significant difference between urban respondents and rural respondents in their overall rated attitudes towards genetically modified organisms.

CONCLUSION

It could be seen clearly from the above discussion that the respondents' have high level attitudes towards genetically modified organisms by citing the events of buying food stuff containing GMOs, transferring, genes from animals to plants is scientifically possible, bacterial resistance to antibiotics may increase because of GMOs, human

have a duty to respect nature and animal welfare, creating GM plants and animals is morally wrong, Buying GM ornamental house plants out of curiosity, GMO research should be additionally stimulated, education about GMOs should be organized for all school teachers irrespective of the subject they teach, GMO could cross into the environment, cultivation of GMO requires less application of spray for pests and pathogens and teaching about GMOs inculcates values and a moral and ethical component as per their secured a mean score above 3.50 on a 5 point rating scale. The respondents' have the moderate level attitudes towards genetically modified organisms by stating the facts that GMO should be a topic in subjects such as biology and home economy and not in other school subjects, genetic modification violates the basic principles regarding the relationship between human and nature, production of GMOs is against the laws of nature and should be forbidden, researchers working on GMOs conceal data about their harmful effects, chocolate containing fats from GM soya, beef from animals fed with fodder that was cultivated with pesticides is more acceptable than beef from animals fed with genetically modified food, preparation of school meal with GMOs affects the health of the children, food stuff produced from GMO are marketed without labeling system, GMO research should be prohibited until it is clear that it is entirely safe, GMO consumption increases number of allergies, GMO apples are not accepted, effects of GMO consumption could show up after a long time period and genetic modification is like playing God as per their secured a mean score in the range of 2.50 to 3.50 on a 5 point rating scale. The respondents' have low level attitudes towards genetically modified organisms by indicating facts that students are not capable of creating their own system of values about GMOs and need to be guided by teacher, eating GM foods will not modify a person's gene, worrying about farmers' cultivate the GMO crops, GMO plants are more accepted than GMO animals, GMO food are healthier than conventional food and cultivation of GMO plants in garden as per their secured a mean score below 2.50 on a 5 point rating scale. It could be observed that the CBSC school teacher respondents' rank the first position in their rated overall attitudes towards genetically modified organisms, matriculation school teacher respondents' the second, government school teacher respondents' the third, and municipal school teacher respondents' the last.

The result of education wise analysis indicates that the post graduate science degree level educated respondents rank the first position in their overall rated attitudes towards genetically modified organisms, post graduate social science degree level educated respondents' the second, under graduate science degree level educated respondents' the third and under graduate social science degree level educated respondents' the last. The result of caste wise analysis reflects that that the forward caste respondents rank the first position in their overall revealed attitudes towards genetically modified organisms, backward caste respondents' the second, most backward caste respondents' the third and scheduled caste respondents' the last. The result of sex wise analysis points out that that the female respondents lag behind the male respondents in their overall rated attitudes towards genetically modified organisms and it is cleared that males are more aware of genetically modified organisms than the females. The result of area wise analysis shows that that the rural respondents lag behind the urban respondents in their overall rated attitudes towards genetically modified organisms.

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