MANAGING AGRICULTURAL PRODUCTION BY MINIMISING ENVIRONMENTAL RISKS: A STUDY OF FARMERS PERCEPTION OF ENVIRONMENTAL RISK IN PESTICIDE USE

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With the growing demand for enhancing foodgrain production to feed more than 90 crores people at one end and increasing yield loss due to pest infestation on the other, the farmers of India till recently, have been relying on chemical fertilizers and pesticides. It is estimated that about thirty percent of the potential of food production is lost due to insect pests, diseases, weeds, rodents and birds. In terms of money, it is estimated that every year crops worth Rs.6000 crore are lost due to pests (Sheth 1994). The demand for pesticides from the agricultural sector during 1989-90 was placed at 70, 000 tonnes. It may go up to 97, 000 tonnes by 2000 A.D. By that time, demand from public health sector may be around 21, 000 tonnes. Thus, the total demand for pesticides by 2000 A.D. may be around 118, 000 tonnes, (Sundaram 1992).

Although efforts are made to restrict pesticides to the target crops and their pests, pesticides easily reach adjacent vegetation, wild life, soil, water and some times humans (Piementel et al 1992). In this way, the impact of pesticides is felt throughout the environment and public health. Frequent use of pesticides often adversely affect the health of humans when they are exposed to them. Based on the survey data collected by the World Health Organisation (WHO/UNEP 1989), an estimated 1 million human pesticide poisoning occur each year in the world, with about 20,000 deaths. Health

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and environmental problems arise not only from the use of chemical pesticides but also from their production. For an example the Bhopal Gas tragedy in the state of Madhya Pradesh in December 1984 killed thousands and injured tens of thousand (Dudani 1987). Heavy use of pesticides causes three main problems. Firstly, the risk of poisoning human being, particularly through dangerous residues in food stuff; secondly, the risk of general contamination of the environment by the use of persistent chemicals of high biological activity affecting domestic animals, beneficial insects and wild life; and thirdly, the production of strains by insect-pests resistant to insecticides, so that the latter becomes ineffective for their control (Potter 1965).

According to studies conducted by scientists at the Andhra Pradesh Agricultural University (APAU), Hyderabad, the percentage of pesticide residue in the milk of mothers in Guntur and Krishna districts is the highest in the world, next only to that in Guatemala. According to a WHO study, the average consumption of pesticides in the world is 450 grams per hectare and in India it is around 3 kg. But in Guntur district, the figure touches an alarming 10 kg per hectare (Rama Krishna 1995). Vegetables sold in various Delhi markets indicate significant levels of pesticides residues (Suresh 1995). Alarmed by this, the Agriculture Ministry has launched South-East Asia's first Integrated Pest Management (IPM) project to make available chemical-free vegetables in the capital.

Frequent use of pesticides destroys not only target pests but also naturally present beneficial predators and parasites which help keep pest populations in cultivated and wild areas in check. Without their natural enemies then secondary pests present in the crop are able to reach outbreak levels (Croft 1990). Another serious and costly side-effect of heavy pesticide use has been the development of pesticide resistance in pest insects, pathogens and weeds. A good example is the case of failure to control cotton bollworm in Guntur, Prakasam, and Krishna districts of Andhra Pradesh during the cotton season 1987-88, due to development of high degree of resistance against synthetic pyrethroids (Mehrotra 1992). One of the best example in Andhra Pradesh (Nizamabad district) during 1981 was the mass poisoning of farmers/spraymen with ediphenphos (Rao 1994).

Talking of the damage to environmental and public health in terms of cost factor, a report of the Washington based International Food Policy Research Institute says for every one dollar worth of pesticide an estimated five to ten dollar damage is caused (Nair 1996). The economic loss is enormous since these highly poisonous chemicals find their way into the air and water systems, including rain, fog and snow, affecting, often fatally, the flora and fauna, even humans. Some of the chronic effects of pesticides on human beings identified by doctors are cancer, genetic mutations, damage to the immune systems, kidneys and liver.

Regarding the amount of pesticides reaching the target pests, studies show that pests, insects, pathogens and/or weed require the minutest amount of the chemicals to eliminate them. For some major pest insects, it has been documented that on an average less than 0.1% to as little as 0.0000001% of the pesticide applied actually reaches the target pests (Graham-Bryce 1975, Joyce 1982, Piemental and Levitan 1986). This means that more than 99% remains as a pollutant in the environment.

Farmers are using excessive amount of pesticides in a wrong manner with disproportionate dosage, which leads to a higher cost of cultivation as well as ecological imbalance. Hence, reducing the hazards arising due to pesticides needs immediate action to be taken by the environmentalists and all other concerned to mitigate the health hazards to the enormous human population. In a society like India where farming is a family affair, the problem of reaching the target group gets further compounded. The farming family as a whole needs to be educated, then only the damages could be checked or at least minimized to a safe level. Only when they start to understand and appreciate the risks involved in the use of pesticides, then only changes can take place in the desired direction i.e. IPM.

Keeping all the above facts in mind, the present investigation was undertaken to know the Environmental Risk Literacy (ERL) among the cash crop growers of Guntur District of Andhra Pradesh. (Peters 1994) defined ERL as "the knowledge about environmental risks, their causes and possible ways to deal with them.

Objectives :

The study was based on the following specific objectives:

1. To ascertain the extent of knowledge level of respondents about pesticides and their use to avoid possible environmental risks.
2. To know the extent of environmental risk perception of the respondents
3. To find out the relationship between selected independent variables (socio-economic and communication characteristics) and selected dependent variables (Pesticide Knowledge and Risk Perception).

Methodology :

The study was conducted in Guntur district of Andhra Pradesh because it is considered as a progressive agricultural belt of the state. Among different mandals of the district, Guntur mandal was selected for the present study. Among the different villages of the Mandal, four villages namely Padapalakaluru, Chinapalakaluru, Nallapadu and Ankireddy palem were selected based on the cultivable area of cotton and chilli crops. Unit of the study was "whole family" (male head, female head and one child of above 15 years). Out of the total farm families, 10 from each village were selected randomly to make a sample size of 120. The information were collected with the help of a structured interview schedule .

Findings and Discussion:

The findings in table-1 revealed that in all the three categories of respondents, majority were having medium source of agricultural information. In case of male heads, only 30% were having low source of pesticidal information whereas, in case of offsprings it was 17.5% and among female heads, it was 12.5%. it is amazing to note that mean score of sources of pesticidal information was highest in case of offsprings, followed by male heads and female heads. This might be due to the fact that the offsprings were more educated than the parents and most of them were still in schools or colleges and they were most exposed to pesticidal information by extension staff, journals, books and mass media. The lowest mean score among female heads

might be due to their low level of education and less contact with extension agencies.

An attempt has been made in Table-2 to know the knowledge level of respondents in different areas of pesticides. It was observed that majority of male respondents were having strong knowledge in seven areas of pesticides out of eleven selected areas. In contrast to this, majority of female respondents were having strong knowledge in only three selected areas. The offsprings were found to be most literate persons in the selected farming families as they had strong knowledge in nine of the eleven selected areas.

A perusal of the findings in Table-2 also reveals that all the categories of respondents were having strong knowledge in Formulations of pesticides, Cost of plant protection and Traditional practices in pest control; whereas all were having poor knowledge in Bio-pesticides, their dosages and preparation.

Table-1: Distribution of respondents according to their socio-economic and communication characteristics.

S.No	Characteristics	Categories	Frequency (Percentage)		
			Male head	Female head (Spouse)	Offsprings
1.	Age	Lower age (15-25yrs)	4 (10.0)	11 (27.5)	20 (50.0)
		Young age (26-35yrs)	11 (27.5)	16 (40.0)	19 (47.5)
		Middle age (36-45yrs)	12 (30.0)	9 (22.5)	1 (2.5)
		Higher age (>45yrs)	13 (32.5)	4 (10.0)	0 (0.0)
2.	Education	Illiterate	2 (5.0)	0 (0.0)	0 (0.0)
		Can read only	3 (7.5)	3 (7.5)	0 (0.0)
		Can read & write	7 (17.5)	12 (30.0)	1 (2.5)
		Up to Primary school	13 (32.5)	18 (45.0)	5 (12.5)
		Up to middle school	9 (22.5)	6 (15.0)	10 (25.0)
		Up to high school	5 (12.5)	1 (2.5)	11 (27.5)
		Up to Graduation	1 (2.5)	0 (0.0)	8 (20.0)
		Above Graduation	0(0.0)	0 (0.0)	5 (12.5)
3.	Size of land holding	Below 2 ha	13 (32.5)	13 (32.5)	13 (32.5)
		2-4 ha	18 (45.0)	18 (45.0)	18 (45.0)
		Above 4 ha	9 (22.5)	9 (22.5)	9 (22.5)

Contd...

S.No	Characteristics	Categories	Frequency (Percentage)		
			Male head	Female head (Spouse)	Offsprings
4.	Farm Power & machinery	Low Medium High	11 (27.5) 18 (45.0) 11 (27.5)	10 (25.0) 19 (47.5) 11 (27.5)	11 (27.5) 18 (45.0) 11 (27.5)
			($\bar{x}$ = 14.575 S.D. = 1.534)		
5.	Average annual income (in Rs.)	Below 6, 500 6, 500 – 9, 500 9, 500 – 12, 500 Above 12, 500	5 (12.5) 13 (32.5) 16 (40.0) 6 (15.0)	5 (12.5) 13 (32.5) 16 (40.0) 6 (15.0)	5 (12.5) 13 (32.5) 16 (40.0) 6 (15.0)
6.	Sources of Credit	Low Medium High	14 (35.0) 17 (42.5) 9 (22.5	3 (7.5) 28 (70.0) 9 (22.5)	14 (35.0) 17 (42.5) 9 (22.5)
			($\bar{x}$ = 2.580 S.D. = 0.975)		
7.	Sources of pesticidal information	Low Medium High	12 (30.0) 25 (62.5) 3 (7.5)	5 (12.5) 28 (70.0) 7 (17.5)	7 (17.5) 25 (62.5) 8 (20.0)
			($\bar{x}$ = 74.15) S.D. = 5.419	($\bar{x}$ = 55.7) S.D. = 4.398	($\bar{x}$ = 85.87) S.D. = 6.541

$\bar{x}$ = Mean, S.D. = Standard Deviation

N.B. : Low = ($< \bar{x}$-S.D.), Medium = ($\bar{x} \pm$ S.D.), High = ($> \bar{x}$ + S.D.)

Table-2: Knowledge level of respondents in different areas of pesticides

S.No	Area of Pesticidal knowledge	Male	Female (Spouse)	Offspring
1.	Names of different pests in cotton and chilli crops and symptoms of their infestation	S.K.	M.K.	S.K.
2.	Quantum of pesticides used for pest control	M.K.	P.K.	M.K.
3.	Precautions at the time of pesticide application	M.K.	P.K.	S.K.
4.	Common and Trade names of pesticides	S.K.	P.K.	S.K.
5.	Formulations of pesticides	S.K.	S.K.	S.K.
6.	Pesticides companies and their good products	S.K.	P.K.	S.K.
7.	Cost of plant protection	S.K.	S.K.	S.K.
8.	Traditional practices in pest control	S.K.	S.K.	S.K.
9.	Knowledge related to IPM (Integrated Pest Management)	M.K.	P.K.	S.K.
10.	Bio-pesticides, their dosages and preparation	P.K.	P.K.	P.K.
11.	Changes (size, colour) in pests & pest resistance	S.K.	P.K.	S.K.

S.K. = Strong Knowledge; M.K = Moderate Knowledge; P.K. = Poor Knowledge

Table-3: Risk Perception level of respondents regarding the impact of pesticides on the environment

S.No	Environmental components	Male	Female	Offspring
1.	Soil	S.P.	M.P.	M.P.
2.	Water	M.P.	P.P.	S.P.
3.	Air	M.P.	P.P.	S.P.
4.	Animals & human beings	S.P.	M.P.	S.P.
5.	Beneficial insects	P.P.	P.P.	M.P.
6.	Food chain	M.P.	P.P.	M.P.
7.	Total environment and perception to overcome ill effects	P.P	P.P	P.P

S.P.=Strong Perception; M.P.=Moderate Perception; P.P.=Poor Perception

Findings in Table-3 show the risk perception level of the respondents regarding the impact of pesticides on different components of the environment. It is again clearly seen that most of the female respondents were having poor perception about environmental risks caused due to pesticidal use. Out of seven selected areas of the environment, they had poor perception in five areas and had strong perception in none of the areas. Whereas, the male respondents were having strong perception regarding the impact of pesticides on Soil, Animals and human beings.

The offsprings had strong perception in three environmental components, namely Water, Air, and Animals and human beings. It is a matter of serious concern that none of three categories of respondents had strong or even moderate perception regarding possible environmental risks caused due to pesticidal use.

The findings in Table-4 revealed that the three categories of respondents were having medium level of knowledge about pesticide use in cash crop cultivation. In case of male heads, only 7.5% were having low level of knowledge, whereas in case of offsprings it was 17.5%. About $1/4^{th}$ of the total number of respondents in each category were having high level of knowledge regarding pesticide use. The mean knowledge score was highest

Table-4: Overall knowledge level of respondents about pesticide use in cash crop (Cotton, Chilli) cultivation

Case	Category	Number of respondents	Percentage
Male head	Low	3	07.5
	Medium	28	70.0
	High	9	22.5
		N=40, Mean (x) = 70.597, S.D.=9.207	
Female head (Spouse)	Low	5	12.5
	Medium	28	62.5
	High	10	25.0
		N=40, Mean (x) = 60.875, S.D. = 6.107	
Offsprings	Low	7	17.5
	Medium	24	60.0
High	9	22.5	
		N=40, Mean (x) = 71.075, S.D. = 5.427	

in case of offsprings, followed by male heads and female heads. The lowest mean knowledge score among female heads might be due to their low level of education, less participation in field activities & less contact with extension agencies.

Table-5: Overall perception level of respondents about pesticide risks

Case	Category	Number of respondents	Percentage
Male head	Low	7	17.5
	Medium	25	62.5
	High	8	20.0
		N=40, Mean (x) = 13.5, S.D.=2.195	
Female head (Spouse)	Low	9	22.5
	Medium	22	55.0
	High	9	22.5
		N=40, Mean (x) = 10.525, S.D. = 2.276	
Offsprings	Low	10	25.0
	Medium	24	60.0
	High	6	15.0
		N=40, Mean (x) = 15.4, S.D. = 2.351	

Table-6: Relationship of independent variables with the selected dependent variables in case of male heads.

S.No.	Independent Variables	Dependent Variables (r-value)	
		Pesticide knowledge	Risk perception
1.	Age	0.594**	0.747**
2.	Education	0.793**	0.560**
3.	Size of land holding	0.708**	0.788**
4.	Farm power & machinery	0.719**	0.825**
5.	Average annual income	0.672**	0.820**
6.	Sources of credit	0.835**	0.842**
7.	Sources of Pesticidal information	0.386*	0.338*

** : Significant at 0.01 level of probability.

* : Significant at 0.05 level of probability.

A critical analysis of the findings in the table-5 showed that mean risk perception score was highest in case of offsprings followed by their fathers and mothers. This indicates that the offsprings were more cautious regarding pesticidal use. They were supposed to read carefully the instructions and precautions written on the pesticide labels and instructions given by the extension agencies.

Here, in case of risk perception also maximum number of respondents were having medium level of perception in each category. Only 20% of male heads, 22.5% of female heads and 15% of offsprings were having high level of perception. Figure 1 shows a comparison among the three categories of respondents on the basis of their mean score of pesticide knowledge and risk perception.

A critical examination of the data presented in table-6 revealed that out of seven, six selected independent variables were highly significantly related with the dependent variables i.e. pesticide knowledge and risk perception, except the sources of pesticidal information, where it was only significantly related. It means that the seven variables exert their influence on the knowledge level (Pesticide & risk) of the male heads about the pesticide use. Therefore we can say from the findings that all the selected independent

variables were important as well as essential factors for an innovative, progressive and knowledgeable farmer.

Table-7 : Relationship of independent variables with the selected dependent variables in case of female heads (Spouse)

S.No.	Independent Variables	Dependent Variables (r-value)	
		Pesticide knowledge	Risk perception
1.	Age	0.415*	0.378*
2.	Education	0.172^{NS}	0.166^{NS}
3.	Size of land holding	0.161^{NS}	0.002^{NS}
4.	Farm power & machinery	0.632**	0.683**
5.	Average annual income	0.748**	0.698**
6.	Sources of credit	0.694**	0.718**
7.	Sources of Pesticidal information	0.280^{NS}	0.308^{NS}

** : Significant at 0.01 level of probability.

* : Significant at 0.05 level of probability.

NS : Non Significant

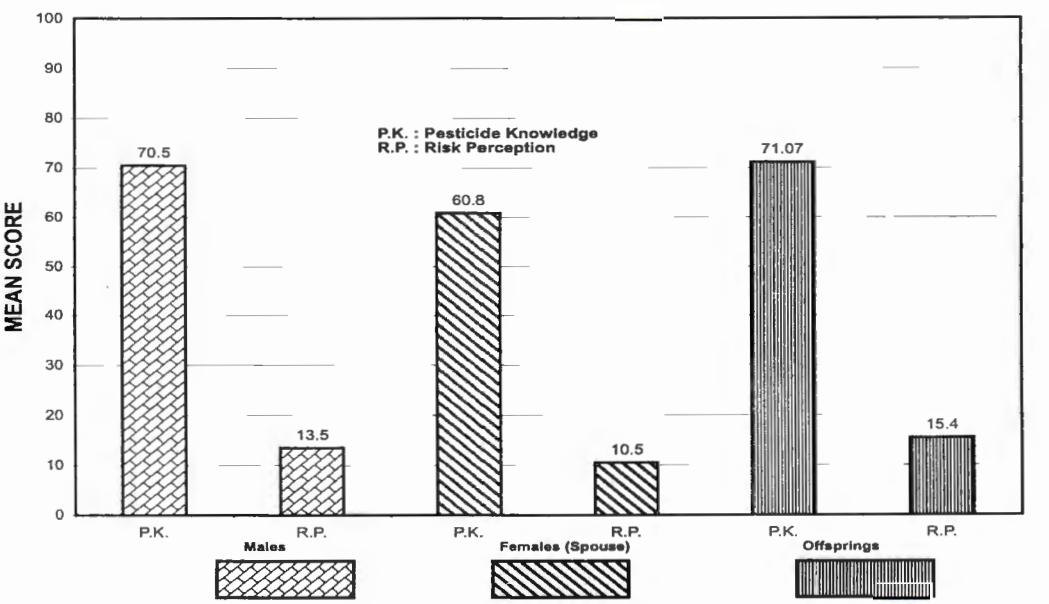

Fig.1 : Comparison of three categories of respondents according to their mean score of pesticide knowledge and risk perception

Findings in the table-7 depicted that age, farm power and machinery, average annual income, sources of credit were positively and significantly related with pesticide knowledge and risk perception in case of female heads, whereas, education, sources of pesticidal information, size of land holding were non-significantly related with pesticide knowledge and risk perception. This means that age, farm power and machinery, average annual income and sources of credit exert their influence on the knowledge level (pesticide and risk) of female heads regarding pesticide use. Therefore these four variables were important in affecting the knowledge level of female heads.

Table–8: Relationship of independent variables with the selected dependent variables in case of offsprings.

S.No.	Independent Variables	Dependent Variables (r-value)	
		Pesticide knowledge	Risk perception
1.	Age	0.447**	0.543**
2.	Education	0.744**	0.665**
3.	Size of land holding	0.142^{NS}	0.199^{NS}
4.	Farm power & machinery	0.694**	0.596**
5.	Average annual income	0.577**	0.626**
6.	Sources of credit	0.763**	0.731**
7.	Sources of Pesticidal information	0.815**	0.749**

** : Significant at 0.01 level of probability.

NS : Non-Significant.

Regarding the offsprings, data in table-8 showed that except size of land holding, all other six independent variables were highly and significantly related with pesticide knowledge & risk perception. This means that except size of land holding, all other variables exert influence on the knowledge level of offsprings and are important in determining the knowledge level of offsprings regarding pesticide use.

Thus, it is seen that there is a significant difference in pesticide knowledge among the three categories of users of pesticides within a family. This difference can be attributed to level of education and extent of outside contact

and media-use pattern. It seems that there is a realization of environmental risk in the use of pesticides in the farming families, which too varies in the similar manner as found in case of pesticide knowledge level.

Policy Implications :

The study brings out vividly the need for proper understanding of pesticide uses and abuses and their consequences on the society. To reduce frequent health hazards occurring due to pesticides use and to increase the ERL among the farming community in particular and the people in general, following suggestions are of utmost importance to be considered by the farming communities, extension trainers, policy makers and all concerned with environmental health.

Although women contribute to about more than fifty percent of farm labour, but still they are the most deprived section in the farming community in relation to pesticidal knowledge. Therefore, it is alarming to go for a new policy to train this neglected section about the uses and abuses of pesticides by involving women specialists.

This is again very disheartening as younger people are also severely affected by environmental damage, being caused due to use of pesticides. Now, time has come to contemplate to renew the conventional educational system by introducing compulsory course from primary level on environment, its components, causes of environmental damages and their remedies etc.

It was found from the investigation that Private Input Supplying Agencies were being consulted frequently by the farmers for any type of pesticidal information. Therefore, the authors strongly believe that ERL can only be promoted among the target group by bringing those agencies into the mainstream of extension service.

Pesticides need to be applied to crops in prescribed quantities and not haphazardly. Improper handling of pesticides is as hazardous as its excessive use.

Training programme for farmers, extension workers and field functionaries is of utmost urgency. Both government as well as non-government organizations (NGOs) should come forward and work hand in hand for this.

Step should be taken by the chemical industries to strictly maintain the highest standards in the manufacture and use of chemical products. They should also chalk out their own programme to educate and train the people about the proper use.

There is an urgent need to quicken the research activities and come out with newer and safer chemical products. Before approving a pesticidal product for commercial use, full technical data on toxicology and residues should be scrutinized by experts to fix waiting period for harvest.

The Acts relating to pesticide manufacture and use should be strictly enforced.

The use of crop rotations is an important technology that would reduce pesticide use. In addition to crop rotation, there are numerous other cultural and biological methods of pest control which should be practiced.

To avoid the dangers to environment, ecology and human being, the adoption of traditional and ecological farming is the best alternative.

Several studies suggest that it is technologically feasible to reduce pesticide use without reducing crop yields. Therefore, India needs now is a complete review of its old traditional and indigenous systems, that would help reduce the pest control costs of farmers; that would reduce the exposure of farmers and their families to pesticides; and would help protect the farm and natural environment, making agriculture more productive and more sustainable for the future.

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