ORIGINAL ARTICLE

A Cross-Sectional Survey on the Awareness of Pesticide Labels and Pesticide Safety Pictograms among Paddy Farming In South India

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Abstract

Background: Hazardous pesticides continue to be used in the farming industry purely because of economic reasons. Farmers need to understand this risk. Pesticide labels and pictograms were enforced to propagate this risk information to the farmers in a simple way. However, their effectiveness has not been evaluated in India. This study attempts to evaluate the efficacy of these labels and pictograms to help farmers understand the pesticide risks.

Methods: A cross-sectional, questionnaire-based survey was conducted among 172 paddy farmers in Kancheepuram district of Tamil-Nadu, India. Their interpretation of four pesticide labels and fifteen pesticide safety pictograms were analyzed using (SPSS version 20) for descriptive statistics. Chi-square test was used for dichotomic variables. A p value of < 0.05 was considered significant.

Results: Of the 172 farmers interviewed, 93% were unaware of the pesticide regulations and 72.6% had never attempted to read the labels. Only, the red color in the label was identified correctly by 66.1% of farmers. Four out of fifteen pictograms were interpreted correctly by more than 60% of the farmers. Educational status had a significant influence on the way the labels and pictograms were interpreted.

Conclusion: We need to consider restructuring these labels in a more scientific way. Instead of a top-down approach, we need to start working at the grass root level if we tend to have better appreciated labels. It is recommended that plans and strategies should be devised to educate the farmers about the labels and pictograms.

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Introduction

Like most developing countries in the world, India has primarily been an agricultural nation with over 49% of the workforce engaged in agriculture.[1] The ever increasing demand for food has resulted in a constant strife to increase production. Pests alone, to a great extent, were thought to account for the destruction of a large part of the food crop. This warranted the use of pesticides to improve productivity.

In 1966, when the green revolution was first introduced and use of pesticides was advocated, it was not clearly known if it would have a long term effect. Though the production increased exponentially, the hazards of pesticides have been gradually seeding. India is currently the fourth largest producer of pesticides and agrochemicals in the world with the market selling over 500 compounds.[2] Some of these

compounds are banned in most parts of the world, but their continued use in India is justified by the economists. Since 1958, when the first incidence of mass poisoning was reported, the pesticide industry has been plagued with disasters of similar nature.[3]

WHO estimates that on an average about 20,000 deaths every year are reported directly due to pesticides all over the world and over 8, 00,000 people have died due to the use of pesticides since the start of green revolution.[3] People have realized the hazards of pesticides, but for some reason they continue to use them. It is difficult to understand this peculiar behaviour among farmers as there are a large number of factors leading to this consequence.

Government of India has realized this hazard for a long time and hence passed stringent regulations on the pesticide industry by implementing the Insecticide Act 1971. Multiple attempts were also made to educate the stakeholders on the correct use of these pesticides. Considering the Indian scenario, it was found that the majority of the workforce involved in agriculture were illiterate or of primary education. This required a simpler means of communication of the risk involved in the use of pesticides.[4]

One mode of communicating the risk advocated by the Insecticide rules in 1971[4] is the pesticide label. It gives clear guidelines for labeling the pesticide packages to guide the farmer clearly about the toxicity level and risks involved while using these pesticide. It is mandatory by law that the pesticide containers should be stored in a prominent place occupying not less than one-sixteenth of the total area, a prescribed label. The label appears like a squared area, set at an angle of 45° (diamond shape). In this square, there is a danger symbol with a warning, a specific quote and color indicating the toxicity level. Besides, there are detailed descriptions of the method of use, side effects, and symptoms of toxicity, antidote and treatment options printed on the label.

In addition, based on the recommendations of the Food and Agricultural organization (FAO-United Nations) and International Association of Agrochemical manufacturers (GIFAP) in 1988 a series of pictograms specially designed for the semi and non-educated farmers are printed on the pesticide labels.[5,6] These primarily describe safety precautions to be taken during the application of the pesticides in the field. Apart from these standard pictograms, NGOs have suggested similar pictograms to help the farmers adopt best practices while using these pesticides.

FAO conducted a study during the earlier part of this century to check the effectiveness of these labels and pictograms. They reported about 61-80% of farmers could interpret these pictograms effectively. However, nearly 91% of the farmers who participated in this study were literate and had some sort of schooling.[6] This does not reflect the actual population in many developing countries as most of the workforce in farming is either semi-literate or illiterate.

Many other studies conducted in the field by various researchers in Brazil, Pakistan, Iran, America, Australia etc. have shown varied understanding of these labels.[7-10] These have been found not to be as effective as that predicted by FAO. Most farmers either didn't understand it or identified it wrongly. The understanding of these labels has also been influenced by cultural factors.

No attempt has been made in India to understand the effectiveness of these labels. There are no studies to verify if these labels are actually interpreted properly in India. Keeping these aspects in mind, we have tried to document and analyze the understanding of these labels among the paddy farmers in Tamil Nadu. In our experiment, we have attempted to test whether the existing Agro Pesticide label communicates information understandably. We have also made an attempt to check if the suggested pictograms improve the understanding of the safety precautions to be practiced during the application of pesticides.

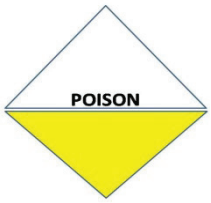
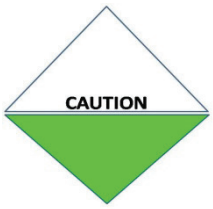
Methods

The data for the study was collected in Kancheepuram district of Tamil Nadu, near Thiruporur located between 11° 00' to 12° 00' latitudes and 77° 28' to 78° 50' longitudes. It is located about 60 kms south of Chennai, the capital of Tamil Nadu. Over 16.8% of the population is involved in agriculture in paddy fields, being the most common crop cultivated. The consumption of pesticides for cultivation amounts to about 2332 Metric tons of dust and 21242 lts of liquid annually. Kancheepuram district is said to produce about 30,095 Metric tons of paddy every year.[11]

A cross-sectional analytical interview-based survey was conducted over a period of four months between September to December 2013 in Kancheepuram district of Tamil Nadu, near Thiruporur after obtaining ethical clearance from the Institutional Ethics committee of Shri Sathya Sai Medical College & Research Institute. The interview was conducted by two undergraduate medical students who participated in the study.

A standardized questionnaire with both open ended and closed ended questions after a pilot study and literature search was made to get the information regarding the demographic data, crops being cultivated, general knowledge and attitude on pesticide handling, safety, risk perception, and protection ideas. The four labels prescribed as per the Insecticide Act 1971 (Table 1) and 15 pictograms (Table 2) suggested

Table 1: Pesticide labels and their interpretations as directed by the Insecticide act of India-1971

Interpretation				
Colour of lower triangle	Bright red	Bright Yellow	Bright blue	Bright Green
Toxicity Class	Extremely Toxic	Highly Toxic	Moderately Toxic	Mildly Toxic
LD50- Oral Dose	<50 mg/kg BW	51-500 mg/kg BW	501-5000 mg/kg BW	>5001 mg/kg BW
Signal Words	Poison (In red	Poison (in Black)	Danger	Caution
Warning Words	KEEP OUT OF REACH OF CHILDREN. IF SWALLOWED OF SYMPTOMS SEEN CALL DOCTOR	KEEP OUT OF REACH OF CHILDREN.	KEEP OUT OF REACH OF CHILDREN.	-----

by FAO and printed on the pesticide labels were included. The labels and pictograms were printed on a bond paper in a size similar to that printed on actual pesticide labels. This was then shown to the farmers for interpretation.

After meeting the village leaders and convincing them on the purpose of our research, people working in the fields were persuaded to take part in the study. Farmers were selected by purposive non-probability sampling method keeping in mind the selection criteria. The samples had to have experience in the farming and should have used pesticides in some form. All the participants were above 18 years of age. Informed consent was obtained from all the participants of our study.

The minimum sample size was calculated considering the response distribution to be 50% and confidence level of 95% at $P<0.05$. With the Absolute error at 8%, the minimal sample size required was 150.

In the process of collecting data, 172 subjects involved in farming were interviewed based on the standardized questionnaire and asked to identify and interpret the pesticide labels and the pictograms. An attempt was made to understand their attitude towards reading the labels, and taking the safety precautions. The data thus collected was statistically analyzed using SPSS (version 20) and the results are presented here. The data are presented in terms of rates, ratios, percentages and other descriptive statistics for the age, sex, socio-demographic data, work experience, pesticide risks, attitude towards pesticide, etc. Chi-square test was used for dichotomic variables and a p value of less the .05 was considered significant.

During the interview as a means to improve the farmers understanding and answer the questions raised during the interview, the interviewers explained the pictograms and labels which were misinterpreted by them.

Results

Demographics of the farm Workers in the Study

In the process of collecting the data, a total of 172 subjects were interviewed and the results of the interpretation are presented. The demographic variables studied in the farmers are described in Table 3. 152 (88.4%) subjects were male and 20 (11.6%) were female. The subjects were aged 20-73 years with a mean of 44 years. The study group consisted of 138 (80.2%) subjects who were involved primarily in farming.

Most of the farmers (75.6%) owned the land they cultivated compared to just 3.5% who were employed as labour. However, 91.9% of the farmers were of the middle socio-economic group in terms of income. Most of them had completed some form of schooling and were able to read. Only, 25.6% of the farmers were illiterate. On average, the subjects who took part in the study had 17 years of experience in farming and only 9.3% had less than 5 years of experience.

All the farmers in the study accepted they have problems with pests and all had used pesticides for cultivation. About 88.4% of them applied pesticide more than three times per paddy field cultivated. Of the 172 farmers, nearly 50% applied pesticides by themselves and only 37.2% employed regular sprayers for the job. The average cost of pesticide for 79.1% of the subjects was 10-15 thousand rupees per paddy crop. Almost 88.4% of the farmers purchased the pesticide for one single application and didn't store any for later use. When they were asked why they preferred chemical pesticides, about 50% of them didn't have any specific reason and 25.6% felt that chemical pesticides were cheap and available. About 60.5% of the subjects also believed that the yield of the crop was better with pesticide in addition to the prevention of crop loss.

Table 2: Correct interpretations of the pictograms selected for analysis in the study

SL no	Pictogram	Correct Interpretation	SL no	Pictogram	Correct Interpretation
A		Wash the clothing before and after use	I		Don't eat while spraying
B		Don't smoke while spraying	J		Use gloves and face covering while use
C		Dangerous to animals	K		Spray in the direction of the wind
D		Wear a mask or goggles	L		Wash boots and glove before and after use
E		Wash your hand well after use	M		Bury the excess
F		Dangerous to fish and cattle	N		Corrosive
G		Be careful while mixing	O		Explosive
H		Keep away from children			

Knowledge of the Pesticide Labels

When the farmers were asked if they knew that there are regulations for the use of pesticides, 93% (n=160) said that they were not aware of any regulations. Only 3.5% said they knew the regulations. Only 18.6% (n=32) accepted reading the instructions given on the pesticide label. 72.1% (n=124) didn't know that there is a risk label printed on the pesticide container.

The farmers were shown the pesticide label and were asked to interpret its meaning. The results are presented in Table 4. As shown in the Table, only the red colour had a significant influence on the interpretation with 66.3% of the farmers identifying it correctly. Other colours were more frequently interpreted wrongly. Only 8.1 %(n=14) of the subjects

Table 3: Demographic data of the farmers participating in the study

Variable	Variable sub groups	Percentage (n=172)
Sex	Male	88.4% (n=152)
	Female	11.6% (n=20)
Age groups	Less than 30 years	7% (n=12)
	Between 31- 40 years	36% (n=62)
	Between 41-50 years	30.2% (n=52)
	More than 50 years	26.7% (n=46)
Occupation	Farmer	80.2%(n=138)
	Farming and business	12.8% (n=22)
	Farming and student	4.7% (n=8)
	Primarily Business	1.2% (n=2)
	Primarily Student	1.2% (n=2)
Years of experience in farming.	<5 years	9.3% (n=16)
	6-10 years	29.1% (n=50)
	10-20 years	32.6% (n=56)
	>21 years	29.1% (n=50)
Employment status	Land Owner	75.6% (n=30)
	House wife	10.5% (n=18)
	Son of a farmer	10.5% (n=18)
	Employed in farming	3.5% (n=6)
Educational Status	Illiterate	25.6% (n=44)
	Primary School	48.8% (n=84)
	High School	17.4% (n=30)
	Graduate	8.1% (n=14)

Table 4: Farmer's interpretation of the pesticide label prescribed by the Insecticide act of India by (N=172)

Label	Correct Interpretation (%)	Wrong interpretation (%)	Don't know response (%)
Red	66.3	Nil	33.7
Yellow	31.4	Nil	68.6
Blue	34.9	Nil	65.1
Green	18.6	1.2	80.2

identified all the labels correctly compared to 18.6% (n=32) who identified all the labels incorrectly.

An attempt was made to analyze the effect of various demographic variables like age, sex, land ownership, educational status, socio-economic status, and years of experience in farming with the interpretation of the risk labels using cross tables and Chi-square test. Educational status had a statistically significant influence on the way the farmers interpreted the risk labels. The results are represented in Table 5. It is significant to note here that educational status certainly has a positive influence on the way the farmers interpret the labels. Farmers with better education are more likely to interpret the labels correctly. The results are significant at $P<0.05$.

Knowledge of the Pictograms

The farmers were shown 15 standard pictograms commonly printed on the pesticide containers and asked to interpret the meaning. These pictograms are designed to help inform the farmers who cannot read, and understand the correct practices of pesticide use. The results of their interpretation are presented in Table 6. Of the 15 pictograms shown, only four were correctly identified by more than 60% of the farmers. Some pictograms like the ones suggesting "burying the excess pesticide" and "being careful while mixing" were of very little use as the correct identification rate was just 2.3% and 3.5%, respectively. The most common wrong interpretations of the pictograms are also mentioned in the Table.

About 9.3% (n=16) of the farmers didn't identify any of the pictograms correctly and 79.2% of them could identify 8 or less pictograms. Only two subjects could identify a maximum of 10 pictograms. An attempt was made to analyze the effect of various demographic variables like age, sex, land ownership, educational status, socio-economic status and years of experience in farming with the interpretation of the pictograms using cross tables and Chi-square test. Table 7 displays the statistical significance (P value) of the difference noted in the interpretation of pictograms under various demographic variables.

As these pictograms were primarily designed to help farmers who can't read any language, the difference of interpretation in farmers with various levels of education was compared. The differences were statistically significant for six of the pictograms.

Table 5: Analysis of educational status as a factor influencing the interpretation of various pesticide labels. (N=172) (Chi-square test)

Educational status	Green Label (%)		Blue Label (%)		Yellow Label (%)		Red Label (%)	
	Correct	Wrong	Correct	Wrong	Correct	Wrong	Correct	Wrong
Illiterate	9.1	90.9	18.2	81.8	13.6	86.4	63.6	36.4
Primary Education	9.5	90.5	40.5	59.5	31.0	69.0	66.7	33.3
High School	33.3	66.7	33.3	66.7	40	60	53.3	46.7
Graduate	71.4	28.6	57.1	42.9	71.4	28.6	100	0
P value (Sig at P<0.05)	P<0.000		P<0.022		P<0.000		P<0.023	

Table 6: Farmer's interpretation of the pictograms printed on the pesticide containers (N=172)

Sl/no	Correct interpretation of Pictogram's	Correct interpretation (%)	Wrong interpretation (%)	Most commonly misunderstood concept
A	Wash the clothing before and after use	68.6	31.4	Wear Shoe
B	Don't smoke while spraying	80.2	19.8	No smoking
C	Dangerous to animals	24.4	75.6	Banned for cattle or cattle in field
D	Wear a mask or goggles	26.7	73.3	Some person wearing a mask
E	Wash your hand well after use	82.6	17.4	----
F	Dangerous to fish and cattle	16.3	83.7	Cow drinking water
G	Be careful while mixing	3.5	96.5	Someone mixing things
H	Keep away from children	4.5	95.5	Home sweet home
I	Don't eat while spraying	17.4	82.6	Eat some thing
J	Use gloves and face covering while use	3.5	96.5	Seeing some thing
K	Spray in the direction of the wind	83.7	16.3	-----
L	Wash boots and glove before and after use	42.6	57.4	-----
M	Bury the excess	2.3	97.7	Bury some thing
N	Corrosive	25.6	74.4	Wash hand
O	Explosive	44.2	55.8	Bomb or cracker

Table 7: Statistical significance (p Value) of the influence of various factors on the farmer's interpretation of the pictograms (N=172) (Chi-square test)

Sl/ No	Label Interpretation	Age	Sex	Educational status	Land ownership	Socio-economic status	Experience in farming
A	Wash the clothing before and after use	0.101	0.003	0.174	<0.001	0.002	0.199
B	Don't smoke while spraying	<0.001	0.016	0.04	0.007	0.071	0.650
C	Dangerous to animals	0.507	0.110	0.321	0.523	0.27	0.890
D	Wear a mask or goggles	0.276	0.469	<0.001	0.031	0.307	0.408
E	Wash your hand well after use	0.591	0.115	0.094	0.601	0.213	0.415
F	Dangerous to fish and cattle	0.400	0.036	0.330	0.133	0.227	<0.001
G	Be careful while mixing	0.048	0.366	0.03	0.257	0.729	0.127
H	Keep away from children	<0.001	0.293	0.007	0.413	0.690	0.001
I	Don't eat while spraying	0.591	0.115	0.067	0.543	0.030	0.724
J	Use gloves and face covering while use	0.904	0.366	0.112	0.571	0.759	0.200
K	Spray in the direction of the wind	0.007	0.077	0.028	0.110	0.017	0.087
L	Wash boots and glove before and after use	0.225	0.771	0.288	0.089	0.309	0.503
M	Bury the excess	0.011	0.015	0.123	0.071	0.001	0.019
N	Corrosive	0.063	0.089	0.235	0.178	0.073	0.537
O	Explosive	0.058	0.001	0.003	0.05	0.015	0.700

Three of these pictograms, namely the ones denoting "don't smoke while spraying", "spray in the direction of the wind and "explosive" were interpreted correctly by the all the groups. The three other pictograms, namely the ones meaning "wear glove & mask", "be careful while mixing" and "keep away from children were very poorly interpreted by the illiterate group compared to the literate group. Nine of the pictograms were ineffective in delivering the message as they were incorrectly interpreted in the group with no schooling.

Discussion

India has, ever since its creation, been known as a country run by farming. Agriculture is a very widely practiced by the majority of the population and yet farmers are significantly considered as economically

underprivileged class of the society. Even in this study group, only 8.1% had graduate level education and the majority belonged to the middle socio-economic group. Farming is learnt traditionally and no formal or scientific training is performed for most of the farmers. It is surprising to note here that 93% of the subjects in this study had no knowledge of ant pesticide regulations despite the fact that the insecticide act was passed some 45 years ago. Nearly, half the subjects claimed to apply the pesticides in the field themselves.

Knowledge of the Label

Similar to what has been reported by many other studies,[6,7,9,10] even in our study nearly three quarters of the participants had no knowledge of the pesticide label itself. Only one fifth of the farmers attempted to read the labels. The farmers did not seem to view the labels for information and relied mostly on the information provided to them by the pesticide vendors. With regard to the data presented in Table 4, it is clear that the labels are not effective in conveying the risk associated with the pesticides. Only the label with red colour was interpreted as dangerous by more than 66% of the subjects. This is probably related to the cultural influence of the RED colour and the symbol of the skull with two bones crossed which signifies danger in most cultures.[7,8,12] The words caution, danger and poison written on the label don't seem to have any differential value for the farmers.[7] This tendency of farmers to ignore the labels could be due to low literacy rates and their limited ability to read complex language used in the label. This should be taken into account when we design a label as farmers don't comprehend complex terms.[8] Unlike few other studies[5,6] done in various countries which showed gender as an important factor, there was no statistically significant difference in the way these labels were interpreted by men and women.

The labels were primarily designed to aid the farmers who didn't have formal education to understand the pesticide risks as it is believed that pictorial representation of the data will be better appreciated by all groups. However, when we analyze the finding in Table 5, it is evident that these labels are ineffective in delivering their purpose, a finding similar to many other studies.[6-11] There is a statistically significant difference in the way farmers, with different level of education, interpret these labels. Educated farmers tend to interpret these labels more correctly. Among the illiterate group, except for the red colour, all other labels were significantly ineffective as the farmers couldn't interpret the meaning.

Knowledge of the Pictograms

The pictograms were primarily introduced to aid better understanding of the safety measures necessary to be taken during the pesticide application. Unlike the suggested effectiveness of the studies conducted by FAO, these pictograms don't seem to be effective in conveying the correct meaning. As can be seen in Table 6, only four pictograms suggesting "hand washing", "don't smoke while spraying", "spray in the direction of the wind", and " washing one's clothes" were being interpreted correctly by the farmers over 60% of times. The rest of the eleven labels were wrongly interpreted by more than 70% of the subjects. The pictograms were also found to be conveying wrong messages as can be seen by the list of common misinterpretations presented in the Table. This was also found to be the case in many other studies conducted in similar lines.[6-9]

When the interpretation of the pictograms was compared using various demographic factors, it was found that some of these variables showed a statistically significant difference. Table 7 shows that nearly six pictograms had a statistically significant difference when variables like educational status and socio-economical status were considered. As to the educational status, it can be inferred that pictograms were not effectively interpreted by uneducated farmers. Only four pictograms were effectively understood by farmers who couldn't read and write. This is again a finding which has been repeatedly found in various other studies.[6-10]

The pictograms are designed to aid those who cannot read literary work. It is because these pictures are thought to elicit aspects of one's memory and help communicate better. They are meant to make them understand easier.[12,13] But as noticed in this and many other studies, these pictograms and labels have not been doing so. These pictograms are very frequently misunderstood and can spread wrong notions and ideas. It cannot be denied that most of the farmers are not previously trained as to the use of pesticide; hence, these pictograms are interpreted differently and don't actually elicit a prior memory response.[14]

There could be a lot of other factors influencing this finding. The size of the pictograms, colour, clarity, location, background colours that reduce contrast, the label layout and placement of the information that cannot attract the farmer's attention, their cultural significance, economics, etc. all influence how these pictograms are interpreted.[8] Small-sized labels, small fonts, illegible font types, poor contrast between the ink and the paper, and wrong placement of the information can lead to a reduced interest in the label for the farmers.[15] Coloured labels and pictograms have sometimes been found to be perceived as more important by the farmers.[16] Even when the pictograms are understood, there will be indigenous factors which might cause more harm. Some of the pictograms might be more dangerous when understood in such

situations.[6,7] Considering the one which asks the farmers to cover the face with a mask, due to socio-economic constrains like lack of availability of masks, the farmers might use a piece of cloth instead. This is more dangerous as the cloth can soak the pesticide and enhance the risk of inhalation. The popular belief that economic risks are more important than health risks leads to most of the wrong choices by the farmers.[17,18]

The results of this study reveal the deficiencies in the current labels and pictograms prescribed by our regulatory authorities. This study strongly demonstrates the need for revision of the current labels and also emphasizes the importance of education and training of the farmers, without which this system cannot be a successful model.

Limitations of this study: Our study had some limitations. The sample is not actually a random sample as the farmers were interviewed in the field just based on their availability and meeting of the inclusion criteria. The sample size was small compared to the large number of farmers in the country. Still the results clearly show major flaws in the labels and pictograms prescribed for pesticide containers.

Conclusion

The result clearly revealed that only a few of the labels and pictograms are effective in delivering risk information to the farmers. We need to consider restructuring these labels in a more scientific way. Instead of a top to down approach, we need to start working basically if we have to design labels which are better appreciated. The use of colour codes alone is not effective. They need to be accompanied at least by simple explanations.

The pictograms need a significant revision. More colourful, clear and larger pictograms designed based on the cultural beliefs are needed to be designed. A statement of correct meaning of the labels should also be given in colloquial languages along with clear segregation of labels suggesting do's and don'ts to avoid misinterpretation by the educated groups of farmers.

It is concluded that elaborate plans and strategies are required to educate the farmers about the labels and pictograms in order to stimulate behaviour already enlisted in memory. No modification and research can design effective labels unless we make an attempt to familiarize the farmers with these aspects of safety.

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