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## Assessment of protective clothing for pesticide applicators while spraying in different crops

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### Abstract

Majority of farmers rely on pesticides and fertilizers to increase yields. Farmer suffers from various ailments due to spraying of such pesticides such as nausea, vomiting, headache, skin disorders, digestive problems and breathing problems. Krishi Vigyan Kendra, Rudrur had been used the protective clothing, which contains Gloves, Mask, Apron (old white cotton shirt) Cap, Sun glasses, this technology proved technologically feasible, economically profitable, ecologically sustainable and culturally compatible. Structured schedule was prepared for getting farmers response or feedback about protective clothing. Farmers opined that protective clothing has excellent to good functional features i.e suitability, comfort ability, durability; adoption feasibility. Majority of farmers had positive opinion about protective clothing that it protects the body from external matters and reduces health hazards. Farmers expressed that with the utilization of protective clothing, the morbidity / health hazards were decreased over a period of time from day one today thirty.

**Keywords:** Protective clothing, functional features, health hazards, pesticides, assessment

### Introduction

Agriculture is an important sector for economic development in India. Majority of farmers rely on fertilizers and pesticides to increase yields. Pesticides are widely used in agricultural production, to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. Exposure to chemical pesticides while spraying in their field has become a major health problem for farmers in Telangana state with a special mention to Nizamabad district. Many studies showed harmful effects of pesticides on human health without wearing any protective clothing or safety measures while spraying.

Headache (73.8%), skin irritation (62.3%), eye irritation (32.8%), weakness (22.4%) and muscle pain (19.1%) were some of the common self-reported toxicity symptoms of pesticides by them [1]. Similarly, a study carried out in Duhabi – Bhaluwa municipality of Sunsari district showed that dizziness, headache, skin irritation, nausea, parasthesia, restlessness, eye pain, and vomiting were common health problems among farmers within 48 hours of pesticides application. WHO data shows that 500000-1000000 people around the world per year have experienced pesticide poisoning and around 500-1000 people per year experience fatal effects such as cancer, disability, infertility and liver disorders [2]. Exposure to insecticides within the home and herbicides outside is associated with blood cancers in children [3].

Farm workers are exposed to pesticide vapours which enter body via dermal absorption, inhalation and ingestion. Pesticides are absorbed through skin at the time of mixing, loading, application and equipment maintenance. Dermal exposure accounts for 87-90% of total exposure of pesticides because the skin of a human adult has a superficial surface area of approx. 1.73m<sup>2</sup>, a major focus of accidental exposure [4]. Many studies have examined the effects of pesticide exposure on the risk of cancer. Associations have been found with: leukemia, lymphoma, brain, kidney, breast, prostate, pancreas, liver, Lung and skin cancers. This increased risk occurs with both residential and occupational exposures [5]. A mother's occupational exposure to pesticides during pregnancy is associated with an increase in her child's risk of leukemia, wilms' tumor and brain cancer [6]. Agent orange, a 50:50 mixture of 2,4,5-T and 2,4 – D has been associated with bad health and genetic effects in Malaya and Vietnam [7]. According to researchers from the National Institutes of Health (NIH), licensed pesticides applicators that used chlorinated pesticides on more than 100 days in their life time

were at greater risk of diabetes. One study found that associations between specific pesticides and incident diabetes ranged from a 20 per cent to a 200 per cent increase in risk. New cases of diabetes were reported by 3.4 per cent of those in the lowest pesticide use category compared with 4.6 per cent of those in the highest category. Risks were greater when users of specific pesticides were compared with applicators who never applied that chemical [8]. A 2007 systematic review found that "most studies on non-Hodgkin lymphoma and leukemia showed positive associations with pesticide exposure" and thus concluded that cosmetic use of pesticides should be decreased [9]. Strong evidence links pesticide exposure to birth defects, fetal death and altered fetal growth [10]. Due to inadequate protective clothing and drift of spray droplets, farm workers suffer from short term health risks i.e allergy, eye irritation, nausea, vomiting, diarrhea, headache and rashes and in long run may affect the brain, lungs, heart, liver, blood and other organs [11]. In some situations, exposure to pesticides can occur from accidental spills of chemicals, leakages, or faulty spraying equipment. The exposure of workers increases in case of not paying attention to the instructions, on how to use the pesticides and particularly when they ignore basic safety guidelines on the use of personal protective equipment and fundamental sanitation practices, such as washing hands after pesticide handling or before eating.

In this connection, Krishi Vigyan Kendra, Rudrur had been used the protective clothing which contains Gloves, Mask, Apron (old white cotton shirt) Cap, Sun glasses for pesticide applicators to reduce the health hazards while spraying. This technology proved technologically feasible, economically profitable, ecologically sustainable and culturally compatible. Thus keeping in view the needs and problems faced by the farmers, the present study was undertaken with the following objective; to assess suitability, comfort ability, durability, adoption feasibility and morbidity pattern of protective clothing for pesticide applicators while spraying.

## Materials and methods

**Experimental layout:** Expressing a concern over farmers, not following minimum safety precautions while spraying pesticides, Krishi Vigyan Kendra, Rudrur had been conducted On Farm Trial on Protective clothing for pesticide applicators in the year 2015-16. Home Scientist, received this technology and schedules from Home Science, All India Coordinated Research Project (AICRP) Textiles Department, Post Graduate & Research Centre, Rajendranagar.

The five (5) adopted villages of Krishi Vigyan Kendra, Rudrur includes Jalalpur from Varni Mandal, Suddulam from Kotagiri Mandal, Neela from Renjal Mandal of Nizamabad District and Thimmapur, Mirzapur from Birkur Mandal of Kamareddy District had been selected purposively and conducted on farm trials, front line demonstrations during the period 2015-2019. Conducted training programmes, method demonstrations to the farmers on use of protective clothing and distributed protective clothing set to the farmers with clear instructions and the observations were recorded for one month.

**Treatments:** Treatments namely farmers practice i.e without any protective clothing as T<sub>1</sub>, protective clothing set including mask, apron, glasses, gloves, cap as T<sub>2</sub> framed as per the

recommendations of the Professor, AICRP (Textiles & Clothing) Home Science, Rajendranagar during the Annual Action Plan meeting during the year 2015-16.

**Observations:** Technical observations include functional features of protective clothing like comfort ability, suitability, durability, adoption feasibility and morbidity assessed from the sprayers with standard schedule. An economic indicator includes cost effectiveness in terms of reasonability.

**Data analysis:** Farmer's feedback has been taken through the standard schedule. All the data was calculated through standard rating scale. The respondents were categorized into three class intervals low, medium and high based on the maximum and minimum scores obtained by the respondent for each variable. From the individual farmer opinion, the weighted mean score (WMS) was calculated this replicates the overall opinion of the five locations farmers.

## WMS calculation

Multiply frequencies with respective weightage = Figure

$$\text{Weighted Mean Score (WMS): } \frac{\text{Sum of the figures}}{\text{Sample size}}$$

## Results and discussions

### Functional features of garments

Functional clothing is defined as that specifically designed and engineered to ensure pre defined performance requirements and functionality for the user. This includes protection under harsh environmental conditions during work activities and protection against extreme hazards and environment.

The functional features of protective clothing selected for the study were suitability, comfort ability, durability, adoption feasibility and morbidity pattern of protective clothing while spraying. Protective clothing can be defined as clothing including those protectors which cover or replace personal clothing and which are designed to provide protection against one or more hazards.

### Suitability

Suitability operationally defined as old shirt or upper garment which is used for spraying is right or appropriate for farmer with regard to size, appearance, length and shape.

The respondents were distributed into three categories based on their old shirt suitability scores as indicated in the Table 1

**Table 1:** Distribution of respondents based on their suitability of old shirt (n=30)

S. No.	Category	Frequency (%)
1	Low (7-16)	0
2	Medium(17-26)	8 (26.6)
3	High (27-35)	22 (73.3)

The Table 1 reveals that majority (73.3%) of the farmers expressed that old shirt was highly suitable for spraying than the designed apron as the old shirt appearance was superior, had sufficient length, size and shape was appropriate, size and shape of collar, cuffs and pockets are appropriate and convenient and followed by 26.6 per cent medium suitability.

**Table 2:** Suitability Assessment of Upper garment – old shirt (n=30)

S. No.	Suitability assessment	Characteristics of functional features	Excellent	Good	Fair	Poor	Very Poor	WMS
a.	Appearance	Superior	11	10	9	-	-	4.06
b.	Length of the garment	Sufficient	11	9	5	5	-	3.86
c.	Size and shape of the garment	Appropriate	13	8	6	3	-	4.03
d.	Size and shape of collar	Appropriate	13	8	6	3	-	4.03
e.	Size of sleeves and cuffs	Appropriate	8	15	7	-	-	4.03
f.	Size and placement of pockets	Convenient	-	12	18	-	-	3.04
g.	Placket opening & fasteners of the garment	Suitable	11	9	10	-	-	4.03

Table 2 consists of all the suitability components like appearance and the characteristic of functional feature is superior. Out of the thirty farmers, 11 farmers had given the excellent, 10 farmers good and 9 farmers had given fair feedback. The weighted mean score was 4.06, which replicate the overall appearance of the garment was good. Sufficient length of the garment, as the characteristics functional feature, 11 farmers responded as excellent, 9 perceived as good and each 5 farmers rated as fair and poor. The overall WMS score was 4.5, which indicates that the length of the garment is sufficient for farmers, for protection while spraying. Size and shape of the garment characteristic of functional feature is appropriate and out of 30 respondents 13 assessed as excellent, 8 farmers as good, 6 as fair and 3 as poor because depend on the working hours. The overall WMS score was 4.03, indicates the size and shape of the garment is good, as the size and shape of the garment is not affecting the farmer's activity during spraying.

Size and shape of the collar characteristic functional feature is appropriate and out of 30 farmers 13 farmers expressed as excellent, 8 are good, 6 are fair and remaining 3 farmers expressed that poor as the wetting of old shirt during spraying time causes irritation. The overall WMS score was 4.03 which indicate the size and shape of the collar is appropriate to the particular protective clothing. Size of sleeves and cuffs characteristics of functional feature is appropriate and out of 30 farmers 15 farmers perceived as good followed by 8 excellent and 7 fair as old shirt sleeves and cuffs are appropriate for spraying. The overall WMS score was 4.03, which indicates that farmers had good feedback on size of sleeves and cuffs of protective clothing. Size and placement of pockets characteristics of functional feature is convenient and majority (18) of the farmers had given fair response and remaining 12 farmers gave good feedback. The overall WMS

was 3.04 as old shirt pockets are convenient for spraying and it may not affect the work. Placket opening & fasteners of the garment characteristics of functional feature is suitable and out of 30 farmers, 11 farmers gave excellent feedback followed by 10 fair and 9 good. The overall WMS score was 4.03, which indicates that the placket opening & fasteners of the garment is suitable to the protective clothing. The findings are in line with the findings of [12][13].

### Comfort ability

The term comfort is being mentioned as the absence of unpleasantness or a natural state compared to more active state of pleasure. Clothing comfort is a state of mind when it is at its lowest stress level. Comfort is defined as the absence of perceived pain and discomfort. Based on the farmer's feedback on protective clothing, the respondents were distributed into three categories low, medium and high.

**Table 3:** Distribution of respondents based on their comfort ability of old shirt (n=30)

S. No.	Category	Frequency (%)
1	Low (8-18)	0
2	Medium (19-29)	8 (26.6)
3	High (30-40)	22 (73.3)

It can be inferred from the Table 3 that majority (73.33%) of farmers expressed that old shirt as protective clothing is highly suitable followed by 26.6 per cent had medium comfort ability as it is easy to wear and remove and it protects body from external matters. Old shirt is starched to close the pores of the garment, here the starch is acted as a barrier between the skin and chemical and each usage starch application is must.

**Table 4:** Comfort ability Assessment of Upper garment – old shirt (n=30)

S. No.	Comfort ability assessment	Characteristics of functional features	Excellent	Good	Fair	Poor	Very Poor	WMS
a.	Easy to wear		17	11	2	-	-	4.5
b.	Easy to remove		11	13	6	-	-	4.16
c.	How long can be wear	1. 0-1 hr	27	3	-	-	-	4.9
		2. 1-2 hr	4	16	10	-	-	3.8
		3. 2-3 hr	11	12	7	-	-	4.13
		4. More than 3 hrs	8	9	9	4	0	3.7
d.	Fabric	Protects body from external matters	13	12	5	-	-	4.26
		Absorbency of perspiration/pesticide	16	10	4	-	-	4.4

It was found that the overall WMS score for easy to wear and remove of old shirt as protective clothing while spraying were 4.5 and 4.16 which indicates that farmers comfortable with old shirt to wear and remove. Farmers feedback for easiness towards wearing was 17 farmers gave excellent followed by good (11) and fair (2). Out of 30 farmers 13 farmers expressed good feedback is easy to remove old shirt as it is not very difficult after spraying followed by 11 excellent, 6

gave fair response and also state that farmers are not facing any problem while removing protective clothing after their operations. The comfort ability assessment also included the duration the clothes can be worn comfortably. The study revealed that, 27 farmers perceived the clothing comfort ability as excellent during first hour. The comfort ability of clothing was perceived as good by 16 farmers during 1-2 hrs of duration followed by 10 fair and only 4 comfortable

excellent. Out of 30 farmers, 11 farmers rated comfort ability as excellent when it was worn for 2-3 hrs. When the protective clothing was worn for more than 3 hrs, comfort ability was found to be excellent by only 8 farmers. The overall WMS scores for worn comfort ability were 4.9, 3.8, 4.13 and 3.7 and farmers are not feeling comfortable to wear the protective clothing, why because the starch gets absorbed by the chemical, as well as at the time of spraying the farmers sweat eventually, the dress sticks to the body creating discomfort. Fabric characteristics of functional feature are to protect body from external matters and out of 30 farmers 13 farmers expressed as excellent, 12 as good and 5 as fair. The overall WMS score was 4.26, which indicates that, the fabric protecting the body from external matter excellently. Regarding absorbency of perspiration/ pesticide, out of 30 farmers 16 farmers gave excellent feedback about old shirt with starch application as the starch is acted as a barrier between the skin and chemical and so for each usage old shirt must be starched. The overall WMS score was 4.4, which indicates that old shirt has excellent absorbency of perspiration as the starch application shirt cannot absorb pesticide/ chemical during crop period. The findings are

coordination with the findings of [12, 13].

### Durability

Durability refers to the service life as well as to the elements that cause them to be no longer wearable. Based on the farmer's feedback on protective clothing durability, the respondents were distributed into three categories low, medium and high.

**Table 5:** Distribution of respondents based on their durability/ serviceability of old shirt

S. No.	Category	Frequency (%)
1	Low (5-10)	0
2	Medium(11-15)	1 (3.33)
3	High (16-20)	29 (96.6)

It could be inferred from the table 5 that majority (96.6%) of the farmers highly satisfied with old shirt durability for entire crop period as it protects body from external matters and starched cloth cannot absorb pesticides into body, so farmers adopted old shirt as protective clothing for spraying.

**Table 6:** Durability/ serviceability assessment of Upper garment – old shirt (n=30)

S. No	Durability/ serviceability	Characteristics of functional features	Excellent	Good	Fair	Poor	Very Poor	WMS
1.	Garment old/new	1. 0-5 days	19	9	2	-	-	4.56
		2. 5-10 days	20	6	4	-	-	4.53
		3. 10-20 days	6	14	10	-	-	3.86
		4. Entire crop period	8	14	8	-	-	4

It was evident from the Table that, farmers expressed that using old/ new shirt for 0-5 days for spraying has excellent durability followed by good (9) and fair (2). The overall WMS score was 4.56, which indicates that protective clothing was suitable, comfortable and durable for spraying. With regard to serviceability of garment in 5-10 days, twenty farmers gave excellent and 6 gave good response and the WMS score was 4.53, which replicate that using old shirt as protective clothing for 5-10 days for spraying is good. Regarding 10-20 days durability of garment, 14 farmers experienced old shirt is good, 10 farmers fair and 6 farmers experienced as excellent and the overall WMS score was 3.86, it indicates that 10-20 days they can use for spraying. Durability of garment entire crop period, out of 30 farmers 14 farmers gave good feedback, 8 gave excellent and fair. The overall WMS score was 4, which indicates fair response to the protective clothing, whether it is the old garment or new garment, it can be easily used for the entire crop period and

also farmers feel good with old shirt as they habitual to worn it.

### The findings are supported with the findings of [12, 13].

**Table 7:** Distribution of respondents based on their adoption feasibility of old shirt (n=30)

S. No	Category	Frequency (%)
1	Low (1-2)	0
2	Medium(3-4)	20 (66.6)
3	High (4-5)	10 (33.3)

It was seen from the Table 7 that majority (66.6%) of the farmers had medium feasibility to adopt old shirt as protective clothing and followed by 33.3 per cent highly adopted entire protective clothing set for spraying as they felt that it is better to spend money on protective clothing rather than to spend money on health diseases.

**Table 8:** Adoption feasibility assessment of Upper garment – old shirt (n=30)

S. No	Adoption feasibility	Characteristics of functional features	Excellent	Good	Fair	Poor	V. Poor	WMS
1.	Cost of the new garment (INR 650/-)	Reasonable	10	12	8	-	-	4.06

It was clear from the Table 8 that the adoption feasibility and the cost of new garment or protective clothing set is 650/-. The characteristic of functional feature is reasonable. Out of 30 farmers, 12 farmers gave Good, 10 gave fair and 8 gave

fair response and the WMS score was 4.06 which indicate that, the farmers are felt that it is better to spend money on protective clothing rather than to spend money on health diseases.

**Table 9:** Distribution of respondents based on their opinion regarding protective clothing

S. No	Category	Frequency (%)
1	Negative (4-6)	2(6.66)
2	Neutral (7-9)	2 (6.66)
3	Positive (10-12)	26 (86.6)

It could be inferred from the Table 9 that majority (86.6%) of the respondents had positive opinion towards old shirt as protective clothing for spraying as it protect body from dust

and other organic matter, so there is no need of specially designed apron. They felt good with old shirt as they habitually worn it.

**Table 10:** Opinion of the respondent regarding protective clothing (n=30)

S. No	Statements	Strongly Agree	Agree	Dis agree	WMS
1.	Old shirt protect neck from dust and other organic matter, so there is no need of specially designed protective clothing	21	7	2	2.63
2.	I feel good with old shirt as I am habitual to wear it.	21	7	2	2.63
3.	Functional features/fasteners used in protective clothing do not cause pinching	30	-	-	3
4.	Protective clothing though look different still one should wear these as health protection is important than look	22	4	4	2.6

Table 10 indicates that, opinion of the respondents regarding the old shirt as protective clothing; the overall WMS scores were 2.63, 2.63, 3, and 2.6. With regard to old shirt, it is protecting from the organic matter and dust so there is no need of specially designed apron. Farmers are feeling good with the old shirt because they are habituated. Functional features/ fasteners used in protective clothing/ old shirt do not cause pinching to the respondents and with those features; they are not having any problem. Farmers strongly agree with it, even though the protective clothing look different they want to wear because, health and protection was considered important than look. The findings are in line with the findings<sup>[12]</sup>.

#### Adoption feasibility

Adoption is concerned with how consumers accept a prevailing style during a particular time. The respondents categorized into three groups based on their scores pertaining

to protective clothing adoption feasibility.

**Table 11:** Distribution of respondents based on their adoption feasibility regarding protective clothing (n=30)

S. No	Category	Frequency (%)
1	Low (4-6)	4(13.3)
2	Medium(7-9)	17 (56.6)
3	High (10-12)	9 (30)

It was evident from the Table that above fifty per cent of the respondents had medium adoption feasibility followed by high (30%) and low (13.3%). The possible reasons might be farmers opined that protective clothing can avoid health problems during spraying and it covers body from dust particles. The health problems like itching, irritation, skin allergies, burning, vomiting, headache and faintness should be reduced.

**Table 12:** Adoption feasibility of the respondents regarding protective clothing

S. No	Statements	Strongly Agree	Agree	Dis agree	WMS
1.	One must wear protective clothing to avoid health problems during agricultural activities	15	7	8	2.23
2.	It is better to spend money on protective clothing rather than to spend money on health diseases/problems	18	10	2	2.53
3.	Protective clothing are the needs of every farm workers	4	15	11	1.76
4.	To avoid health problems faced by farm workers with the use of normal clothing, everyone will use Protective clothing during working hours	4	15	11	1.76

It was observed that farmers had positive opinion and medium adoptability towards protective clothing. The overall WMS were 2.23, 2.53, 1.76 and 1.76. With regard to adoption feasibility, the statements showed that farmers strongly agree to the fact that, one must wear protective clothing to avoid health problems during agricultural activities. Farmers feel

that, it is better to spend money on protective clothing rather than to spend money on health diseases/ problems. In the agricultural operations, protective clothing is needed to avoid the health problems. The findings are contrary with the findings of<sup>[12]</sup>.

**Table 13:** Morbidity pattern of protective clothing Vs Normal clothing (n=30)

Parameter	Daily		Weekly		Quarterly		Monthly	
	NC	PC	NC	PC	NC	PC	NC	PC
Itching	30	20	25	15	25	11	20	0
Irritation	30	22	25	12	25	8	20	0
Skin allergies	30	18	25	12	25	10	20	0
Burning	28	18	23	13	20	5	20	0
Vomiting	25	15	23	10	20	5	20	0
Headache	22	15	20	10	20	5	20	0
Faintness	20	12	20	10	20	5	20	0

NC – Normal Clothing

PC – Protective Clothing

Table 13 shows that morbidity pattern or occupational health hazards of respondents. Majority of them are suffer from various health hazards during spraying time because nobody taking any safety measures. Identified health hazards were

itching, irritation, skin allergies, burning, vomiting, headache and faintness. With the use of protective clothing includes, cap, old shirt, gloves, mask, sun glasses were protecting the body from pesticide inhalation as well as pesticide particles.

And also observed that protective clothing utilization was decreased the health hazards or morbidity pattern over a period of time, from day one to day 30. The findings are supported with the findings

## Figures



**Fig 1:** Protective clothing set worn by farmer



**Fig 2:** Method demonstration on Protective clothing at Farmers field by B. Sc. RAWEP students



**Fig 3:** Skill Teaching on Protective clothing at Farmers field



**Fig 4:** Training programme on Protective clothing by Home Scientist, KVK, Rudrur

## Conclusion

Pesticides are widely used in agricultural production, to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. Exposure to chemical pesticides while spraying in their field has become a major health problem for farmers in Telangana state with a special mention to Nizamabad district. According to Bhandari, headache (73.8%), skin irritation (62.3%), eye irritation (32.8%), weakness (22.4%) and muscle pain (19.1%) were some of the common self reported toxicity symptoms of pesticides faced by farmers. WHO data shows that 500000-1000000 people around the world per year have experienced pesticide poisoning and around 500-1000 people per year experience fatal effects such as cancer, disability, infertility and liver disorders. Exposure to insecticides within the home and herbicides outside is associated with blood cancers in children. Farm workers are exposed to pesticide vapours which enter body via dermal absorption, inhalation and ingestion. Pesticides are absorbed through skin at the time of mixing, loading, application and equipment maintenance. Dermal exposure accounts for 87-90% of total exposure of pesticides because the skin of a human adult has a superficial surface area of approx. 1.73m<sup>2</sup>, a major focus of accidental exposure.

Exposure to the chemical pesticides while spraying in the field has become a major health problem, among the farmers. By taking safety measures, these health problems can be reduced. So Krishi Vigyan Kendra, Rudrur popularized the protective clothing technology proved technologically feasible, economically profitable, ecologically sustainable and culturally compatible to the farmers to reduce the health hazards. Collected 30 farmers' responses through structured schedule and calculated Weighted Mean Score for each functional feature of protective clothing. Here, the polyester and cotton blended garment with the starch application, mask, gloves and glasses are used as protective clothing for each spraying. The suitability, comfort ability, durability, adoption feasibility and opinion of the farmers were good about protective clothing while spraying. By this protective clothing utilization, the morbidity / health hazards were decreased over a period of time from day one to day 30 among the farmers.

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