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The Model for Use of Chemicals by Sugarcane Farmers for Reducing Health and Environmental Impacts in Thailand

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Abstract:- This study was meant for research and development with the following objectives: 1) develop a model for the use of chemicals by sugarcane farmers for reducing the consequent health and environmental impacts in Thailand's Phetchabun province, 2) compare the level of knowledge, attitude, and behavior in practice regarding self-regulation in the use of chemicals among sugarcane farmers before, during, and after using this model. The Delphi technique was employed to collect data, and the concepts of environmental education were applied to develop the model. The sample of phase 1 included 24 experts who made recommendations for model development; they were selected by simple random sampling. Phase 2 involved trials for developing the model for which 36 farmers were selected by multi-stage random sampling by which who had planted sugarcane and whose blood samples, when tested, contained the cholinesterase enzyme at levels either equal to or more than risk level. The tools used for data gathering were interviews, a knowledge test, and attitude and behavior questionnaires with IOC = 0.83, discriminant power = 0.46, difficult value = 0.45, and reliability score = 0.92. The statistics employed for data analysis were frequency, percentage, mean, standard deviation (S.D.), and Paired Samples T-Test. The research findings used to construct a suitable model comprised the following" 1) group responses 2) knowledge construction, and 3) cooperation. The results of evaluation by experts for having a better-quality model showed that were at a high level (mean = 4.33, S.D. = 0.57). The comparisons of the level of knowledge, attitude, and behavior in practice for self-regulation regarding the use of chemicals by sugarcane farmers before, during, and after using this model showed that the level of knowledge, attitude, and behavior in practice of the post-test group were higher than the pre-test group at a statistical significance level of 0.01.

Keywords:- *Chemicalst; Famers; Environment.*

I. INTRODUCTION

Rapid economic and social changes have influenced a leap in development as science and technology have helped manufacture a variety of convenience products. The agriculture sector needed to increase food production to respond to human needs, causing greater economic competition. Chemicals were used to activate growth in plants such that consumers are lured to them, and these are not eaten by any animals and insects. For these reasons, farmers have been attracted to increase their use of chemicals in their process of cultivation [1,2].

Thailand has been an agricultural country for the longest time since the days of our ancestors; its geography and climate suit plantations the most. Most of the country's population is engaged in farming as their occupation, and farmers have chosen to extensively use chemicals to proliferate plantations, i.e., adopt the so-called chemical agriculture cycle and they expected that increasing agricultural products [3,4].

In Thailand, the situation of chemical use can be understood from the relevant data from 2014 to 2017. This data shows that the import of herbicides averaged 512,191 kilograms per year, import of insecticides averaged 64,494 kilograms per year, and import of fungicide averaged 54,914 kilograms per year. Because Thailand could not produce chemicals, it imported raw materials or substances for being sold by themselves or in the form of mixtures [5].

Phetchabun province administers 11 districts totaling an area of 12,668.42 km^2; its agricultural area is 5,119.61 km^2. There are 199,533 farmer households and 698,132 farmers in the province. These farmers cultivate monoculture cash crops, and chemicals are used during cultivation in all the areas of the province. The farmers registered as sugarcane growers are found mostly in the following 4 districts: Wichian Buri district has 3,169 farmers with an area of 131.06 km^2, Si Thep district has 3,187 farmers with an area of 109.10 km^2, Bung Sam Phan district has 1,249 farmers with an area of 46.45 km^2, and Nong Phai district has 552 farmers with an area of 18.71 km^2 [6]. Though the plantations in these comprise rice, garden crops, and field crops, the use of chemicals is the most in sugarcane cultivation in terms of not only volume but also concentration [7].

The Si Thep district's population comprises mostly farmers; they grow sugarcane, rice, corn, and tapioca. Chemicals are used when all of these plants start to grow. As much as 90 percent of these chemicals are organophosphate, carbamate, and neonicotinoid, which were highly absorptive. These chemicals have a special property to permeate into the trunk, and they are capable of destroying insects because of the hazardous substances in them. The surveillance report on chemicals by Si Thep District Public Health Office in 2017 revealed that there were 703 farmers who used chemicals,

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and the cholinesterase enzyme was found in their blood; in the case of 438 farmers, the level was higher than the risk level, while 102 farmers were at no risk. Based on the quoted data, it can be said that sugarcane farmers in Si Thep district are at a greater risk of the said enzyme than in other areas.

The problems that are caused by the use of chemicals include their adverse effects on health and environment. These adverse impacts on health can be divided into two types as follows: acutely hazardous impacts whereby the farmers may start showing symptoms immediately after they come in contact with chemicals such as squeamishness, vomits, headaches, muscle pains, diarrhea, shortness of breath, and blurred vision. The chronic impacts caused by accumulated toxic chemicals are diseases and health problems such as cancer, diabetes, paralysis, skin diseases, infertility, paralysis of newborns, and sexual dysfunctions [8]. The adverse impacts on the environment include a deterioration in the quality of critical ecosystems comprising the environment such as soil deterioration, reduction of ground cover plants, air pollution, and contamination of water by chemicals causing the death of aquatic animals and a further damaging effect on the ecosystem [9,10].

The efforts to solve these problems must focus on reducing the use of chemicals or using them moderately. For this, it is needed that the farmers concerned have the necessary knowledge and understanding about the destructive effects that the use of chemicals has on health and the environment. Further, they should be skilled in using chemicals such that it does not cause environmental imbalance. In the Si Thep district, this problem could not to be concretely solved because though the public health officials focused on training and knowledge dissemination to reduce the use of chemicals, they did not ensure continuous monitoring and evaluation. The surveillance results and annual checks revealed the presence of the cholinesterase enzyme in the blood of farmers who used chemicals, and most of them were at risk (Si Thep District Public Health Office, 2018). The problem-solving to reduce the use of chemicals needs to adopt a new approach that focused on participation. This approach should draw on the relevant body of knowledge and experiences of pertinent sectors, including the public sector, the agriculture sector which uses chemicals, the industrial sector, and the sellers of chemicals. These data were analyzed, synthesized, and organized in the form of a proper model and then applied to on-ground practices. Thus, using this approach, and with reference to the problem situation, a researcher can develop a model for reducing the health and environmental impacts of the use of chemicals by sugarcane farmers. This research used the Delphi technique as it aimed to prevent and solve the problem of the use of chemicals in plantations and emphasized on promoting awareness and relevant learning in communities that would be consistent with the local situation and the concerned farmers benefit in terms of good health, livable environment, and sustainable livelihoods. The objectives of this research were to (1) To develop a model for sugarcane farmers' use of chemicals to reduce the health and environmental impacts of these chemicals. (2) To test the model for use of chemicals by sugarcane farmers and compare their level of knowledge, attitude, and behavior in practice for self-regulation of the use of chemicals before, during, and after using this model for reducing health and environmental impacts of these chemicals in Phetchabun province, Thailand.

II. METHODOLOGY

A. Research design and Conceptual framework

This study used the research and development approach and applied the Delphi technique [11] and a combination of other data collection tools used for conducting both qualitative and quantitative research to achieve the objectives of this study as illustrated in Fig. 1.

Fig. 1: Delphi technique, T1 = Phase 1: X = Phase 2: T2 = Phase 3.

This research and development was divided into 3 phases as shown in Fig. 2.

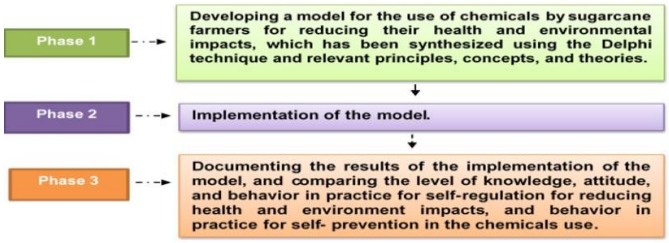

Fig. 2: Conceptual framework

B. Population and sample sizes

- Phase 1: The total number of 146 officials who work as public health academicians and have suitable expertise and who are responsible for disease control, a sample of 24 officials was drawn using the simple random sampling method.
- Phase 2: During this phase, of the 3,187 farmers in the Si Thep district whose data was available in the registration records, a sample of 341 persons was determined by the statistical program and find out a Power of the test G* Power [12] (e = 0.5, power of test = 0.60 [13]. Further, a sample of 36 farmers was selected using multi-stage random sampling and purposive sampling. The cholinesterase enzyme was present in the blood of these farmers, and its level was equal to or more than the risk level (≥75.0 mg/l).
- Phase 3, The population concerned, and the sample used were the same as that for phase 2.

C. Research tools

- Semi-structured interviews were conducted in the first phase, and interviews with experts as part of employing the Delphi technique [14-15] were organized during the second and third phases.
- The participants were also administered knowledge tests and questionnaires on attitude and behavior in practice for self-regulation vis-à-vis the sugarcane farmers' use of chemicals before, during, and after using this model for reducing their health and environmental impacts.

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Verification of the quality of the tools used.

To verify the quality of interviews and tests, the researcher verified content validity and the appropriate use of language with the help of 5 experts, the item-objective congruence or IOC = 0.83, difficult power = 0.46, discriminate power = 0.45, and reliability level = 0.92.

D. Methods of data gathering

- Phase 1: To gather data and get the opinions of experts on it, using the Delphi technique, the researcher sent out invitation letters. The researcher used the relevant tools themselves. A total of 24 experts were interviewed. Thereafter, the constructed model and evaluation forms were evaluated by 5 experts.
- Phase 2: The researcher carried out the implementation of the model to devise apt learning activities for the sample of 36 participants chosen from the data of registered farmers available with the Si Thep District Public Health Office, Phetchabun province.
- Phase 3: Post-implementation of the model, the researcher administered knowledge tests and questionnaires on attitude and behavior in practice to the selected sample (which was the same as in Phase 2. These tests/questionnaires pertained to the situation before and after the implementation.

E. Data collection

- The required data was gathered and the opinions of 24 experts, which were obtained by using semi-structured interviews, were analyzed in the first phase. Subsequently, the experts were also administered questionnaires in the second and third phases. All of these inputs were then summarized, analyzed, synthesized, and evaluated to construct a model.
- As mentioned earlier, this was the implementation phase. The following figure illustrates the activities during this phase.

During this phase, the researcher administered knowledge tests and questionnaires to ascertain the respondents' attitudes and behavior in practice (Fig. 3).

Fig. 3: Conceptual framework. Model implementation – illustrated; O1 stands for Pretest, X1 stands for the model that was developed, O2 stands for Posttest.

F. Data analysis and Ethical compliance

- Descriptive statistics were used for the analysis of the data collected, viz. frequencies, percentage, mean, and S.D. Further, inferential statistics such as the Paired Samples T-Test and qualitative data were used for further content analysis.
- The researcher obtained a letter of consent from the human research ethics committee, Research Division, Mahasarakham University, No. mhesi. 0605.1 (9)/2685, effective from 20th November 2019 (Certificate no.: 203/2019).

III. RESULTS AND DISCUSSIONS

A. Research findings

The results of developing and implementing a model for the use of chemicals by sugarcane farmers for reducing their health and environmental impacts were as follows:

1) The information gathered from the experts by using the Delphi technique comprised information related not only to the theories of model construction but also the concepts of safe agricultural practices, collaborative learning, and environmental education. The methods and activities were carried out in the following three steps: (1) Constructivism: learners seek and construct knowledge and understanding by themselves, through the exchange of experiences with others, through the discovery of new things, progressing their knowledge based on basics, better quality of learning-related contexts, orientation activities, re-structured new ideas as well as their application and review. (2) Participation in a group process/group activities/group dynamics through games, role-plays, case study discussions, and group discussions, and (3) Cooperative learning carried out in small groups wherein the participants learned by exchanging ideas with each other, resource sharing, cheering each other up, and facilitating successful completion of the learning for all. These activities comprised circle tellers, dialogue corners, check matching, partner, mind puzzle, cooperative groups, and competitive cooperation.

The conclusions are drawn from the application of the model for developing knowledge, attitude, and behavior in practice to create desirable behaviors concerning the use of chemicals by cotton farmers are shown in Fig. 4.

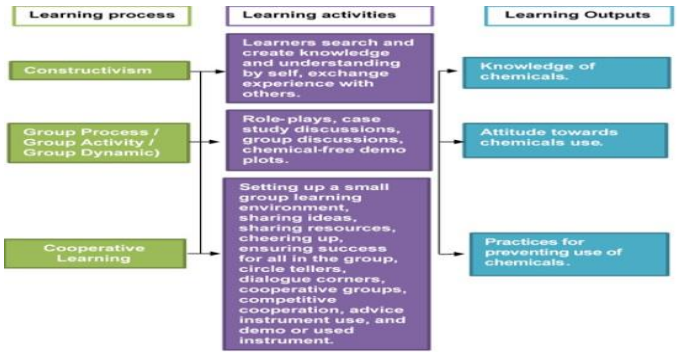

Fig. 4: Model developed for use of chemicals by sugarcane farmers for reducing their health and environmental impacts.

2) The results of a model that was developed for the use of chemicals by sugarcane farmers for reducing their health and environmental impacts were obtained by triangulation, involving experts, farmers, and public health academicians.

Model	Mean	S.D.	Level
Quality of model	4.33	0.57	*High*

Table 1: the model for use of chemicals for reducing their health and environmental impacts as evaluated by the experts (n = 5).

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3) The model was tested on an experimental group for whom learning activities were organized in the Si Thep District Public Health Office. The group comprised 36 persons in all, and their involvement was had for 3 days in March, 2018 (14th, 21st, and 27th). The learning process comprised constructivism, group processes, and cooperative learning to inculcate in them the requisite knowledge, attitude, and behavior in practice for self-regulation of use of chemical by them (Fig. 5).

Fig. 5: Process of the model tested with the sugarcane farmers, Constructivism (Top panel), Group process (middle panel), Cooperative learning (bottom panel).

4) Comparing the level of knowledge, attitude, and behavior in practice for self-regulation in the use of chemicals by sugarcane farmers before, during, and after using this model (TABLE II).

Factors	n	mean	S.D.	t	df	P-value
Knowledge about use of chemicals						
Pre-test	36	5.75	1.81	-27.84	35	<0.00
Post-test	36	17.38	1.71			
Attitude toward use of chemicals						
Pre-test	36	40.33	2.56	-6.05	35	<0.00
Post-test	36	43.88	3.26			
Behaviours in practice for self-regulation of use of chemicals						
Pre-test	36	42.05	2.99	10.58	35	<0.00
Post-test	36	44.72	2.88			

Table 2: Comparing the level of knowledge, attitude, and behavior in practice of the sugarcane farmers before, during, and after using this model (n = 36).

Table 2 shows the before and after results concerning the self-prevention in the use of chemicals sugarcane farmers for reducing their health and environmental impacts. The average of the sugarcane farmers' knowledge, attitude, and behaviors in practice was found to be higher (at a statistical significance level of 0.01) than it was before the model was tested on them.

B. Discussions

The results of the integration of the data, which was collected using the Delphi technique for developing the model revealed that the methods and activities included in the training imparted good knowledge or attitudes toward the use of chemicals and for the self-regulation of their use. The cooperative learning processes were undertaken by a small group of learners who shared ideas, resources, cheered each other up, helped each other succeed in their learning through circle tellers, dialogue corner, check matching, check matching, partner, mind puzzle cooperative group. The competitive cooperation based on constructivism that was consistent with Stapp, B. W. & Dorothy A. C. (1979) [13] means that when the learners searched for and constructed knowledge by themselves and through sharing experiences with each other, they discovered new ideas, learned according to their contexts and orientation, and re-structured new concepts and applied and reviewed them. The evaluation of the model by the experts was showed good results (Mean = 4.33, S.D. = 0.57).

Hohmann et al. [14] has explained the Delphi technique to be a group process wherein the participation of experts is sought by using questionnaires. This way, undue influences on the group or other considerations or conflicts can be avoided, and this helps all of the groups' members to express themselves freely and without any hesitation. Furthermore, this technique can be repeated after offering data feedback to the group's members to review their replies. it is properly collected the data with educated men but limited in skill of discussions, focused on effectiveness of group interaction by eradicated influential personality. This observation is consistent that of the studied of the development of the drug system in central hospitals by using the Delphi technique in Thailand. Concerning the structural aspect, it was suggested that there must be 3 pharmacists of which 1 pharmacist should work at center hospital, whose experience in a clinic or pharmacy should be at least 2 years, and he should be able to use the computer, 2 officials to support, service counters, executive by board of multidisciplinary, budget were subsidized, database storage.

The process aspect; service on answering questions, aware for undesirable symptoms, supporting drug data to pharmacists by self or telephone, channel to connect all time, quarantined in drug service. The outcomes aspect was about evaluating the quality of drug services on aspects such as accuracy, completeness, properly, updation, and its utility for problem-solving. The comparisons of knowledge after the testing of the model revealed that, overall, the scores after testing were higher than before testing at a statistical significance level of 0.01 (t = -27.835, p = 0.000) thanks to the awareness generation process carried out using multimedia, the knowledge tests, the questionnaires on

attitude and behavior in practice. The farmers studied for 15 minutes the documents shared with them, understood the documents themselves and then shared their ideas within the group.

A representative each from the groups summarized the body of knowledge, evaluated by answering so that the farmers could be energized to learn, and they can understand easily. The principle of environmental education referred to by Environmental Education [16] states that accurate application of natural, social, cultural, and technological environment requires awareness of ethics and living together with nature, reciprocal interactions, and worthy use of natural resources that entails taking care of or preserving, conserving, preventing harm to, and protecting the environment from deterioration [17].

C. Suggestions of this research

- Public health agencies should carry out model development for the use of chemicals by sugarcane farmers for reducing their adverse health and environmental impacts, and this approach should be extended to the other farmers' groups group in Phetchabun province and its neighboring areas to reduce the overall use of chemicals and to use them safely.
- Agricultural agencies should determine policy-level interventions to promote awareness among farmers about the dangers involved in using chemicals and, more importantly, to encourage organic farming, eco-agriculture, or safe agriculture that emphasizes use of biological inputs in cultivation processes.

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