

FROM THE FIELD TO DINING TABLE: PESTICIDES RESIDUES

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ABSTRACT

This review article aims to present an overview of pesticide residue, focusing from the field to dining table and on the impact on health. This study also shows *that an information campaign regarding pesticide use and food safety for farmers and consumers. The methodology is based on previous research, relevant studies, published and unpublished sources and authors' own experiences. The work is only a review-based study. Food is a more basic need of man than shelter and clothing. The public is concerned about the presence of pesticide residues in foods. Pesticide residues in foods, farmers' exposure to pesticides, and environmental pollution are serious concerns in Nepal. Risks from pesticides are high because of the lack of knowledge of farmers, limited training and awareness on the safe production of food crops, the absence of an effective code of practices, alternatives to chemical pesticide and inadequate residue monitoring* Increasing awareness regarding good nutrition through quality food is creating a rise in the demand for vegetables and fruits and other crops. Despite great demand for safe vegetables, the supply of vegetables labeled as safe or organic is still limited. As growers are in a hurry to sell their produce, they do not wait or abide by the waiting period. As a result, the pesticide residues, left to variable extent in the food materials after harvesting, are beyond the control of consumer and have deleterious effect on human health. The consumer must think twice before eating veggies and biting into that fruits. Pesticides in the field do show up on our dinner plates or onto our kitchen tables. These pesticides often end up on dinner table. Consumers are not aware of food safety. The concentration of pesticide residues in the vegetable crops from the IPM field was considerably lower, suggesting a greater ability of IPM systems to reduce the dietary risks from exposure to pesticides. However, this is an alarming situation.

Keywords: Consumer, farmer, human health risk, pesticide residues, vegetables

INTRODUCTION

PESTICIDE USE SITUATION

Currently, the health hazard caused by pesticides are very important topics for Nepal as the Government is trying to promote a good *health* for its people, who have frequently encountered problems caused by pesticide consumption. Nepal is importing a huge quantity of pesticides every year. Pesticides are one of the major inputs used for increasing agricultural productivity of crops. A recent study shows that the national consumption of pesticide in Nepal is 396g a.i./ha, which is higher than the previous record of

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142g a.i./ha (IUCN, 1995) but is lower than world average 0.500a.i. kg per ha. On the ecological basis, the highest average pesticide used in the Terai region of Nepal i.e. 0.995 a.i. kg/ha followed by valley (0.470 a.i. kg/ha), hill (0.314 a.i. kg/ha) and lowest in the high hill (0.085 a.i. kg/ha) (PPD, 2015). The problem of safe application of pesticides attracts major attention now due to concerns about their health and environmental impacts (Vumillia, 2019). These developments are clearly supported by the Basel, Rotterdam and Stockholm Conventions and many other intergovernmental treaties and documents (WHO, 2020).

Nepal Government has put the mandatory requirement of the phytosanitary certificate at the custom points while importing the goods however, there is no stringent requirement of the traceability report yet. Based on the reports with frequency of *chemical* pesticide use suggests that, pesticide use in Nepal is heavily concentrated in a few locations. Pesticide use however is much more intensive in areas that have greater access to markets, such as the Terai and the districts adjacent to the Kathmandu and Valley. The use of pesticides is more common on fruits and vegetable crops (PRMS, 2015) not only to save them from pests and disease but also to protect their market values. Abuse and misuse of pesticides is common in Nepal. The overuse, abuse or misuse of pesticides can have serious consequences in crop. The current practice adopted in pesticides control in Nepal appears not enough in line with food safety. This has created a promising threat in food safety and human health (Koirala *et al.*, 2008). Large scale poisonings by pesticide contaminated food are unusual but not unknown in Nepal. And an agriculture officer shies away from the question by stating that "the data on residue levels are too sporadic to draw national conclusions".

These problems can arise from misuse of the pesticides or over-reliance on them, particularly if the users are not aware of these potential problems. Often such fruits and vegetables products are brought to the market for sale within a short period of time after use of pesticides on them (PPD, 2015). As such, fruits and vegetable products have more chances of having excessive pesticide residues than what is permissible under the law. Pesticide residues are a major concern in fresh vegetables and their products for domestic consumption and export. Pesticides are not as extensively used in Nepal as in other countries in Asia in terms of the ratio of active ingredients used per hectare of crop land. There is considerable evidence that farmers have overused and misused pesticides especially in vegetable-growing areas. About 89% pesticides are used in vegetables (Dahal, 1995). Increasing use of pesticides on vegetables is a growing environmental problem and food safety threat in Nepal where vegetable farming is becoming more intensive and a widespread. Because of an open and porous border with India, there is a *considerable*, but unknown quantity of trade between farmers close to the

border. Hence, illicit/illegal import of pesticides issue needs to be addressed in multilateral approach with neighboring countries to prevent potential infiltration of banned/ unregistered pesticides (Bhandari *et al.*, 2019).

PESTICIDE RESIDUES

Pesticide residue is defined by the World Health Organization as “any substance or mixture of substances in food for man or animals resulting from *the* use of a pesticide and includes any specified derivatives, such as degradation and conversion products, metabolites, reaction products, and impurities that are considered to be of toxicological significance. The residues are being accumulated from agriculture activities and Malaria control applications.

Pesticide residue refers to the pesticides that may remain on or in food after they are applied to food crops. It includes any derivatives of a pesticide such as their metabolites, conversion products, reaction products and impurities considered to be of any toxicological significance (FAO, 2013). People are potentially exposed to pesticides orally from pesticide residues in foods such as vegetables, fruits and milk. In developing countries like Nepal many crops are grown which are uncommon in developed countries and for which residue data is lacking. The detection of pesticide residues exceeding allowable limits in food crops is considered one of the long standing problems in Nepal despite various actions taken by the government to overcome it. No systemic and regular study has been carried out in Nepal to analyze the pesticide residues in vegetables and fruits. It goes without saying, international, regional and national authorities have the responsibilities to guarantee safe food, free from pesticide residues and put in place traceability systems for both raw and processed food. Sharma, 2016 reported, residues of some pesticides using Gas Chromatography MS detected the highest concentration of Cypermethrin in tomato and brinjal. The study further revealed, the concentration of Deltamethrin was highest in cowpea followed by cauliflower, tomato and brinjal whereas the concentration of Carbandazim and Mancozeb were also the highest in tomato followed by bottle guard and chilli indicating MRL value more than 39% in the studied samples.

WAITING PERIOD

Where applicable, the product label will specify the period which must elapse between the last treatment/application and harvesting of the crop. This period must be strictly observed, in order to ensure that pesticide residues on the crop are within acceptable limits. The pre-harvest interval (*PHI*) is the wait time between a pesticide application and when a crop can be harvested. Less waiting period indicates that there is a higher risk of presence of pesticides residue in crops, which poses higher health risk to crop growers as well as consumers.

Being a member of WTO, Nepal must comply with the SPS requirements. Residues levels in food consumed must, of course, be acceptable toxicologically. Therefore, an estimate is required of a level of pesticide residue intake below which the risk to health is too small to be of concern. This level of intake is normally referred to as the Acceptable Daily Intake (ADI), which is the amount of a pesticide which can be consumed every day over an individual's lifetime. The ADI value is expressed in terms of milligrams of the residue ingested per kilogram of body weight. Assuming humans would consume the pesticides, the higher the hazard ratio the greater the hazard. Maximum residue limits (MRLs) are the maximum pesticide residues limit in food considered safe to human as set by the Codex Alimentarius Commission (Codex) and the joint Food and Agriculture Organization/World Health Organization meeting on pesticide residues (JMPR). The JMPR aims to protect consumer's health and ensures fair practices in international food trade (FAO, 2013). The MRLs are always set far below levels considered to be safe for humans. MRLs can be used as guidance. MRL setting can be the responsibility of one or more authorities in a country and normally involves the health, agriculture and environmental agencies. MRLs are generally published in open literature or websites of the regulatory bodies for public usage.

RAPID BIOASSAY OF PESTICIDE RESIDUE

The Government of Nepal has already set up the Rapid Bioassay of Pesticide Residue Laboratory (RBPR) on the premises of Kalimati (Kathmandu) Fruits and Vegetables Market in 18 June, 2014 under the supervision of Plant Protection Directorate (now Plant Quarantine and Pesticide Management Centre). The Government has established some more such laboratories at Kakarvitta (Jhapa), Nawalpur (Sarlahi), Pokhara (Kaski), Butwal (Rupandehi), Nepalgunj (Banke) and Attaria (Kailali), The RBPR technology being used in Nepal was developed in Taiwan. It is an acetylcholinesterase (AChE) test used for detecting two categories of neurotoxin insecticides, organophosphate and carbamate. This method provides toxicological indication on plant samples (vegetables and fruits) with residue of Organophosphate and Carbamate insecticides. The major reason for adopting RBPR is that organophosphates-based pesticides are widely used in Nepal. Until a few years ago, around 80 percent of the pesticides used in Nepal would be organophosphates-based. This has come down to around 60 percent over the past four years. RBPR is quick and cost effective technique to monitor pesticide residues and the quick results helps in avoiding shipment of contaminated products and in turn protecting consumers from consumption of such pesticides contaminated products. Fruits and vegetables are also highly perishable in nature; therefore, RBPR being rapid technique is more useful for monitoring pesticide residues on these products. A reliable and highly

sensitive determination of multi-pesticide residues can be achieved by chromatography techniques coupled with MS, tandem MS (MS/MS), triple quadruple MS, or high-resolution MS (Q-TOF).

RESIDUE LEVELS IN FRUITS AND VEGETABLES

The levels of pesticide residue in fruits and vegetables have been closely monitored in Nepal for the past 6 years. An analytical method is the series of procedures from receipt of a sample to the production of the final result. A study was conducted to determine the pesticide residues in different vegetables. Residues of 23 pesticides were analyzed in the three main vegetable crops grown in Southern Nepal: 27 egg plant, 27 chili and 32 tomato samples representing (i) conventional (N = 67) and ii) integrated pest management (IPM) fields (N = 19). The study revealed that pesticide residues were found in 93% of the eggplant samples and in all of the chili and tomato samples. Multiple residues were also observed in 56% of the eggplant samples, 96% of chili samples and all of the tomato samples (Science Direct Topics, 2020). The analytic concentrations are in the range mg/kg to mg/kg. The range ($\mu\text{g}/\text{kg}$) of total detected pesticide residues in eggplants, chilies and tomatoes was 1.71-231, 4.97-507, 13.1-3465, respectively. The most frequently detected pesticides in these vegetables were carbendazim (Fungicide) and chlorpyrifos (Insecticide). Pesticide residues in 4% of the eggplant, 44% of the tomato and 19% of the chili samples exceeded the EU MRLs. The concentration of pesticide residues in the vegetable crops from the IPM field was considerably lower, suggesting a greater ability of IPM systems to reduce the dietary risks from exposure to pesticides (Bhandari *et al.*, 2019).

Pesticides residue tests of fruits and vegetables conducted by the government in various parts of the country between July 16, 2017 and May 14, 2018 have revealed that out of 3,677 samples 33 were found inedible due to high concentrations of pesticides. Likewise 93 samples of *fruits* and vegetables were quarantined. Out of the 507 samples tested at the Pokhara lab, 19 were inedible while 23 samples were quarantined, (Bhandari, 2019) most cases, the quarantined samples can be consumed after a few days (PPD 2018). Vegetables with AChE inhibition below 35 percent pesticide residue will be categorized as acceptable (Green) and safe for consumption purpose. Vegetables with pesticide residue of 35-45 percent will be acceptable only if they are consumed after 4-5 days (Yellow). Vegetables with more than 45 percent pesticide residue are harmful not only to human being but also animals. Such vegetables with more than 45 percent pesticide residue should not be consumed and need to immediately dump such vegetables regardless of their quantity (Red). RBPR does not calculate amount of pesticide neither it gives type of pesticides. It gives only inhibition percentage from which the result is withdrawn.

Residues analysis of 75 samples of 13 vegetables indicated that 58% of the vegetable samples contained no detectable level (NDL) of the monitored pesticides, 38% samples resulted in trace level of the pesticides residue or below the minimum residue level (MRL), while 4% samples *showed* above MRL (EU Standard) (Sharma, 2015). However, this is an alarming situation. So there is an urgent need to analyze the marketable produce and to generate awareness among farmers and consumers.

TRAVELING ON/IN FOODS FROM FIELDS TO THE DINNER TABLES

This article focuses on pesticide residues, or the pesticides found on the surface of fruits and vegetables when they are purchased as groceries. Vegetable production in Nepal is now significantly dependent on pesticides, either on large scale production or smallholder production systems. The deep concern of society about environmental pollution, especially pesticide residues in food crops and products, has been growing in recent years. Fruit and vegetable production, easily are undertaken by unskilled and untrained farmers (WHO, 2003). Chemical contaminants in raw fruits and vegetables may be added during agricultural *production*, post-harvest handling and other unit operations. Much of the problem too has come about because of misuse of pesticides by farmers. Farmers are known to spray certain pesticide on cauliflower to give it an extra white appearance. Okra is dipped in chemical (copper sulphate) to make it look greener. Several farmers violate the rule that no spraying should be done a week before harvest to prevent high pesticide residues in vegetables. That has seen residue levels shoot up to dangerous levels in such vegetables as okra, tomatoes, cabbage and cauliflower. The highest level of use was on brinjal (3.34 a.i. kg/ha), which was much higher than on any of the other arable crops. The tomato crops were next highest in level of use (1.95 a.i. kg/ha), potato (1.03 a.i. kg/ha) and Cole crop (0.70 percent a.i. kg/ha) (Bhandari *et al.*, 2019).

The specter of pesticides traveling on/in foods from fields to the dinner tables has concerned the public. Farmers use higher amounts of pesticides than recommended doses because of ignorance, lack of training, experience, awareness etc. Farmers believe that production will be more if they apply more of pesticides. For that reason they use excess pesticides. It has been suggested by various studies that fruits and vegetables may contain residues of pesticides. Among all crops, comparatively more pesticides are applied for vegetables crops. The pesticide residue is expected to come from field to kitchen/dining table. The transmittal of pesticide residues is also expected through the food chain to the farm family and urban consumers. Milk and milk products sometimes are found contaminated with insecticides from feed and fodder which remain associated with its fat portion. Theoretically, it will never reach zero concentration, and therefore there will always be pesticide residue o/in food. Ever more pesticides, many illegal, are being used in

Nepal, Yet the tainted or contaminated produce keeps ending up on dinner tables, setting off alarm bells about serious health risks. In reality we (consumers) are also ingesting poisons that can accumulate in our bodies and make us very sick. We all ingest lots of chemicals, one way or another. We breathe them, we drink them, and we eat them. It makes us uncomfortable to think that while we are eating fruits and vegetables. Next time you're shopping at the fruit and vegetable market or grocery store, you may want to think twice about the fruits and veggies you plan to buy. The bigger sizes of vegetables and fruits in the market may look attractive, but people should also think twice before purchasing them. Otherwise, chemicals pesticides in the field do show up on our dinner plates or onto our kitchen tables.

Fruit and vegetables are an important part of a balanced diet. Doctors and nutritionists always advise us to eat plenty of green leafy vegetables, fruits and salads. Fruit and vegetables are an important part of diet as they contain vitamins, essential micronutrients, fiber, vegetable proteins and bio-functional components. We are told to eat two pieces of fruit and vegetables every day, but are they safe to eat? Most of the fruits and some of the vegetables are consumed directly without cooking. But most of these vegetables contain residues of pesticides that are widely used in Nepalese agriculture. However, the use of pesticides during production in the crop field often leads to the presence of pesticide residues in fruits and vegetables after harvest. Hence, the issue of pesticide residues assumes much greater importance for this food items. There are many ways that people are exposed to or come in contact with pesticides every day. One of the ways is eating such fruits and vegetables with pesticides on them. We are not only slowly poisoning ourselves but jeopardizing our future generations too. One of the most common routes of pesticide exposure to consumers is via food consumption. It is important for the consumer to understand the intake of pesticide residues. All agricultural produce marketed and consumed must not contain pesticide residue levels higher than the MRLs. Food safety is defined as the assurance that the food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.

Randomized security checks of pesticide residues in the field will help increase farmers' motivation to use less toxic pesticides and apply them in a standardized way. For this reason, it is urgent to develop programs related to the monitoring of pesticide residues in food to secure consumers. This calls for a comprehensive and integrated **farm-to- dining table** approach in which the producer, processor, transporter, vendor, and consumer all play a vital role in ensuring food safety and quality.

EFFECTS OF PESTICIDE RESIDUES

The presence of pesticide residues is a concern for consumers because pesticides are known to have potential harmful effects to other non-targeted organisms than pests and diseases. Worldwide, people are unwillingly exposed to pesticide residues through food. The persistent use of pesticides leaves behind toxic residues on food crops. These pesticides upon ingestion exert adverse effects on human health, in addition to disturbing ecosystem. Dietary exposure is the function of pesticide residues level in food and rate of consumption of that food. Human health effects associated with pesticide residues exposure include headache, skin irritation, itching, dizziness, restlessness, neurotoxicity, breathing difficulties, unconsciousness, and chronic poisoning-related diseases such as cancer and death incidences. There are two types of health effects—one is acute or immediate and the other is chronic or takes place over longer periods of time. 1 in 10 people fall ill every year from eating contaminated food and 420,000 die each year as a result. Children under-5 is at particularly high risk. 125,000 young children die from food borne diseases every year (WHO, 2020).

It is suggested that different processing operations can be effectively applied on fruits and vegetables to minimize the risk of pesticides on human health. However, pesticide use also has created concerns regarding its effect on the environment and the potentially toxic or carcinogenic residues remaining in the food chain. The main concern of the public is the possibility of adverse reactions due to the 'cocktail effect. The concern has led to three tier governments (central, provincial and local) setting up monitoring systems in order to assess the safety situation and make informed decisions when passing legislation.

FARMERS' AWARENESS OF PESTICIDE RESIDUES

Farmers serve as the main unit of pesticide application. Hence, their degree of awareness of pesticide residues inherently affects their methods of pesticide application. Majority of the farmers are unaware of pesticide types, dose, frequencies and waiting periods and safer disposals (GC, 2015). Risks from pesticides are high because of the lack of knowledge of farmers, limited training and awareness on the safe production of food crops, the absence of an effective code of practices, and inadequate residue monitoring (FAO-TCP/NEP/3502, 2017). Commercial vegetable production in Nepal heavily relies on chemical pesticides. Pesticide residues have always been an important concern in agricultural safety. Most of the farmers have impression in their mind that spray/use of more pesticide will lead to higher production. The farmers do not have adequate knowledge regarding pesticide use, food and health safety. The concept of chronic poisoning and health risks is not fully understood by farmers. In general, farmers often follow the advice of their retailers for choosing pesticides. Farmers refer to pesticides as

medicines rather than poisons, a notion implanted in the mind of the farmer (Palikhe, 2002). The applications of pesticides are unscheduled and normally apply more than the recommended dose of pesticides. This activity raises concerns regarding chemical residues on vegetables and fruits. It is a known fact that farmers do not follow the pre-harvest waiting period. Waiting period is the duration after which the commodity treated with pesticides can be used. Each crop protection product has its own Pre-harvest interval (PHI), and the PHI for a specific product often varies by crop. There is a waiting period prior to harvesting. They apply pesticides near harvest time. Vegetables tend to be sprayed heavily up to the time of harvest, and then transported directly to market with no waiting period; moreover, many are consumed whole. In the absence of moral and legal barriers, vegetable growers are working on grow-fast sell-fast principle. Vegetables sold in market are mainly grown in commercial villages around the city and are harvested and sold fresh. Vegetables sprayed the day earlier are brought to the market the next day. These create a very significant potential for pesticide residues causing negative health effects on consumers. Awareness is needed (by both producers and consumers) of “win-win” practices that will lead not only to improvements in terms of yield and productivity but also for the environment, health and safety of workers.

CONSUMER AWARENESS

The consumer is the ultimate buyer and/or end-user of produce in horticultural supply chains. A consumer may be a business, a household or an individual. Public concern over pesticide residues in vegetables and fruits has been increasing during the past years. The general public concerns include: What about the chemicals the farmers use to keep their crops free from pests? Does my food contain any pesticide residues? How is my food checked for pesticide residues? Where can I find more information? How safe are the vegetables and fruits that we consume every day? Should I take fewer vegetables as they may contain pesticide residues? The use of pesticide might leave some residues on food crops. There is ground for suspicion of any wrong doing, since then consumers have tried to avoid eating it, but for how long? Pesticides used just before harvesting can lead to excessive residue in food, affecting the health of consumers. Pesticide residues affect the quality of agricultural goods. Consumers’ perception of quality is based primarily on visual appearance and physical condition, with safety ranking second. Most consumers in Nepal think that fresh fruits and vegetables are safe since they are grown locally and they are not familiar with signs of unsafe food. A small elite group of consumers is becoming more conscious of the detrimental effects of chemical pesticides and is moving towards residue-free produce. Unfortunately, most of the consumers have little or no understanding of pesticide contamination.

Consumer concerns about pesticide residues in foods are widespread, which is reflected in a significant willingness to pay (WTP) for avoiding related risks. In developing countries, widely reported incidents of dangerous levels of pesticides in food have stimulated the demand for organic food, a movement to choose organic agriculture. Almost all the consumers were willing to pay up to 50% premium for the organic fruits and vegetables.

REDUCTION OF RESIDUES

Generally, the quantity of pesticides used in Nepal is still relative low compared to many countries in the SAARC region. As such, the issue of concern should be “proper use of pesticides” rather than purely “reduction of pesticide use”. In practice, the feasibility of pesticide reduction depends on the nature of the crop, the associated environmental and ecological conditions, and the farmer’s socio-economic situation. As consumers we do not have any control on the pesticides that is sprayed on fruits and vegetables in the farms but there are some quick do-it-yourself techniques that can help us get rid of the residues to a large extent.

How safe are the vegetables and fruits that we consume every day? Unfortunately, just washing vegetables is not enough to ensure produce clean enough for consumption. Can washing of produce help get rid of pesticides? Not really. Fruits and vegetables that we purchase and consume are safe, as long as we practice some measures before eating them. To some extent, washing of some fruits and vegetables with warm brine solutions are recommended to flush out the tainted pesticides from their outer surface.

Some pesticides are specifically created to stick to the surface of the crops and they don't come out by washing. To reduce the amount of pesticide residue, wash fruits and vegetables well in salt water (5 spoonful of salt to 1 liter of water), then rinse in fresh water. Immersing fruits and vegetables in water for 15 to 30 minutes can wash away part of the water-soluble pesticides; however, this process can never be 100% effective and is also likely to destroy some of the fruits nutritional value. Surface residues are amenable to simple washing operations whereas systemic residues present in tissues will be little affected. Certain pesticide residues can effectively be removed by blanching. But before blanching (a short treatment in hot water) it is very important to thoroughly pre-wash the vegetables and fruits. Discard the outer layer of leafy vegetables, such as lettuce or cabbage. Peel fruits and vegetables when possible. Trim fat and skin from meat, poultry, and fish to minimize pesticide residue that may accumulate in the fat. Many people choose to buy organic produce to avoid pesticide residues. Organic farming grows produce without the use of synthetic chemicals or pesticides.

In a developing country like Nepal there is a great need to regulate the use of pesticides where the extensive use of pesticides is causing serious health

and alarming environmental problems. To minimize the risk of pesticides on health GAP and different processing operations should be applied on fruit and vegetable crops that reduce the pesticide residues below the risk level. There is a need to educate the consumers through different media. Although alternative measures to chemical pesticide use are still limited, whatever is available should be rapidly transferred through various media to implementing agencies and farmers needing them. In particular, it is crucial to strengthen cooperation among researchers, extension workers and pesticide suppliers to help farmer gain the knowledge to better manage their crops. This paper suggests that great efforts to reduce potential health risks from chemicals should be implemented to improve farmer awareness against pesticides application and its hazards. Agricultural extension should be existed to play an effective and responsible role in these efforts. An improved approaches including farmer field school-integrated pest management (FFS-IPM) and, in general, good agricultural practices (GAPs) must be followed as a national strategy for continued crops production with minimal risks of pesticides to the environment and human health.

AWARENESS RAISING AND EDUCATION

Awareness raising and education are important/integral parts for improving pesticide management and food safety. Raising awareness among decision-makers can help generate necessary political support and resources for awareness raising/educational programmes. Awareness raising, education and training are considered essential to implementation of legal or regulatory scheme. The mass media should be enlisted to explain safety practices in pesticide use. General information about protective clothing, safe storage and disposal of pesticides, appropriate application technologies, and the like, should be made available through newspapers, radio, and television. Therefore, information, education and communication sectors need strengthening to raise awareness about proper use of pesticides and its safety measures. The quality of pesticides and their residue on marketable products is required to monitor regularly for public safety. Growing number of international agreements requires integrated and co-ordinate approaches at the national level. There is a good scope of working with appropriate intervention measures in this area for private sector, CBOs, NGOs/INGOs, research/academic institution stakeholders and journalists in order to monitor and reduce pesticide residues in agricultural products. Government should address the importance of educating various target groups in order to reduce pesticide risks and foster informed decision-making at all stages of the pesticide life cycle, and outlined some practical strategies for incorporating pesticides-related education into schools and universities.

DISCUSSION

Pesticide residues in crops are serious trade barriers. Unregulated and excessive utilization of pesticides is alarming due to its uneven distribution and usage on selective crops and the limited reliance on alternative chemicals like bio-pesticides and botanicals. Therefore, the first priority for the three tier governments is to organize and publish public campaigns to raise awareness of producers (farmers) and consumers on the important of food safety, especially based on pesticide management in pre and post-harvest of agricultural products. Nepal is oriented to the following recommendation: the need for awareness, education and training on the uses of pesticides to the farmers and effective monitoring program for pesticide residues in vegetables (Shrestha, 2002).

RECOMMENDATION

Government of Nepal has provided ample information and recommendation about the safe use of chemical pesticides through various means, however, there is widespread lacking in the implementation level. There seemed to be a mis-matching in principle and practice which needs to be studied why such things are happening and addressed through the “gapping of the maps programs”. One of the main problem of not adopting the safe measures of chemical uses are lack of alternative compounds such as biopesticides and locally produced materials. Similarly, use of personal protective equipment (PPE) in hot and humid area is always difficult. Similarly, the overall feeling is that the effect of chemical pesticide is often quicker regardless of their associated hazards. As a result the producers often tempted to go with chemicals and do not want to go with other means that results slower effects. In order to address these issues, government needs strategies non-chemical measures of pest management programs. Collaborative initiation on biopesticides production with public private partnership is the key to move forward with biopesticides production.

Pre-harvest activities that have to be done:

- Train the farmers on the proper choices of chemical pesticides and their safe usage associated with elevated safety behavior;
- Promote using safe chemical pesticides including biopesticides and, botanical pesticides
- Train the technical staff in province extension workers, IPM-FFS trainers/facilitators and others organization or institution on safe use of pesticide;
- Train farmers, pesticide sellers, fruit and vegetable collectors and whole seller on pesticide on proper pesticide application techniques and safe use of pesticides

- Training manuals/guides should be simple language, easy to understand, and clearly illustrated. The contents should be relevant to the practical needs of farmers and with suggestions that farmers can implement.
- Publish campaign to people on impact of pesticide to the human and environment through many way such as training, TV broadcasting, radio, posters, pamphlet, flip chart with picture, leaflet, and street drama etc.
- Train farmers on pesticide residues in fruits and vegetables crop and pre harvest interval of pesticide application
- Extend the applications of IPM so as to reduce the need for pesticides.
- Promote Good Agriculture Practice (GAP) nationwide;
- Organize annual survey on pesticide available in market and cases of misuse by farmers and pesticide poisoning;
- Help proper pesticide use in vegetables, there is a need to prepare a recommended pesticide list with appropriate guidelines on how to use them on different crops and at different growing stages;

Postharvest activities that have to be done:

- Train farmers on post-harvest technology
- Produce quick test kits for detecting pesticide residues in the agricultural products (relevant to MRLs)
- Obtaining reliable data on the relationship between pesticide residues and PHI for each crop
- The central and provincial governments should help identify the quality standard of 'safe agro-products' that can be conveniently monitored
- Publish public awareness materials, e.g. posters, pamphlets/flyers, leaflets, radio/TV scripts on safe use of pesticides, FFS-based IPM Approach on Farmer, GAP, negative effects of pesticides, new technologies for pre and post-harvests, and alternative use of pest's control.

Policy level issues

Development of the mechanisms for producing safer products like biopesticides and botanical pesticides in joint venture of the national and international organizations. Research involvement in these aspects are almost negligible in Nepal. Hence, joint venture of public and private initiatives is a crucial. Aside from availing the products and their usages, harmonisation of Pesticide Rules and Regulations are equally important.

International standards, networking, and collaboration

- Harmonies pesticide registration procedures and regulation including the establishment of residue analysis facilities accessible to every one
- Create enabling environment for agriculture trades through the promotion of niche agri-products.
- Coordinate the use of simple monitoring tests and standard protocols, ensuring quality assurance by linking their use to key analytical centers at Federal, Provincial and Municipal level.
- Encourage international collaborative research and exchange of information to obtain solutions to pesticide residue problems.

CONCLUSION

Consumers and all players in food production chains should be constantly informed on safe use of pesticides. Moreover, consumer bears responsibility to table safe food by ensuring safe source and abide to safe food preparation guidelines. It goes without saying, international, regional and national authorities have the responsibilities to guarantee safe food, free from pesticide residues and put in place traceability systems for both raw and processed food.

In Nepal, as in most of the other developing countries in the region, the capabilities, expertise and resources to fully implement the regulation are limited. Further, there is a need to strengthen the scientific and technical base for health and environmental risk assessment. There should be coordination and monitoring activity and integrated effort from governmental and non-governmental organizations that focus on the awareness raising of farmers on proper pesticide management and related issues. Therefore, information, education and communication should be strengthening to raise awareness about proper use of pesticides and its safety measures. So there is an urgent need to analyze the marketable produce and to generate awareness among farmers and consumers. Training manuals/guides should be simple language, easy to understand, and clearly illustrated. The contents should be relevant to the practical needs of farmers and with suggestions that farmers can implement. Redundancy in registration requirements should be reduced to expedite adoption of safer alternative products (such as bio-pesticides and reduced-risk conventional pesticides). Legislation promoting the use of safer pesticides is also needed.

Declaration of conflict of interest and ethical approval

Both the authors have drafted or written, or substantially revised or critically reviewed the article on from the field to dining table: Pesticides Residues. Both the authors have read the manuscript before submitting to the journal. The article also discussed conflict of interest (COI) situations. All applicable international, national, and/or institutional guidelines for the pesticide residues were followed.

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