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Pesticide Use in Swat Valley, Pakistan

Exploring Remedial Measures to Mitigate Environmental and Socioeconomic Impacts

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Pesticides are increasingly used in Pakistan, including in remote Northern areas in the country, for several reasons. A study in Swat Valley investigated the use of pesticides and associated problems, and identified possible remedial measures of an indigenous nature. Soil samples were analyzed and a detailed survey was done in 12 villages, based on interviews with 216 farmers and several in-depth interviews with other stakeholders such as the agriculture department and various pesticide dealers. All the soil samples contained residues of pesticides, 2 of which are known to be highly toxic and accumulate in nature. Thus they represent a potential risk to the health of people and the ecosystem. The various factors contributing to heavy pesticide use include adulteration and the unscientific way pesticides are used, which in turn affects apiculture and populations of fish and migratory birds. Therefore, proper awareness and farmer training may be helpful to avoid use of pesticides, including for fishing, while administrative measures should be adopted against adulteration. Pesticide use can also be minimized by crop rotation, early harvesting, and reviving farmers' collective work system in farmer field schools (FFS).

Pesticides: widely used in Pakistan

Pakistan is basically an agricultural country. Its economy largely depends upon good crop yields. Due to the widespread presence of pests and plant diseases, however, the country is suffering a loss of PKR 6.5 billion (US$ 85 million) in major food and cash crops (cotton, rice, sugarcane, and maize) every year, while a continuous increase in pesticide usage has been observed. Use of pesticides increased from 23,212 tons in 1994 to over 69,897 tons in 2002. At present about 400 products comprising over 200 active ingredients are registered. This increasing trend must be discouraged by identifying appropriate measures. The present study is an attempt to identify measures helpful in minimizing pesticide-related problems.

The situation in Swat Valley

A comprehensive study (between 2005 and 2007) investigated the use of pesticides in the watershed of the Swat river, also called Swat Valley. The valley comprises 3 main districts of the North West Frontier Province (NWFP): Swat, Malakand (Swat Ranizai Tehsil), and Lower Dir (Adenzai Tehsil). In all these districts water from the Swat river is available for irrigation and agricultural activities are very common (Figure 1). To increase production and to save time and labor, farmers use pesticides in horticulture (especially for peaches) and in agriculture (vegetables).

Soil samples were collected from 12 villages and analyzed for 12 different pesticides using a Gas Chromatograph equipped with an electron captured detector (ECD). In order to know how pesticides are used in Swat Valley and how they affect apiculture, fish, and birds (especially starlings), a comprehensive survey was conducted in 12 villages: 216 farmers were interviewed, corresponding to 10% of the farmer community. The interviews were supplemented by 15 transit walks in 3 seasons (5 walks per season), in addition to other participatory rural appraisal tech-

FIGURE 1 The Swat river at Chakdara, looking South: agricultural land in the lower Swat Valley is affected by pesticides. In addition, concentrations of pesticides in the Swat river are increased by input from the upper Swat Valley, where steep slopes are prone to leaching, releasing high concentrations of chemicals. (Photo by Mohammad Nafees)

niques. For further technical discussion related to quality, adulteration, and pesticides monitoring, the district head office of the agriculture department in the study area was visited and the officers concerned were interviewed. Moreover, various complaints from farmers were investigated, prescribed uses examined, and a special session was arranged with 5 pesticide dealers.

Contamination of the soils by pesticides

Heavy use of pesticides was observed in Swat Valley—not only for agriculture; indeed, pesticides are also misused for fishing. The residual concentration varied from place to place and crop to crop. Six pesticides were identified in all samples. These included 4 banned types (Dieldrin, DDT, Malathion, Lindane) and 2 restricted ones (Methyl Parathion and Heptachlor). In upper areas (northern side) such as Kalam, the total concentration of residual pesticides was comparatively low, ranging from 6 to 45 mg/kg, while 5 types of pesticides were not detected. The same trend was found in the Bahrain, Miandam, and Malam Jaba areas. This can be attributed to steep slopes (30–40%) and sandy soil texture where residues of pesticides are easily leached. Compared to the southern part of Pakistan, these areas are famous for production of off-season crops and are more profitable for farmers.

Based on the interviews, we know that thousands of kg of pesticides are applied in this upper part of Swat Valley and hence are washed into the Swat river, which is used for irrigation downstream. Therefore, the concentration of residual pesticides rises further in Lower Swat. Dichlorvos increased from 47mg/kg in the north to 159 mg/kg in the south, Endosulfan from 0 to 12 mg/kg, Methidiathion from 38 to 125 mg/kg, and Cypermethrin from 43 to 184 mg/kg. Irrigated water, after passing agriculture fields with such residual pesticides concentration (RPC), appeared as a potential hazard when joining the mainstream of the Swat river in Mardan District, situated downstream of the Swat river, NWFP, Pakistan.

The interviews and market surveys also revealed that the residual concentration of banned or restricted pesticides may be due to heavy spraying during the early 1970s, or to the available stock of banned pesticides. The second statement is valid for DDT, as it was found in 3 houses and 2 shops; the matter of the other 4 banned pesticides is open to question. Two pesticides, Heptachlor and Methyl Parathion, have been recently banned in Pakistan, coming under the Rotterdam Convention; but they remain available on the market, and residues were found in soil in the range of 0.6–137 mg/kg for Heptachlor and 12–128 mg/kg for Methyl Parathion. This can be attributed to the various misuses of pesticides by retailers. The rarely used pesticides include Dichlorvos (30–143 mg/kg), Isoproturan (0.34–126 mg/kg), Diazinon (12–172 mg/kg), and Methidiathion (12–216 mg/kg). The most widely used pesticides identified were Cypermethrin (26–184 mg/kg) and Endosulfan (6.24–12.63 mg/kg).

Observed misuses of pesticides

1. **Adulteration** During the survey 75% of farmers complained about adulteration in all pesticides. The same question was put to the agriculture department and was verified. In the North West Frontier Province (NWFP), only one laboratory is operated by the plant protection department and it is difficult to cover the whole of the province, due to which it is difficult to cope with adulteration.
2. **Unscientific and irregular use of pesticides** is another common practice in the study area, where pesticides are not used according to prescribed doses. Out of 216 farmers, only 10 farmers had proper instruments and gauging equipment to prepare solutions in the prescribed way; 73 farmers were observed in the field preparing solutions unscientifically and with no safety measures whatsoever. We came across 17 people affected by pesticides during spraying (Figure 2).
3. **Illegal use for fishing** was the most unfortunate aspect of pesticide use (Endosulfan and Cypermethrin) in the study area, along with other illegal means of fishing such as electric current and dynamite. This not only undermines biodiversity but also contaminates the food cycle. A total of 36 people were identified as associated

with the fishing business, of which 25 were using pesticides for fishing.

4. **Small landholdings** are another problem encouraging excess pesticide use. If one farmer uses pesticides and a neighbor does not, there will soon be pest attacks from the neighboring field. Therefore, the fields are sprayed again and again. Hence a collective and concerted campaign is required to discourage pests with minimum pesticide use.

Adverse health and socioeconomic impacts

The impacts observed in the study area affected human beings, honeybees and migratory birds (starlings). The survey showed that human health is affected quite considerably: 50 respondents became unconscious during spraying and recovered only after a few hours' time; 25 people became unconscious and recovered only in hospital; and 130 people experienced headaches and vomiting, and recovered after approximately 30 minutes. In addition natural honey production (honey prepared by wild bees) decreased by about 75% and is now no longer available on the market. Apicultural activities exist and people keep honeybees, but pesticides are the main hurdle in this business. As estimated, 90% of daily honeybee deaths are due to pesticides.

Another impact was observed on migratory starlings (*sa-kha-ka* in the local language) visiting Pakistan in the winter season (November–February). As interviews with hunters and other farmers made clear, a decrease was noticed after 1970, attributed to both hunting and pesticide uses.

Remedial measures

Based on our in-depth study, we are able to recommend several remedial technical as well as institutional measures.

Early harvesting (premature cutting)

This is effective to discourage unwanted herbs and herbicides. If herbs increase and dominate over a crop, farmers can cut the crop before maturity. This way the seedlings of unwanted herbs do not spread in the soil. Premature cutting is a practice for wheat, maize, and mustard crops in the study area. Some economic loss is associated with this, and only rich farmers or farmers keeping livestock can afford it. The agriculture department has initiated the establishment of farmer field schools (FFS) in each village: these can play a vital role in encouraging the practice of early harvesting to combat weeds.

FIGURE 2 Farmer applying pesticides in his field without using protective measures. (Photo by Mohammad Nafees)

Crop rotation

This is another solution to discourage the use of pesticides. It is practiced in the area, though not explicitly with the objective of combating pests but with a focus on farmers' use and on market prices. Another aim of crop rotation is to increase soil fertility, eg with *Trifolium*, a source of nitrogen in the soil that is widely used as fodder in the area. The farmers in the area need some guidance on how crop rotation can be used against pests and pesticide use.

Integrated pest management is a new concept recently introduced in the area. But because of experimentation and the possibility of losses, farmers are avoiding these techniques. Hence these kinds of experimentation need confirmation through additional research. However, some experiments make sense only if they are directly implemented by farmers in their fields. To motivate farmers to participate in such on-field integrated pest man-

FIGURE 3 Honeybee keeping in Kalam, a common source of income in the study area. In most cases farmers place hives close to fields and pesticides heavily affect the bees. (Photo by Mohammad Nafees)

agement trials, proper compensation mechanisms have to be established for unsuccessful cases of experimentation.

Social code of conduct

Before the advent of pesticides people helped each other collectively in a system called *ashar*. This was quite effective for removing herbs from wheat, maize, and rice fields. Since 1970 and the advent of pesticides, the use of *ashar* for herb removal has been declining. Today, manual removal of unwanted herbs is no longer practiced; labor appears expensive compared to the use of pesticides. It is estimated that clearing a rice paddy for a field requires 5 laborers, who will cost the host farmer about PKR 750. The pesticide Isoproturon can do the same job for just PKR 200 in a few hours. Therefore, to discourage use of the herbicide Isoproturon, *ashar* should be reactivated again. The agriculture department can play a role by using the FFS to arrange meetings between groups of farmers whose fields are situated next to one another and can thus be cleaned manually in a common activity and/or sprayed simultaneously.

Conclusion

The trend in pesticide use, especially of Endosulfan and Cypermethrin, is on the increase. Owing to bio-accumulative properties, pesticides can become part of the food cycle and harm living beings. Other impacts require attention, such as impacts on honeybees, fish, migratory birds, and insects required for pollination (Figure 3). One solution is to discourage adulteration. Another contamination hazard is the use of pesticides for fishing, which also requires awareness and prevention. The third category is irregular use of pesticides; for this, proper training for farmers is required to handle pesticides wisely. Besides, social codes of conduct need to be encouraged so farmers help each other in the form of *ashar* (collective work) to minimize the use of pesticides. The agriculture department should encourage other methods such as integrated pest management through farmer field schools.

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