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TRENDS OF CROP PRODUCTION, LAND USE AND PESTICIDE CONSUMPTION IN BANGLADESH

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ABSTRACT

Increasing food demand of the growing people of Bangladesh can be mitigated by increasing cropping intensity in the limited land. During the period of 2011 to 2020, total cropped area of cereals, pulses, oilseeds, vegetables and fruits increased in exchange of the land area occupied by less profitable cultivation of jute and cotton. It is also notable that the production of cereals, pulses, oilseeds, vegetables and fruits increased but yearly use of pesticides as well as their import in Bangladesh decreased over last few years. In 2009, total pesticide use was 45172 metric tons which was decreased 37422 metric tons in 2020. In 2020, import value of pesticide was 79.17 million USD which significantly decreased compared to year 2008 having the import value 97.38 million USD. It may be happened act because of the implication of integrated pest management (IPM) strategy including different control measures such as cultural, mechanical and biological control methods including the use of pesticides.

Keywords: Land area, cereal, vegetable, fruit, cash crop, pesticides, integrated pest management.

Introduction

The application of chemical pesticides has been traditionally practiced by the farmers in Bangladesh to maximize the crop production from their limited land. Bangladesh is one of the densely populated countries in the world with per capita cultivable land of 0.06 hectare only which is much less than the existing projected world average of 0.25 hectare (BBS 2011). It is well documented that the excessive use of pesticides has several negative impacts on soil, animal health and environment (Kabir *et al.* 2010). Although the farmers are compelled to increase their yield to meet the demand of ever-growing population; however, they should keep soil and environment safe and sound. As a consequence of Green Revolution, agricultural systems in many countries of Asia have undergone steady commercialization.

The high demand for agricultural products and better access to input and output markets have created incentives for farmers to change their agricultural cultivation practices. Increased commercialization has shifted subsistence farming towards more intensive forms of farming which entail growing high value fruit and vegetable crops, as well as staple cash crops, on a larger scale focusing on profit maximization. In the recent era, production systems have been profoundly transformed by the increased availability and use of new varieties, growth hormones, fertilizers, machinery and chemical pesticides. Some farms have moved straight from subsistence farming to cash crop production, as driven by the steady agricultural commercialization process (Vanwambeke *et al.* 2007, Zeller *et al.* 2013).

In agricultural commercialization, infestation of pests leads not only to the yield loss of crop but also causes direct economic loss if pesticides are applied non-judicially. There are 30,000 species of harmful weeds, 3,000 species of deadly nematodes, 10,000 species of phytophagous insects and numerous dangerous fungi that attack crops (Hassan 2018). These harmful weeds, insects and fungi are commonly referred as pests. An average of 35 percent of the potential crop yield is lost due to pests and diseases across the world (Hassan 2018). There are different categories of pesticides like insecticides for controlling insects, herbicides for managing weeds, fungicides for protecting the plants from various fungal diseases are used to overcome the situation. As a consequence, the use of

pesticides has come into focus to minimize the crop yield loss caused by pests. Keeping these in view, the target of this article is to overview the present condition of the relationship between crop production and land use as well as pesticide consumption scenario in Bangladesh.

Land use and crop production in Bangladesh

Rice, wheat and maize are the major cereals in Bangladesh. Rice is cultivated in three seasons namely Aus, Aman and Boro all over the country. Wheat is cultivated mostly in the northern parts (Dinajpur, Rajshahi, and Rangpur districts) of Bangladesh (Karim *et al.* 2010). Production of maize has been given emphasis since 1990s, however it has been appeared as an important crop in the eastern south and northern areas of Bangladesh namely Bandarban, Rangamati, Dinajpur, and Rajshahi districts because of its high demand for mitigating feeds of fish and poultry industries (Banglapedia 2021). Rice is the main staple crop of Bangladesh which has also been considered as a cash crop of small-scale farmers. Most of the people of Bangladesh eat rice three times a day and the per capita consumption of rice is 170 kg per year (Shelly *et al*. 2016). After independence, government attempted to expand rice production with high yielding varieties following modern technologies like irrigation, use of fertilizers, pesticides etc. During the last fifty years rice production increased from 11 million tons to 34 million tons. The trend of rice production in Bangladesh from 2011 to 2020 showed that the area and production ranged from 28867 to 29178 thousand acres and 36185 to 38142 thousand Mt, respectively (BBS 2020). The production area was the highest in 2017-18 but maximum production was found in 2018-19. In the year of 2019-20, the production was lower as compared to the recent past because of the natural calamities particularly monsoon flood which caused the yield loss of rice. The production of pulses from 2011 to 2020 increased from 240 to 397 thousand Mt covering the land area of 656 to 882 thousand acres (BBS 2020). The highest production of pulses (726 thousand Mt) was obtained in 2014-15 when the total cropped area was also comparatively higher than the other years (1011 thousand acres). The area under oilseed cultivation from 2011 to 2020 ranged from 977 to 1183 thousand acres having the production of 764 to 972 thousand Mt with the highest production (1026 thousand Mt) in 2017-18 from 1122 thousand acres of land (BBS 2020). The land under vegetables and fruit cultivation showed dramatic increase from the year 2011 to 2020 (BBS 2020). The production of vegetables was 3060 thousand Mt occupied the land area of 907 thousand acres in 2011 which reached 4574 thousand Mt covering 1111 thousand acres. A total of 357 thousand acres of land was occupied by fruit cultivation in the year of 2011-12 with the production of 4335 thousand Mt which became 4976 thousand Mt in 2019-20 occupying an area of 1009 thousand acres (BBS 2020). The area under the production of jute and sugar crops little bit changed over the years from 2011-20. The production was 13169 thousand Mt in 2011-12 from 2163 thousand acres which decreased to 12200 thousand Mt from 2132 thousand acres in 2019-20 (BBS 2020). So, the land area under the cultivation of cereals, pulses, oilseeds, vegetables and fruits steadily increased from the period of 2011 to 2020 where the increase of cropped area for fruit corps was predominant (BBS 2020). Introduction of high value fruits and commercial cultivation of fruit production might be the reason behind it (Table 1).

It is also noted that total cropped area and production of cereals, pulses, oilseeds, vegetables, fruits and cash crops showed positive relationship from the year 2011-20 in Bangladesh (Figures 1-6). When the area under a crop fluctuated, the amount of total production of that particular crop also changed proportionately. Still a considerable amount of yield could be maintained over the years due to the implementation of modern tools and techniques like cultivating high yielding varieties, adoption of proper pest management strategies, etc. We know, total cultivable land in Bangladesh is decreasing day by day, but the replacement of one crop by other creates the opportunity to increase the cropped area for that particular crop. In recent years, the area under the production of jute and cotton is decreasing because of lower profit compared to other crops like cereals, vegetables and fruits. Thus, although having constrained land, the production area of some crops specifically vegetables and fruits increased during 2011-20.

Pest management practices in Bangladesh

In conventional farming, farmers are mostly relied on the use of pesticides to control insect pests. Although, some cultural practices like soil solarization, crop rotation

Table 1. Total cropped area and amount of production of different crops in Bangladesh from 2011 to 2020

Type of crops	Year	Area (thousand acres)	Production (thousand MT)
Cereals	2011-12	29867	36185
	2012-13	29842	36684
	2013-14	29925	37784
	2014-15	30035	38332
	2015-16	30057	37156
	2016-17	29178	38141
	2017-18	30559	40666
	2018-19	30374	40978
	2019-20	29178	38142
Pulses	2011-12	656	240
	2012-13	701	265
	2013-14	823	352
	2014-15	1011	726
	2015-16	918	412
	2016-17	920	387
	2017-18	897	390
	2018-19	875	393
	2019-20	882	397
Oilseeds	2011-12	977	764
	2012-13	1009	804
	2013-14	1071	848
	2014-15	1036	301
	2015-16	1124	933
	2016-17	1196	975
	2017-18	1122	1026
	2018-19	1098	954
	2019-20	1183	972
Vegetables	2011-12	907	3060
	2012-13	931	3133
	2013-14	926	3357
	2014-15	989	3729
	2015-16	992	3877
	2016-17	1025	4048
	2017-18	1020	4115
	2018-19	1072	4336
	2019-20	1111	4574
Fruits	2011-12	357	4335
	2012-13	352	4360
	2013-14	338	4587
	2014-15	322	4677
	2015-16	367	4809
	2016-17	373	5018
	2017-18	1468	4901
	2018-19	1106	4948
	2019-20	1009	4976
Cash crops (Jute and Sugar crops)	2011-12	2163	13169
	2012-13	1956	12619
	2013-14	1913	12500
	2014-15	1922	12489
	2015-16	1921	12294
	2016-17	2055	12689
	2017-18	2753	13077
	2018-19	2312	12190
	2019-20	2132	12200

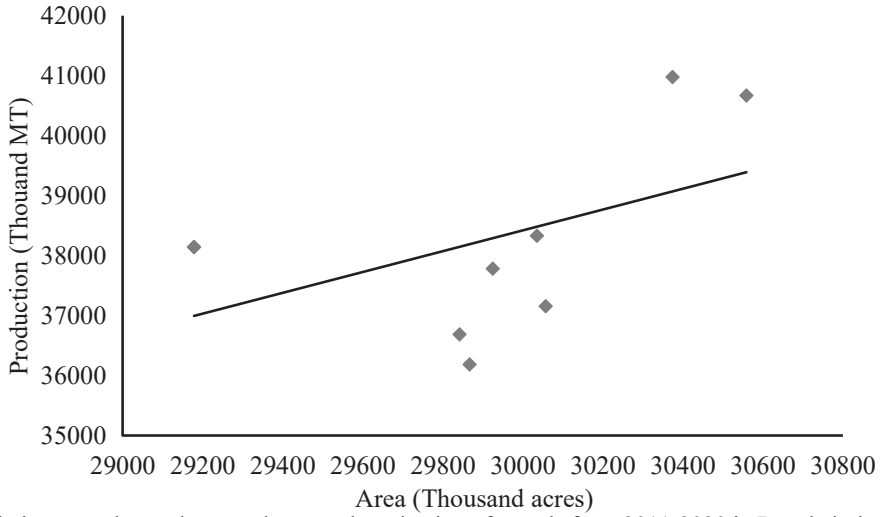


Figure 1. Relationship between the total cropped area and production of cereals from 2011-2020 in Bangladesh.

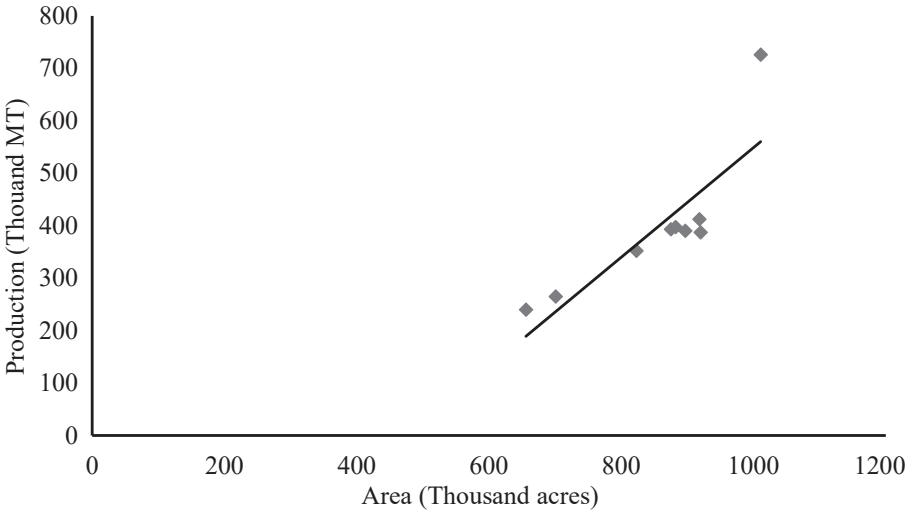


Figure 2. Relationship between the total cropped area and production of pulses from 2011-2020 in Bangladesh.

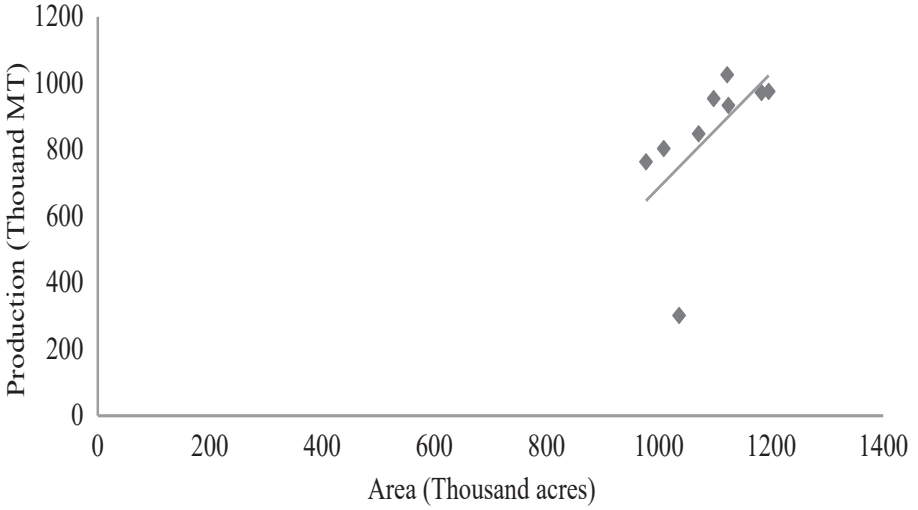


Figure 3. Relationship between the total cropped area and production of oilseeds from 2011-2020 in Bangladesh.

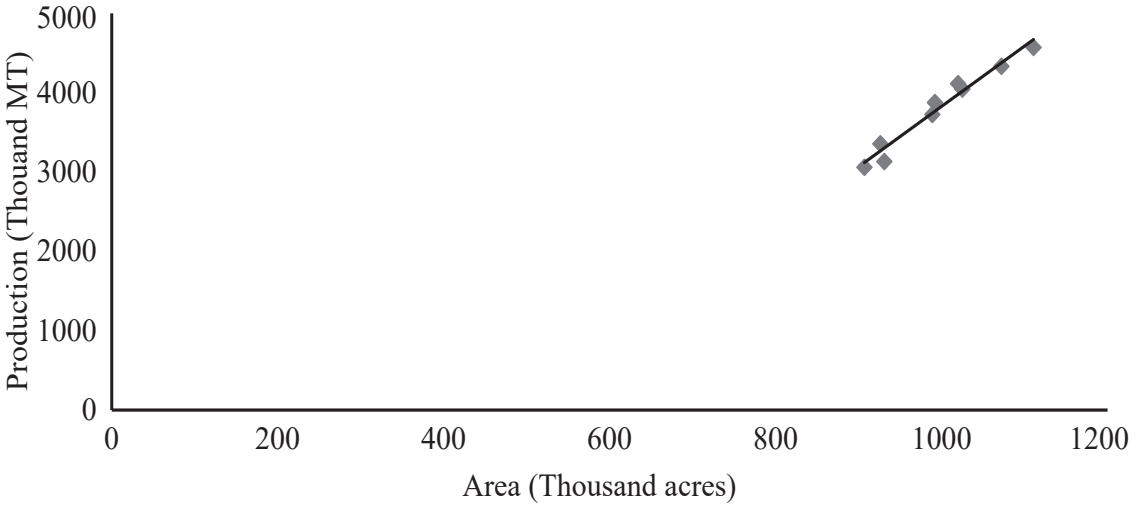


Figure 4. Relationship between the total cropped area and production of vegetables from 2011-2020 in Bangladesh.

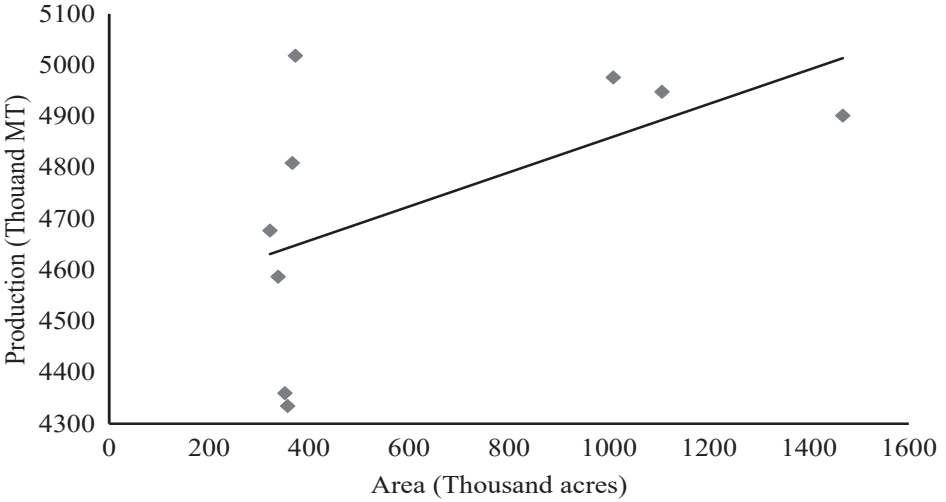


Figure 5. Relationship between the total cropped area and production of fruits from 2011-2020 in Bangladesh.

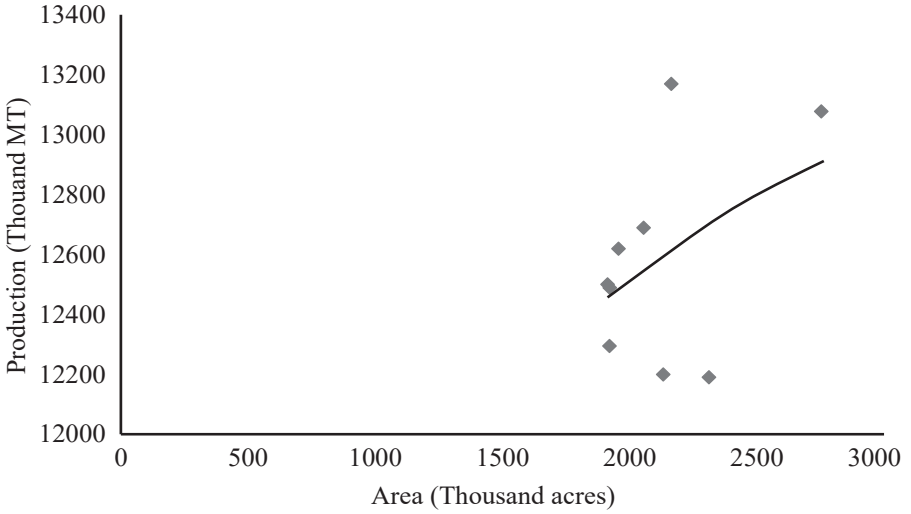


Figure 6. Relationship between the total cropped area and production of cash crops (jute and sugar crops) from 2011-2020 in Bangladesh.

and proper management of irrigation are implemented to reduce pest abundance by the farmers. Besides, bird perching, hand picking of insect pests, intercropping are also practiced in the farmers field to control insect attacks. According to National Integrated Pest Management Policy (2002), healthy crop production should be done following proper management of soil, water and fertilizers, augmentation of biological control agents and measures, use of pest tolerant varieties, modern cultivation practices, mechanical control measures, adoption of integrated pest management and monitoring the fields for pest and diseases control, and use of pesticides not harmful to environment as a last resort. But most of the farmers are not well aware of these; as a result, they use pesticides indiscriminately following their ancestors. Many pesticides used in Bangladesh are already banned or restricted under global agreements. Moreover, inadequate product labeling and farmers' lack of information lead to widespread overuse of dangerous pesticides. But the situation is changing positively that many farmers are now increasingly using different ecofriendly pest management approaches such as use of bait traps, yellow sticky traps and sex pheromone traps, spray of biopesticides, cultivation of insect resistant varieties, etc.

Scenario of pesticide use in Bangladesh in contrast to global consumption

In Bangladesh, chemical control was practiced as the primary method of pest control in the past. A huge number of pesticides are being applied to the crops for managing pests every year. Before 1974, the government promoted the use of pesticides by supplying them free of cost to farmers (100 percent subsidy). The subsidy was reduced to 50.0% in 1974. To initiate the privatization process of pesticide sector, Pesticide Association of Bangladesh was formed in 1976 involving all local suppliers. The Government withdrew subsidy completely in 1979 and the pesticide business was transferred to the private sector, according to Bangladesh Crop Protection Association (BCPA). Increased rice cultivation area, increased cropping intensity and an increase in the area under high yielding varieties led to the increased consumption of pesticides. Huge amount pesticides are imported by Bangladesh every year expending hard-earned foreign exchange.

In 2009, total pesticide consumption was 45172 metric tons which decreased as 37422 metric tons in 2020 (Table 2). On the other hand, in case of all field crops (cereals, pulses and oilseeds) production increased gradually from the year of 2011 to 2020 (Table 1). It is encouraging that gradually the usage of synthetic pesticides is decreasing gradually. The pesticides used in Bangladesh are imported from other countries, so when the use of pesticide decreases, it saves our currency reducing the overall import costs. In 2008, pesticide importing cost was 97.38 million USD (Faruq 2018). In 2011 and 2014 the total import cost of pesticides was 88.82 and 110 million USD, respectively (Shammi *et al*. 2017). In 2020 import value of pesticide was 79.17

Table 2. Yearly use of pesticides in Bangladesh (metric tons) from 2009 to 2020

Year	Insecticide	Miticide	Fungicide	Herbicide	Rodenticide	Total
2009	26998	56	14353	3700	62	45172
2010	25793	51	13269	3346	80	42240
2011	24480	74	16648	3859	59	44357
2012	20635	55	26477	3623	90	40882
2013	17596	71	17053	2949	108	37781
2014	15297.0	79.3	17037.4	3400.3	79.7	35801.7
2015	14266.1	83.3	14896.1	4051.3	74.8	33371.6
2016	14266.1	83.3	14896.1	4,015.3	74.8	33,371.6
2017	14546.1	102.5	15365.8	5049.4	72.5	35136.3
2018	14837.3	112.2	16968.0	6996.6	76.8	38691.9
2019	14523.1	103.1	16522.0	6800	75.3	38023.5
2020	14749.8	109.6	16158.2	6325.7	78.7	37422

million USD (TBS 2021) which implied the decreasing trend of pesticide consumption over the years (Table 3). It might have happened because of using IPM techniques as well as application of different control measures such as cultural, mechanical and biological methods for pest management.

Consumption of pesticides globally is about two million tons per year where Europe alone consumes 45 percent, USA 25 percent and the rest of the world the remaining 30 percent (Sharma *et al*. 2019). Herbicides account for 48 percent of total pesticides applied globally, followed by insecticides 30 percent and fungicides 18 percent. China is the largest pesticide-consuming country in the world, followed by the USA and Argentina. Statistics shows that China also leads the table in per hectare pesticide usage with around 14.8 kg, followed by Japan at 11.9 kg. In Bangladesh, it is about 1.9 kg. Total pesticide consumption in 2016 was around 33,000 tons, of which 14,000 tons were the active ingredients, according to data from BCPA.

Role of pesticide in reducing yield loss

The intensification of crop cultivation activities and the introduction of high-value crops augment the production risks. One source of risk which is usually of great concern to farmers, as well as to consumers, is crop pests (Roitner-Schobesberger *et al.* 2008). The pest management approaches by the farmers are determined by how they evaluate the economic losses caused by pests and what management strategies are available to them in order to cut down such losses. Some farmers are using traditional, cultural and/or mechanical method to minimize this risk; conversely, many farmers choose to spray pesticides to get immediate action. It is documented those pesticides can increase the yield through reducing losses from the weeds, diseases and insect pests which are largely responsible to reduce the amount of harvestable produce.

Positive and negative impacts of pesticide

Pesticides are applied to control pests such as weeds, insects and fungi, and so correspondingly, the most common classes of pesticide used are herbicides, insecticides and fungicides. Chemical pesticides are most widely used in the agricultural sector to enhance crop production preventing damage to crops. Early broad-spectrum pesticides had a toxic effect on most organisms, and required the application of large amounts of active ingredients, while more recent pesticide types are more specific and theoretically require smaller amounts to be applied. Studying the benefits of pesticides to mankind and the environment, Cooper and Dobson (2007) explained the positive outcomes of pesticide use in terms of their primary and secondary benefits. The primary benefits of pesticides are a direct consequence of their use; controlling pests and plant diseases. As secondary benefits, there are benefits to communities that can be measured in terms of food security, children's education and an improved quality of life among farmers. Moreover, national benefits are derived from export revenues and reductions in urban migration.

Even though farmers and societies as a whole obtain considerable benefits from chemical pesticides in producing crops, undesired and unintended consequences also frequently occur. Pesticide use is widely seen to harm ecosystems and human health, and especially the health of farmers. Pesticides have been found to contaminate water bodies and soils, disturb natural pest control and poison animals, before finally being transferred to

Table 3. Consumption and import value of pesticides from 2008 to 2020

Year	Consumption of pesticide (MT)	Pesticide Import Value (M. USD)
2008	48690	97.38
2011	44423	88.82
2014	40000	110.00
2017	37258	78.82
2020	37422	79.17

humans through residues accumulated in the food chain (Thapinta and Hudak 2000, Van Hoi *et al.* 2009). The higher concentration of pesticides in surface water can exceed toxicity criteria for both aquatic vertebrate and invertebrates (Ciglasch 2006). During the pesticide application process, farmers often experience the direct, negative health impacts of pesticides, which include headaches, dizziness, fainting, numb fingers, loss of appetite and skin problems. Consumers also exposed to the negative effects of pesticide use when they consume polluted fruit and vegetables. Thus, the application of pesticides possesses demerits along with positive role in enhancing crop yield.

The role of integrated pest management in pesticide use reduction

Although pesticides may provide temporary relief, it is now widely accepted that indiscriminate and excessive use of pesticides and the long-term dependency on them threaten the sustainability of agricultural production. Dasgupta *et al*. (2007) found that among Boro rice, potato, bean, eggplant, cabbage, sugarcane and mango farmers in Bangladesh, over 47% of the farmers in Bangladesh were overusing pesticides while cultivated boro rice, potato, bean, eggplant, cabbage, sugarcane and mango. The use of toxic pesticides is the main method of pest control and continued sole reliance on chemicals would lead to serious environmental and human health problems, pest resurgence, new pest outbreak and development of resistance. So, there is a need for an alternative method rather than to rely solely on pesticides.

Integrated Pest Management (IPM) has now been considered as the most appropriate technique in this aspect. According to BCPA, IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations in an ecologically and economically sound manner. From the beginning to present, besides government organization's several non-government organizations, development banks, different agencies are involved for establishing IPM practices throughout the country. Research organizations like Bangladesh Agricultural Research Institute (BARI) and Bangladesh Rice Research Institute (BRRI) is responsible for technology dissemination in a small scale; however, Department of Agricultural Extension (DAE) as the largest public agro-based organization in Bangladesh has the major liability. The plant protection wing of DAE directly deals IPM activities. There are some other semi-government organizations, such as Bangladesh Agricultural Development Corporation (BADC), and Bangladesh Academy for Rural Development (BARD) are also working to transfer IPM technologies to the farmers (Kabir and Rainis 2013).

However, to obtain a significant and positive impact of IPM at the national level, still a large number of farmers have to be trained. They should also apply this strategy in their fields on a continual basis. Therefore, necessary facilities should be established to ensure the expansion and co-ordination for a sustainable IPM program in Bangladesh. Thus, the risk of over use of pesticide in agricultural commercialization can be mitigated by proper implication of IPM.

Conclusion

Although production of cereals, pulses, oilseeds, vegetables, fruits and cash crops was increased but yearly use of pesticides decreased in Bangladesh, consequently the import value also decreased. It might be happened due to the consciousness about the hazardous effects of the synthetic pesticides, implication of IPM strategy as well as using of different control measures such as cultural, mechanical and biological control method to the crop field. If we get positive result of the consciousness, we should be more careful about the pesticide use and IPM technique to get sustainable solution which could assure bio-safety and food security.

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