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Effect of Chemical Pesticides and Fertilizers on Agriculture and Human Being -A Study in Nadia District of West Bengal

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ABSTRACT

Agriculture is called to be the backbone of India from tradition to recent and more than 65% population is engaged in agriculture in India. For bumper crop production in agricultural field, green revolution started in 1960s through using high yielding crop varieties which are heavy feeder of chemical pesticides and fertilizers. The main cause of environmental pollution is due to indiscriminate use of pesticides and fertilizers during agricultural operations. The objective of this study is to assess the effect of chemical pesticides and fertilizers on the soil, water, air vis-à-vis human being and farming system; in brief, the environment as a whole. The study was conducted in Ghoragacha and Bhabanipur villages under Chakdah and Haringhata Community Development Blocks of Nadia District, West Bengal with a cropping intensity of 217% and 209% in the selected villages while in West Bengal it is 184%. Participatory Rural Appraisal (PRA) exercises have been conducted to delineate the different features of the impact of agrochemicals on the surrounding ecology. From the results, it is revealed that generally, the farmers do not take precautionary measures at the time of pesticide application, storage, and disposal. The respondents of both the villages are mainly vegetable growers also orchards and cereal crops are cultivated and tend to apply an extra quantity of nitrogenous fertilizer to their crops to get an additional return. High doses of nitrogenous and other synthetic fertilizer applications, cause CO_2 and N_2O emissions from different crops into the atmosphere, which adversely affects agricultural operation in the farmer's field. GWP was developed to allow the comparison of the global warming impact of different gasses. Among the different field crops of the respondent, the highest GWP was recorded from the potato and cabbage followed by the maize and brinjal. CO_2 emission and GWP are also higher in orchard crops in the study area. In the orchard crop, the highest GWP was obtained in bananas and papaya in both the villages. Judicious use of chemical pesticides and fertilizer will control agricultural production and productivity by decreasing the value of GWP and greenhouse gas emission in the atmosphere from the farmer's field.

Keywords Pesticide, Fertilizer, Insect, Pest, Environment. .

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INTRODUCTION

Indian agriculture has passed through three basic phases of modernization these are inductive phase, the integrated phase, and the stimulative phase. In the inductive phase, spanning 1955 to 1975, it has been the intensification of chemical pesticides, fertilizers and growth promoters ushered in the production of food grains in the shortest possible time. In this phase, we started with 55 million tonnes of food grain production and landed in the valley of 'green revolutions' with 125 MT of food grain production. This phase was followed by the integration of agriculture, horticulture, fishery and livestock production in an orchestrated manner to add much-needed sustainability to agricultural production to combat hunger and malnutrition more perpetually. This self-sufficiency in food grain production was achieved through using high-yielding crop varieties. These high-yielding varieties are highly responsive to chemical fertilizers and some extent amenable to pests and diseases. This in turn demanded increased use of fertilizer and plant protection chemicals. The increased application of pesticides has become inevitable to augment agricultural production by saving the crops from the damages inflicted by disease and pest incidents. The other side of the apparent success story went in a deleterious way by inviting heal and hazards to humans and livestock, contamination of groundwater in injecting heavy metals like cadmium, mercury, led and other pernicious elements. The other serious lacuna has been the wrong and unscientific use of pesticides which has been detrimental to both the farmers, who are applying them and the consumers who are taking the agricultural produces as food. The entry of all these heavy metals into the food chain has triggered the process of biological magnification to keep on exponentially doing carnage. The most difficult task for any ecosystem, which has already been contaminated and disrupted, is its subsequent rejuvenation and restoration. The gradual decline of environmental quality and persistent increase of pollutants in the ecological service system has added to the complexity of environmental management for sustainable development by ensuring safety for human and livestock health. The unabated urbanization driven by anthropogenic perturbations has been responsible for the huge emission of greenhouse gases causing global warming and climate change. The contribution of greenhouse gases catered by rice fields of India only has been to the tune of 18.4%. The crux of the problem is that we have to deal both with the issues of hunger and pollution in an isochronous manner. In most cases, hunger and poverty stand jointly against ecological purity and resilience. We have to make a reverse journey from chemical-driven agriculture to an ecologically tuned farming system. To reduce a huge quantum of CO_2 emission, 96.2 MT CO_2 per year from the land of global agriculture substantially we have to go for alternative agriculture which needs less or no inundation of water and minimum of chemical inputs (Xue *et al.* 2016, FAO 2017, Tjandra *et al.* 2016). India is now producing 110 M tons of rice and with a total of 289 million tons of food grain production from 143 M ha of land under cultivation (NSS 2014, GOI). This mammoth production process invariably involves the emission of methane, carbon-di-oxide, nitrous-oxide, and sulfur-di-oxide and these are posing threats to our ecology and economy both. A large proportion of emission of Green House Gas (GHG) in exchange for energy consumed in different agricultural operations has been reported by different researchers across the globe. Though there is a list of causes of environmental pollution through misuse of pesticides and chemical fertilizers such as most the farmers are unaware of the scientific application of fertilizers and pesticides, application of these chemicals at the wrong time wrong field conditions' lack of awareness and lack of technical know how about integrated nutrient, water and pest management, improper storage and manhandling of such chemicals, improper disposal of empty containers. Most of the farmers use banned pesticides even today by accessing corrupt and reluctance vis-à-vis lack of awareness, farm families and common people regarding pesticides pollution in the daily food and water. Keeping all these thoughts in the background, the objective of this study is to assess the effect of chemical pesticides and fertilizers on the soil, water, air vis-à-vis human being and farming system ; in brief, the environment as a whole.

MATERIALS AND METHODS

The Indian state of West Bengal plays a vital contribution in terms of agricultural production and productivity. Six agro-climatic zones in West Bengal, viz. Hill zone, Terai zone, Old Alluvial zone, New Alluvial zone, Red and Lateritic zone, and Coastal Saline zone. Among these agro-climatic zones, the new alluvial zone consists of Nadia, Burdwan, Hooghly, Howrah, North-24-Parganas and some part of Murshidabad where an intensive agricultural system with a modern package of practices use of high yielding varieties, crop intensification, use of more input-intensive agriculture to obtain an increase in profit as a whole. Nadia district follows intensive agricultural practices with more than 2 crops per year. With these in the background, the study was conducted in two villages, Ghoragacha and Bhabanipur under the Chakdaha and Haringhata Community Development Blocks of Nadia district, West Bengal. These two villages are familiar with growing vegetables along with cereals with the application of all kinds of pesticides is very much common here. Some open-ended questions were asked to the farmers to collect information related to the topic to justify the objectives. The questions were mainly linked with the crops : Their varieties, seed rate, spacing, irrigation, used fertilizers, proper plant protection chemicals and their dosages and sources of different agricultural inputs and others. Participatory Rural Appraisal (PRA) exercises have been conducted to delineate the following features of the impact of agrochemicals on the surrounding ecology.

List of tools for participatory data generations.

PRA tools applied	Participatory data generated
1. Focus Group Discussion (FGD)	1. Specific information on health and hazards. 2. Specific information on cattle and livestock disaster due to toxic effect of agrochemicals. 3. The visible impact of ground water contamination, soil erosion and decline of bio-diversity
2. Participatory Train Analysis (PTA)	1. Decade wise decline of bio-diversity through losses of varietal count and genetic stocks including local cultivars 2. Trend of fertilizer and pesticides disposal over a span of time
3. Problem Cause Analysis (PCA)	3. Problem cause diagrams have been delineated to present the network of cause and consequences of different types of pollutions inflicting into the agro-ecosystem

High-yielding crop varieties innovated during the Green Revolution period are highly fertilizer responsive. Since that time respondents have habituated to this method of high doses of fertilizer application to their crop to get an additional return. Later in the future, this high dose of fertilizer application causes a detrimental effect on the soil, water, air, and surrounding ecology.

Estimation of CO_2 equivalents and carbon footprint: The environmental impacts of different N, P, and K fertilization doses, adopted by the farmers of two different villages, were assessed by estimating the Critical Factor (CF) on a spatial and yield scale. Spatial CF is the total amount of Green House Gas Emission (GHG) emission (CO_2 and N_2O) released during crop production in terms of CO_2 equivalents (Pratibha *et al.* 2016). Both CO_2 and N_2O were converted into CO_2 equivalent by using the GWP equivalent factors of 1 and 265 on the volume basis for CO_2 and N_2O, respectively, for the time frame of 100 years (IPCC 2013). GHGs emissions from farming operations (tillage, sowing of seeds, herbicide application in croplands, non-judicious pesticide application, planting and fertilizer application, harvest) and seeds were calculated as per the standard inputs with the corresponding emission coefficients (Deng 1982, West and Marland 2002, Lal 2004, Wang *et al.* 2015). The N_2O emission from applied N fertilizer, manure and crop residue was calculated by the following equation (Tubiello *et al.* 2015).

N_2O emission = Napplied through synthetic fertilizer manure and crop residues × FF1 × 44/28

Where, N_2O emissions =N_2O emissions from synthetic N/manure, crop residue additions to the managed soils, kg N_2O /year; N = Consumption of N from fertilizers, manure, crop residue, kg N input/ year ; EF1 = Emission factor 0.01 for N_2O emissions from N inputs, kg N_2O−N/kg N input. Global warming potential (GWP) is calculated with data from CO_2

Table 1. Respondents of the two villages based of protection means taken by the farmer at the time of spraying application.

General precaution	Goragacha village Yes (%)	Goragacha village No (%)	Bhabanipur village Yes (%)	Bhabanipur village No (%)
Wear a protective hat and goggles	10	90	13	87
Eat, drink or smoke while spraying	87	13	79	21
Washing hands and face with soap after spraying	56	44	49	51
Take shower or bath after spraying	39	61	56	44
Protective clothing during the spraying	16	84	21	79
Insecticide touches the skin wash off immediately with soap and water	36	90	48	52
Change clothes immediately if they become contaminated with insecticides	19	13	16	84

Table 2. Respondents of the two villages in terms of protection means taken by the farmer at the time of pesticide storage.

Storage precaution	Goragacha village Yes (%)	Goragacha village No (%)	Bhabanipur village Yes (%)	Bhabanipur village No (%)
He/she has specific place or room only for storage of pesticides	22	78	17	83
Storehouses located away from people or animals are housed	69	31	73	27
Storehouse access only for authorized persons.	19	81	21	79
Pesticides exposed to sunlight, water, or moisture.	18	82	39	61
Storehouse secure and well ventilated	27	73	19	81
Follows: The principle of "First Expiry First Out"	06	94	10	90
Store room prominently displayed with caution for poisonous substances	10	90	17	83

and N_2O emissions by using the following equation (Pandey and Agrawal 2014) :

Global Warming Potential (GWP) = (Emission of N_20 × 265) – (Emission of CO_2 × 1)

RESULTS AND DISCUSSION

It is evident from the results that the general precaution taken by the respondent is an important factor to determine the health hazards associated with pesticide application. In case of taking general precautions (Table 1) at the time of pesticide application, the respondents in both the village Ghoragachha (90%) and Bhabanipur (87%) are not wearing any protective clothing. They do not change their clothes either immediately if they become contaminated with insecticides 81% and 84% respectively. On the other hand, the respondents of Ghoragachha and Bhabanipur, 56% and 49% by frequency, have followed hand and face washing with soap after spraying. They also take shower or bath after spraying which is 39% in the case of village Goragacha and 56% for Bhabanipur. On the other hand, they are not using protective clothing during spraying (84%) in the case of Goragacha and 79 % for Bhabanipur villages. In both the villages more than half of the respondents i.e. 64% in the case of Goragacha village and 52% for Bhabanipue village were not maintained regarding insecticides touching the skin wash off immediately with soap and water. This is very unfortunate that they are unaware of the hazards of these insecticides and do not use proper protection. They are much concerned about crop health but remain stoic about the family's health and even his own. This has got a deleterious effect on the surrounding ecosystem as well. Due to this unaware noncommittal attitude, the forthcoming generation has to suffer. This is a result of illiteracy and negligence. By protecting themselves from an instant side effect of the chemicals using their well-practiced but an unscientific method, they ignore and refuse to acknowledge when told the long-term and even worse consequences.

The precaution is taken in storage (Table 2) is

Table 3. Respondents of the two villages on the basis of protection means taken by the farmer at the time of disposal.

Disposal precaution	Goragacha village Yes (%)	Goragacha village No (%)	Bhabanipur village Yes (%)	Bhabanipur village No (%)
After spraying washed out the spray pump properly	95	5	90	10
Follow all empty packaging returned to the supervisor for safe disposal	20	80	34	66
Re-use empty insecticide containers	34	66	60	40
Pour remaining insecticide into rivers, pools or drinking-water sources	24	76	39	61
Take adequate measures to avoid expiry of stocks in storehouses	34	66	44	56
Returned expired stocks to manufacturer for safe disposal as per guidelines	45	55	34	66

an important factor to determine the possibility of health hazards. In case of taking storage precautions, store room is an important criterion, and 78% in Ghoragachha and 83% in Bhabanipur village have no specific room or place for safe storage of pesticides, 90% of the respondents in Ghoragachha village and 83% in Bhabanipur village do not use to display caution symbols prominently for poisonous substances store, also do not follow the basic principle or thumb rule of safe use of pesticide "First expiry first out" 94% in case of Ghoragachha and 90% in case of Bhabanipur. Next, the respondents in both the villages Ghoragachha and Bhabanipur respectively 82% and 61% were exposed to pesticides under sunlight or water or moisture. Lastly, 81% and 79% of respondents respectively in Ghoragachha and Bhabanipur do not pursue storehouse access only for authorized persons. Most of the respondents said that they keep the sprayers and other similar apparatus within their houses as reported during the investigation, but the farmers are always advised and instructed not to keep the machinery used for applying chemicals in their living places. They are told to make a different place for this to restrict the children and other members of their family who do not know the poisonous nature of these chemicals from coming in contact with them. Very often it seems that due to insufficient place for living and sometimes driven by unawareness farmers

Table 4. Recommended and farmers practices of fertilizer doses of major crops of Ghoragacha village. *Recommended doses as per the guideline of PPIC-IP Publication on "Review and refinement of fertilizers recommendation for major crops of West Bengal (2004) (Economic review. Evaluation wing, Directorate of Agriculture, West Bengal). **Farmers practice = average values ± standard deviation.

Sl. No.	Season	Crop	Recommended Dose (kg/ha)* N	P_2O_5	K_2O	Farmers practice (FP) (kg/ha)** N	P_2O_5	K_2O	Excess/less (±) N	P_2O_5	K_2O
1.	*Kharif*	Rice	80	40	40	125±15	55±13	26±8	+45	+15	-14
		Jute (Olitorious)	40	40	20	65±11	47±9	15±6	+25	+7	-5
		Onion	150	100	100	207±23	92±11	75±14	+57	-8	+25
2.	Pre *kharif*	Pointed gourd	120	60	60	160±22	85±17	55±13	+40	+25	-5
		Okra	100	50	50	122±10	48±9	36±10	+22	-2	-14
		Black gram	20	40	20	12±3	35±7	17±6	-8	-5	-3
		Maize	200	60	60	250±35	75±18	45±8	+50	+15	-15
3.	*Rabi*	Mustard	80	40	40	72±14	55±16	35±13	-8	+15	-5
		Cauliflower	150	100	100	210±35	117±14	79±13	+60	+17	-21
		Chilli	90	60	60	125±27	85±14	54±15	+35	+25	-6
		Brinjal	180	90	90	233±45	105±21	86±18	+53	+15	-4
		Tomato	180	90	90	215±29	117±18	72±13	+35	+27	-18
		Potato	200	150	150	290±48	176±33	169±23	+90	+26	+19
4.	Orchard crops	Mango	100	75	75	175±47	105±33	122±31	+75	+30	+47
		Banana	500	125	750	683±76	127±29	893±82	+183	+2	+143
		Guava	104	128	104	146±40	162±42	137±28	+42	+34	+33

Table 5. Recommended and farmers practices of fertilizer doses of major crops of Bhabanipur village. *Recommended doses as per the guideline of PPIC-IP Publication on "Review and refinement of fertilizers recommendation for major crops of West Bengal (2004) (Economic review. Evaluation wing, Directorate of Agriculture, West Bengal) **Farmers Practice = average values ± standard deviation

Sl. No.	Season	Crop	Recommended dose (kg/ha)* N	P_2O_5	K_2O	Farmers practice (FP) (kg/ha)** N	P_2O_5	K_2O	Excess /Less (±) N	P_2O_5	K_2O
1.	*Kharif*	Rice	80	40	40	117±11	59±19	25±10	+37	+19	-15
		Jute (Olitorious)	40	40	20	59±13	52±7	13±8	+19	+12	-7
		Sesame	30	60	30	52±15	72±8	25±6	+22	+12	-5
		Pointed gourd	*120*	*60*	*60*	*152±17*	*87±19*	*62±18*	*+32*	*+27*	*+2*
2.	Pre *kharif*	Sesame	30	60	30	52±15	72±8	25±6	+22	+12	-5
		Pointed gourd	120	60	60	152±17	87±19	62±18	+32	+27	+2
		Okra	100	50	50	127±13	42±11	34±9	+27	-8	-16
		Black gram	20	40	20	13±3	42±7	16±6	-7	+2	-4
		Maize	200	60	60	237±31	76±18	41±8	+37	+16	-19
3.	*Rabi*	Mustard	80	40	40	70±16	57±19	30±11	-10	+17	-10
		Groundnut	20	60	60	40±17	55±10	45±15	+20	-5	-15
		Cabbage	200	100	100	270±45	122±18	85±16	+70	+22	-15
		Brinjal	180	90	90	224±45	111±19	84±17	+64	+21	-6
		Capsicum	100	80	80	128±32	97±31	66±23	+28	+17	-14
		Potato	200	150	150	273±41	171±30	157±19	+73	+21	+7
4.	Orchard crops	Banana	500	125	750	655±62	118±23	851±74	+155	-7	+101
		Guava	104	128	104	137±43	151±40	140±23	+33	+23	+36
		Papaya	500	625	1250	622±42	734±82	1427±94	+122	+109	+177
		Ber	160	80	160	219±37	124±37	223±41	+59	+44	+63

are compelled not to take these precautions. It is evident that the precaution during disposal of pesticide container or residue amount resides in the spraying applicator is taken by the respondent is an important

Table 6. Contribution of CO_2 emission (kg CO_2e/ha), N_2O emission (kg CO_2e/ha) and Global Warming Potential (GWP) from major cultivated crops of Ghoragacha village.

Sl. No.	Season	Crop	CO_2 emission (kg CO_2e/ha) N	P_2O_5	K_2O	Total	N_2Oemission (kg CO_2e/ha)	GWP
1.	*Kharif*	Rice	162.5	11	5.2	178.7	1.96	340.7
		Jute (Olitorious)	84.5	9.4	3.0	96.9	1.02	173.4
		Onion	269.1	18.4	15	302.5	3.25	558.75
2.	Pre *kharif*	Pointed gourd	208	17	11	236	2.51	429.15
		Okra	158.6	9.6	7.2	175.4	1.92	333.40
		Black gram	15.6	7	3.4	26	0.19	24.35
		Maize	325	15	9.0	349	3.93	629.45
3.	*Rabi*	Mustard	93.6	11	7.0	111.6	1.13	187.85
		Cauliflower	273	23.4	15.8	312.2	3.30	562.3
		Chilli	162.5	17	10.8	190.3	1.96	329.1
		Brinjal	302.9	21	17.2	341.1	3.66	628.8
		Tomato	279.5	23.4	14.4	317.3	3.38	578.4
		Potato	377	35.2	33.8	446	4.56	762.4
4.	Orchard crops	Mango	227.5	21	24.4	272.9	2.75	455.85
		Banana	887.9	25.4	178.6	1091.9	10.73	1751.55
		Guava	189.8	32.4	27.4	249.6	2.29	357.25
		Papaya	790	147	250	1187	9.67	1375.55

Table 7. Contribution of CO_2 emission (kg CO_2e/ha), N_2O emission (kg CO_2e/ha) and global warming potential (GWP) from major cultivated crops of Bhabanipur village.

Sl. No.	Season	Crop	NN	CO_2 emission (kg CO_2e/ha) P_2O_5	K_2O	Total	N_2O emission (kg CO_2e/ha)	GWP
1.	*Kharif*	Rice	152.1	11.8	5	168.9	1.84	318.7
		Jute (Olitorious)	76.7	10.4	2.6	89.7	0.93	156.75
2.	Pre *kharif*	Sesame	67.6	14.4	5	87	0.82	130.3
		Pointed gourd	197.6	17.4	12.4	227.4	2.39	405.95
		Okra	165.1	8.4	6.8	180.3	2.00	349.7
		Black gram	16.9	8.4	3.2	28.5	0.20	24.5
		Maize	308.1	15.2	8.2	331.5	3.72	654.3
3.	*Rabi*	Mustard	91	11.4	6	108.4	1.10	183.1
		Groundnut	52	11	9	72	0.63	94.95
		Cabbage	351	24.4	17	392.4	4.24	731.2
		Brinjal	291.2	22.2	16.8	330.2	3.52	602.6
		Capsicum	166.4	19.4	13.2	199	2.01	333.65
		Potato	354.9	34.2	31.4	420.5	4.29	716.35
4.	Orchard crops	Banana	808.6	146.8	285.4	1240.8	9.77	1348.25
		Guava	178.1	30.2	28	236.3	2.15	333.45
		Papaya	851.5	23.6	170.2	1045.3	10.29	1681.55
		Ber	284.7	24.8	44.6	354.1	3.44	557.5

factor to determine the human health hazards impact and broad impact on the environment by irresponsible disposal of pesticide containers and residues. This is also a burning issue where most of the respondents failed to show their sincerity and awareness regarding the facts related to the health hazards and environmental impacts of plant protection chemicals vis-à-vis the disposal of the pesticide containers as reported in the investigation. Disposal of different pesticides container is an important issue for precautionary measures of the farmers as well as others. It should be kept in mind how to overcome this issue in a general way. In the study area, it is found that (Table 3) the respondents of the Goragacha (95%) and Bhabanipur (90%) villages washed out the spray pump properly after spraying. The respondents in both the villages don't follow up about empty packaging returned to the supervisor for safe disposal in the case of Goragacha village 80% and 66% in the case of Bhabanipur village. The respondents of Ghoragacha village (34%) and in Bhabanipur (60%) are re-using empty insecticide containers for their personal use. Pouring remaining insecticide into rivers, pools, or drinking water sources is a common practice in the villages. It is also found that 24% in Goragacha village and 39% in Bhabanipur village are using the practices. Lastly, it is found that 45% of Goragacha and 34% of Bhabanipur respondents returned expired stocks to the manufacturer for safe disposal as per guidelines. Interrogation of sample farmers and subsequent data analysis proves that most of them are usually the unaware and reluctant case of proper disposal of pesticide residues. Some of them are also habituated to reusing the pesticides jerry cans for keeping water for domestic use. All these practices are detrimental to the environment, human beings and domestic animals. Moreover, the thrown-out agrochemical containers spread their meager remaining left inside them to the surrounding environment destroying many non targeted species of the ecosystem. Though a few farmers dispose of the containers by burning them, which is a bit healthier practice.

Nutrient management practices of major crops: Nutrient management is one of the most important factors that govern the final yield of the crops. Generally, farmers tend to supply an extra amount of chemical fertilizer to the crops to get additional returns. But indiscriminate use of these nutrients not only hampers the yield but also reduces soil fertility. Farmers' plant nutrient practices for different crops along with their corresponding recommended doses are presented in Tables 4 and 5. Nitrogenous fertilizer is the major plant nutrient used by the farmers followed by phosphate and potassium fertilizer. In both villages, farmers used an excessive amount of nitrogenous fertilizers above the recommended dose. Amongst the different field crops, the highest amount of additional nitrogenous fertilizer was used in potatoes followed by maize and rice. Interestingly in black gram farmers used fewer amounts of nitrogenous fertilizers than the recommended dose. It may be due to non-cognitive adoption of recommended practices wherein socialization results without understanding the science behind it. Recommendation mostly generated from government houses (Department of Agriculture, Government of West Bengal), has got an auto induction effect through training and campaign. For example expansion of pulse, the area has been resultant to ISOPOM campaign, science may not be that complex or dominating to refrain the farmer from adopting it for its subsequent assimilation. Potassium fertilizer is the most neglected fertilizer in both villages. Farmers used a very small amount of potassium fertilizer in agronomic crops as well as in vegetables also. Orchard crops like mango, banana, and papaya are the major cash crops of those selected villages. Contrary to the vegetable crops, farmers used a higher amount of NPK fertilizers in orchard crops. Stability and persistence of food production in the context of climate change merit the selection of existing potential crops and their sustainable improvement for a region. A few reasons detected for such stagnation are over-mining of soil nutrients, inefficient water use, pest problem, depletion of groundwater. Diversification of crops in the dry season may bring some solutions to these problems with existing rice-based systems (Meena *et al.* 2018). Green House Gas (GHG) emission from the plant nutrients: Emission of carbon dioxide and nitrous oxide from different crops is presented in Tables 6 and 7. CO_2 and N_2O emission from different crops is directly associated with the number of chemical fertilizers applied. Amongst the 3 primary sources of plant nutrients, nitrogenous fertilizers have the highest carbon dioxide emission potential. Amongst the different field crops, emissions from vegetable crops are considerably higher than agronomic crops. Interestingly the emission from the pulse crop mainly black gram is quite low as farmers grow crops in the marginal soil with fewer amounts of applied fertilizers. The GWP is the comparison of the global warming impact of different gases mainly CO_2 and N_2O in our case study. Among the different field crops, the highest global warming potential was recorded from the potato followed by maize and brinjal in Ghoragacha village and in Bhabanipur village, the highest GWP was recorded from cabbage followed by potato, brinjal, and maize. Orchard crops are generally longer duration than agronomic crops and they require a significantly higher amount of fertilizers throughout the year. Thus, carbon dioxide emission and global warming potential are also higher in orchard crops. Amongst the orchard crops, the highest GWP was obtained in bananas of Ghoragachha village and papaya in Bhabanipur village.

CONCLUSION

With the ever-growing population, increased production of food grains is a must. The gap between total potential yield and actual yield can be bridged by the judicious, timely use of agrochemicals with proper training knowledge, label specifications, and application guidelines. Science helps to evolve new tangled ideas and technologies which however misused; overused and underused can lead to negative consequences in agriculture. More pollution in the environment can be attributed not only to agricultural operations but also to the industries. Thus pesticides are indispensable to attain our targeted food production standards if used judiciously and properly. Unscientific and inept spraying and over-dosages coupled with the spraying of spurious insecticides have also aggravated the problem of pest resistance.

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