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Research Article

GREEN HOUSE GAS EFFECT AND PESTICIDE RESIDUE FOR INAPPROPRIATE USE OF PESTICIDES AND FERTILIZERS AT FIELD CROPS

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Abstract: The chemical pesticides and fertilizers are well known in today's farming and played a significant role in boosting crop yield during the last four to five decades worldwide. But on the other hand, excessive use of these chemicals and fertilizers has been degrading natural resources (soil, water, air) globally and leads to increase environmental pollution and causes for the Green House Gas emission at the surrounding environment. With this background, the broader objective is to study different parameters of Green House Gas emission with calculation GWP and the pesticide residue of different agronomic, vegetable and fruit crops after applying a certain quantity of fertilizers and pesticides to the crop field in two different villages (Ghoragachha and Bhabanipur village) of Nadia district, West Bengal, India. Perception data on the pesticide poisoning of farming households have been collected by Participatory Rural Appraisal (PRA) method with a structured questionnaire schedule from 200 farming households. Different environmental impact indicators (Yield scale, Global Warming Potential (GWP), Carbon Footprint) of various field crops were assessed based on data revealed from questionnaire surveys (doses of N, P, K fertilizers used by farmers). The QuEChERS method is used to determine the pesticide residue of different agronomic crops, vegetables, and fruits from the identified villages. In the case of the Green House Gas (GHG) emission, banana and papaya among the fruit crops contributing the highest GHG emission in these two villages. Maximum GHG emission was accounted from potato followed by cabbage and maize among all agronomic crops cultivated in two villages. Cabbage, brinjal and tomato among all vegetable crops were contributing the highest GHG emission in our research locale. Besides, after analysis of maximum residue limit (MRL) from different crop samples collected from households, the local marketplace of the study area; pesticides like azoxystrobin in a pointed gourd, acephate in cauliflower, imidacloprid in chilli, cypermethrin in tomato, trifloxystrobin in cabbage and aldrin in banana were found above MRL.

Keywords: *Chemical pesticides, Toxicity, Green House Gas Emission, Environmental Impact Indicators, Maximum Residue Level*

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Introduction

The Green Revolution was a period of modern agricultural practices which exposes the increased use of agro chemicals and fertilizers to meet the huge food demand for an increased population and as a result contamination of many hazardous chemicals. This is the milestone associated with the development of independent India in terms of food grain production. 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. Indirectly the increased application of fertilizers and pesticides has arisen the temperature in the soil and ultimately emergence of CO_2, methane, SO_2 and N_2O at the surrounding ecosystem. The increased application of pesticides and fertilizers has many detrimental effect not only surrounding eco system but also has effected on ground water by contamination with 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 it 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 doing carnage in an exponential manner.

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 to 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 percent. The crux of the problem is that we must deal both with the issues of hunger and pollutions in an isochronous manner. In most cases, hunger and poverty stand jointly against ecological purity and resilience. We must 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 must go for alternative agriculture which needs less or no inundation of water and minimum of chemical inputs [1-3]. India is now producing 110 MT of rice and with a total of 289 MT 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 both our ecology and economy both.

Table-1 *Application of fertilizer dozes of important field crops by the farmers of Ghoragacha village*

SN	Season	Crop	Recommended Dose(kg/ha)*			Farmers Practice (FP)(kg/ha)**			Excess/Less(±)		
			N	P_2O_5	K_2O	N	P_2O_5	K_2O	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*	PointedGourd	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
		Blackgram	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

**Recommended doses as per the guideline of PPIC-IP Publication on "Review & 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*

Table-2 *Application of fertilizer dozes of important field crops by the farmers of Bhabanipur village*

SN	Season	Crop	Recommended Dose(kg/ha)*			Farmers Practice(FP)(kg/ha)**			Excess/Less(±)		
			N	P_2O_5	K_2O	N	P_2O_5	K_2O	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
2.	*Pre kharif*	Sesame	30	60	30	52±15	72±8	25±6	+22	+12	-5
		PointedGourd	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
		Blackgram	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

Recommended doses as per the guideline of PPIC-IP Publication on "Review & 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*

Table-3 *CO_2 emission(kgCO_{2e}/ha), N_2O emission(kgCO_{2e}/ha) and Global Warming Potential (GWP) contribution from most important field crops of Ghoragacha village*

SN	Season	Crop	CO_2emission(kgCO_{2e}/ha)				N_2Oemission (kgCO_{2e}/ha)	GWP
			N	P_2O_5	K_2O	Total		
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*	PointedGourd	208	17	11	236	2.51	429.15
		Okra	158.6	9.6	7.2	175.4	1.92	333.40
		Blackgram	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

The pesticide application in India is happening to the tune of 400 grams per hector, whereas in the volume of chemical is not that alarming as its mode of application; almost 60 percent of pesticide application in India is not following the standard protocol. The occupational health hazard in India has been contributed by two dominant factors; one by the indiscriminate use of pesticides and the other is the unskilled operation of farm machinery. A large proportion of emission of Green House Gas (GHG) in exchange for energy consumed in different agricultural operations has been reported by different researches across the globe. The real concern would be quantifying the emission GHGs and taking up of suitable strategy or its mitigation by following an energy-friendly farming system. The energy prodigal nature of our farming, excess application of nitrogenous fertilizers, intensive mechanization, in proportionate consumption of fossil fuel collectively damaging the subtle energy balances into the operating farms. Keeping all these thoughts in the background, the broader objective is to study

Table-4 CO_2 emission(kgCO2e/ha), N_2O emission(kgCO2e/ha) and Global Warming Potential (GWP) contribution from most important field crops of Bhabanipur village.

SN	Season	Crop	CO_2emission(kgCO_{2e}/ha)				N_2Oemission (kgCO_{2e}/ha)	GWP
			N	P_2O_5	K_2O	Total		
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
		Blackgram	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

Table-5 Pesticides residues in different crops from the selected villages and their possible health hazards

Crop	Pesticide used	Mode of action	Residue obtained (ppm)	Maximum residue limit* (ppm)	Possible health hazards
Rice	Chlorpyrifos	Affects the nervous systems of insects by inhibiting the acetylcholinesterase enzyme	0.34	0.5	Considered moderately hazardous to human. It links to neurological effects, persistent developmental disorders, and autoimmune disorders. During pregnancy may harm the mental unborn baby
Pointed Gourd	Azoxystorbin	Prevent the respiration of fungi due to the disruption of electron transport chain. Prevent the ATP synthesis of fungus	0.56	0.05	Low human and mammalian toxicity Very toxic to aquatic organisms
Black gram	Carbendazim	Inhibiting the development of fungi probably by interfering with spindle formation at mitosis	0.06	0.025	Cause infertility
Mustard	Metalaxyl- mancozeb	Acylalanine fungicide with systemic function fungicide. Inhibition of the transcription process remains open	0.07	0.1	Low acute toxicity Moderate eye irritant
	Dimethoate	Acetylcholinesterase inhibitor which disables cholinesterase, an enzyme essential for central nervous system function of insects	0.04	0.01	Headache, sweating, nausea and vomiting, diarrhea, loss of coordination, muscle twitching
Cauliflower	Acephate	Systemic insecticide used to control sucking and biting insects by direct contact or ingestion. Acetylcholinesterase inhibitor which disables cholinesterase, an enzyme essential for central nervous system function of insects	0.5	0.2	Nausea, diarrhea, abdominal cramps of human body
	Carbendazim	Inhibiting the development off ungi probably by interfering with spindle formation at mitosis	9.6	0.025	Infertility in mammals
Chilli	Imidachlorprid	Acts on post- synaptic nicotinic acetylcholine receptors in the nervous system. Following binding to the nicotinic receptor, nerve impulses are spontaneously discharged at first, followed by failure of the neuron to propagate any signal.	0.56	0.3	Salivation, vomiting, diarrhea and muscle weakness.
Tomato	Metalaxyl- mancozeb,	Acylalanine fungicide with systemic function fungicide. Inhibition of the transcription process remains open	0.89	1	Low acute toxicity Moderate eye irritant
	Cypermethrin	Causes disruption of VGSC function. Disruption of sodium channel function is mediated by specific binding sites.	4.8	0.01	Irritation to the skin and eyes. Itching, burning sensation and nervous disorder.
Potato	Metalaxyl- mancozeb	Acylalanine fungicide with systemic function fungicide. Inhibition of the transcription Process remains open	0.04	0.2	Low acute toxicity Moderate eye irritant
	Cymoxanil- mancozeb	Post-infection activity stops the development of the fungus during the incubation	0.07	0.2	Low acute toxicity via oral, dermal, and inhalation routes of exposure. Mild skin irritant.
Cabbage	Trifloxystrobin	Inhibit the mitochondrial respiration by blocking electron transfer in the electron transfer chain.	0.121	0.09	Aallergic reactions
	Tebuconazole	Possesses systemic action (as well as preventive, curative, eradicative action). Acts as a sterol inhibiting fungicide (preventing spores).	0.68	0.55	Neurotoxicity, causes cancer, and damage reproductive system.
Capsicum	Carbendazim	Inhibiting the development of fungi probably by interfering with spindle formation at mitosis	3.38	0.025	High doses of carbendazim cause infertility among human beings.
Banana	Aldrin	Causes the neurotoxic effects by blocking the GABAA receptor- chloride channel complex	0.2	0.1	Exposure to moderate levels for a long time causes headaches, dizziness, irritability, vomiting, or uncontrollable muscle movements.

different parameters of Green House Gas emission with calculation GWP and the pesticides residues of different agronomic, vegetable and fruit crops after applying a certain quantity of fertilizers and pesticides to the crop field. In brief, it is to say the entire nation should consume the product of "*Sujalam- Sufalam-Malayaja-Shitalam*" (the people of the nation should consume the food through pristine and eco friendly agriculture).

Materials and Methods

The study was conducted in Ghoragacha village of Chakdah Block and Bhabanipur village of Haringhata Block under the Nadia district of West Bengal. Indiscriminate use of chemical pesticides is rampant in the study area over the years and adoption of proper, judicious agricultural practices are lacking for a long time. All these things are detrimental to the overall ecosystem. Data were collected by Participatory Rural Appraisal (PRA) methods as well as personal interview methods from both the villages, 100 respondent farmers from each of the villages' i.e., 200 respondents in total were selected for the generation of data in two consecutive years.

Estimation of CO_2 equivalents, carbon footprint and GWP

The environmental impacts of different N, P, and K fertilizer doses, adopted by the farmers of two different villages, were assessed by estimating the Critical Factor (CF) on 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 [4]. 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 emission from farming operations (tillage, sowing of seeds, herbicide application in croplands, non-judicious pesticide application, planting and fertilizer application, harvest, *etc*.) and seeds were calculated as per the standard inputs with the corresponding emission coefficients [5-8]. The N_2O emission from applied N fertilizer, manure, and crop residue was calculated by the following equation [9].
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, *etc*., kg N input/year; EF_1 = Emission factor 0.01 for N_2O emissions from N inputs, kg N_2O-N/kg N input. Global warming potential (GWP) calculated with data from CO_2 and N_2O emission by using following equation [10]:
Global Warming Potential (GWP) = (Emission of N_2O x 265)-(Emission of CO_2 x 1)

Analysis of pesticide residue

To study the residue from the different agronomic crops, vegetables, and fruits from the identified villages, 10 samples of each crop were collected from the village market, field, or farmer's houses accordingly. The collected samples were then kept in tagged and kept in the plastic packets and finally stored in the deep freezer for residue analysis. The QuEChERS (quick, easy, cheap, effective, rugged, and safe) method is used to determine the residue samples from the collected agronomics crops, vegetables, and fruits [11]. Dispersive-solid-phase extract in (dispersive-SPE) cleanup was done to remove organic acids, excess water, and other components with a combination of primary secondary amine (PSA) sorbent and $MgSO_4$; then the extracts are analyzed by mass spectrometry (MS) techniques after chromatographic analytical separation. Food samples (well-chopped) along with 1 ml of 1% acetic acid (HOAc) in MeCN and 0.5 g anhydrous $MgSO_4$/NaOAc (4/1, w/w) per gms sample were added to a centrifuge tube or bottle, which was shaken and centrifuged. A portion of the MeCN extract (upper layer) is added to anhydrous $MgSO_4$/PSAsorbent (3/1, w/w; 200 mg per 1 mLextract), mixed, and centrifuged. This final extract was transferred to auto-sampler vials for analysis through gas chromatography/mass spectrometry (GC/MS) to identify and determine the ranges of pesticide residues. The following is the stepwise progression of residual toxicity analysis.

Procedure

Comminute>1 Kg sample with vertical cutter.
Homogenize ⁼ 200 g subsample with probe blender
↓
Transfer 15 g subsample to 50 ml Teflon tube.
↓
Add 15 ml 1% Hac in MeCN + 1.5 g anh.
NaAc + 6g anh. $MgSO_4$ + 75 µL I.S solution.
↓
Shake vigorously for 1 min. Centrifuge > 1500 rcf for 1 min.
↓
Transfer 1-8 mL to tube with 150 mg anh. $MgSO_4$
+50 mg PSA per mL extract and shake for 30 s.
↓
Centrifuge >1500 rcf for 1 min
↓
Transfer 0.5-1 ml extract to GC vial and add TPP.
Transfer 0.15-0.3 mL to LC vial and add e.g., 0.45-0.9 mL 6.7 mM formic acid
↓
Transfer 0.25 mL from Step 10 to LC vial.
Add TPP and e.g., 0.86 mL 6.7 mM formic acid
↓
Transfer 4 mL from Step 10 to grad. cent. tube.
Add 0.4 mL TPP Sol'n and 1 mL toluene
↓
Evaporate at 500C with N2 to 0.3-0.5 mL Add toluene to make 1 mL.
Add 0.2 mL anh. $MgSO_4$ and swirl> 6 mL mark
↓
Centrifuge > 1500 rcf for 1 min. Transfer ⁼ 0.6 mL to GC vial
↓
Analyze by (LVI/) GC/MS and LC/MS-MS

Fig-1 Outline of the QuEChERS protocol used in the residue analysis study

Results and Discussions

Nutrient management Practices of Major Crops

Results reveal that 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 reduce soil fertility. Farmers' plant nutrient practices of different crops along with their corresponding recommended doses are presented in [Table-1] and [Table-2]. 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 [12]. It may be due to non- cognitive adoption of recommended practices wherein socialization results without understanding the science behind it. Recommendation mostly generating 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 [13]. Orchard crops like mango, banana, and papaya are the major cash crops of those selected villages. In contrary to the vegetable crops, farmers used a higher amount of NPK fertilizers in orchard crops.

Green House Gas (GHG) emission from the plant nutrients

The emission of carbon dioxide and nitrous oxide from different crops is presented in [Table-3] and [Table-4]. Carbon dioxide and nitrous oxide emission from different crops is directly associated with the number of chemical fertilizers applied. Amongst the three primary sources of plant nutrients, nitrogenous fertilizers have the highest carbon dioxide emission potential. Amongst the different field crops, emission from vegetable crops 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. Global warming potential is the comparison of CO_2 emission and N_2O emission. Among the different field crops, the highest global warming potential was recorded from the potato followed by cabbage followed by 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 banana in Ghoragacha and papaya in Bhabanipur village.

Pesticides residues in food crops and their possible health hazards

[Table-5] represented the pesticide residue found in different food crops and their possible health hazards. From the experimental data, it was found that several food crops have very high pesticide over maximum residue limit. Significantly higher pesticide residues are found in a pointed gourd, black gram, mustard, cauliflower, chili, tomato, cabbage, capsicum, and banana. In pointed gourd, a very high residue of Azoxystorbin (fungicide) was found. This fungicide was used to prevent different types of fungal attack in the pointed gourd. This fungicide causes very low human and mammalian toxicity but has some acute toxic effects on the aquatic organism. Any contamination of this fungicide to the aquatic body may lead to a serious health hazard for the aquatic living beings. In black gram high residue of carbendazim was found. Although this fungicide moderately safe for human beings, prolonged exposure to this fungicide at high doses can cause infertility and destroy the testicles of the animals. Unlike the pointed gourd and black gram, the safe limit of mancozeb and dimethoate are found in mustard as 0.040>0.010. Farmers used a very high amount of pesticides in winter vegetables. In cauliflower, a very high residue of acephate was found (.500 ppm). This insecticide was generally used to control sucking and biting type insect.

This insecticide has serious health hazards on human beings. Prolonged exposure to this insecticide can cause nausea, diarrhea, abdominal cramps, sweating, rapid heart rate as well as dizziness. In mustard, a very high residue of metalaxyl+mancozeb was also found. It has been observed that residue obtained in mustard is less than MRL, even it is harmful to mustard crops. After application of metalaxyl+mancozeb, the same consequence has also been observed in tomato and potato. In Chilli significantly higher amount of copper residue of imidacloprid was found. This insecticide acts as a postsynaptic acetylcholine receptor in the nervous system of the insect. Exposure too can cause acute salivation and vomiting [14].

Like in cauliflower farmers also used a very high amount of carbendazim in capsicum. Very high fungicide residue was found in capsicum also. Farmers of these villages frequently used neurotoxic insecticides, like Aldrin in bananas. A significantly higher residue of these insecticides was also found in a banana. Agrochemicals are labile within the atmosphere via the soil by two methods: erosion and leaching. In the process of soil erosion, the residual pesticides are spilled over to the adjoining crop fields to expand the area of pollutions. In this process, it is inevitable that the congruent plots act as the sink. The leaching losses are another case of a concern, especially when residue pesticides are leached down to the ground water reserve, the natural source for drinking water. Excessive tillage operations and disturbance of surface soil echelons are responsible for the emission of CO_2 and N_2O which are dreadful agents for environmental pollution and global warming [15-20].

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 and fertilizers with proper training knowledge, label specifications, and application guidelines of the Department of Chemicals and Petrochemicals, Government of India & manufacturers. Science helps to evolve new tangled ideas and technologies which however misused; overused & underused can lead to negative consequences such as Green House Gas effect on the environment and residual toxicity on the field crops. Thus, hue and cry about pesticide pollution can be abated through proper training and technological know-how transfer between end-users and manufacturers. More pollution in the environment can be attributed to emissions from industries & automobiles than pesticides alone. Unscientific and inept spraying and over-dosages coupled with a spraying of spurious insecticides have also aggravated the problem of pest resistance.

Application of research: Study of chemical pesticides and environmental impact

Research Category: Chemical pesticides, Agronomy

Abbreviations: CF: Carbon Footprint, CSR: Corporate social responsibility
FGD: Focus Group Discussion, FP: Farmers Practices, FYM: Farm Yard Manure,
GC: Gas Chromatography, GHG: Green House Gas,
GWP: Global warming potential, HYV: High Yielding Variety,
IPM; Integrated Pest Management,
ISOPOM: Integrated Scheme of Oilseeds, Pulses, Oilpalm and Maize
MRL: Maximum Residue Limit, MS: Mass Spectrometry,
NM: Nutrient Management, PGR: Plant Growth Regulators
PHH: Possible health Hazards, PN: Plant Nutrient, PR: Pesticides Residue
PPC: Plant Protection Chemicals, PRA: Participatory Rural Appraisal,
QuEChERS : Quick, Easy, Cheap, Effective, Rugged, and Safe

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Study area / Sample Collection: Nadia District, West Bengal

Cultivar / Variety / Breed name: Cauliflower, Chilli, Tomato, Banana

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