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Agrochemicals Uses and Pattern in the Western Central Tableland: A Case Study

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Abstract

A survey-based study was conducted during February, 2022 in the western central tableland, Sambalpur and Bargarh district of Odisha, India to understand and identify the pattern of agrochemicals usage. A total of hundred farmers from both the districts, according to the guidelines of a questionnaire survey, were interviewed, with respect to the type of crop cultivation practice, types of agrochemicals used, the investment on agrochemicals procurement annually, the effect of agrochemicals on the peripheral environment, and impact on health conditions of the farmers. From the survey conducted, it was found that the use of DuPont Pexalon (Triflumezopyrim), Acephate, 505 (Cypermethrin+Chlorpyriphos) and SAATHI (Pyrazosulfuran ethyl), were higher in Bargarh region, while the usage of Round-up (Glyphosate), Osheen (Dinotefuran) and Reagent (Phenyl pyrazole) were found to be more utilized in the Sambalpur zone for pest control. The survey also helped in identification of the aftereffects of agrochemicals on environment, which includes loss of microbial population, frogs, birds, earthworms from the agricultural fields. The survey also indicated towards the effects of agrochemicals on the farmers health as well. This study would further contribute towards investigating the impact of these agrochemicals on the aquatic life, the amount of leaching occurs, and the preventive measures, that should be taken, to lessen the use of agrochemicals (Pesticides, herbicides and insecticides), and to introduce alternate forms of agrochemicals to ensure crop safety.

Keywords: Agrochemicals, brown planthopper, herbicides, insecticides, pesticides

1. Introduction

India ranks second at the global level, in agricultural output (Joshi and Varshney, 2022). Around 54.6% of people are directly or indirectly involved in the farm sector (Anonymous, 2021c). About two-third of the rural and urban population of our country, generate income from agriculture and farming practices, in a direct or indirect manner. Some of the salient features of the Agricultural scenario of the Country includes, (1) It stands as the largest producer of livelihood in rural India, (2) The agriculture is majorly dependent on monsoon and, (3) The growth in agricultural production is stagnant since several years (Arjun, 2013).

Odisha stands as the ninth largest state in our country India, with a total of 4.7% of India's total landmass. Odisha is largely a rural and agrarian economy state (Anonymous, 2020d). Predominantly with the red soil, the crop commodities of the state, includes paddy, mangoes, tomatoes, brinjal, sugarcane, jute and poultry. Paddy is widely cultivated crop, holding a share of 48% in the gross cropped area (Hoda et al., 2021). Sambalpur and Bargarh districts of Odisha, geographically called the western central table land, are the major rice producing districts of the state (Sahoo et al., 2020).

Odisha is one of the important marine states of India, having excellent scope for the development of fisheries sector (Anonymous, 2020e). The state has 0.69 mha of freshwater resources, 0.42 mha of brackish water resources and 480 km. of coastline for fisheries development of the state (Anonymous, 2020a). Odisha stands in 4th position, after Andhra Pradesh, West Bengal and Gujarat (Anonymous, 2018a). The total fish production in Odisha in 2020–21, was estimated to be 0.87 mt, contributing to 2.33% of the total state economy (Anonymous, 2021) The fish species which are cultured in Odisha, mainly includes Indian major carps, classified into Catla (*Catla catla*), Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus cirrhosis*). The fish culture of the state also includes exotic carps like common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*) (Ngasotter et al., 2020)

The term pesticide covers a wide range of compounds including insecticides, fungicides, herbicides, rodenticide, molluscicides, nematicides, plant growth regulators (Akhtar

et al., 2009). Pesticides can be defined as "substances used to prevent, destroy, repel or mitigate any pest ranging from insects, animals and weeds to microorganisms (Bonner and Alavanja, 2017). Pesticides are referred to by their functional class, for the organisms that they are designed to control (e.g., herbicides, insecticides, or fungicides). Composed of chemicals that have the ability to kill pests, pesticides serves as a widely used tool for pest management across developing countries (Alavanja, 2009). The major role of pesticides is to kill insects, but a significant property of pesticide is that, it affects non-target organisms too (Bayo, 2021). The constant exposure of non-target organisms, to pesticides can induce toxicity, once it crosses the threshold limit in the system (Ngasotter, 2020).

Herbicides are chemicals that are used to kill weeds, or unwanted plants (Anonymous, 2023) Herbicides are mainly applied before or during planting, to maximize crop productivity by terminating the growth of weeds (Alavanja, 2009). Herbicide's mode of action is strongly influenced by its toxic mode of action, followed by their method of application (Duke, 1990). Herbicides have the potential to act by inhibiting cell division, photosynthesis or amino acid production or by mimicking natural growth hormones, causing deformities (Ross and Childs, 1996). According to (He, 2012) herbicides are the most consumed substances throughout the world (Sharma, 2019).

Insecticides are chemicals that are mainly used to control the insects, either by killing them or by preventing them from engaging themselves in undesirable or destructive behavior (Anonymous, 2022). Insecticides are commonly used in agricultural, public health, industrial applications, as well as household and commercial uses (Anonymous, 2020f). The most commonly used insecticides are the organophosphates, pyrethroids and carbamates (Simaremare, 2020).

The major objective of this study, was to identify the utility of the major agrochemicals in the Western Odisha basin of the state, and to find out its impact on the human population, soil mass, microbial population and aquaculture.

2. Materials and Methods

2.1. Study area

For the survey and study purpose, two districts of the western central table land, namely Sambalpur and Bargarh from Odisha, India were selected, for conducting the study. The survey work was carried out in the month of February, 2022.

The Sambalpur district is situated in the western province of Odisha state. The adjoining district, that surrounds Sambalpur, includes Deogarh district located in the eastern part of Sambalpur, Bargarh district, is the adjoining neighbour district of Sambalpur, Jharsuguda district lies towards north and Sonepur and Angul districts are present to the south. The history of Sambalpur district is associated to a number of historic events that mainly includes Indian freedom struggle which represents the different sections of the society. The

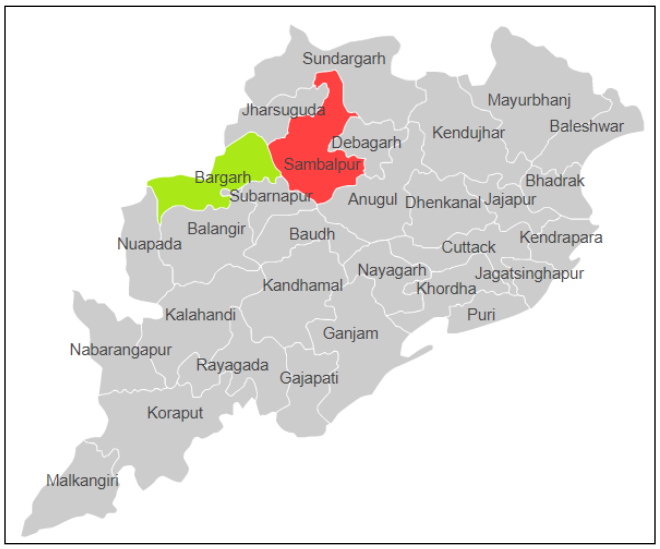

Figure 1: Pictorial representation (map) of Sambalpur and Bargarh district (Source: Paintmaps.com)

very name of Sambalpur district is mentioned in the book of Ptomely as Sambalaka on the river Manada. Sambalpur district was subsequently sub-divided into four different districts. Bargarh district was separated from Sambalpur in 1993, and Jharsuguda and Deogarh districts were separated from Sambalpur in 1994. The district covers a geographical area of 6702 km^2, and lies between 20°40' to 22°11' North Latitude and 82°39' to 85°15' East Longitude. The economy of Sambalpur district is basically dependent on agriculture and secondly, on forests. The important crops grown in the district are rice, gram, , arhar, sesame, groundnut, mustard, castor, linseed. Sugarcane comes as a major cash crop which is grown in this region (website of Sambalpur district). As rice is the major crop that is cultivated here, so this particular district was chosen for the survey work that was to be conducted.

Bargarh is a district, which is located towards the western border of Odisha. Prior to 1992, Bargarh was a subdivision of Sambalpur district. However, Bargarh emerged as an independent district on 1st of April 1993 being divided from Sambalpur district. Bargarh lies at the close contiguity of Sambalpur subdivision, separated by the Mahanadi river. It is one of the renowned district of Odisha, popularly known for its agricultural aspect. The district has been named after the headquarter town Bargarh situated on the left bank of the Jira River. The town is on the National Highway No.6 and located at 59 km to the west of Sambalpur district. It is also served by the D.B.K railway running from Jharsuguda to Titlagarh. The railway station is about 3 kms off the town. A meter gauge railway line connects Bargarh with the lime stone quarry at Dunguri. The main Hirakud canal passes through the town and is known as the Bargarh canal (website of Bargarh district).

Bargarh district is situated at the western most corner of Odisha in between 20°43' to 21°41' N latitude and 82°39' to 83°58' E longitude. The district is bounded by Chhatisgarh

state on the north, Sambalpur district on the east, Balangir and Subarnapur on the south and Nuapada district on the west.

Agriculture acts as the backbone of the district economy. Most of the indigenous residents in Bargarh district mainly practice crop cultivation. Due to its extensive rice cultivation in both the agricultural seasons, it is therefore called the "Rice bowl of Odisha".

Sambalpur and Bargarh, being the major rice producing districts of the state, the use of agrochemicals is substantially high in both these regions. This was the major objective for the selection of Bargarh and Sambalpur district for conducting the survey work.

2.2. Secondary data collection

2.2.1. Opitionnaire based data collection

The study conducted is mainly based on primary data. However, to fulfill the secondary data requirements, opinion of the concerned officials regarding the agricultural profile, and other information on agrochemicals data, farmer's background, and the statistical data regarding to the agricultural conditions of both the districts, aquaculture data and the fisheries data were collected. The above data, were mostly collected from District Agricultural office, District Fisheries office, Block office, Krishi Vigyan Kendra of Sambalpur and Bargarh District, College of Agriculture, located at Chiplima respectively.

2.2.2. Questionnaire based field survey

The field survey was conducted in the month of February, 2022. Two villages, Barahaguda and Gaurangatikra, in Bargarh district, and Sattupalli, a village located at Chiplima block in Sambalpur district, were selected for conducting survey work. Fifty farmers from both the districts were selected for the survey. The survey was mainly carried out with a set of structured questionnaires for the rural farmers (Sahoo., 2020), which mainly consisted of the farmer history, cropping pattern, annual expenditure on crop and procurement of agrochemicals, which agrochemicals are in the usage, the amount of agrochemicals used in for the application, the health effects etc.

3. Results and Discussion

The survey was conducted amongst the farmer population, in both Sambalpur and Bargarh, which provided us with some factual information about the then-current scenario of agriculture and agrochemicals utility in these districts. This gave us an insight into the cropping pattern, agrochemical utility pattern, and its impact on the environmental system at that time.

3.1. Cropping pattern of Sambalpur and Bargarh district

The agricultural system of Bargarh and Sambalpur districts was mainly categorized into two broad areas a) Command areas and b) Rainfed areas. The command areas of the Western Odisha Tableland were mainly dependent on the Hirakud canal system, while the Rainfed areas were majorly dependent on monsoon rains and the local water system, which included ponds, wells, borewells, and groundwater bodies (Figure 2).

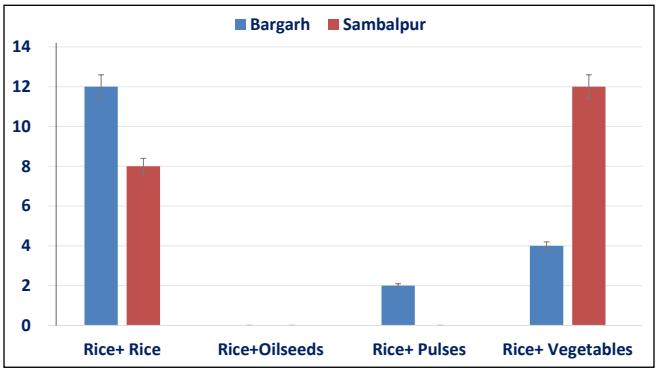

Figure 2: Graphical description of the cropping pattern of Sambalpur and Bargarh zone

From the below table 1, we gained an insight that paddy (rice) was the dominant crop in both the cropping seasons. However, alongside paddy, cereals/pulses, groundnuts, and oilseeds were also being cultivated in the agricultural seasons.

Table 1: Cropping pattern followed in Sambalpur and Bargarh

Sambalpur	Bargarh
Paddy → Cereals (Pulses)	Paddy → Paddy
Paddy → Oil seeds	Paddy → Oilseed/ Grounnut
	Paddy → Cereals (Pulses)

Annual crop calendar of Sambalpur and Bargarh

3.2. Agrochemicals: Classification and their consumption pattern

Agrochemicals utility in the Bargarh district was recorded to be high, and the major objective of over-utilization of agrochemicals, was to improve the crop loss and prevent crops from pest attack. The table shows the types of agrochemicals which are mainly used in Bargarh region (Table 2).

The DuPont Pexalon pesticide was considered the supposed inhibitor of the Brown Planthopper (BPH). It belongs to the novel mesoionic pesticide class and was applied in the post-sowing period. To inhibit the rice ear bug, the farmers of Bargarh used 505, which is an amalgamated form of Chlorpyriphos and Cypermethrin. While Chlorpyriphos constituted 50% of the pesticide formulation, Cypermethrin constituted 5% of the pesticide. This pesticide belongs to the Organophosphate+Pyrethroid family and was applied during the sowing period.

To control the growth of weeds, which mainly constituted of grass variants, in the agricultural fields, the farmers in Bargarh applied SAATHI, or Pyrazosulfuron Ethyl, which belongs to the Sulphonylureas family. SAATHI was applied during the pre-sowing period, mostly 15–20 days prior to sowing, to control the weed growth during the sowing period.

Table 2: The description of the type of agrochemicals(Insecticides/ herbicides) used in Bargarh region. The table contains the chemical name, family, formulation and the type of pests it targets.

Sl. No.	Name of the pesticides	Chemical name	Chemical family	Formulation	Target pest
1.	DuPont Pexalon	Triflumezopyrim	Mesoionic Pesticide	10% Soluble Concentrate (SC)	Brown Plant Hopper
2.	505	Chlorpyriphos 50%+ Cypermethrin 5%	Organophosphate+ Pyrethroid	50%+5% Emulsifiable Concentrate (EC)	Rice Ear Bug
3.	SAATHI	Pyrazosulfuron Ethyl	Sulphonylureas	10% Weightable Powder (WT)	Rice weeds

The farmers of Sambalpur district mostly used new-generation pesticides during the agricultural season, which ensured better crop protection from pests and increased crop yields (Table 3).

Farmers in Sambalpur district mainly used Osheen (Dinotefuran) and Reagent (Fipronil) to control and inhibit the Brown Planthopper (BPH). Both these chemicals were mostly applied during the harvesting season. Osheen belongs to the neonicotinoid chemical family, while Reagent belongs to the phenyl pyrazole chemical family.

In order to control the weeds in the agricultural fields, the farmers of Sambalpur applied RoundUp (Glyphosate). Glyphosate belongs to the organophosphorus group and was applied 20–30 days before the sowing procedure began. However, the farmers of this region used Pexalon (Triflumezopyrim) as a preventive measure to control the BPH induction after almost 3 days of the post-sowing period.

Table 3: Agrochemicals used in Sambalpur

Sl. No.	Name of the pesticides	Chemical name	Chemical family	Formulation	Target pest
1.	Osheen	Dinotefuran	Neonicotenoid	20% Soluble granule	Brown plant hopper
2.	Reagent	Fipronil	Phenyl pyrazole	5% Soluble concentrate (SC	Rice bug
3.	Round-up	Glyphosate	Organophosphorus	41% Soluble liquid (SL)	Grasses
4.	DuPont Pexalon	Triflumezopyrim	Mesoionic Pesticide	5% Soluble concentrate (SC)	As a preventive

3.3. Agrochemicals Utility trend: Case study in Sambalpur and Bargarh

The consumption and utility of agrochemicals was comparatively high in the western central table land, of the state in comparison to the rest of the state. The chart analysis shows that a certain trend was followed with the application of agrochemicals in both the Sambalpur and Bargarh (Figure 3).

According to the data curated from the field survey, it was observed that, DuPont pexalon, 505 and SAATHI are the major agrochemicals that are pre-dominantly used in the agricultural field of Bargarh region. Almost all the respondents, use these three pesticides, to save their crop loss, due to pest attack. Pexalon is said to save the annual crop loss by 30-40% that would have occurred due to BPH attack.

But, in a contradictory approach, the agrochemical consumption trend in Sambalpur is different to that of the agrochemicals used in Bargarh.

The farmers of Sambalpur region used Osheen and Reagent pesticide to control Brown Planthopper in the paddy fields and Roundup herbicide for weed removal as a predominant set of pesticides used in the agricultural fields. Only a few farmers were identified using DuPont Pexalon for controlling Brown Planthopper.

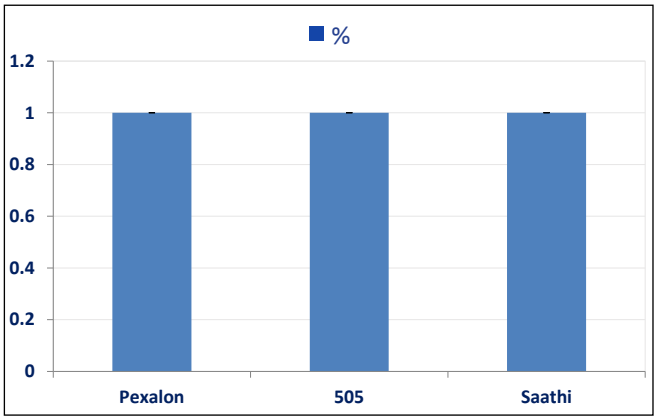

Figure 3: Agrochemicals used in Bargarh region

3.4. The trend of agrochemicals utility- A comparative analysis

The survey in the western central tableland identified a variety of agrochemicals being used in both Sambalpur and Bargarh districts. The increased utility of pesticides had helped the farmers of both districts to increase the crop gain. Application of agrochemicals has helped the farmers in reducing the crop loss by 30–40%. Agrochemicals were also capable of effectively inhibiting pests (Figure 4).

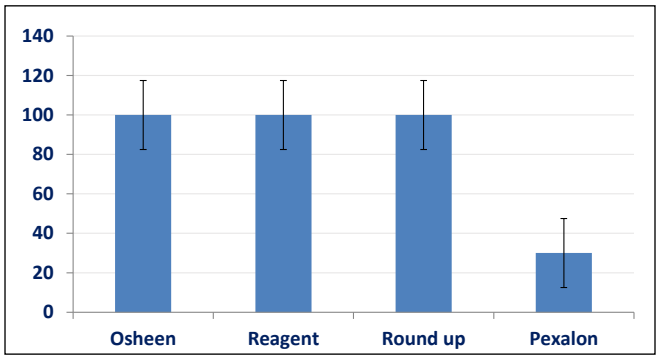

Figure 4: Agrochemicals used in Sambalpur region

From the observations recorded, it was concluded that there was a difference in the type of agrochemicals that is utilized in both Sambalpur and Bargarh districts. Depending on the utility pattern and the trend of agrochemical consumption based on the questionnaire-mediated field survey method, the agrochemicals were prioritized as follows: 1) DuPont Pexalon (Triflumezopyrim), 2) RoundUp (Glyphosate), 3) Osheen (Dinotefuran), 4) Reagent (Fipronil), 5) SAATHI (Pyrazosulfuron Ethyl), and 6) 505 (50% Chlorpyriphos and 5% Cypermethrin).

3.5. Knowledge and training on application of agrochemicals

With the development of science and communication, agriculture had reached new heights. However, due to the lack of resources, many had failed to avail the opportunities. The graphical data had described the data on the farmers who had been trained in the application of agrochemicals (Figure 5).

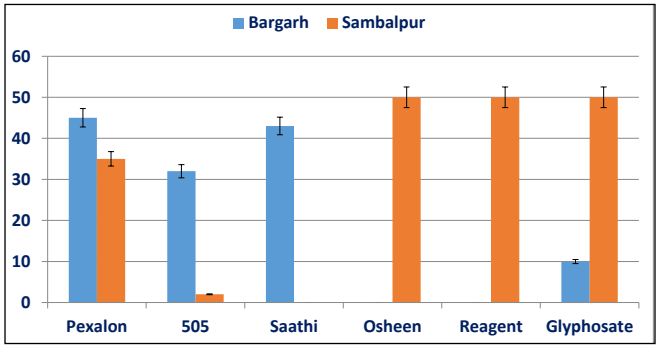

Figure 5: Comparative analysis graph of agrochemical use in Sambalpur and Bargarh

From the observations recorded in Bargarh, from the total farmer respondents, around forty-three farmers had not possessed any training on pesticide application, while only seven farmers had undergone training on applying pesticides. On the other hand, in Sambalpur, out of the total farmer respondents, 30 farmers had undergone a training program on pesticide application, while 20 farmers had not undergone any kind of training program.

According to the recorded data from the survey work, it was found that around fifteen farmers possessed adequate knowledge on the proper application of agrochemicals in the agricultural fields. While thirty-five farmers had very little or no technical knowledge on the application of agrochemicals in Bargarh district. In Sambalpur, however, the farmers had acquired knowledge on pesticide application through various training programs. Amongst the farmer population, thirty-five respondents had acquired adequate knowledge on agrochemical application, while twenty respondents had not acquired proper knowledge on agrochemical application.

3.6. Impact of agrochemicals on farmer's health condition

The agrochemicals tends to possess a toxic effect on non-target organisms as well. The lethal effect of pesticides was found to be only 1% in target pests, but they possessed a toxic effect on non-target organisms as well. Agrochemicals have the ability to affect the entire biomass once they entered the environment. Even the overuse of agrochemicals led to the abolition of biological pest controls, like birds, soil microbes, and frogs (Figure 6).

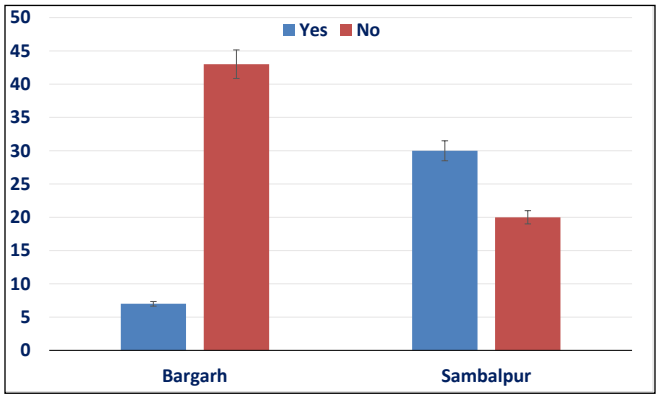

Figure 6: Graph describing the training programs on agrochemicals application

From the study conducted, it was evident that the farmers who were working regularly in agricultural fields and were under constant exposure to agrochemicals, were prone to various acute and chronic health issues. According to the findings obtained from the survey work, it was found that in both Sambalpur and Bargarh, maximum cases of headache were reported, as excessive use of agrochemicals tended to affect the neuron system of the body. This was followed by cases of hypertension, eye and skin irritation, and body weakness as well. The major reason for these health problems in farmers was due to exposure to agrochemicals through inhalation, exposure through food, and exposed parts of the body. This data indicated the toxic effect of agrochemicals on the farmers. However, only a few responses of no health issues were recorded.

3.7. Impact of agrochemicals on aquatic organisms

The survey data gave an insight that there were no major reported cases of the impact of agrochemicals on aquatic organisms in both Sambalpur and Bargarh. The practice of Integrated Crop Management (ICM) resulted in less leaching of pesticide-treated water into the water system. Also, the lack of proper investigative measures, lacuna in aquatic survey,

and other factors could be the possible reasons for cases of agrochemical impact on aquatic organisms being unreported in the past (Figure 7).

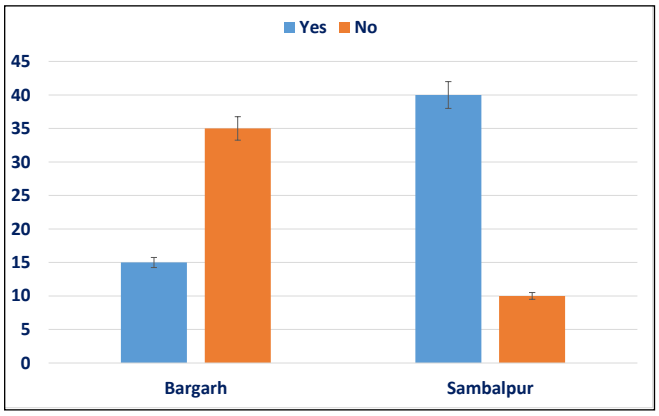

Figure 7: Graph describing the knowledge on agrochemicals application

3.8. Development of the endocrine disruption and fish health (EDFH) database

The survey work conducted in the western central tableland provided an insight into the agrochemical utility pattern and the types of agrochemicals that were majorly used in both these areas. Looking up to the long-term impact of agrochemicals on the environment and the impact of agrochemicals on non-target organisms, the concept of developing a database on fish health and the impact of agrochemicals on metabolic activities, reproduction, and other processes of fish led to the development of The Endocrine Disruptors and Fish Health (EDFH) database in the past (Figure 8).

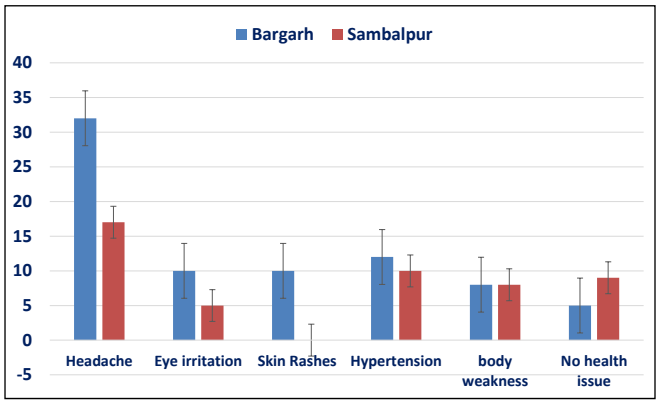

Figure 8 : Graph describing the data of farmer's health condition.

The EDFH database was conceptualized to contain detailed information about the types of agrochemicals in use, their formulation, dosage quantity, application, the major fish population found in the Indian aquatic ecosystem, along with their physical features, information on the genes associated with endocrine disruption, and many more. The secondary data collected was majorly from the survey conducted, and the other data were collected from different online sources, including the National Centre for Biotechnology Information (NCBI), PubChem, European Molecular Biology Laboratory (EMBL), DNA Data Bank of Japan (DDBJ), etc.

The EDFH database was developed on the .NET platform, using Visual Studio 2019. SQL Server had been used as a backend database. The major programming languages used for developing the database included HTML 5.0, Javascript, JQuery, CSS 3.0, and C#. The site was responsive and was computer, mobile, and tab-friendly. An android application of the database is currently under development (ICAR-CIFA annual report 2021).

3.9. Analysis

India, is one of the leading crop producers of the world. While a variety of soils are grown over here, Rice is the predominant crop of Indian agricultural system, as rice is the staple diet of the country. It covers about a total of one- third of the total cultivated area of the country. One of the important observations, that was noted during the field survey was paddy being the major crop, cultivated both in Sambalpur and Bargarh region. The Western Odisha tableland, due to its geographic features, and the soil type, is mostly suitable for the growth of paddy. Availability of water, due to the presence of Hirakud Dam, in the region, fulfills the demand of water required for growing paddy. Out of the 30 districts of the state, Bargarh district is the largest producer of paddy, and is also known as "Rice Bowl" of the state. The total area under rice cultivation in Bargarh district is around 2, 42,718 ha of land in *kharif* season, and around 81,069 ha of land in *rabi* season (Anonymous, 2020b). Along with paddy cultivation, seasonal vegetables, groundnut, oilseeds are also grown here.

Around 2 million tonnes of agrochemicals are being used globally, out of which around 47.5% are herbicides, 29.5% are insecticides, 17.5% are fungicides and 5.5% are other pesticides. The top ten pesticide consuming countries in the globe are China, The USA, Argentina, Thailand, Brazil, Italy, france, Canada, Japan and India (Anonymous, 2018a, Anonymous, 2018b)

India stands 12th in utility of agrochemicals globally, and 3rd in Asia, after China and Turkey. There are 293 pesticides used in the country, and it is reported that, around 104 pesticides are stil be manufactured/ used in the country (Anonymous, 2021) The pesticide usage pattern differs from the global pesticide usage pattern. The pesticide usage pattern is insec ticides>herbicides>fungicides+bactericides>other pesticides (). Chlorpyriphos, is most widely used insecticide in India (Anonymous, 2020c) Sulphur is the most widely consumed fungicide, and a high concentration of 2-4-D amine salts is being used as a weedicide (herbicide). The most consumed insecticide in our country includes organophosphate, followed by neonicotenoids and pyrethroids (Sanchis, 2012).

A comparative analysis of the pesticide utility trend, in both the regions, was of major importance, to prioritize and rank

the agrochemicals depending on the trend of agrochemical application. A questionnaire-mediated survey, carried out with the local farmers from the region, and the secondary level data, provided by the government officials, states that, the use of Pexalon (Triflumezopyrim) was the highest in both the areas, followed by RoundUp (Glyphosate), Osheen (Dinotefuran), Reagent (Fipronil), SAATHI (Pyrazosulfuron ethyl), 505 (Cypermethrin 50% and Chlorpyrifos 5%).

Glyphosate (N-(phosphonomethyl) glycine), is an organophosphorus insecticide, developed in 1971, by Mosanto. The active molecule was marketed as a product called RoundUp in the year 1973.Glyphosate has become most utilized herbicide all over the world. Glyphosate is a toxic endocrine disruptor, and its accumulation will impact the environmental compartment. It's use in the agricultural practices will possess serious threat to the environment (Choudhary, 2016).

In India, glyphosate is in use since 1980's, and is one of the most widely used pesticide all over the country. Although, the glyphosate based herbicides, were registered and approved in India for control of weeds in tea garden, and non-crop producing areas, it was still found to be used in more than 20 crop fields, conservation agriculture and as well as in non-crop areas (Bighaat.com). Both the primary survey data, and the secondary data, provided by the govt. officials, reflects that, the utility of glyphosate is a common scenario in Sambalpur region. Farmers apply glyphosate 20–30 days prior to sowing period begins, in order to eliminate the weed completely. However, data from Bargarh suggests that, the use of SAATHI (Pyrazosulfuron ethyl), is quite common. SAATHI herbicide (Pyrazosulfuron ethyl), is a highly versatile pre emergence herbicide, considered to be both soil and foliage active, to control rice weeds, effectively from the beginning (Mohapatra, 2021 and Krishnaiah, 2014).

Among the insect pest infesting rice crop, Brown Plant hopper (BPH) (*Nilparvata lugens,* Stal*),* is a typical resurgent pest, that has been threatening the rice cultivation post- green revolution period.it is considered as a major yield limiting factor in all the rice growing countries, both in tropics and temperate regions. A variety of insecticides, including chlorpyriphos, profenophos, cypermethrin, deltamethrin, bifenthrin, lambda cyhalothrin and imidacloprid, is being widely used (Jeschke, 2010). The survey conducted in Sambalpur and Bargarh, brings up a different picture. In Bargarh, DuPont Pexalon (Triflumezopyrim), which is an effective novel class of mesionic insecticide, is a dominating insecticide over the region. Data from Sambalpur suggests that, the use of Osheen (Dinotefuran), belonging to the neonicotenoid and phenyl pyrazole class of insecticides respectively, is being commonly used in inhibition of Brown Planthopper (BPH).

Neonicotinoids represents a relatively new class of insecticides, that have become most widely used insecticide all over the world (Jeschke and Nauen, 2008, Jeschke et al., 2010). Industry crop scientists, consider the discovery of neonicotinoid insecticide as a milestone, in the field of agrochemical research, as it resulted in the most rapidly growing class of insecticides, since the commercialization of pyrethroids (Cordova, 2016). Triflumezopyrim was developed by DuPont crop protection and is effective against sap-sucking pests (Zhang and Zhu, 2017, 2018). Earlier studies conducted, suggests that, triflumezopyrim is highly effective to plant brownhopper, however, additional information suggests that, triflumezopyrim is less harmful its natural enemies, that includes organisms such as *Anagrus nilaparvatae* (Hymenoptera: Mymaridae), *Cyrtorhinus lividipennis* (Hemiptera: Miridae), and *Paederus fuscipes* (Coleoptera: Staphylinidae). The survey data of Sambalpur and Bargarh states that, maximum number of cases related to headache was reported in both these areas, followed by eye and skin irritation, due to application of triflumezopyrim, in both these regions.

The relationship between the herbicide utility and the effect on human health has been extensively studied. Many laboratory tests have demonstrated the possible absorption of glyphosate in the gastrointestinal tracts of humans and mammals, as well as absorption through inhalation, ingestion and dermal contact. In addition, numerous studies have been conducted on mice and rats, by administering high doses of glyphosate. The results show that, glyphosate causes growth delays, kidney damage, liver enlargement and inflammation, and gastric diseases too (Webster, 2022). On the other hand, not much studies have been conducted to assess the impact of triflumezopyrim on human health. However, survey revealed that, a majority of farmers have headache issues, mostly occurring just after applying pesticides in the agricultural fields, both in Sambalpur and Bargarh. Apart from this, acute health cases like, eye and skin irritation, hypertension, body weakness etc, were also reported in both these regions. However, only a few instances of zero health issues were recorded.

A study on effect of glyphosate on Adult zebrafish, provided evidence that the glyphosate reduction caused a reduction in the number of eggs, spawned by female zebrafish, exposed to high concentrations of glyphosate. However, this concentration was well above the concentration of glyphosate measured in the environment, till date, and most unlikely to occur in the aquatic system, except when, glyphosate is directly applied to the aquatic environment, to prevent algal population (Fu, 2017). Even it is also reported that, novel neonicotinoids exhibit good inhaling activity and high toxicity to sucking pests, however their toxicity to non-target organisms, including mammals, fishes, birds etc is relatively low. On the other hand, the survey study reveals that, there was no significant impact of glyphosate in the aquatic system of Sambalpur and Bargarh regions. One of the possible reasons of the lowered impact of glyphosate on aquatic organisms, may be the lack of investigations on the water body, to check

the impact of agrochemicals on the aquatic ecosystem. Also, the practice up of ICM (Integrated Crop Management), in both these areas, leading to reduced leaching of agrochemicals into the water bodies, might be other reason. In order to explore the possible effects of glyphosate and triflumezopyrim on the aquatic organisms, we conducted experiments to study the effect of glyphosate and pexalon exposure on zebrafish (*Danio rerio)*, the model fish, and the effect of triflumezopyrim exposure on sub-adult rohu (*Labeo rohita),* an important commercial food fish, by exposing the animals to different dosages of glyphosate and triflumezopyrim in an controlled environment, for 21 days, and observed the changes, that occurred due to the exposure to both these agrochemicals. Histological and biochemical analysis, suggested the damage in the organelles, and changes of different enzymes and enzymatic activity in treated organisms, thereby confirming the impact of agrochemicals on the aquatic organisms.

4. Conclusion

Triflumezopyrim had emerged as a widely used agrochemical in both Sambalpur and Bargarh regions. However, the increasing utility of these new generation pesticides negatively affected the environment. The excessive use of agrochemicals resulted in the declination of soil microbes and local fish populations. These agrochemicals could also be a threat to human health. It was, therefore, necessary for the farmers to understand the underlying issues of using agrochemicals and to reduce their usage.

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