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Impact of Pesticide Usage on Potato Cultivation in Dhangadhi, Kailali, Sudurpashchim Pradesh, Nepal

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Abstract

This research paper examines the impact of pesticide usage on potato cultivation in Dhangadhi, Kailali, Sudurpaschim Pradesh, Nepal, with a specific focus on the environmental and health consequences. The study utilises a descriptive and experimental research design to examine the inhibition of pesticide residue in potato crops. This is achieved through thorough sampling and analysis. The data collection process comprised of conducting interviews with local farmers and locals, as well as organising focus group talks to evaluate the level of awareness and the practices associated with pesticide usage. The study indicates that a substantial proportion of the local populace is cognizant of the detrimental impacts of pesticides, however only a minority consistently assesses soil fertility. The findings reveal diverse concentrations of pesticide residues in the samples obtained from the market, emphasising the necessity for more stringent rules and improved practices. Suggestions are given to alleviate the adverse effects of pesticide utilisation, fostering both food safety and environmental sustainability.

Keywords: Pesticide Usage, Potato Cultivation, Pesticide Residue, Food Safety, Environmental Sustainability

Introduction

Potatoes are a widely cultivated and popular vegetable in Nepal, grown abundantly in many places such as the Terai, hills, and highlands. Potatoes are an essential component of Nepal's agricultural environment due to its ability to grow in various cropping locations. Potato cultivation in the Terai region is exceptionally lucrative because of the advantageous weather conditions and fertile soil. The Terai region, surrounded by Indian states like Sikkim, Bihar, and Uttar Pradesh, has emerged as a central location for large-scale potato farming (Vincent et al., 2013).

Kailali is distinguished among the Terai districts, with Dhangadhi serving as its most populous city. Dhangadhi functions as both the administrative hub of Kailali and the interim capital of Sudurpaschim Province. The city holds significant strategic importance as it serves as a key border point with India, facilitating large cross-border trade and agricultural exchange (Adhikari, 2018). As a result, the potato output in Kailali is significant, with additional supplies coming from nearby cities in India. These imports provide a consistent provision of potatoes in both local and wholesale markets, meeting the substantial demand.

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In the 1930s, Nobel laureate Paul Herman Muller discovered DDT, revolutionizing pest control worldwide (Beyer &Biziuk, 2008). In the 1950s, the Nepalese government began using DDT to combat malaria, later employing other pesticides such as nicotine sulphates and gammexene(Baker &Gyawali, 1994). The Government of Nepal allowed the use of pesticides to control malaria starting from a specific date. Nepal, a landlocked country bordering Sikkim, Bihar, Uttar Pradesh, and Tibet, relies heavily on pesticides to maintain crop health and increase harvests). These pesticides, including insecticides, play a crucial role in agriculture by killing, repelling, and reducing pests, as recognized by the Environmental Protection Agency (EPA, 1991). Over time, various types of pesticides have been developed, ranging from chemical to biological ones (Baker &Gyawali, 1994). The diversification of pesticides into many categories, including organophosphates, carbamates, and pyrethroids, has significantly broadened the range of choices available for agricultural pest control (EPA, 1991).

An important problem that arises from these activities is the increasing infertility of the soil. The indiscriminate and uncontrolled application of artificial fertilisers exhausts the soil of its inherent nutrients, resulting in a gradual and irreversible decline in fertility over time. The decline in soil quality has a negative impact on both the present potato harvests and the future potential for agricultural output in the area. Furthermore, the widespread use of pesticides is causing a disturbance in the natural equilibrium.These chemicals have a dual effect: they not only specifically target pests, but also have negative effects on beneficial creatures and pollute water supplies, therefore worsening the overall environmental impact (Kumari et al., 2006).

Although these challenges are important, the environmental consequences of potato farming in Kailali have not been adequately addressed.In order to build sustainable agriculture systems, it is important to perform a thorough investigation and evaluation of these elements.Tackling these obstacles is essential to guarantee the sustainable existence of potato farming in the area, preserving food security, and safeguarding the environment. The objective of this research is to address the existing knowledge gap by conducting a thorough review of the ecological consequences of pesticide utilisation and proposing suggestions for adopting more environmentally friendly farming methods.

Issues

An important problem that arises from these activities is the increasing infertility of the soil. The indiscriminate and uncontrolled application of artificial fertilisers exhausts the soil of its inherent nutrients, resulting in a gradual and irreversible decline in fertility. The decline in soil quality has a negative impact on both present potato harvests and future agricultural output in the area. Furthermore, the natural equilibrium is being upset as a result of the indiscriminate utilisation of pesticides. These pesticides have a dual effect, as they not only specifically target pests but also have detrimental effects on beneficial creatures and contribute to the pollution of water sources, so worsening the overall environmental impact.

Although these challenges are important, the environmental consequences of potato farming in Kailali have not been adequately addressed. The primary aim of this research is to determine the proportion of pesticide residues that are reduced in vegetables, with the purpose of evaluating the possible risks they pose to human health. Additionally, the second goal is to assess the extent of understanding, beliefs, and self-reported behaviours among stakeholders on the proper use of pesticides in agricultural

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activities. This research aims to enhance food safety standards and promote ecologically sustainable agriculture practices by achieving these goals. Tackling these difficulties is essential to guarantee the sustainable existence of potato farming in the area, preserving food security, and conserving the environment. This study seeks to address this deficiency by conducting a thorough examination of the ecological consequences of pesticide utilisation and proposing suggestions for adopting more environmentally-friendly agricultural methods.

Methods and methodology

The data and information for this study were obtained through extensive field research. A stratified random sampling technique was utilized to get samples from several marketplaces, including wholesalers, retailers, and farmers. After determining the sample size and sampling method, potatoes were taken from all strata and tested in the laboratory. In order to guarantee the acquisition of precise and dependable data, a designed questionnaire was employed. Additionally, extensive oral interviews were conducted with farmers from various socioeconomic backgrounds and categories to gather comprehensive data at both the block and village levels.

Study Area

Nepal is characterized by thousands of rivers, high slopes, rugged terrain, and unusual formations, with distinct topographical regions such as the High Himalayas, High Mountains, Middle Mountains, Siwalik Hills, and Terai plains extending along the north-south axis. This study was conducted in Dhangadhi, Kailali, located in Sudurpaschim Pradesh, Nepal. Dhangadhi is the administrative centre of Kailali district and is located in latitudes of around 28°41'N to 29°02'N and longitudes of around 80°30'E to 80°38'E. It borders Uttar Pradesh, India, to the south; Godawari and Gauriganga municipalities to the north; Kailali rural municipality to the east; and Kanchanpur district to the west. The primary agricultural activity in this area is vegetable farming. Nepal's climate varies from subtropical to arctic depending on altitude. The Terai region experiences hot and humid conditions, whereas the midlands enjoy pleasant weather year-round with cool winter evenings. The northern mountainous areas are dominated by alpine climates with low winter temperatures. Deforestation has significantly impacted the ecological balance across Nepal's five seasons: summer, monsoon, autumn, winter, and spring. Dhangadhi, the 10th largest city in Nepal, is located in Province No. 7 of the far-western development region and covers an area of 261.75 km². The city has a population of 147,181, with a significant portion involved in vegetable farming. Pesticide exposure is a concern for the predominantly elderly population, as many young people migrate abroad for work. The terrain of Dhangadhi is primarily agricultural, with land use heavily influenced by extensive farming activities.

Population and Sample size

Population

The study focuses on the potato market, which includes a diverse population consisting of wholesalers, retailers, and farmers. The production of potatoes spans across various regions within the Akilali district, encompassing hilly, mountainous, and plain areas. Additionally, the market also includes potatoes imported from India. Given this diversity, the population is characterized by significant variability in terms of geographical origin and market roles.

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Sample Size

To determine an appropriate sample size for this study, we employed a systematic approach considering the lack of a known population size. Using a 95% confidence level and a 5% margin of error, we applied the following formula to estimate the sample size:

$n = Z^2 . p. \{1 - p\} / e^2$

Where:

Z = 1.96 (Z-value for 95% confidence level)

p = 0.5 (estimated proportion)

e = 0.05 (margin of error)

Plugging in these values, we calculated:

n ={ $(1.96)^2$. 0.5 (1 - 0.5)}/{$(0.05)^2$}} =approx 384

Given the heterogeneity of the population, we increased the sample size to 450 to ensure robustness and adequate representation across different strata. This sample size allows for comprehensive data collection and analysis while balancing practical constraints.

To ensure representativeness, the sample is stratified as follows:

Wholesalers (Puronosabjimandi): (Local produc 100 t + Imporyecd50)=150

Retailers (Dhangadhi market): 150

Hat bazar (Farmers from hilly regions: 50; Farmers from mountainous regions: 50 Farmers from plain regions: 50) =150

This stratification ensures that each subgroup within the diverse population is adequately represented, providing a reliable basis for analysis and conclusions in the study.

Result and Findings

Presence of Carbonate

Table 1. Amount of Carbamate in Potato

Entire Sample	Minimum Carbamate	Minimum Carbamate	Mean	Standard deviation
450	14.292 %	20.23%	17.83%	3.124%

The data analysis was conducted on a sample size of 450, measuring carbamate content across three market samples. The summary statistics reveal important insights into the distribution and variability of carbamate levels in the potatoes sampled from these markets.

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The mean carbamate content across the samples is 17.83%. This average value provides a central point of the data, indicating that, on average, the carbamate content in the potatoes sampled is below 18%. This suggests a moderate level of carbamates in the overall sample, which is within acceptable limits for safe consumption. The minimum recorded carbamate content is 14.292%, while the maximum recorded carbamatecontent is 20.230%. This range demonstrates that there are some variations in carbamate levels, but they are not extreme.

The standard deviation of 3.124% indicates the extent of variation or dispersion of carbamate content in the samples. A standard deviation of 3.124% suggests moderate variability around the mean. This means that most of the carbamate content values lie within the range of 14.706% to 20.954% (mean ± one standard deviation), showing that the data points are reasonably spread out but not excessively scattered.

Presence of Organophosphat

Table 1. Amount of Organophosphate in Potato

Entire Sample	Minimum Organophosphate	Minimum Organophosphate	Mean	Standard deviation
450	25.27%	30.014%	27.305%	2.443%

The average content of organophosphate observed across the various samples amounts to 27.305%. This figure serves as an indication that, on average, the potatoes that were subjected to sampling exhibit a level of organophosphate content that slightly surpasses the threshold of 27%. This numerical representation of the mean offers a central tendency measure, thereby imparting insight into the characteristic organophosphate concentration present within the sampled potatoes.

The lowest documented level of organophosphate content stands at 25.270%, whereas the highest recorded content reaches 30.014%. These numerical values serve to imply the existence of a spectrum of organophosphate concentrations within the samples, with the minimum falling at approximately 25% and the maximum surpassing the 30% mark. The range between these two extremes indicates a certain degree of variability in the organophosphate content observed across the diverse market samples.

The standard deviation, calculated at 2.443%, serves as a metric to delineate the extent of variation or dispersion within the dataset pertaining to organophosphate content. This numerical value elucidates that the levels of organophosphate are relatively homogeneous, with the majority of data points clustering within a range of 2.443% around the mean value. More specifically, it can be inferred that the organophosphate content values are expected to fall within the interval of 24.862% to 29.748% (mean ± one standard deviation). y.

Discussion

The mean organophosphate content across the samples is 27.305%. This indicates that, on average, the potatoes sampled have an organophosphate content slightly above 27%. This mean value provides a central measure, giving a sense of the typical organophosphate level in the sampled potatoes. The minimum recorded organophosphate content is 25.270%, while the maximum recorded is 30.014%.

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The data indicates a variation in the quantities of organophosphates in the samples, ranging from around 25% to slightly above 30%. This range indicates some variability in the organophosphate content among the different market samples. The standard deviation of 2.443% shows the extent of variation or dispersion in the organophosphate content data. This value indicates that the organophosphate levels are relatively consistent, with most values falling within a 2.443% range around the mean. Specifically, the organophosphate content values are likely to lie between 24.862% and 29.748% (mean ± one standard deviation).

The data analysis was conducted on a sample size of 450, measuring carbamate content across three market samples. The summary statistics reveal important insights into the distribution and variability of carbamate levels in the potatoes sampled from these markets. The mean carbamate content across the samples is 17.83%. This average value provides a central point of the data, indicating that, on average, the carbamate content in the potatoes sampled is below 18%. This suggests a moderate level of carbamates in the overall sample, which is within acceptable limits for safe consumption. The minimum recorded carbamate content is 14.292%, while the maximum recorded carbamate content is 20.230%. These values indicate the range of carbamate concentrations found in the samples, with the lowest being relatively close to the mean and the highest being somewhat higher. This range demonstrates that there are some variations in carbamate levels, but they are not extreme. The standard deviation of 3.124% indicates the extent of variation or dispersion of carbamate content in the samples. A standard deviation of 3.124% suggests moderate variability around the mean. This means that most of the carbamate content values lie within the range of 14.706% to 20.954% (mean ± one standard deviation), showing that the data points are reasonably spread out but not excessively scattered.

The average content of organophosphate observed across the various samples amounts to 27.305%. This figure serves as an indication that, on average, the potatoes that were subjected to sampling exhibit a level of organophosphate content that slightly surpasses the threshold of 27%. This numerical representation of the mean offers a central tendency measure, thereby imparting insight into the characteristic organophosphate concentration present within the sampled potatoes. The lowest documented level of organophosphate content stands at 25.270%, whereas the highest recorded content reaches 30.014%. These numerical values serve to imply the existence of a spectrum of organophosphate concentrations within the samples, with the minimum falling at approximately 25% and the maximum surpassing the 30% mark. The range between these two extremes indicates a certain degree of variability in the organophosphate content observed across the diverse market samples. The standard deviation, calculated at 2.443%, serves as a metric to delineate the extent of variation or dispersion within the dataset pertaining to organophosphate content. This numerical value elucidates that the levels of organophosphate are relatively homogeneous, with the majority of data points clustering within a range of 2.443% around the mean value. More specifically, it can be inferred that the organophosphate content values are expected to fall within the interval of 24.862% to 29.748% (mean ± one standard deviation).

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