International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol.10 No.4 March – April 2023

INNOVATIVE STRATEGIES TO MINIMIZE PESTICIDE DEPENDENCY: PROMOTING SUSTAINABLE AGRICULTURE AND PUBLIC HEALTH

Ishfaq Majeed Malik

Department of Environmental Science

Jammu and Kashmir, India

Corresponding Author - Ishfaq Majeed Malik

DOI - 10.5281/zenodo.10719073

Abstract:

Inefficient utilization of water, petroleum products, and dirt describes the modern farming framework. It worsens a large number of natural issues, like soil disintegration, declining biodiversity, air and water contamination, and fish mortality. Since there is a critical energy squander when grain is taken care of two dairy cattle for meat creation as opposed to individuals, creature farming purposes a larger number of assets than other food creation techniques, and meat creation is a significant supporter of these challenges. Contamination from extreme groupings of creature squanders and the abuse of anti-toxins, which might decrease their viability in medication, are two general wellbeing and ecological issues brought about by the increment of plant style creature farming. As far as utilization, creature fat is related with various persistent degenerative sicknesses, including cardiovascular infection and a few malignancies, that plague modern and post-modern nations. Approaches that all the more reasonably appropriate high-protein food sources would be valuable to human wellbeing in both rich and unfortunate countries. There is developing worry that the pesticides utilized broadly in modern farming might be connected to endocrine disturbance, regenerative brokenness, and an expanded gamble of malignant growth in the two workers and clients. This article spreads out the current food creation strategies, the wellbeing takes a chance with the posture to people and the climate, and how these frameworks might be improved to be more supportable.

Keywords: Sustainable Agriculture, Public Health, Pesticide Dependency, Agriculture Mechanisation Services (AMS).

Introduction:

Synthetic pesticides are a typical instrument for ranchers to battle weeds and irritations, yet their abuse is jeopardizing biological systems and individuals' wellbeing. India is the world's driving client of pesticides, representing around million tons yearly. [1] Openness to pesticides raises the chances of creating disease, immunological concealment, mental weakness, variant proliferation, and chemical interruption. It is basic to decrease pesticide inputs and moderate their hindering effect on human wellbeing and the climate to address food security challenges. Proficient agriculture

automation services (AMS) and other horticultural hardware might increment yield while diminishing information costs.

Motorization in agriculture assists with weed and bug control, accuracy splashing of pesticides, and less utilization of compound pesticides. [2] As yet absent, however, is a quantitative report that records for varieties in ranch size and geographical conditions as far as what AMS means for pesticide input.

Pesticides:

Substances determined to control vermin are known as pesticides. This envelops many pesticides, including those that kill nematodes, mollusks, piscicides, avenom, rodents, microorganisms, bugs, parasite, and lampricides. Herbicides are by a wide margin the most well-known sort of pesticide, and they make up around half of all pesticides utilized around the world. Plant insurance items, frequently called crop security items, are the essential capability of most pesticides. These medicines safeguard plants from destructive creatures including weeds, organism, and bugs.

Figure:1 Pesticide in Food

Pesticides can be synthetic specialists like carbamate or natural specialists like infections, microbes, or parasites that deter, cripple, or kill bothers. Bugs, weeds, mollusks, birds, warm blooded animals, fish, nematodes (roundworms), and microorganisms are expected focuses for bug control endeavors. [3] These vermin can harm property, cause annoyance, or spread disease. Pesticides have both positive and negative angles. One pessimistic perspective is that they might be unsafe to the two individuals and different creatures.

Objectives:

The core objectives of the research are as follows:

- To fine Technological Interventions for Precision Agriculture.
- To identify the Impact of parricides on Public Health.
- To examine how to Promote Sustainable Agriculture.

Literature Review:

Muhadith, J. K., Hamid, H., Rather, A., & Dar, Z. A. (2020) examined the effectiveness of integrated pest management (IPM) as a long-term approach to managing insect pests in crops. In order to reduce the negative effects of conventional pesticides on the ecosystem, the study highlights the significance of implementing holistic pest control techniques. [4] IPM integrates chemical, cultural, and biological control techniques to lower insect populations while advancing sustainable farming methods.

Tilman, D., Clark, M., Williams, P., & Clark, S. (2020) examined the complex

connection between food systems and the effects they have on the environment. The research emphasised the necessity for sustainable farming practices by highlighting the complex effects of the existing food production systems on the ecosystem. [5] Examining how food systems affect the environment, the authors emphasised how critical it is to implement more eco-friendly and resource-efficient strategies in order to guarantee global food security.

Pretty, J., Bharucha, Z. P., & Dicks, L. V. (2018) completed an exhaustive examination of the impacts that agriculture and food production have on general wellbeing. The relationship between farming practices and general wellbeing impacts was featured by the review. [6] The creators underlined the meaning of feasible and wellbeing focused cultivating techniques and contended for a thorough system that considers the impacts of rural decisions on human wellbeing.

Barbosa, P., Dinis, A., & Morais, M. A. (2019) offered a comprehensive analysis of nano biopesticides and their possible uses in the management of pests and plant diseases. The study investigated the newly developing area of agricultural nanotechnology, with a particular emphasis on nanoscale materials for efficient pest control. [7] The writers talked about the benefits and drawbacks of nano biopesticides, emphasising its potential to lessen environmental effect and improve the accuracy of pest management techniques.

The Food and Agriculture Organization (FAO) (2020) saw a partnership between and the United Nations Environment Programme (UNEP) to release "The State of Food Waste and Loss Prevention 2020." The important problem of food loss and waste on a worldwide scale is clarified by this paper. [8] In order to address the significant amounts of food wasted and lost across the food supply chain, it offers a thorough review of the situation as it is now, the reasons behind it, and possible remedies. The research emphasises how crucial it is to implement sustainable practices in order to reduce food waste and improve food security.

Methodology and Data:

Hypothesis:

- **Hypothesis 1:** AMS can effectively reduce pesticide input.
- **Hypothesis 2:** The reduction in pesticide input achieved by AMS is higher in plain regions compared to mountainous and hilly regions.
- **Hypothesis 3:** Large-scale farmers experience a higher reduction in pesticide input compared to small-scale farmers due to the scaling effects of AMS.

Data Source:

To analyze provincial families in India, this exploration utilizes 2020 information procured by Zhejiang College's Indian Family Database (IFD). Subsequent to cleaning the information,

12,853 examples were acquired from 593 towns across 30 regions, making up the examination test. As far as rural efficiency, 8649 examples settled on AMS, while 4,204 didn't, as per the report.

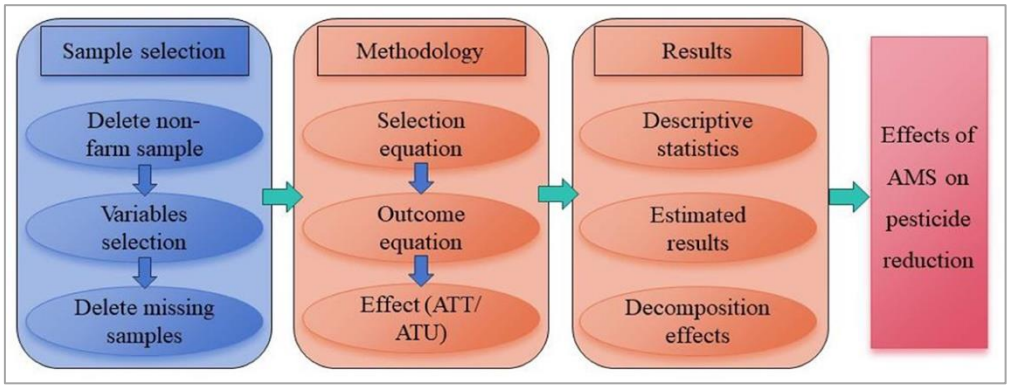

Figure 2: Procedure for choosing samples and conducting research

Variable Selection:

The exploration takes a gander at four measurements — per pesticide utilization, per insect spray spending, per herbicide use, and per pesticide use — to perceive how ranchers are lessening their pesticide use. [9] The power of pesticide use is estimated by the per insect spray and herbicide consumption, which considers valuing variations among regions, and the per pesticide use, which looks at yearly pesticide use to rural region.

Table 1: Descriptive statistics and variable definitions

Variable Name	Mean	Standard Deviation
Explained Variables		
Pesticide Expenditure	291.438	783.586
Insecticide Expenditure	247.231	619.115
Herbicide Expenditure	55.318	244.846
Pesticide Use per Unit of Cropland Area	8.331	38.129
Pesticide Use	1.742	1.594
Control Variables		
Age	57.197	29.151
Gender	1.626	1.611
Educational Level	1.298	1.411
Health Status	3.834	2.114
Agricultural Labor Force	2.988	1.878
Household Income	6.415	7.613
Cultivated Land Scale	12.676	33.262
Number of Land Plots	7.853	26.514
Agricultural Subsidies	1.876	1.534
Self-owned Agricultural Machinery	1.631	1.611
Hired Laborers	1.259	1.466
Purchasing Agricultural Supplies	1.288	1.412
Distance from Village	7.118	7.452
Per Capita Income of Village	1.811	1.684

Economic Crops Ratio in the Village	44.996	42.461
Instrumental Variables		
Village Agricultural Mechanization Services	1.717	1.433

Explicitly taking a gander at whether ranchers lease horticultural motorization, this study examinations the reception of AMS by ranchers. Individual, family, and local area attributes act as control factors. Contemplations incorporate age, orientation, level of schooling, wellbeing, and the size of the land. Factors, for example, the town's area, financial improvement level, and harvest extent are viewed as highlights. Since it shows the pervasiveness of automation in the town without anily affecting ranchers' pesticide utilization, the AMS rate fills in as an instrumental variable to deal with endogeneity concerns. [10] Assessing how ranchers' pesticide-decrease conduct changes in light of automation use is conceivable utilizing this technique.

Methodology:

As a result of both noticeable and unnoticed factors, endogeneity predisposition in model results can be credited to ranchers' self-determination of AMS. The review surmises that ranchers are risk-unwilling and gauge the likely benefits of utilizing AMS (D_c^*) and the expected benefits of non-choosing AMS (D_n^*) To realize how choosing AMS analyzes to not picking AMS, the extended advantages of both are $D_i^*(i.e., D_i^* = D_i^* = \ddot{D}_c^* - D_n^*)\ if D_i^* > 0,$ the farmer chooses AMS. [11] The determination condition might be utilized to address the emotional part of (D_i^*) in a dormant variable model, which impacts factors like ranchers' acknowledgment of AMS.

$$D_i^* = aZ_i + \mu_i,\ \ D_i = \begin{cases} 1 & if\ D_i^* > 0 \\ 0 & otherwise \end{cases} \qquad (1.1)$$

A two-esteemed metric an obscure coefficient and a routinely circulated mistake influence Di, a vector of boundaries influencing AMS decision, which is impacted by family qualities and pesticide inputs.

$$\begin{cases} Y_{ci} = \beta_{ci}X_i + \varepsilon_{ci} & if\ \ D_i = 1 \\ Y_{ni} = \beta_{ni}X_i + \varepsilon_{ni} & if\ \ D_i = 0 \end{cases} \qquad (1.2)$$

In conditions (1.1) and (1.2), there are three factors with a trivariate ordinary dissemination: Yci and Yni, Xi, which are logical factors, and the obscure coefficients βci and βni, as well as the blunder terms μi, εci, and εni.

$$\Omega = \begin{bmatrix} \sigma_u^2 & \sigma_{cu} & \sigma_{nn} \\ \sigma_{cu} & \sigma_c^2 & . \\ \sigma_{nu} & . & \sigma_n^2 \end{bmatrix} \qquad (1.3)$$

The section makes sense of the non-zero expected upsides of λ_i, εci, and εni as well as the changes of blunder factors in choice and ceaseless conditions, as well as the covariances:

$$E(\varepsilon_{ci}|D_i = 1)\sigma_{cu}\frac{\varphi(aZ_i)}{\Phi(aZ_i)} = \sigma_{cu}\lambda_{ci} \quad (1.4)$$

$$E(\varepsilon_{ni}|D_i = 0)\sigma_{nu}\frac{\varphi(aZ_i)}{1-\Phi(aZ_i)} = \sigma_{nu}\lambda_{ni} \quad (1.5)$$

Utilizing the coefficients of the ESR model, one might decide the average treatment impact on the treated (ATT), considering both noticeable and unseen counterfactual results while choosing AMS:

$$E(Y_{ci}|D_i = 1) = X_i\beta_{ci} + \sigma_{cu}\lambda_{ci} \quad (1.6)$$

$$E(Y_{ni}|D_i = 1) = X_i\beta_{cn} + \sigma_{nu}\lambda_{ci} \quad (1.7)$$

The expected aftereffects of Equations (1.6) and (1.7) might be utilized to decide the fair average treatment impact on the treated (ATT).

$$\begin{aligned} ATT &= E(Y_{ci}|D_i = 1) - E(Y_{ni}|D_i = 1) \\ &= (\beta_{ni} - \beta_{ci})X_i + (\sigma_{cu} - \sigma_{nu})\lambda_{ci} \end{aligned} \quad (1.8)$$

Coming up next is one method for communicating the average treatment impact on the untreated (ATU):

$$\begin{aligned} ATU &= E(Y_{ci}|D_i = 0) - E(Y_{ni}|D_i = 0) \\ &= X_i(\beta_{ci} - \beta_{ni}) + \lambda_{ni}(\sigma_{cu} - \sigma_{nu}) \end{aligned} \quad (1.9)$$

Results and Discussions:

Descriptive Statistics:

The overview uncovered that families' spending on pesticides differed enormously, with an average of yuan/mu. The sum spent on bug sprays is more than that on herbicides and pesticides per cubic meter. Pesticide spending is most noteworthy in the territories of Zhejiang and Guangdong and least in fields and enormous grain-creating regions. [12] Horticultural apparatus is all the more commonly involved by maize ranchers in northern and northeastern India.

The examination dives into the reception of blended utilize rustic automation frameworks (AMS) and rural strategies in India, observing that cultivation equipment is claimed by 52% of families and that 63% take on AMS. Additionally, the review shows that pesticide use differs among sizes and regions, which shows that farmers have shifted approaches.

Table 2: Average AMS and pesticide usage across various farming sizes and terrains

Variables	Nationwide	Terrain		Cultivated Land Scale (mu)	
		Plain	Mountains and Hills	< 30 mu	≥30 mu
Pesticide Expenditure (yuan/mu)	291.438	251.269	311.892	211.174	74.524
Insecticide Expenditure (yuan/mu)	247.231	214.284	271.389	2540917	53.858
Herbicide Expenditure (yuan/mu)	55.318	47.196	51.614	57.278	31.771
Pesticide Use per mu (kg/mu)	8.331	6.763	9.496	8.721	3.657
Agricultural Mechanization Services	1.742	1.874	1.646	1.747	1.677
Self-owned Agricultural Machinery	1.631	1.669	1.514	1.511	1.997
Samples	12,853	6,163	7,911	2,2135	129

Estimation Results of the ESR Model:

Determinants of Choosing AMS:

To appraise the selection and result equations, the review utilized the full information maximum likelihood (FIML) procedure. Rural gear (AMS) adoption is strongly affected by ranchers' personal, home, and production attributes, as per the outcomes. Higher paces of adoption are connected to more prominent degrees of family pay and secondary school education. Agrarian sponsorships lower administration costs, while the pay impact of non-ranch work supports rural result. Economics, the executives, society, strategy, and education are factors that impact the viability of AMS.

Ranchers are bound to utilize Farming Administration Frameworks (AMS) on web-based business stages since they are bound to embrace new innovation and have more straightforward admittance to information. [13] On the other hand, AMS implementation is prevented by the need to enlist workers and own farming hardware. Since enormous ranches may give specific AMS to other homesteads, lessening the earn back the original investment period, they are more disposed to put resources into self-claimed apparatus.

Factors Influencing Pesticide Inputs:

The examination takes a gander at how the selection and result equations for horticultural sources of info (AMS) and pesticide inputs are mutually free. It is important to appraise both the selection and result equations simultaneously, as the discoveries demonstrate. Additionally, the review shows that AMS pesticide inputs are adversely affected by age, developed field region, recruited work, agrarian appropriations, and internet business stages. Pesticide inputs are decidedly impacted by attributes like the quantity of cultivated plots, responsibility for hardware, per capita pay, and the proportion of money crops.

The Impact of AMS on Pesticide Inputs:

As indicated by the ESR model, ranchers that utilization Agrarian Frameworks (AMS) may cut their pesticide use by 67.19 percent, while the people who don't can cut their contributions by 25.18 percent. Spending on pesticides might be cut by 59% when ranchers use machines. Despite the fact that pesticide application force may be adversely impacted by specific agriculture services. Diminishing pesticide openness and its impacts on human wellbeing needs help for innovation leap forwards that advance low-input rural strategies.

Table 3: The effect of AMS on the cost of pesticides

Variables	Estimation	Mean Pesticide Expenditure (yuan/mu)		Treatment Effects	t-value	Reduction Rate (%)
		Adoption of AMS	Non-Adoption of AMS			
Pesticide Expenditure	ATT	242.965 (2.372)	434.127 (2.913)	-292.273***	-93.466	67.19
	ATU	311.457 (3.267)	357.328 (3.113)	-47.981***	-1.119	25.18

Robustness Test:

Consistent discoveries were acquired by subbing average pesticide use per mu for average pesticide use per mu in the review utilizing the substitution variable methodology. The strong impact of AMS on pesticide reduction was demonstrated by the considerable adverse consequences that both ATT and ATU showed at the 1% level.

Table 4: AMS's effects on pesticide usage

Variables	Estimation	Mean Pesticide use (kg/mu)		Treatment Effects	t-value	Reduction Rate (%)
		Adoption of AMS	Non-Adoption of AMS			
Pesticide use	ATT	6.717 (1.162)	23.121 (1.183)	-8.345***	-93.381	66.16
	ATU	9.519 (1.197)	1.966 (1.221)	-2.558***	-1.936	25.79

Decomposition effects of AMS on Pesticide Input:

Type of Pesticide Input:

As indicated by the exploration, ranchers that utilization AMS might set aside to 65.75 percent on herbicides and 68.16 percent on insect sprays. On the

other hand, a diminishing of 27.64% and 9.64% happens for the individuals who don't take on. Despite the fact that there might be wellbeing dangers, the pesticide reduction impact is higher for insect sprays when ranchers use AMS.

Type of Terrain:

In plain, sloping, and rocky regions, the review takes a gander at how ranchers utilizing Rural Administration Frameworks (AMS) influence their utilization of pesticides. As per the outcomes, AMS can bring down how much pesticide utilized by up to 85.76% in plain regions and 55.36% in bumpy and rocky regions. Additionally, the review found that ranchers in the mountains significantly diminished their contributions of plastic film, manure, and pesticides, recommending a stronger reduction impact in plain regions.

Table 5: The effect of AMS on the cost of pesticides in various terrain situations

Variables	Estimation	Mean Pesticide Expenditure (yuan/mu)		Treatment Effects	t-value	Reduction Rate (%)
		Adoption of AMS	Non-Adoption of AMS			
Plain area	ATT	232.615 (3.179)	581.768 (3.837)	-469.175***	-1.112	85.76
	ATU	281.211 (6.138)	211.411 (6.716)	-31.311***	-4.957	25.77
Mountainous and hilly areas	ATT	273.171 (2.821)	313.439 (4.125)	-231.4789***	-48.442	55.36
	ATU	332.448 (3.542)	374.724 (4.111)	-53.386***	-1.159	27.15

Type of Cropland Scale:

Scientists took a gander at both huge scope and limited scope homesteads to perceive how much insect poison was required in the wake of executing Rural Termite The board (AMS). A treatment impact of - 53.575 yuan/mu is felt by huge scope ranchers, contrasted with - 244.233 yuan/mu by limited scope ranchers. Pesticide spending might be cut by 46.1 percent and 33.97 percent, separately, by the individuals who decide not to utilize AMS. AMS is an incredible device for enormous scope ranchers to decrease the adverse consequences of pesticides on people and the environment.

Table 6: How AMS affects pesticide spending for farmers working various acreages of land

Variables	Estimation	Mean Pesticide Expenditure (yuan/mu)		Treatment Effects	t-value	Reduction Rate (%)
		Adoption of AMS	Non-Adoption of AMS			
Small scale farmers	ATT	259.371 (2.682)	392.412 (3.621)	-244.233***	-55.178	58.42
	ATU	362.298 (3.535)	374.516 (4.999)	-1.329***	-3.123	4.61
Large scale farmers	ATT	66.821 (2.376)	19.294 (2.979)	-53.575***	-29.466	54.36
	ATU	67.812 (3.311)	84.614 (3.784)	-27.913***	-5.964	33.97

Conclusions:

Specialists tracked down that ranchers that carried out Farming Administration Frameworks (AMS) cut their pesticide spending by 67.19 percent. The rate that doesn't embrace could drop by 25.18 percent. When contrasted with herbicide cost, AMS has a more noteworthy impact in lessening insect spray use. [14] Plain regions have a bigger reduction than uneven and rocky ones. Albeit more limited size ranchers decrease their pesticide admission more than enormous scope cultivates, the latter utilize less pesticide generally speaking. Agrarian appropriations, family pay, education level, responsibility for, recruiting workers, and internet business deals are a portion of the qualities that impact ranchers' adoption of AMS, as indicated by the review. The accompanying arrangements ought to be instituted: monetary endowments, extended supply, specialized preparing, and information distribution. [15] Furthermore, legislatures should advance and improve the accessibility of AMS in uneven and rocky regions.

References:

1. Simpson, S. (2001). Shrinking the dead zone: political uncertainty could stall a plan to rein in deadly waters in the Gulf of Mexico. Scientific American, 285(1), 18–20.
2. Pender, J. L., & Alemu, D. (2007). Determinants of smallholder commercialization of food crops: Theory and evidence from Ethiopia
3. FAO & UNEP. (2020). The state of food waste and loss prevention 2020.
4. Muhadith, J. K., Hamid, H., Rather, A., & Dar, Z. A. (2020). Integrated pest management: A sustainable approach for the management of insect pests in agricultural crops. Journal of Applied Entomology, 144(1-2), 1-13.
5. Tilman, D., Clark, M., Williams, P., & Clark, S. (2020). Food systems and their environmental

impacts. Environmental Science & Technology, 54(8), 4885-4935.
6. Pretty, J., Bharucha, Z. P., & Dicks, L. V. (2018). Public health impacts of food production and agricultural ecosystems. Annual Review of Public Health, 39, 87-104.
7. Barbosa, P., Dinis, A., & Morais, M. A. (2019). A review of nano biopesticides and their potential applications for plant disease and pest control. Nanomaterials, 9(5), 601.
8. U.N. Food and Agriculture Organization. (2020). FAOSTAT Database.
9. Simpson, S. (2001). Shrinking the dead zone: political uncertainty could stall a plan to rein in deadly waters in the Gulf of Mexico. Scientific American, 285(1), 18–20.
10. Sirieix, L., Grolleau, G., & Schaer, B. (2007). Consumers and food miles. AIEA2 and Sober.
11. U.N. Food and Agriculture Organization. (2001). FAOSTAT Database.
12. Union of Concerned Scientists. (2001, January 22). Industrial Agriculture: Features and Policy.
13. Union of Concerned Scientists. (2001, January 22). Industrial Agriculture: Features and Policy.
14. USDA. (2000). Agricultural Statistics 2000. Washington DC: U.S. Department of Agriculture, National Agricultural Statistics Service.
15. USDA. (2000). Agricultural Statistics 2000. Washington DC: U.S. Department of Agriculture, National Agricultural Statistics Service.