A case of Negative Externality: Use of pesticide and its impact on health among farmers in Salumbhu village, Nepal

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October 11, 2018

Background and motivation

• In the process of mass level Agricultural production, there is a necessity of using pesticides to increase the net yield for the farmers.

• The widespread and uncontrolled use of harmful pesticide also creates negative externalities such as environmental degradation, adverse health implications (Huang et al, 2003; Sunding and Zivin, 2000; Hurley et al, 2000; Kim et al, 2016).

• A World Bank report estimates a worldwide death of 3,55,000 people every year due to pesticide poisoning (World Bank 2008).

• This issue has attracted a wider debate in developing countries because of its excessive application (Wesseling et al, 1997; Donald J. Ecobichon, 2001; Michael Eddelston, 2002; Kesavachandran et al, 2009, Jeyaratnam and Chia, 1994; Gunnell and Eddleson, 2003).

Research Question

- This study explores a primary village level data of farmers in the Salumbhu, Nepal to investigate the effect of pesticide use on different health symptoms experienced by the farmers?

Literature Review

• Different dimension such as market of pesticide (Popp et al, 2012), inefficiencies in the market of pesticide (Skevas et al, 2012), laws (Jin et al 2010), and externality of using pesticide.

• In their pioneering study on pesticide use in the Phillipines, Pingali et al (1994) identify a set of health problems associated with pesticide use such as watering of eyes, asthma, cold cough, and other abnormal lung functioning.

• Neurological headache (27 percent) is mostly experienced (Dasgupta et al, 2006) as well as on tobacco farmers in Pakistan (Khan et al, 2009).

• Experimental tests reveal the health problems associated with the pesticide use such as pesticide poisoning through Plasma cholinesterase (Khan et al, 2009), testing blood of farmers (Dasgupta et al, 2006), and neurobehavioral functioning (Zhang et al, 2016).

- Farmers face an increasing cost-of-illness from pesticide-induced symptoms (Maumbe and Swinton, 2003).

- Khan and Damalas (2015) in Pakistan found 77 percent farmers showed the varying level of WTP some fee up to 20 percent to avoid the pesticide health risks; vegetable farmers in Nicaragua (Garming and Waibel, 2008).

- Not only avoiding health hazard, but farmers also have the WTP to reduce the environmental damage (Gallardo and Wang, 2013).

- In the context of Nepal, not many studies have been done on pesticide-induced health hazard on farmers. Atreya et al (2012) estimated the WTP to reduce health and environmental costs among farmers closer to the capital, Kathmandu.

Data

• The data is collected from a primary survey entitled "*Need assessment survey on agricultural and health in Salumbhu, Majhifedha VDC, Kavre, Nepal*".

• Data on 252 individuals is collected over various sections of the survey: information on land use pattern, types of crop production, pesticide usage, information on the users of pesticide, the duration of use, preventive mechanism, health symptoms, and farmers' perceived knowledge.

• From the overall sample of 252 respondents, our study mainly focuses on 159 farmers whose main occupation is agriculture. .

Measures

•Our primary dependent variable of interest is health symptoms experienced by farmers and they are binary.

• An individual probit regression is used to select a total of six symptoms and they are grouped in two categories. From each category, a health index is constructed.

• The first index which is "*Health Index 1*" includes three symptoms such as a headache, chest pain, and dizziness; it is the summation of those have said 'yes' to any or to all the health-related questions.

• *Health Index 2* is the second index created from three symptoms which are skin rashes, burning sensation of the skin, and watering of eyes.

• Both the indices appear range from 0 to three where three indicates the farmer has experienced all the health problems and 0 means not experiencing any of the problems.

Table 1: Definition table of variables

Variables	Definition
Dependent variables	
Health Index 1	0= Did not experience, 1 = Experienced
Headache, Watering eyes, Dizziness,	
Health Index 2	
Skin rash, Itching skin, Chest Pain	0= Did not experience, 1 = Experienced
Independent variables	
Using Pesticide	0= Not applicator, 1 = applicator
Other control variables	
Traditional Stove	0 = Everything else, 1 = Using Traditional Stove
Smoke Daily	0 = Does not smoke every day, 1 = Smokes everyday
Male	0 =Female, 1 = Male
Age	Continuous
Religion	1=Hindu, 2=Buddhist, 3=Christian, 4 = Others
Caste	1 =Brahmin, 2=Chettri, 3=Newar, 4 = Tamang, 5=Others
Observations	159

Empirical strategy

$$Y_i^* = \beta_0 + X_i\beta + \gamma P_i + \epsilon_i \quad (1)$$

Y=Health indices, P = Using Pesticide and X= Vector of other factors,

Primary technique

1. Ordered logit.

Robustness Check

2. Poisson regression.
3. Negative Binomial Model.

Descriptive Statistics

Table 2: Summary statistics table of health symptoms

	Mean	SD	Min	Max
Headache	.49	.50	0	1
Watering eyes	.41	.49	0	1
Skin rash	.08	.28	0	1
Chest pain	.30	.46	0	1
Dizziness	.37	.48	0	1
Itching skin	.19	.39	0	1
Observations	159			

Table 3: Summary statistics table of control variables

	Mean	SD	Min	Max
Using Pesticide	.09	.29	0	1
Traditional Stove	.17	.38	0	1
Smoke Daily	.42	.49	0	1
Male	.76	.42	0	1
Age	54.15	13.82	7	91
Religion	1.51	.509	1	3
Caste	3.01	1.31	1	5
Observations	159			

Source: *Need assessment survey on agricultural and health in Salumbhu, Majhifedha VDC, Kavre, Nepal*

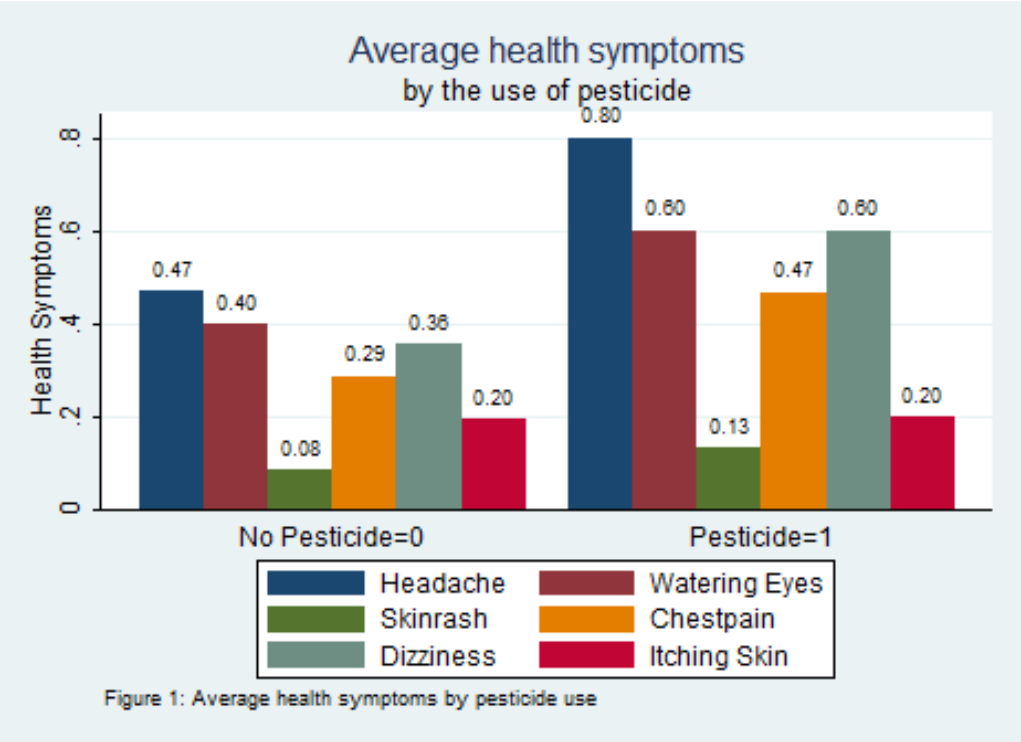


Figure 1: Average health symptoms by pesticide use

Source: *Need assessment survey on agricultural and health in Salumbhu, Majhifedha VDC, Kavre, Nepal*

Regression Results

1. Ordered logit estimates

Table 3: Ordered logit estimation of Health indices

	Health Index 1	Health Index 2	Health Index 3
Using Pesticide	2.108***	1.284***	1.651***
	(0.627)	(0.210)	(0.297)
Traditional Stove	0.195	-0.107	0.145
	(0.402)	(0.353)	(0.387)
Smoke Daily	0.138	0.104	0.101
	(0.407)	(0.532)	(0.461)
*Male*PestUse*	-1.690***	-1.748***	-1.619***
	(0.643)	(0.365)	(0.459)
Current Age	0.0227	0.0142	0.0226
	(0.0165)	(0.0143)	(0.0153)
Buddhist	-0.886	-1.016	-0.935
	(0.589)	(0.646)	(0.698)
Chhetri	0.818***	0.593	0.686*
	(0.190)	(0.584)	(0.382)
Newar	1.222***	0.549	1.120**
	(0.342)	(0.575)	(0.539)
Tamang	1.183	1.567**	1.267
	(0.889)	(0.788)	(0.921)
Others	-1.164	-15.71***	-1.623**
	(0.758)	(0.968)	(0.700)
Observations	119	119	119
Log-Likelihood	-152.34	-128.15	-205.70
AIC	320.76	274.31	427.41
BIC	343.00	299.32	449.64
Pseudo R-Squared	.049	.053	.035

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

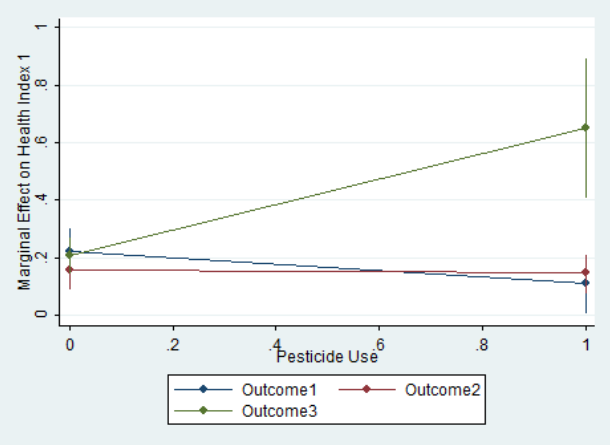
2. Odd Ratios

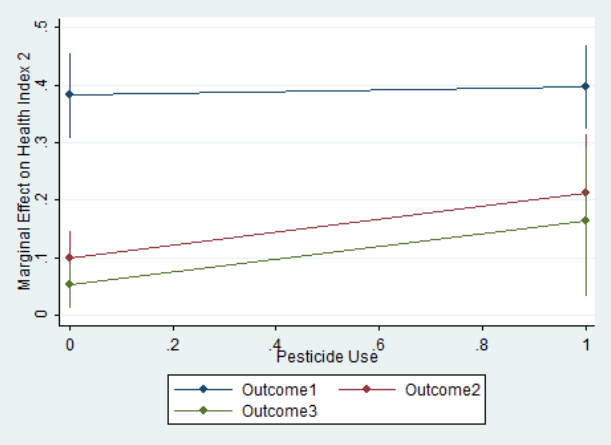
Table 4: Odd ratios of the ordered logit estimation of the Health indices

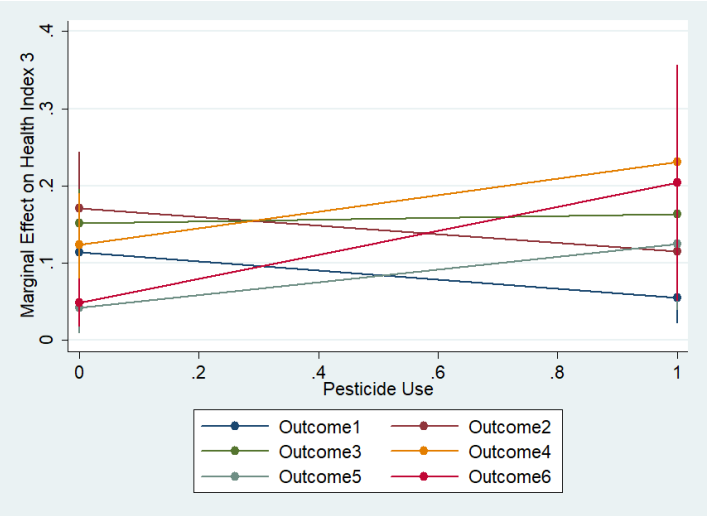
	(1) index1	(1) index2	(1) index3
Using Pesticide	8.234***	3.612***	5.212***
	(3.36)	(6.12)	(5.55)
Traditional Stove	1.215	0.898	1.156
	(0.49)	(-0.30)	(0.38)
Smoke Daily	1.148	1.110	1.106
	(0.34)	(0.20)	(0.22)
*Male*PestUse*	0.184**	0.174***	0.198***
	(-2.63)	(-4.79)	(-3.53)
Current Age	1.023	1.014	1.023
	(1.38)	(0.99)	(1.48)
Buddhist	0.412	0.362	0.392
	(-1.50)	(-1.57)	(-1.34)
Chhetri	2.265***	1.809	1.987
	(4.31)	(1.02)	(1.80)
Newar	3.393***	1.732	3.066*
	(3.57)	(0.96)	(2.08)
Tamang	3.264	4.794*	3.550
	(1.33)	(1.99)	(1.38)
Others	0.312	0.000000151***	0.197*
	(-1.54)	(-16.23)	(-2.32)
Observations	119	119	119

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Margins plot







Robustness

Table 5: Poisson and a Negative Binomial estimate of the health symptoms

VARIABLES	(1) Index 1	(2) Index 2	(3) Index 3	(4) Index 1	(5) Index 2	(6) Index 3
Using Pesticide	0.716***	0.524***	0.646***	0.716***	0.523***	0.697***
	(0.111)	(0.0699)	(0.0885)	(0.111)	(0.0701)	(0.0968)
Traditional Stove	0.104	-0.0923	0.0312	0.104	-0.0923	0.0571
	(0.174)	(0.162)	(0.154)	(0.174)	(0.162)	(0.156)
Smoke Daily	0.0726	0.0998	0.0821	0.0726	0.0998	0.0979
	(0.169)	(0.263)	(0.189)	(0.169)	(0.263)	(0.199)
*Male*PestUse*	-0.542***	-1.075***	-0.692***	-0.542***	-1.075***	-0.715***
	(0.153)	(0.332)	(0.149)	(0.153)	(0.332)	(0.122)
Current Age	0.0114	0.00758	0.0100	0.0114	0.00758	0.0120*
	(0.00776)	(0.00646)	(0.00629)	(0.00776)	(0.00646)	(0.00720)
Buddhist	-0.408	-0.438	-0.419	-0.408	-0.438	-0.497
	(0.261)	(0.371)	(0.296)	(0.261)	(0.371)	(0.422)
Chhetri	0.291**	0.263	0.280	0.291**	0.263	0.252
	(0.114)	(0.298)	(0.180)	(0.114)	(0.298)	(0.154)
Newar	0.560***	0.428	0.512***	0.560***	0.428	0.513***
	(0.117)	(0.356)	(0.195)	(0.117)	(0.356)	(0.194)
Tamang	0.505	0.604	0.542	0.505	0.604	0.601
	(0.405)	(0.423)	(0.391)	(0.405)	(0.423)	(0.528)
Others	-0.787*	-13.93***	-1.281***	-0.787*	-14.50***	-1.293***
	(0.435)	(0.865)	(0.423)	(0.435)	(0.865)	(0.426)
Constant	-0.435	-0.717**	0.121	-0.435	-0.717**	0.0352
	(0.383)	(0.340)	(0.346)	(0.383)	(0.340)	(0.344)
Observations	119	119	119	119	119	119
Log-Likrlihood	-173.99	-131.42	-229.39	-173.99	-131.42	-222.46
AIC	363.99	280.84	474.79	363.99	280.84	460.93
BIC	386.22	305.85	479.03	386.22	305.85	483.17

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Conclusions

- The farmers who are the applicator of the pesticide face health symptoms significantly.
- Farmers have the higher chance to be affected by the serious health issues that the irritants.
- Women farmers are more likely to be protected against the health risks.
- Results are robust over different specifications.
- Marginal effcts are significant. Stronger for the serious health related issues.

Policy Recommendation

- Due to the inapplicability of property-rights suggested by Ronal Coase (Coase, 1960) for attaining efficiency in this context, the extent of externality can be minimized through non-market based solutions.

- Investment in the awareness program by the administrative authority to promote the use of mitigation strategy (masks, gloves etc) is highly important.

- Delivering this result during the awareness program will make farmers more cautious in handling and applying the pesticide in the field.

Limitations

- The sample size is small and only a small portion of the farmers are the applicators of pesticide.
- The study comes with some problem of the omitted variable bias. Variables like the length and amount of pesticide could explain the health symptoms more succintly.

Future Research

- Developing a solid waste management program in Siddharthanagar Municipality, Nepal.
- Efficient use of landfilling, recycling, and composting.
- Increase the awareness for a better environment and health.

Thanks