# Neurological Effect of Farmer Pesticide Use in China: Implications for Agricultural Cleaner and Healthier Production

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## Introduction

- Pesticide use greatly contributes to the growth of agricultural productivity worldwide. However, severe externalities due to excessive use of pesticides have been well documented.
- China has become the largest user of pesticides since the mid-1990s. Chinese farmers overuse pesticides for the purpose of high crop yield.
- In the context of the supply-side structural reform in agriculture, to seek a cleaner and healthier agricultural production pattern mainly characterized by the reduction of pesticide use has been the strategic choice of the Chinese government.
- From the perspective of human health safeguard, it is of much greater importance to evaluate the potential health effect of agricultural uses of different pesticides in an integrative framework.

## Objectives

- To evaluate and compare the neurological effect of agricultural uses of different pesticides on farmers in China utilizing multiple linear, logistic and negative binomial regression analyses
- To discuss the implications for cleaner and healthier agricultural production

## Sampling Procedure

- Random sampling
- Research duration: March 2012 to December 2012
- Locations: Guangdong, Jiangxi and Hebei provinces in China
  - Two counties within each province
  - Two villages within each county
  - 20-25 farmers within each village
- Initially 246 farmers, 218 out of them were effective

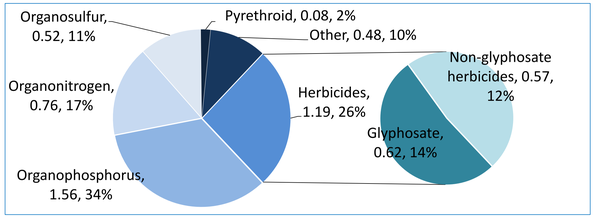
## Data Collection and Modeling

- ***Conventional nerve conduction studies (CNCS)***
  - Time: Mar. 2012 (1st rnd), Aug. and Dec.2012 (2nd rnd)
  - Nerves: median, ulnar, tibial, common peroneal and sural nerves
  - Parameters (22): MCV, SCV, CMAP, SNAP and DML
- ***Agricultural pesticide use***
  - Measured by: actual amount in active ingredients
  - Records of pesticide use
    - Training sessions on how to make proper records
    - Enumerators' checks
  - Pesticide types:
    - Herbicides: glyphosate, and non-glyphosate herbicides
    - Insecticides and fungicides: organophosphorus, organonitrogen, organosulfur, pyrethroid and others
- ***Confounding factors***
  - Age
  - Gender
  - Smoking habit
  - Alcohol consumption
  - Adoption of protective measures
  - Body mass index (BMI)
- ***Modeling***
  - ***NP*** = *f* (***Pesticide***, ***Characteristics***, ***BaselineNP***, ***Regions***)
    - ***NP***: nerve conduction parameters of 2nd ***CNCS***
    - ***BaselineNP***: nerve conduction parameters of 1st ***CNCS***

## Demographic and lifestyle characteristics

| Characteristics | Mean | S.D. | No. | % |
|---|---|---|---|---|
| **Age (year)** | 51.6 | 10.1 | | |
| **Male** | | | 161 | 73.9 |
| **BMI (kg m-2)** | 23.4 | 3.4 | | |
| **Smoking habit** | | | 104 | 47.7 |
| **Alcohol consumption** | | | 94 | 43.1 |
| **Adoption of protective measures** | | | 27 | 12.4 |

## Pesticide Use Structure (kg)




## Estimation Results (OLS)

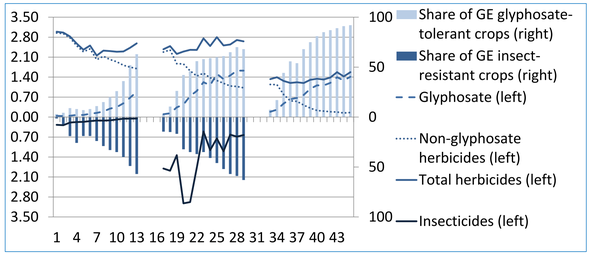
| | MCV | | | | CMAP | | | DML |
|---|---|---|---|---|---|---|---|---|
| | Median | Ulnar | Tibial | Common peroneal | Ulnar (D) | Tibial (P) | Tibial (D) | Common peroneal |
| Glyphosate | 0.26 | 0.12 | -0.29 | -0.25 | 0.10 | -0.03 | -0.23 | 0.00 |
| Other herbicides | -0.06 | -0.12 | -0.11 | -0.02 | -0.00 | 0.00 | 0.07 | 0.00 |
| Organophosphorus | -0.14 | -0.24* | -0.20* | -0.28** | 0.01 | -0.15** | -0.15* | -0.01 |
| Organonitrogen | -0.38* | -0.18 | -0.27 | 0.10 | -0.17* | 0.01 | 0.04 | 0.02 |
| Organosulfur | 0.30 | -0.11 | -0.02 | -0.21 | -0.08 | 0.19 | 0.27 | 0.01 |
| Pyrethroid | 1.17 | 2.77 | 0.40 | 1.47 | 1.13 | -0.11 | 0.00 | 0.49** |
| Other | -0.06 | -0.14 | 0.10 | 0.11 | 0.09 | 0.13 | -0.01 | 0.01 |
| Adjusted $R^2$ | 0.25 | 0.28 | 0.29 | 0.57 | 0.53 | 0.63 | 0.58 | 0.50 |

| | SCV | | SNAP | | |
|---|---|---|---|---|---|
| | Median | Ulnar | Median | Ulnar | Sural |
| Glyphosate | 0.16 | 0.06 | 0.03 | -0.05 | -0.13 |
| Other herbicides | -0.35* | -0.03 | 0.06 | 0.10 | -0.15 |
| Organophosphorus | -0.11 | -0.27** | 0.04 | 0.04 | 0.09 |
| Organonitrogen | -0.43* | -0.09 | -0.23* | 0.04 | 0.03 |
| Organosulfur | 0.16 | -0.10 | -0.02 | -0.20* | -0.42 |
| Pyrethroid | 0.32 | -0.06 | -0.09 | -0.16 | 1.09 |
| Other | 0.31 | -0.27 | 0.02 | -0.02 | -0.71* |
| Adjusted $R^2$ | 0.54 | 0.26 | 0.60 | 0.65 | 0.50 |

## Results (Logistic & Negative Binomial Regression)

| | Conduction velocity | | MCV | | SCV | | Amplitude | |
|---|---|---|---|---|---|---|---|---|
| | ORs | IRRs | ORs | IRRs | ORs | IRRs | ORs | IRRs |
| Glyphosate | 0.68 | 0.86 | 1.39 | 1.12 | 0.63 | 0.74 | 1.20 | 0.96 |
| Other herbicides | 0.86 | 0.96 | 1.48 | 0.91 | 0.85 | 1.01 | 1.19 | 1.12 |
| Organophosphorus | 1.49** | 1.15** | 1.76** | 1.23** | 1.42** | 1.11 | 0.95 | 1.05 |
| Organonitrogen | 2.03** | 1.17* | 1.17 | 0.82 | 2.19** | 1.26* | 1.48* | 1.36* |
| Organosulfur | 0.56 | 1.02 | 1.68 | 1.30 | 0.52 | 1.04 | 0.94 | 0.67 |
| Pyrethroid | 0.05 | 0.59 | 0.02 | 0.09 | 2.45 | 1.81 | 2.89 | 2.83 |
| Other | 1.80* | 1.16 | 1.70 | 1.13 | 1.54* | 1.23 | 0.79 | 0.95 |
| Pseudo $R^2$ | 0.66 | 0.40 | 0.83 | 0.57 | 0.57 | 0.35 | 0.64 | 0.51 |
| Log Likelihood | -105.38 | -144.37 | -77.65 | -92.93 | -83.58 | -90.89 | -66.83 | -89.52 |

## Discussion




## Conclusions

- Overall, agricultural use of herbicides, both glyphosate and non-glyphosate herbicides, was not found to induce the abnormality of peripheral nerve conduction.
- Agricultural uses of organophosphorus and organonitrogen insecticides and fungicides were found to induce severe damages to peripheral nerve conduction.
- From the perspective of farmer health safeguard, a cleaner and healthier agricultural production pattern might be obtained by either substituting low-toxic pesticides for high-toxic ones or reducing the total pesticide use.
- In practice, the introduction of biological pesticides and adoption of GE crops might be sensible choices for the cleaner and healthier agricultural production.

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## References

1. Alavanja, M.C.R., Hoppin, J.A., Kamel, F., 2004. Health effects of chronic pesticide exposure: cancer and neurotoxicity. Annu. Rev. Public Health. 25, 155–197.
2. Cooper, J., Dobson, H., 2007. The benefits of pesticides to mankind and the environment. Crop Prod. 26, 1337-1348.
3. Fernandez-Cornejo, J., Nehring, R., Osteen, C., Wechsler, S., Martin, A., Vialou, A., 2014. Pesticide use in US agriculture: 21 selected crops, 1960-2008. US Department of Agriculture, Economic Research Service, Washington, DC.
4. Hall, J., Crowther, S., 1998. Biotechnology: the ultimate cleaner production technology for agriculture? J. Clean. Prod. 6(3-4), 313-322.