



## CERTIFICATE OF APPRECIATION

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This is to certify that

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As  
SPEAKER

had presented her/his lecture on Community Outreach Program: Stunting Prevention Acceleration, an online International Program

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# **Risk factors of stunting: a case study in Brebes District, Central Java**

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# Introduction



- **Stunting** (short stature, being too short for one's age) → a height that is more than two standard deviations below the WHO Child Growth Standards median ( $H/A < -2 \text{ SD}$ )
- Childhood stunting is one of the most significant impediments to human development
- Globally affecting approximately 162 million children under the age of 5 years (WHO 2014)

# Stunting



- It is a largely **irreversible outcome** of **inadequate nutrition** and **repeated bouts of infection during** the first 1000 days of a child's life
- Stunting has long-term effects on individuals and societies, including: **diminished cognitive and physical development, reduced productive capacity** and **poor health**, and an **increased risk of degenerative diseases** such as **diabetes**

# What causes stunting?

Factors that contribute to stunted growth and development include:

1. **Poor maternal health and nutrition**
2. **Inadequate infant and young child feeding practices, and**
3. **Infection**





# The role of the environment for stunting

- So far, the role of the environment in the incidence of stunting has always been associated with **infection**, so that the priority for environmental health efforts is **environmental sanitation** (availability of clean water, latrines, etc.) → this is not wrong, but it should also be noted that there are **local specific problems** (causes, risk factors) → environmental toxicants

# Can exposure to pesticides cause stunting?

- In addition to poor nutrition and repeated infections, exposure to toxic substances in the environment, such as **pesticides**, should be suspected as a risk factor for stunting
- Exposure to pesticides can interfere with the function of hormones that play an important role in the growth process, such as **IGF-1** (Boada et al 2007) and **thyroid** (Diamanti-Kandarakis et al 2009) → **Endocrine Disrupting Chemicals** (EDCs)



# What is EDCs?

“an exogenous agent that interferes with **synthesis, secretion, transport, metabolism, binding action, or elimination of natural blood-borne hormones** that are present in the body and are responsible for **homeostasis, reproduction, and developmental process**” [U.S. Environmental Protection Agency (EPA)]



# Stunting in Indonesia



- Stunting prevalence in Indonesia: **37.2%** (2013) and **30.8%** (2018)
- **Brebes District** is a shallot farming area with very **high levels of pesticide use** → the stunting prevalence reaches **40.7%** (Risksdas 2013) → the highest in Central Java Province

# Some research results in Brebes district



- Pesticides exposure is an independent risk factor for **hypothyroidism** among women at childbearing age in agricultural area (**adj-OR=3.31**, 95% CI=1.25 to 8.78) (Suhartono et al. 2012)
- Study on elementary school students in 2015 ( $n=66$ ) showed: (Kartini et al. 2016)
  - a) **72.7%** of students are involved in agricultural activities
  - b) **15 (22.7%)** students detected pesticide metabolites in the urine
  - c) The prevalence of stunting was **21.2%**
  - d) **42.4%** of students experience **bone age delays**

- The prevalence of **goiter** and **hypothyroidism** among elementary school children was **53.0%** and **17.4%** respectively → the proportion of goiter in the children whose fathers were farmer and non-farmer was **80.8%** and **43.2%** respectively ( $p=0.002$ ; **Prevalence Ratio=1.9**; 95% CI=1.3-2.6) (Kartini et al. 2018)
- **High level of pesticide exposure** and **low IGF-1 levels** were **independent risk factors** for **stunting** in children (**adj-OR 3.90, 95% CI 1.15 to 13.26**; and **adj-OR 8.35, 95% CI 3.65 to 19.14**) (Kartini et al. 2019)



# Binary logistic regression analysis

Variables	Adj-OR (95% CI)	p
<b>Pesticide exposure</b>		
• 'High'	<b>3.90 (1.15-13.26)</b>	<b>0,029</b>
• 'Moderate'	1.96 (0.64-5.98)	0.235
• 'Low'	1.18 (0,39-3.51)	0.769
<b>'Low' IGF-1 level</b>	<b>8.35 (3.65-19.14)</b>	<b>0,001</b>

# How can exposure to pesticides cause stunted growth?

- The pathway/pathogenesis of growth disturbance (stunting) due to exposure to pesticides possibly through **disruption of thyroid function** (hypothyroidism)
- **'Low' IGF-1 levels** were also shown to be a risk factor for stunting, but in our study there was no proven relationship between pesticide exposure and IGF-1 levels

# The other theories about how pesticide exposure can impair children's growth:

- The wasteful use of energy due to exposure to toxic materials → **Barrel Model**
- The disruption in the absorption of nutrients in the digestive tract → **Environmental Enteric Dysfunction (EED)**

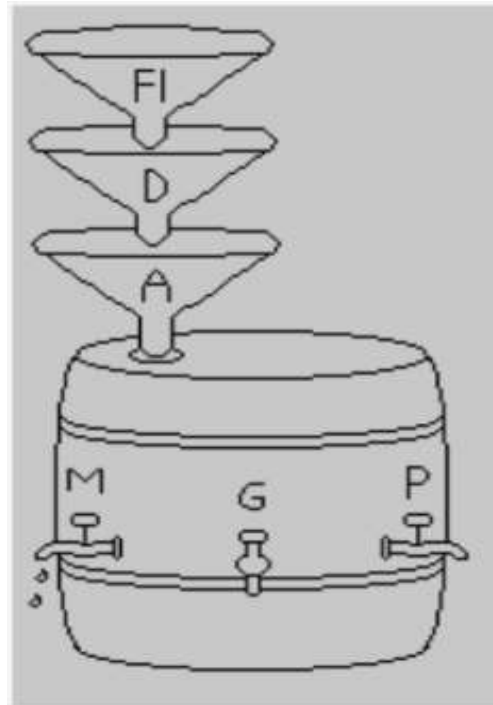




# Barrel Model

- Exposure to toxic substances in the environment, including pesticides, leads to **oxidative stress**, which results in **increased energy expenditure** for activation of the immune system → therefore, less energy will remain to be spent for the maintenance, reproduction, growth and thermoregulation
- The term for this wasteful use of energy is “Barrel Model.”

## Wasteful use of energy due to exposure to toxic materials



**Figure 1:** The '**Barrel model**' of an organism's energy balance. The first spigot always leaks (basal metabolic rate).

**FI** = food intake; **D** = digestion; **A** = absorption; **M** = maintenance; **G** = growth; **P** = production (**Weiner, 1992**).



- Animal studies proved that **chlorpyrifos** exposure (a type of pesticide that is often used in agricultural areas) increases **energy expenditure** (Narvaez et al. 2016)
- Another study proved the relationship between the incidence of stunting with the level of pesticide use, the high incidence of **EED**, and **Zn deficiency** in several countries (Mapesa et al. 2016)

# What is EED?

- a generalized disturbance of small intestinal structure and function with blunting or atrophy of intestinal villi, inflammatory cell infiltrates, and hyperplasia of small intestinal crypts
- EED is found at a high prevalence in stunted children living under unsanitary conditions and is pandemic in developing countries with limited resources

# What is Environmental Enteric Dysfunction?

- Blunting of the villi, reduced epithelial surface area and absorptive capacity, altered gut mucosal barrier integrity and immuno-inflammatory changes.
- No universally accepted case definition, often asymptomatic, diarrhea is not a necessary component.
- Highly prevalent in LMICs, acquired during infancy, can persist into adulthood or can be cured/improved with a change in environment.
- Strongly associated with undernutrition.
- During EED there are abnormal changes in structure and function of the small intestine

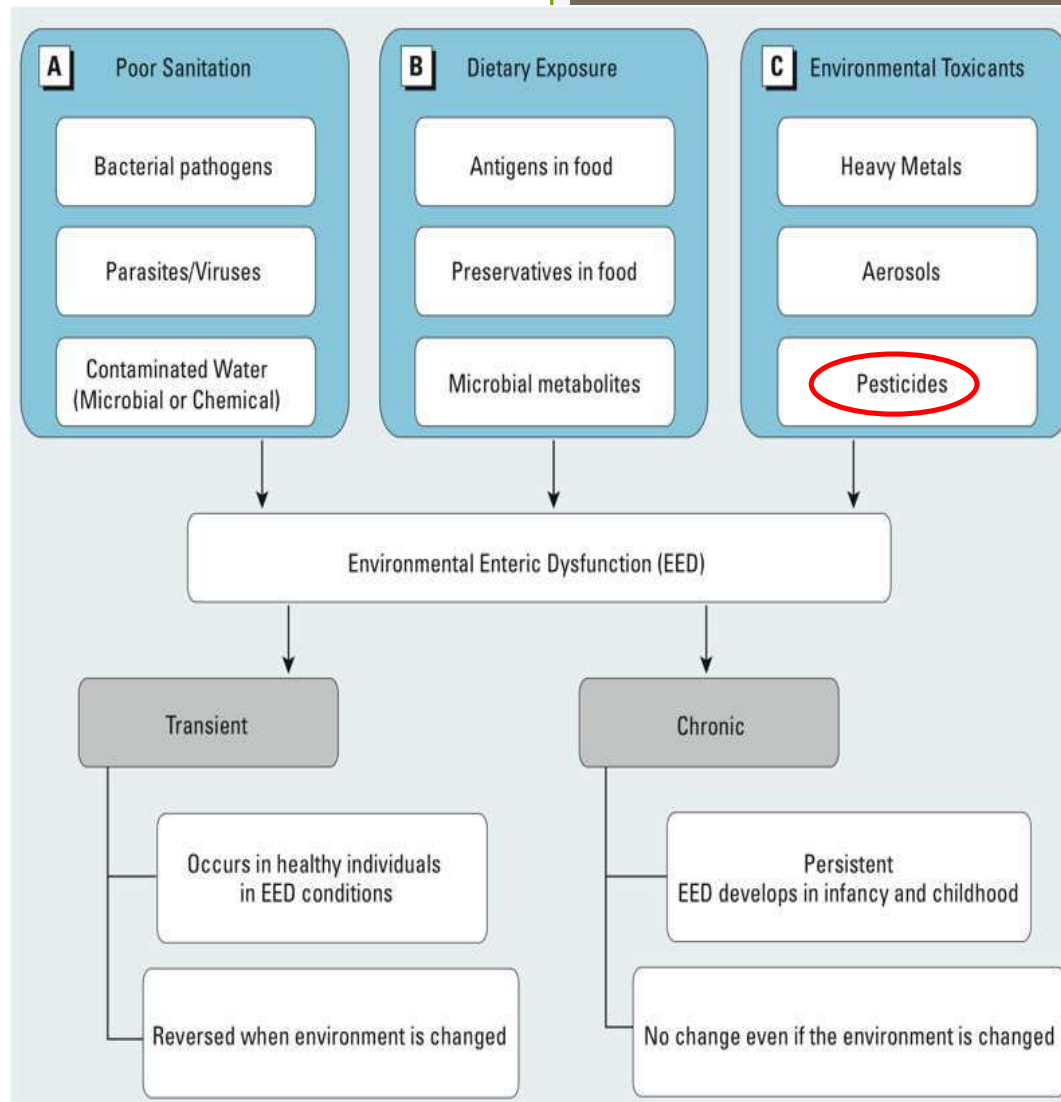
Structural Change	Functional Change
Villous atrophy (flat)	Reduced nutrient absorption
Cells are inflamed and permeable	Microbial translocation

Normal



EED





**Figure 2:** Effect of environmental toxicants on EED events (Mapesa et al 2016)



- EED results in impaired absorption of nutrients in the gastrointestinal tract, thus having a negative impact on the process of growth and development of children



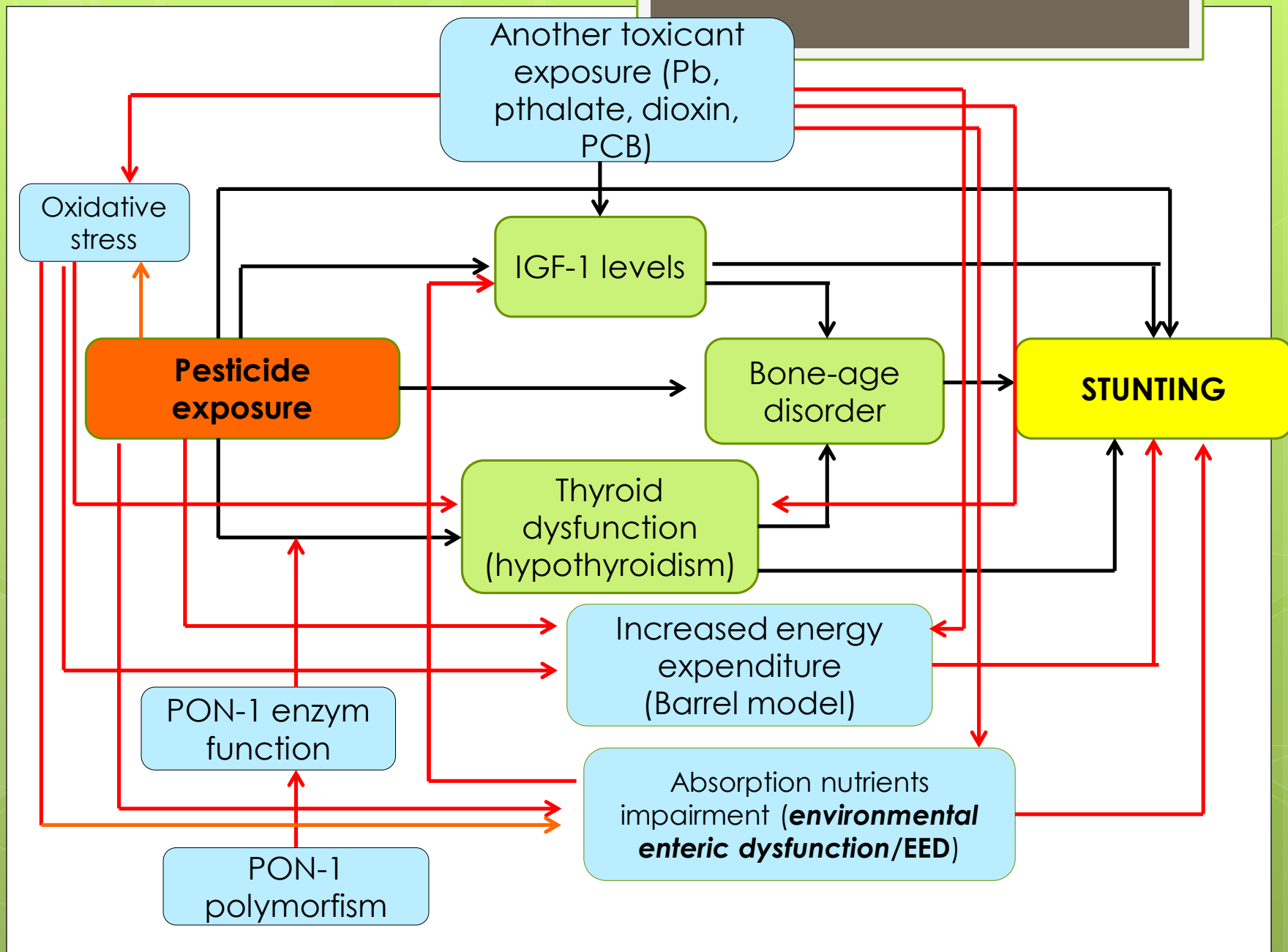


Figure 3: Summary of the pathway of the influence of pesticide exposure on stunting

# CONCLUSION:

- To solve the problem of stunting in Indonesia, in addition to nutrition and infection problems, environmental issues such as toxic exposure need to get our attention

# Documentations:



# Height Measurement



# Bone age examination





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# The use of several types of pesticides for each spraying



# Unsafe pesticide practices





# The risk of direct exposure through the skin



# Children playing in agricultural areas



## Children involvement in agricultural activity





# Children with thyroid gland enlargement (goiter)



# Women engaged in agricultural activities



**Store the harvest in the top of places  
for cooking**





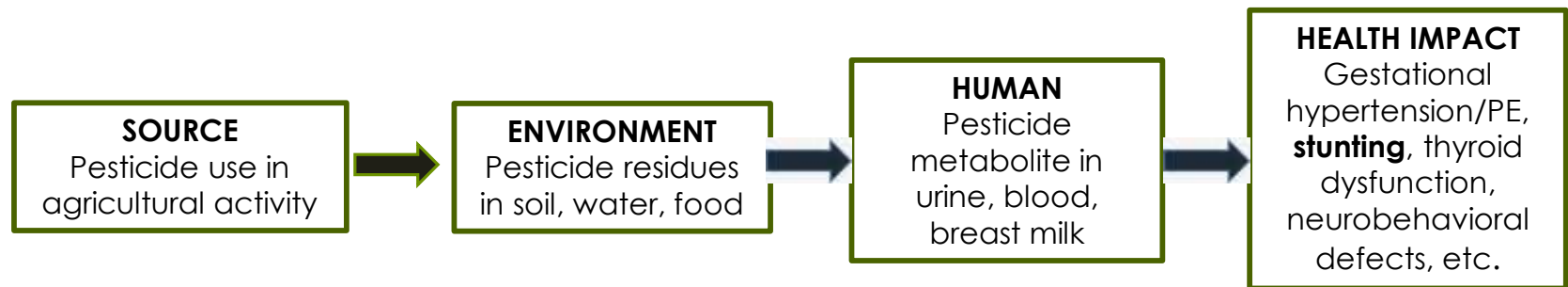
***THANK YOU.....***



***How to overcome/control  
these various health  
problems?***



# The 'node' (point) theory of environment risk assessment:



# Action/effort that can be done in each 'node'

Node A (Source)	Node B (Environment)	Node C (Human)	Node D (Health Impact)
<ol style="list-style-type: none"><li>1. <b>Reduce the pesticide use in agriculture activity</b></li><li>2. <b>Organic farming</b></li><li>3. <b>??</b></li></ol>	<ol style="list-style-type: none"><li>1. Soil remediation</li><li>2. Heavy metals concentration reduction</li><li>3. Etc.</li></ol>	<ol style="list-style-type: none"><li>1. Personal protective equipment (prevention) → behavior changes</li><li>2. Anti oxidant supplementation</li><li>3. Do not involved in agricultural activities during the first 1000 days of life</li></ol>	<ol style="list-style-type: none"><li>1. Clinical treatment (curative)</li></ol>