A risk assessment for the use of wastewater in agriculture in Accra, Ghana

PRINCE ANTWI-AGYEI

UNC conference - 16th October, 2014
Rationale for study

• Increasing use of wastewater for urban agriculture

• Wastewater use linked to health risk but how the risks to consumers change from field, to market to kitchens/household are poorly documented.

• Lack of data needed to quantify health risk arising from wastewater use and post harvest handling and practices.

• Could knowledge and awareness of wastewater irrigation risk influence people to buy and consume produce and also adopt health protective measures?
Research Objectives

1. To determine the risk factors associated with the microbial quality of salad produce at different entry points of the food chain

2. To assess how farmers, market salespersons and consumers’ knowledge and awareness of wastewater use for urban agriculture influenced their buying and consumption of produce grown on wastewater, and also how it affected their adoption of health protective measures
Methods

Cross-sectional study – Dry & Rainy seasons, 8 neighbourhoods

1. **Questionnaires** - 582 participants (farmers, market vendors, street food vendors, chefs at restaurants & hotels)

2. **Observations**, > 450 hr observations, 150 participants (farmers, market vendors, street food vendors)

3. **Focus group discussions** - 6 FGDs (Farmers, market vendors)

4. **Environmental sampling & lab analysis**: > 800 samples (Irrigation water, farm soil, raw produce (cabbage & lettuce), ready-to-eat salad)

   **Microbes**: *E. coli*, norovirus & adenovirus

   **Analysis** – Summary statistics/univariate analysis, multiple linear and logistic regressions
Results
Farm-to-Fork analysis of produce contamination

2. Produce Analysis

- Wastewater, soil & poultry manure contaminants
- Farmer & Field
- Transportation and Unpacking of harvested produce at markets
- Market Hygiene & Produce Handling Practices
- Food hygiene at Kitchens/Street vending sites
- Consumer

Fig. 6. Produce hygiene practices that could lead to changes in the levels of faecal contamination along the food chain.
Produce quality at different domains

Dry season

Log E. coli/g

Rainy season

Combined season

farm lettuce market lettuce market cabbage restaurant salad street salad

farm lettuce market lettuce market cabbage restaurant salad street salad
## Produce risk factors – farm level

<table>
<thead>
<tr>
<th>Exposure</th>
<th>n</th>
<th>Mean (Log E. coli/g)</th>
<th>95% CI</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source of irrigation water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain water</td>
<td>36</td>
<td>3.48</td>
<td>3.13 – 3.83</td>
<td>0.0001</td>
</tr>
<tr>
<td>Dug-out/pond</td>
<td>41</td>
<td>2.40</td>
<td>2.03 – 2.77</td>
<td></td>
</tr>
<tr>
<td>Piped water</td>
<td>3</td>
<td>1.61</td>
<td>-0.63 – 3.84</td>
<td></td>
</tr>
<tr>
<td><strong>Irrigation water contamination</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 3.0 Log E. coli/100ml</td>
<td>24</td>
<td>2.52</td>
<td>1.98 – 3.07</td>
<td>0.002</td>
</tr>
<tr>
<td>&gt; 3.0 Log E. coli/100ml</td>
<td>130</td>
<td>3.46</td>
<td>3.27 – 3.65</td>
<td></td>
</tr>
<tr>
<td><strong>Soil contamination</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 2.3 Log E. coli/g soil</td>
<td>81</td>
<td>3.00</td>
<td>2.72 – 3.29</td>
<td>0.0004</td>
</tr>
<tr>
<td>&gt; 2.3 Log E. coli/g soil</td>
<td>76</td>
<td>3.64</td>
<td>3.41 – 3.85</td>
<td></td>
</tr>
</tbody>
</table>
Risk factors for produce contamination

Soil effect on produce quality

Irrigation water effect on produce quality
Risk Practices
Wastewater irrigation & health risk awareness

- **Market vendors, n=40**: 78% awareness of health risk, 23% awareness of sources of irrigation water.
- **Produce buyers, n=160**: 80% awareness of health risk, 21% awareness of sources of irrigation water.
- **St. Food vendors, n=29**: 75% awareness of health risk, 35% awareness of sources of irrigation water.
- **St. Food consumers, n=160**: 67% awareness of health risk, 43% awareness of health risk, 30% awareness of sources of irrigation water.
Factors influencing buyers and consumers to buy from vendors

(A): What street food consumers consider when buying food from one vendor and not the other

- No reason: 17.1%
- Cost (cheap): 1.4%
- Clean environment: 2.1%
- Convenience: 0.7%
- Friend: 7.1%
- Good customer care: 2.1%
- Other: 4.3%
- Stay close by: 19.3%
- Taste: 45.7%

(B): What market customers consider when buying produce from one vendor and not the other

- Know source vegetables: 3.1%
- No reason: 10.7%
- Clean environment: 1.5%
- Fresh vegetables: 4.6%
- Friend: 19.1%
- Good price: 19.8%
- Good supply: 4.6%
- How vegetables are displayed: 1.5%
- Sell by road side/market entrance: 3.8%
- Site close to where I live: 6.9%
- Wash vegetables: 1.5%
Farmers’ exposure to faecal contamination

<table>
<thead>
<tr>
<th>Exposure type/risk practice</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet-to-soil (working barefooted)</td>
<td>93</td>
</tr>
<tr>
<td>Hand-to-soil</td>
<td>86</td>
</tr>
<tr>
<td>Feet/hand-to-irrigation water</td>
<td>≥ 91</td>
</tr>
<tr>
<td>Hand-to-mouth/face</td>
<td>53</td>
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<tr>
<td>Poultry manure use (both seasons)</td>
<td>80</td>
</tr>
<tr>
<td>Open defaecation</td>
<td>73</td>
</tr>
<tr>
<td>Farmers who irrigated after 2 days before harvest (rainy season)</td>
<td>44</td>
</tr>
</tbody>
</table>
Summary

1. Produce contaminated at all domains with street vended salad the most contaminated
2. Between 60% to 90% of salad produce microbiologically unsatisfactory for consumption ($\geq 100\ E.\ coli/g$)
3. Irrigation water & farm soil main risk factors for farm produce
4. Risk factors for produce contamination at markets not clearly identified. Wash water potential risk factor
5. Uncovered salad, method of salad treatment, source of produce, storage duration could all influence salad quality at kitchens
6. Awareness of wastewater health risk high but consumers do not prioritise health indicators when buying salad produce
7. Farmers’ awareness of wastewater irrigation health risk was also not associated with working unprotected and being exposed to faecal contamination or adopting risk reduction measures
Limitations & next steps

• Produce not followed from farms to markets, street vending sites or restaurants

• Association of wastewater contamination on produce contamination at markets and restaurants still unclear – more field trials needed to establish this.

• Small sample size for restaurants

• Quantify the heath risk using QMRA and compare to health based targets
Conclusion

1. Interventions at farms may result in significant public health impact, but adequate post-harvest measures at markets and food kitchens regarded as more effective in terms of cost, ease of implementation and public health significance.

2. Reliance on health indicators to create awareness or promote the uptake or adoption of health protective measures may not be sufficient to influence positive behaviour change.
Acknowledgement

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• Sanipath project staff

• Study participants (farmers, market vendors, street food vendors, consumers, buyers)

• Enumerators & Environmental sampling team

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THANK YOU