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New insights on the nexus of diet-related environmental impacts, nutritional quality, and consumer behavior along rural – urban population transect: Evidence from Vietnam

Thi Huong TRINH

Alliance Bioversity International and CIAT, Asia Hub, Hanoi, Viet Nam

Thuongmai University, Hanoi, Vietnam



Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
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1. Introduction/Research questions (1/3)

- The modern global food system faces the two-fold challenge: supplying nutrition and addressing the environmental impacts.
- Vietnam's recent rapid economic development has involved trade-offs between human health and nutrition, and environmental sustainability, livelihoods, and social equity
 - The composition of Vietnamese diets included more proteins and fats and less starchy staples, as food expenditure increased
 - The increased dietary-related per-capita GHG emissions associated with the increased ruminant meat (particularly, beef) consumption per capita in Vietnam (Heller et al. 2019a) .

1. Introduction/Research questions (2/3)

- Many studies have analyzed the environmental impacts -- including GHG emissions, water footprint, and land use-- associated with various dietary patterns, but mainly at developed nations.

 Need more evidence at low and middle income countries and at higher revolution.

- Socio-demographic characteristics have been previously associated with food consumption patterns, which contribute to nutritional and environmental outcomes
- Other impacts, such as where households obtain food (food sources).

1. Introduction/Research questions (3/3)

The main objectives of this study:

- Explore variation in quantity and quality in food groups consumed across the rural-urban transect and the respective contribution of these food groups to diet-related GHG emissions and water footprint heterogeneity.
- Explore differences in diet-related GHG emissions and blue water between men and women across the rural-urban transect.
- Examine the associations between food sourcing, perceptions of food choices, nutritional quality and diet-related environmental impacts



Data: Individual level survey to analyze the relationship between diet-related environmental impacts, diet composition, and food choice behaviors in Vietnam across the urban-rural and sociodemographic transect

2. Materials and methods

2.1. Study sample

Data: Partial Food Systems Baseline Assessment at the Vietnam Benchmark Sites

Study area : 3 districts

1.Cau Giay -Urban area

2.Dong Anh – Peri urban area

3.Moc Chau – Rural area

Design: Using a PPS procedure, selected 30 random communes (PSUs).

Adults: male and female

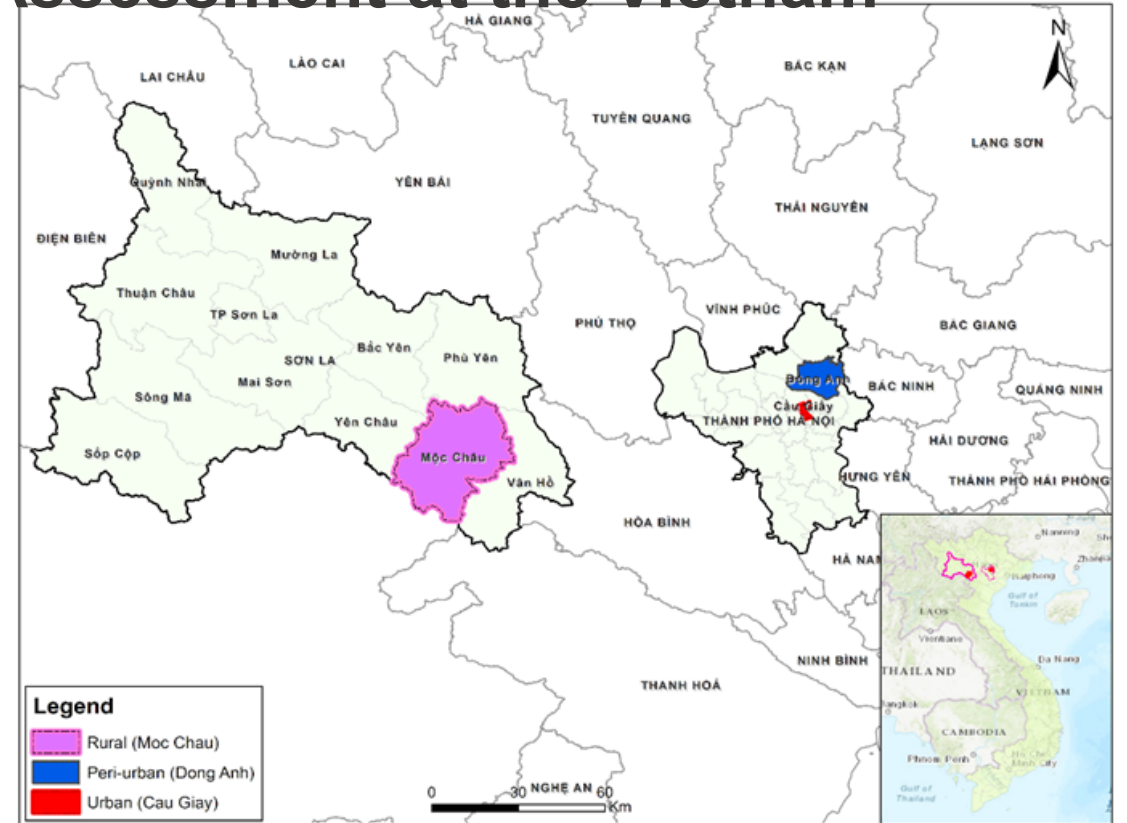


Figure 1: Maps of three districts.

2. Materials and methods

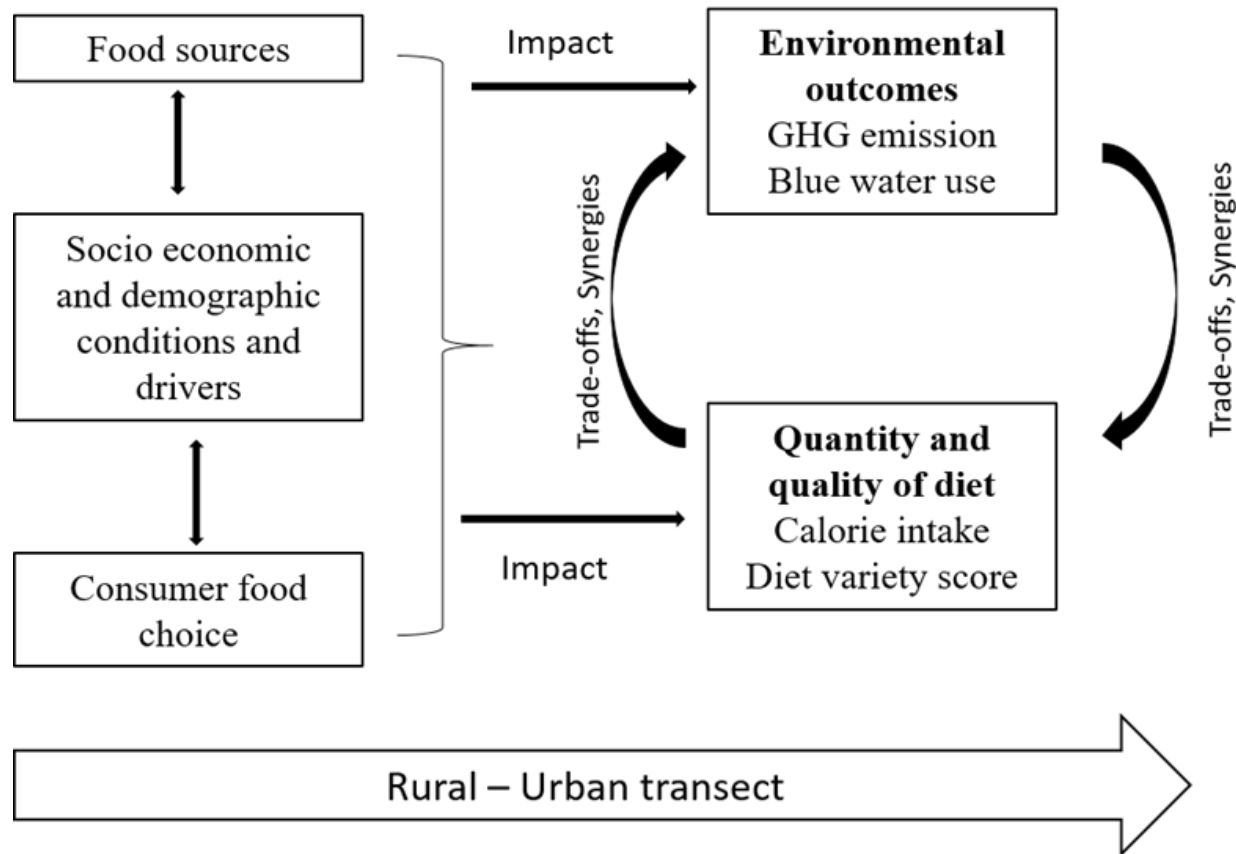
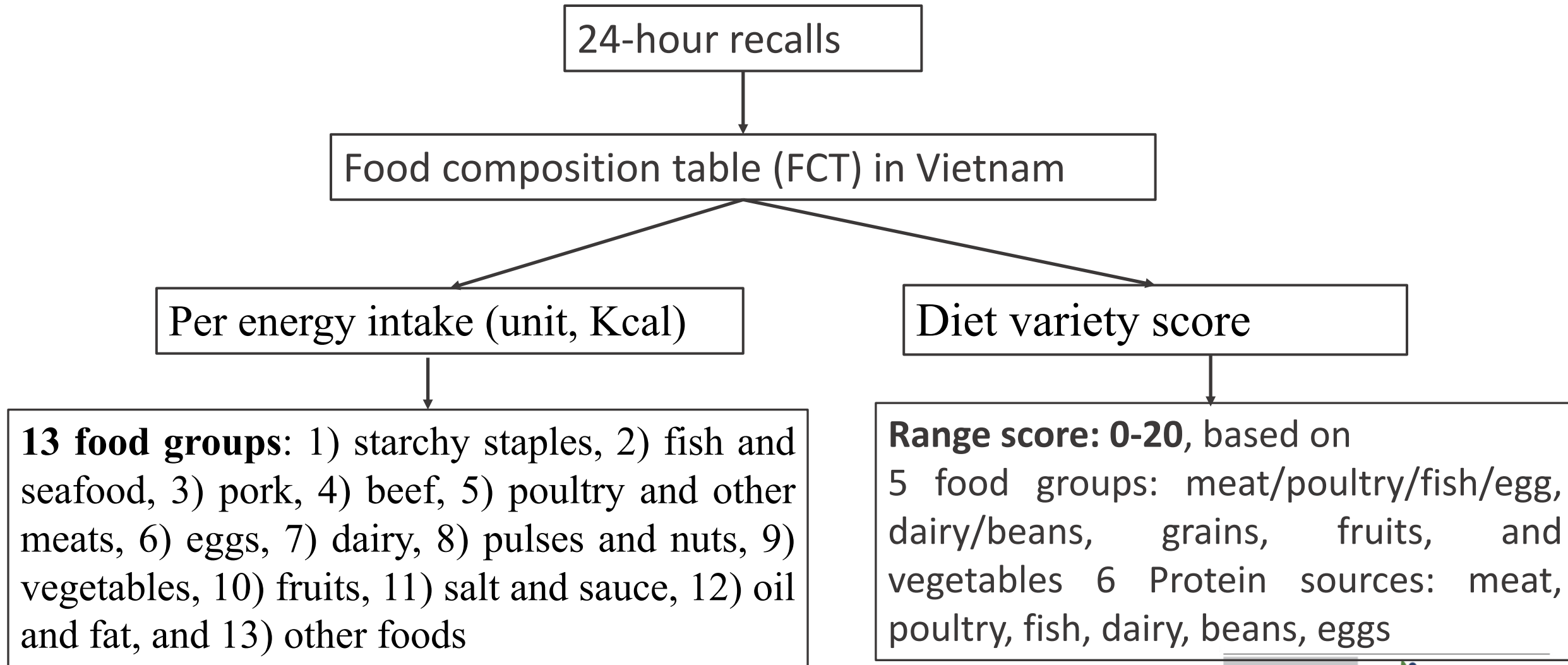


Figure 2: Flow chart of all components and framework in this study, along the rural-urban transect. Authors adapt from HLPE, 2017.

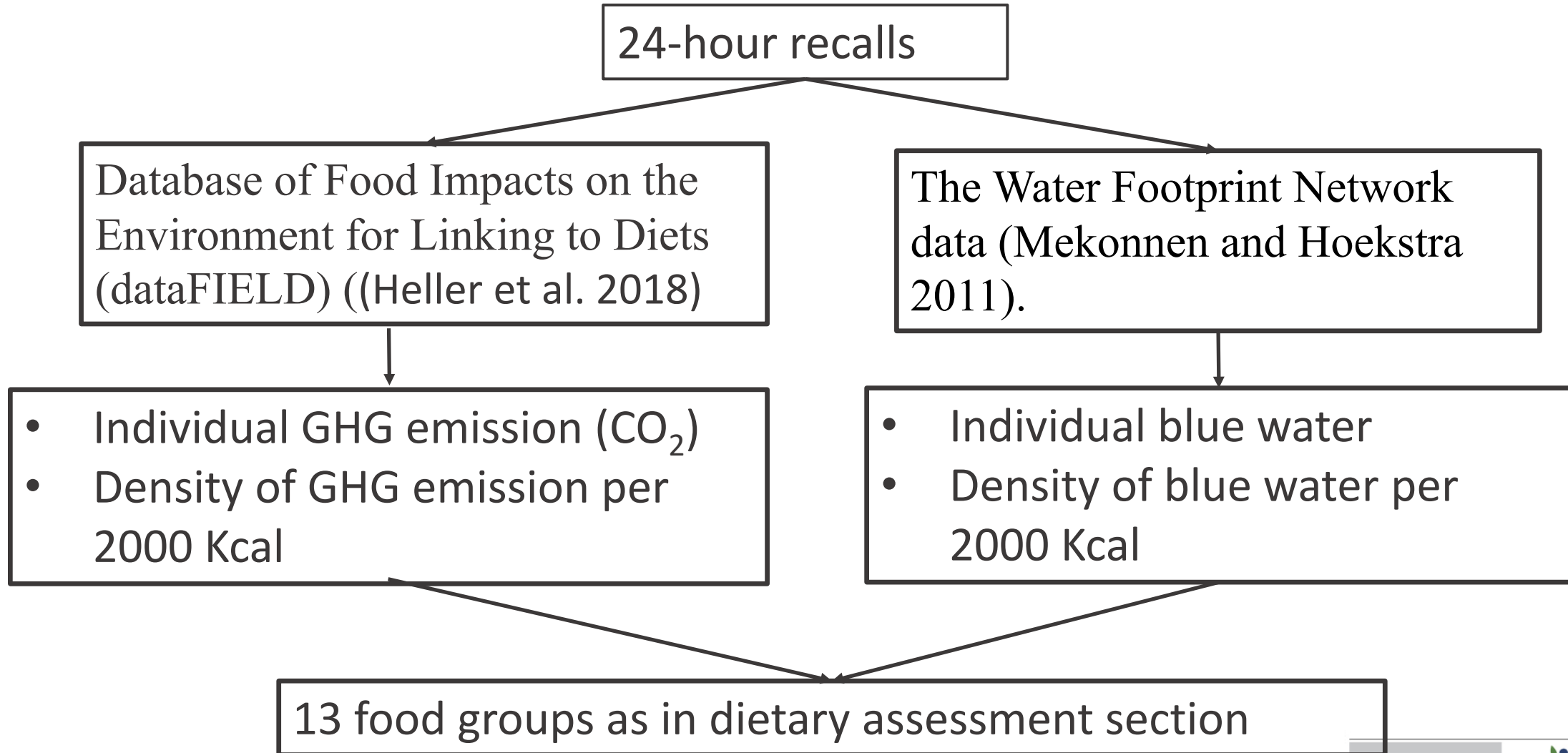
2. Materials and methods

2.2. Dietary assessment and food sources



2. Materials and methods

2.3. Environmental impact assessment



2. Materials and methods

2.4. Individual socio-demographics

- Gender
- Age
- Occupation: employed, self-employed, and other
- Education level: primary school, secondary-high school, university and college
- Household income level: less than 7 million VND per month (less than approximately 300 USD), from 7 to 11 million VND (from approximately 300 to 500 USD) and above 11 million VND (over approximately 500 USD).

2. Materials and methods

2.5. Perceptions of food choices

- 25 questionnaires on food choice.
- A-5-point scale
 - 1 = Not at all important
 - 2 = Slightly important
 - 3 = Neither unimportant nor important
 - 4 = Fairly important
 - 5 = Very important

| Factor | Description | Factor | Description |
|------------------------|--|------------------------|---|
| Health | Is high in fiber and roughage | Sensory Appeal | Tastes good |
| | Is high in protein | | Smells nice |
| | Contains a lot of vitamins and minerals | | Looks nice |
| | Keeps me healthy | | Has a pleasant texture |
| Mood | Makes me feel good emotionally | Price | Is not expensive/cheap/good value for money |
| | Keeps me awake/alert | Weight Control | Is low in fat |
| Convenience | Is easy and/or fast to prepare and cook | | Is low in calories |
| | Is easily available in shops and supermarkets | Familiarity | Is familiar what I usually eat when I was a child |
| | Can be bought in shops close to where I live or work | Ethical Concern | Has the country of origin clearly marked |
| Natural Content | Contains no additives | | Is not forbidden in my religion |
| | Contains natural ingredients | | Comes from countries I approve of politically |
| | Is produced without chemicals | | Is packaged in an environmentally friendly way |
| | | | Produced in a humane way |

2. Materials and methods

2.6. Statistical analysis

Regression models

$$\log F_i = \alpha_0 + \alpha_1 \text{Variety} + \sum_{j=1}^n b_j X_{ij} + \varepsilon_i \quad (*)$$

- Where F_i is the GHE emissions or blue water per 2000 Kcal, i is the individual number.
- Variety is individual diet variety score.
- The X_j variables include all socio-demographic characteristics, food choices and food sources
- ε_i is the random error term.
- We stratified the sample by gender and districts.
- Backward stepwise selection method is used for variable selections

3. Results

3.1. Socio-demographic characteristics of study participants

Table 1: Description of sociodemographic variables in the three districts

| | Male | | | Female | | |
|---|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | Urban | Peri-urban | Rural | Urban | Peri-urban | Rural |
| Number of observations | 105 | 92 | 110 | 109 | 92 | 111 |
| Age in years (st.dev) | 35.19 (6.16) | 32.39 (6.14) | 31.02 (6.98) | 31.55 (4.65) | 28.87 (5.28) | 28.28 (6.25) |
| Share of household in income classes (%) | | | | | | |
| Less than 7 million VND per month | 9.5 | 20.7 | 72.7 | 5.5 | 32.6 | 72.1 |
| From 7 to 11 million VND per month | 21.0 | 34.8 | 22.7 | 22.9 | 29.3 | 22.5 |
| 11 million VND per month and more | 69.5 | 44.6 | 4.5 | 71.6 | 38.0 | 5.4 |
| Share of highest education levels of respondents (%) | | | | | | |
| Primary school or no formal education | 2.0 | 8.7 | 37.0 | 0.9 | 9.9 | 33.6 |
| Secondary – high school | 19.8 | 56.5 | 57.4 | 11.9 | 50.6 | 61.8 |
| University and college | 78.2 | 34.8 | 5.6 | 87.2 | 39.5 | 4.5 |
| Main occupation (%) | | | | | | |
| Employee | 67.6 | 38.0 | 4.5 | 70.6 | 32.6 | 4.5 |
| Self-employed | 23.8 | 44.6 | 79.1 | 15.6 | 35.9 | 86.5 |
| Others | 8.6 | 17.4 | 16.4 | 14.0 | 32.0 | 9.0 |

Means and standard deviation (in parentheses) are reported for age

3. Results

3.2. Diet across the rural-urban transect in Vietnam

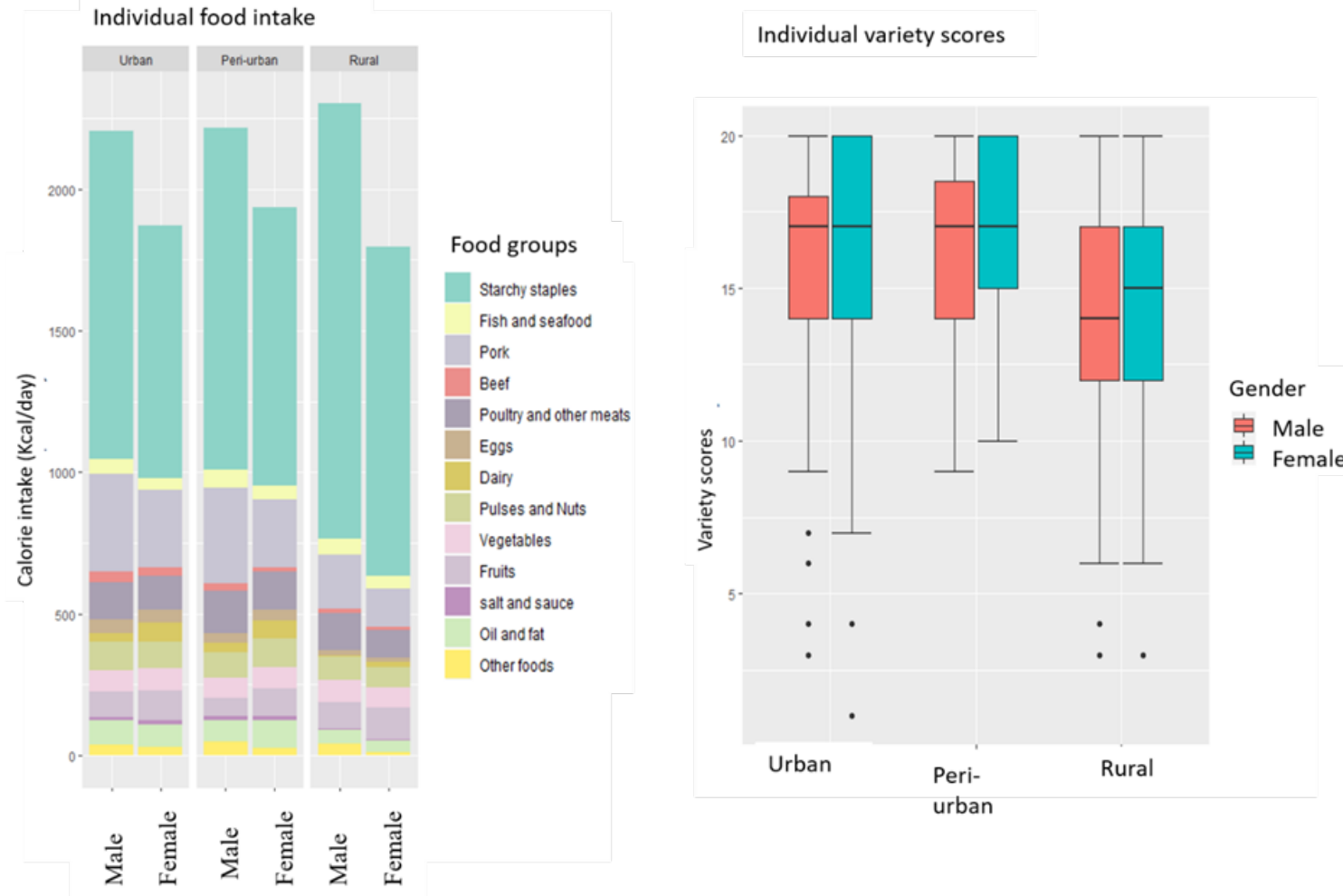


Figure 3. Average individual calorie intake (left) and individual variety scores (right) by gender and by district

3. Results

3.2. Diet across the rural-urban transect in Vietnam

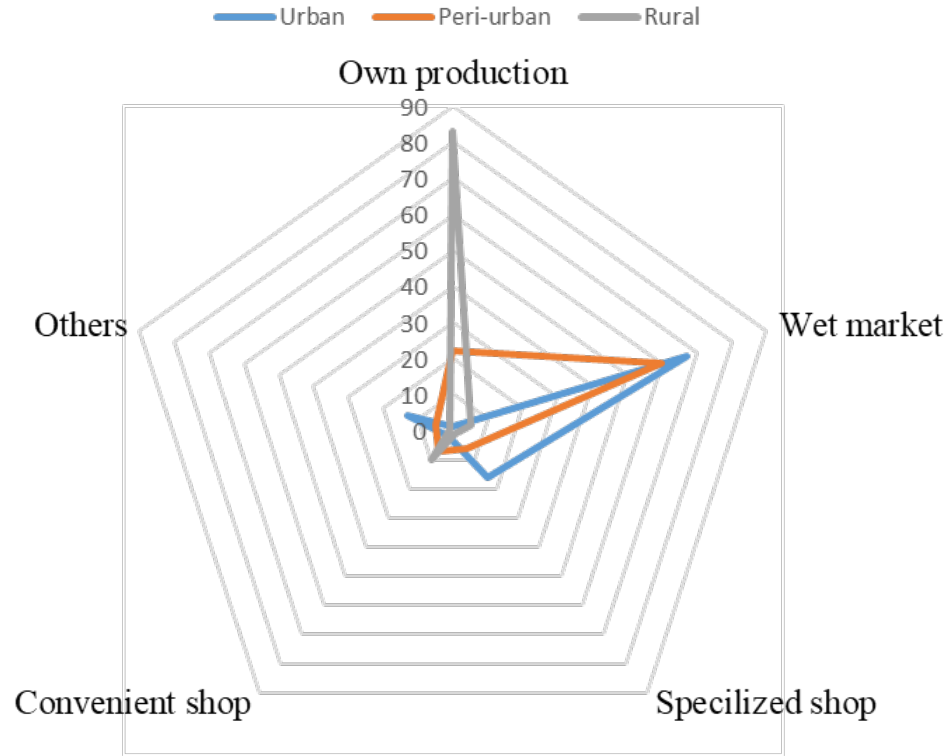


Figure 4. Food sources (%).

3. Results

3.3. Environmental impacts of diets

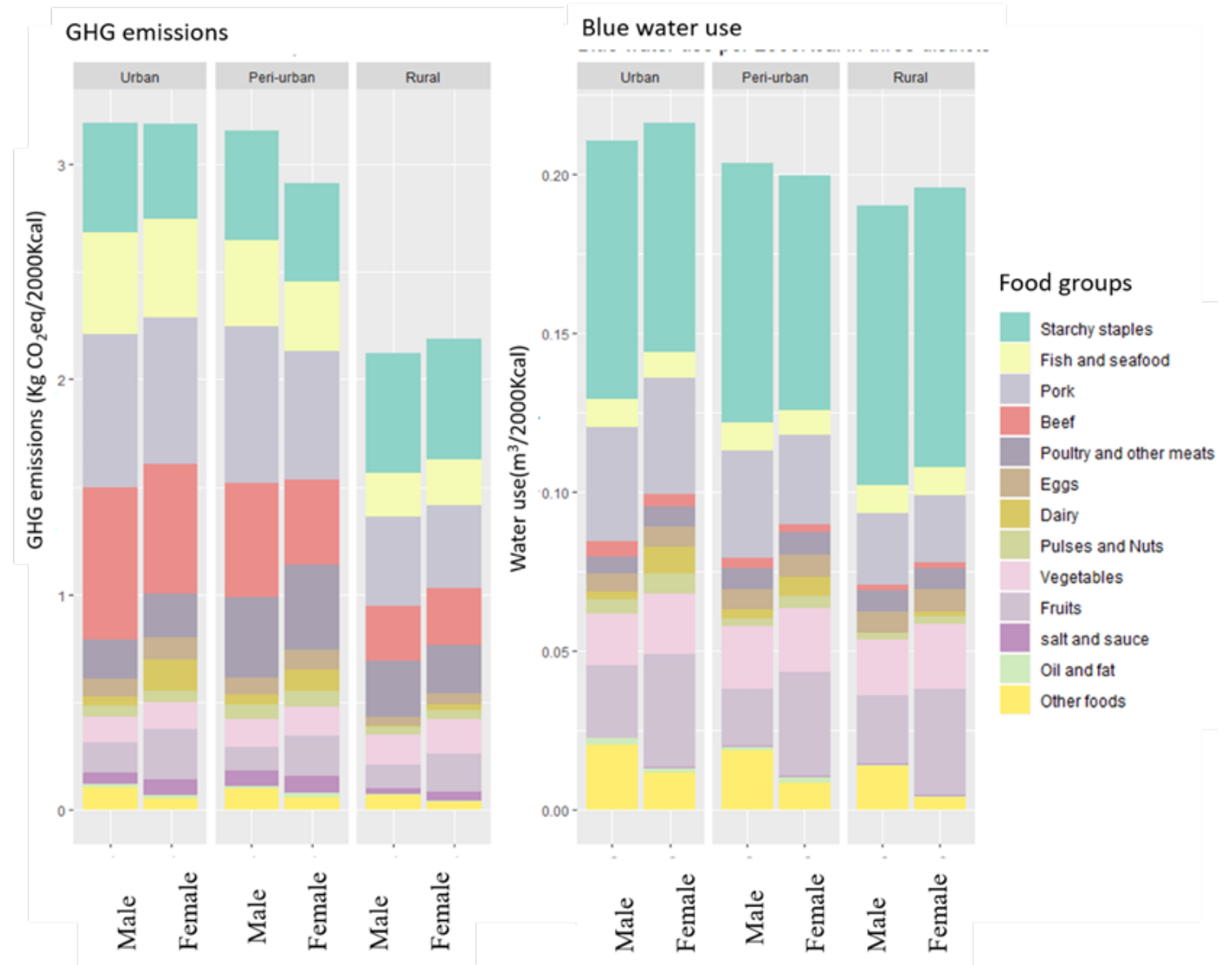
Figure 5: Actual environmental footprints for different members and by districts



3. Results

3.3. Environmental impacts of diets

Figure 6:
Environmental
footprints per 2000
Kcal for different
members and by
districts.



3. Results

3.4. Perceptions of food choices

| Factor | Items | Urban | Peri-urban | Rural |
|-----------------|-------|----------------------------|---------------------------|----------------------------|
| Health | 4 | 16.5 ^a (2.4) | 15.8 ^b (2.5) | 14.3 ^c (3.5) |
| Mood | 3 | 6.8 ^a (1.8) | 7.4 ^b (1.6) | 7.4 ^b (1.7) |
| Convenience | 3 | 10.8 ^a (2.2) | 10.8 ^a (2.0) | 9.8 ^b (2.5) |
| Sensory Appeal | 4 | 15.4 ^{ab} (2.8) | 15.0 ^b (2.5) | 15.7 ^{ac} (2.5) |
| Natural Content | 3 | 12.9 ^a (1.6) | 12.1 ^b (2.0) | 11.6 ^c (2.2) |
| Price | 1 | 3.3 (1.0) | 3.5 (0.9) | 3.4 (1.1) |
| Weight Control | 2 | 7.2 ^a (1.6) | 6.9 ^a (1.4) | 6.1 ^b (2.0) |
| Familiarity | 1 | 3.2 ^a (1.1) | 3.2 ^a (1.0) | 3.5 ^b (0.9) |
| Ethical Concern | 5 | 20.6 ^a (3.5) | 20.5 ^a (3.3) | 19.2 ^b (3.6) |

Significant different at 5% by one-way analysis of variance (ANOVA) and post-hoc Tukey's range test. Values market with the same letter are not significant different at $P < 0.05$.

Table 2: Average food choices scores (standard deviation) by factor and districts

3. Results

3.4. Perceptions of food choices

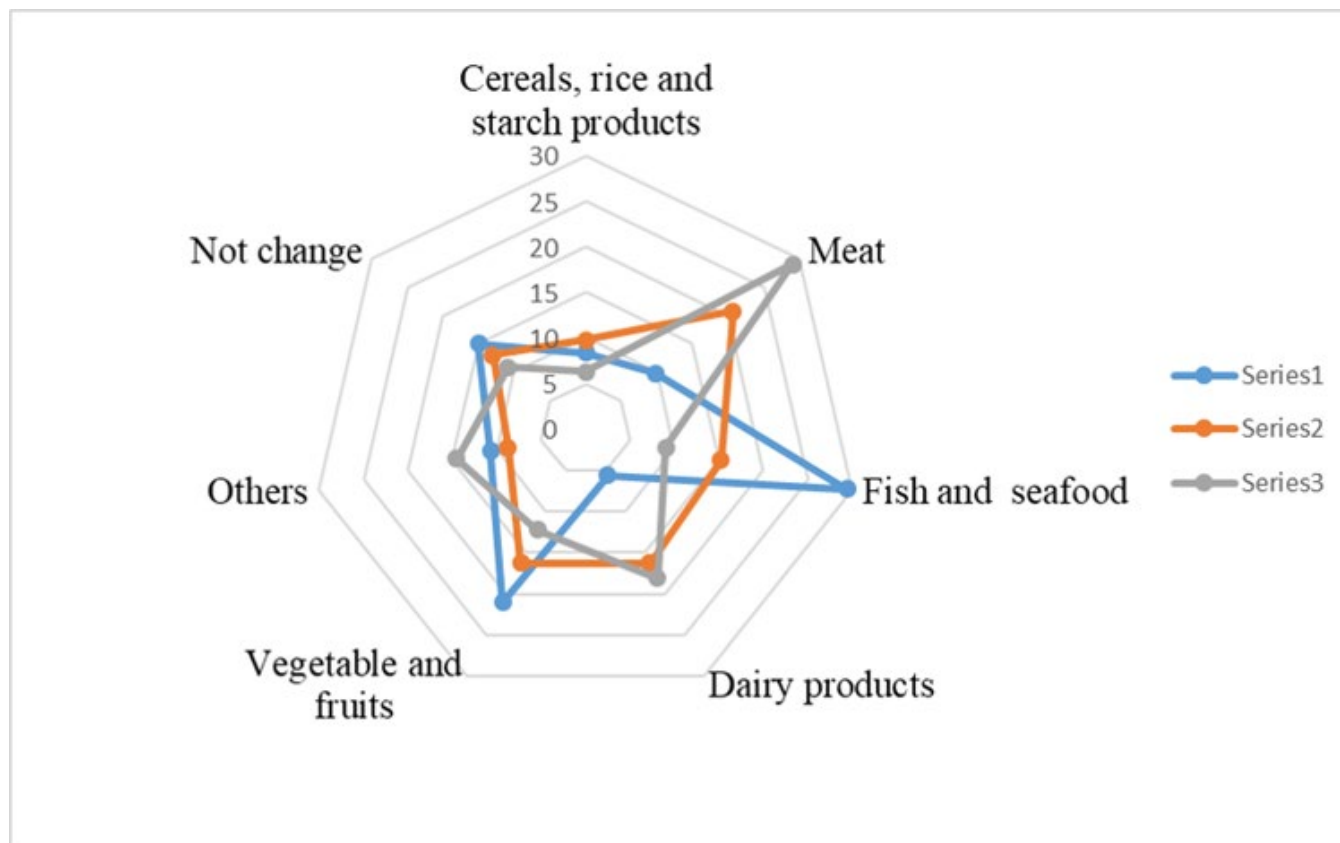


Figure 7: Food groups households would prefer to buy more of if their food budget were to increase (%).

3. Results

3.5. Trade-offs and synergies in the environment - nutrition along urban-rural transect and potential leverage points of consumer choices toward a sustainable environmental diet intake

| Variables | Logarithm of GHG emission per 2000Kcal | | | | | | Logarithm of Blue water use per 2000 Kcal | | | | | |
|---|--|----------------|-----------|-----------|----------------|-----------|---|----------------|-----------|------------|-----------------|------------|
| | Male | | | Female | | | Male | | | Female | | |
| | Urban (1) | Peri-urban (2) | Rural (3) | Urban (4) | Peri-urban (5) | Rural (6) | Urban (7) | Peri-urban (8) | Rural (9) | Urban (10) | Peri-urban (11) | Rural (12) |
| (Intercept) | 0.064 | 0.889** | 0.116 | -0.322 | 0.469 | -0.269 | -1.794*** | -1.644*** | 1.997*** | -1.681*** | 2.011*** | -2.104*** |
| Variety scores (cont.) | 0.032** | 0.025* | 0.038*** | 0.041** | 0.029** | 0.047*** | 0.008 | 0.006 | 0.02*** | 0.014** | 0.016** | 0.022*** |
| Income: reference: Less than 7 millions VND | | | | | | | | | | | | |
| From 7 to 11 millions VND | -0.042 | 0.061 | -0.001 | 0.05 | 0.078 | -0.17 | 0.028 | 0.019 | -0.014 | 0.086 | 0.032 | -0.02 |
| Greater than 11 millions VND | 0.167 | 0.032 | -0.034 | 0.14 | -0.146** | -0.146 | 0.025 | -0.008 | -0.03 | 0.021 | -0.047 | -0.048 |
| Education: Reference: Primary school or no formal education | | | | | | | | | | | | |
| Secondary – high school | -0.439 | 0.039 | 0.141* | 0.417 | -0.068 | 0.113 | -0.124 | -0.138** | 0.033 | 0.131 | -0.035 | 0.046 |
| University and college | -0.288 | 0.03 | 0.083 | 0.371 | 0.031 | 0.79*** | -0.12 | -0.157** | 0.004 | 0.038 | 0.002 | 0.061 |
| Own production (reference: No Own production) | -0.183 | -0.121 | 0.017 | -0.24 | -0.204** | 0.088 | 0.185 | -0.049 | -0.003 | 0.056 | -0.085* | 0.018 |
| Factor 1—Health | -0.028 | -0.021 | -0.01 | -0.023 | -0.018 | -0.009 | -0.007 | 0.021** | -0.001 | -0.012 | 0.027*** | 0.004 |
| Factor 5—Natural Content | 0.092* | 0.005 | 0.03 | 0.067 | 0.026 | 0.025 | 0.028* | -0.033** | 0.014 | 0.005 | -0.033** | 0.002 |
| Factor 9—Ethical Concern | 0.01 | 0.006 | -0.017 | -0.007 | 0.009 | -0.005 | -0.001 | 0.003 | -0.009* | -0.001 | 0 | 0 |
| R squared | 0.115 | 0.084 | 0.269 | 0.129 | 0.18 | 0.417 | 0.096 | 0.15 | 0.313 | 0.141 | 0.235 | 0.325 |
| Number of observations | 105 | 92 | 110 | 109 | 92 | 111 | 105 | 92 | 110 | 109 | 92 | 111 |

Table 3: Summary of regression results

3. Results

3.5. Trade-offs and synergies in the environment - nutrition along urban-rural transect and potential leverage points of consumer choices toward a sustainable environmental diet intake

Discuss results GHG emission

- DVS has significant positive coefficients for all subsamples, which means that more divers diets are associated with higher environmental impacts. Household income has no significant effect for the male subsamples, while women in the peri-urban area have a negative coefficient for the largest income class
- Education by gender have some impacts
- **Comparison of sites:** There are no structural differences between the coefficients of the (peri-)urban areas and the rural areas.

3. Results

3.5. Trade-offs and synergies in the environment - nutrition along urban-rural transect and potential leverage points of consumer choices toward a sustainable environmental diet intake

Discuss results blue water use

- Except for men in urban and peri-urban areas, DVS has significant positive coefficients, which means that more diverse diets are associated with higher blue water use.
- Household income indicators had insignificant coefficients for the blue water use models.
- **Comparison of sites:** In the case of blue water the significant coefficients of variables of males and females large correspond across the areas. The blue water use specifications for peri-urban males and females have significant coefficient which are not found in the other areas.

4. Discussion and Conclusion (1/3)

- ❖ The average individual calorie intake of men was higher than that of women in all districts. For all members, starchy staples was the most important sources of calorie intake.
- ❖ The individual DVS in urban site are significant higher than in rural site.
- ❖ Households from the urban site mainly purchased food, especially from wet markets and specialized shops. In the rural site, 80% of households foods came from own production

4. Discussion and Conclusion (3/3)

- ❖ Based on different groups (by gender and districtss), perception in food choices have both positive or negative impacts on environmental outcomes.
- ❖ For both GHG emission and blue use, women from households in peri-urban areas involved in agricultural production have a significant negative coefficient.
- ❖ All results show the trade-off between nutrition and environmental outcome => Need different actions for each targeted groups.

4. Discussion and Conclusion (2/3)

- ❖ The total GHG emission between members in urban and peri-urban site, regardless of gender, were quite similar.
- ❖ The overall trend in average blue water use associated with diet were similar to GHG emission patterns.
- ❖ Pork and beef groups generated the most GHG emissions from the diets of all members in three districts, starchy staple group contributed the most to blue water use.

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Thank you!

Huong Trinh^{1,2}, Vincent Linderhof³, Vy Vuong⁴, Erin Esaryk⁵, Martin Heller⁶, Roel Helmes³, Youri Dijkhoorn³, Trang Mai Nguyen^{1,3}, Van Luu¹, Ricardo Hernandez¹, Thanh Thi Duong¹, Tuyen Thi Thanh Huynh¹, Andrew Jones⁶, Thom Ahterbosch³, Stef De Haan⁷

¹International Center for Tropical Agriculture (CIAT)-Asia Office, Hanoi, Vietnam

²Thuongmai University, Hanoi, Vietnam

³Wageningen University and Research, The Netherlands

⁴Cornell University, Ithaca, NY, USA

⁵Department of Epidemiology and Biostatistics, University of California, San Francisco, CA, USA

⁶University of Michigan, Ann Arbor, MI, USA

⁷International Potato Center

