An exploration of the impact of animal agriculture on Human Sustainable Development Index and the Child Health Indicator of a nation

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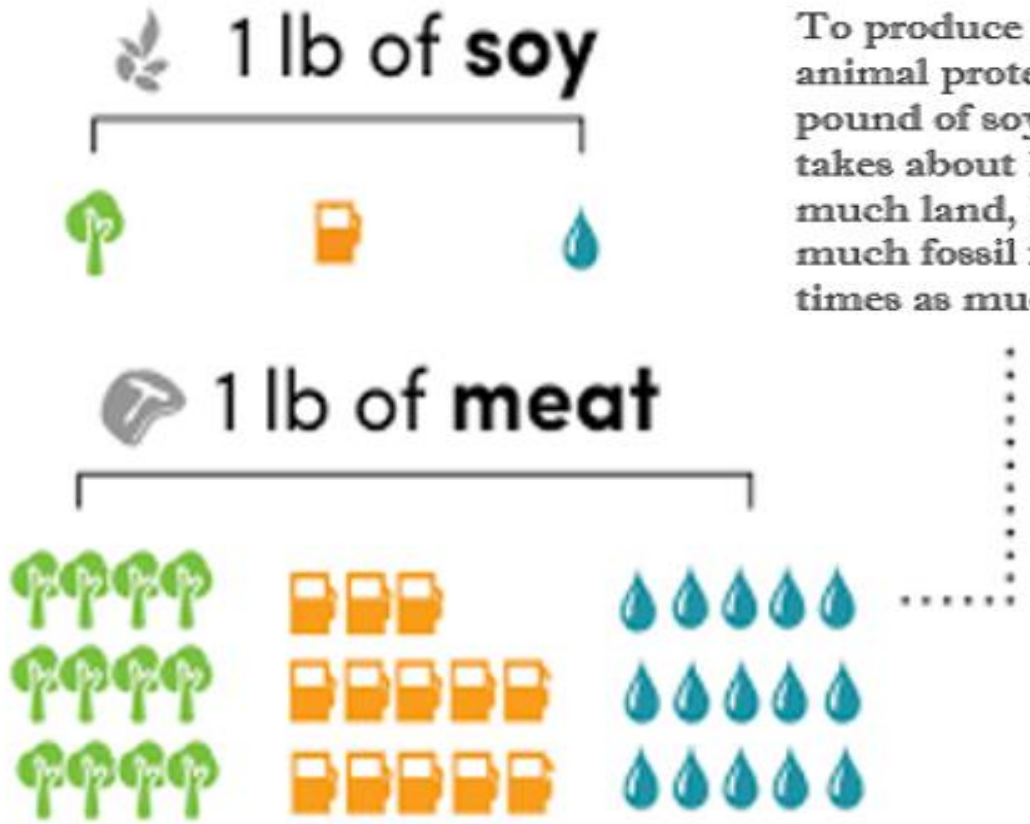
Background



To produce one pound of animal protein vs one pound of soy protein, it takes about 12 times as much land, 13 times as much fossil fuel and 15 times as much water

- Global warming
- High land use
- Deforestation
- Species extinction
- Less bio-diversity
- Fresh water shortages
- World hunger

Apart from these, meat consumption also increases the likelihood of many health conditions like Cancer, Cardiovascular disease, type II diabetes and obesity

Sustainable development indicators

1. **Human Sustainable Development Index**

$$HDI = (I_{life} * I_{education} * I_{lincome})^{1/3}$$

$$HSDI = (I_{life} * I_{education} * I_{income} * I_{emissions})^{1/4}$$

where $I_{emissions} = (max - x) / (max - min)$ *and x is the amount of*

CO_2 *emissions per capita for a country in a given year*

GHG emissions per capita for a country in a given year

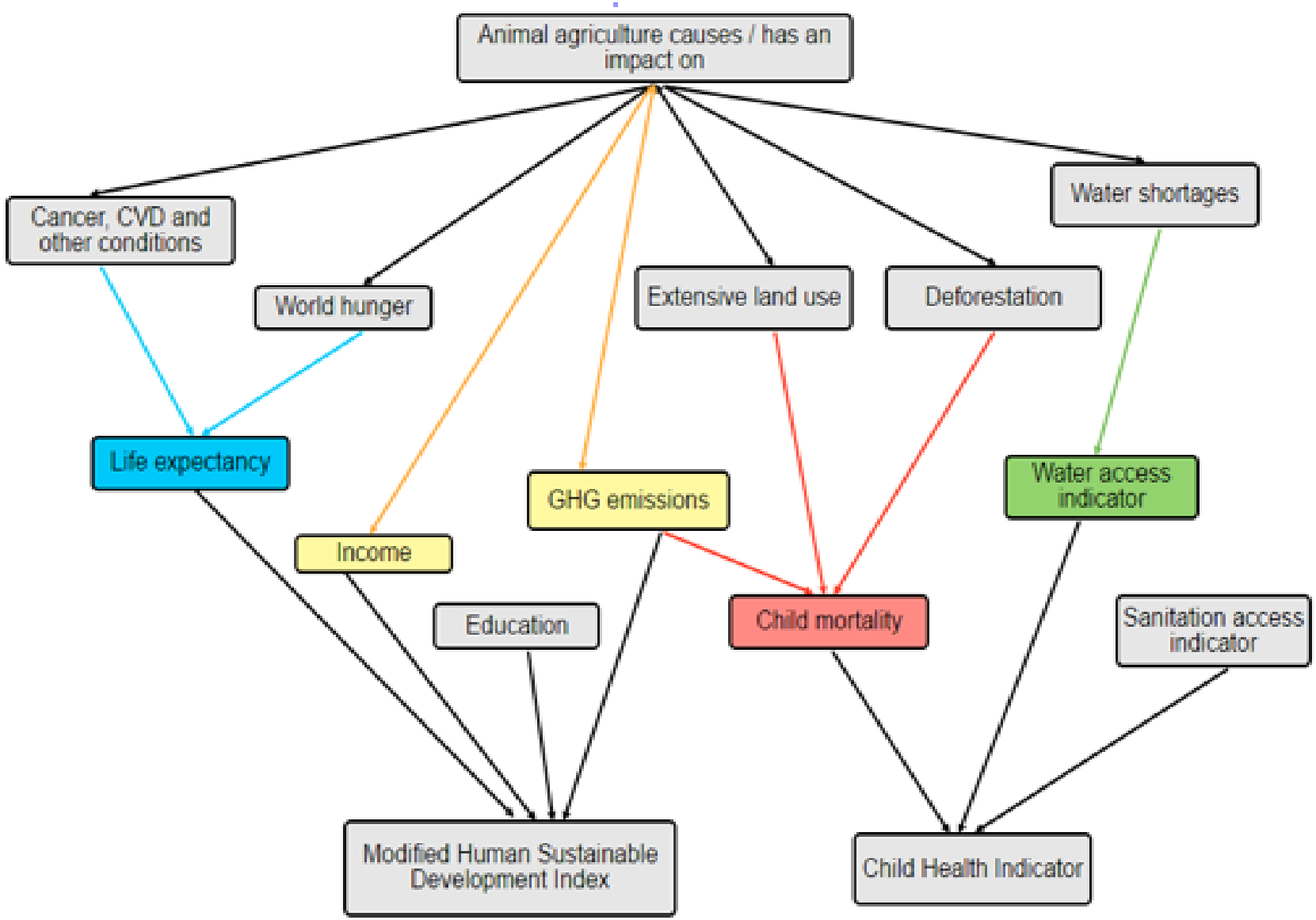
Total GHG emissions for a country in a given year

Total GHG emissions per unit area for a country in a given year

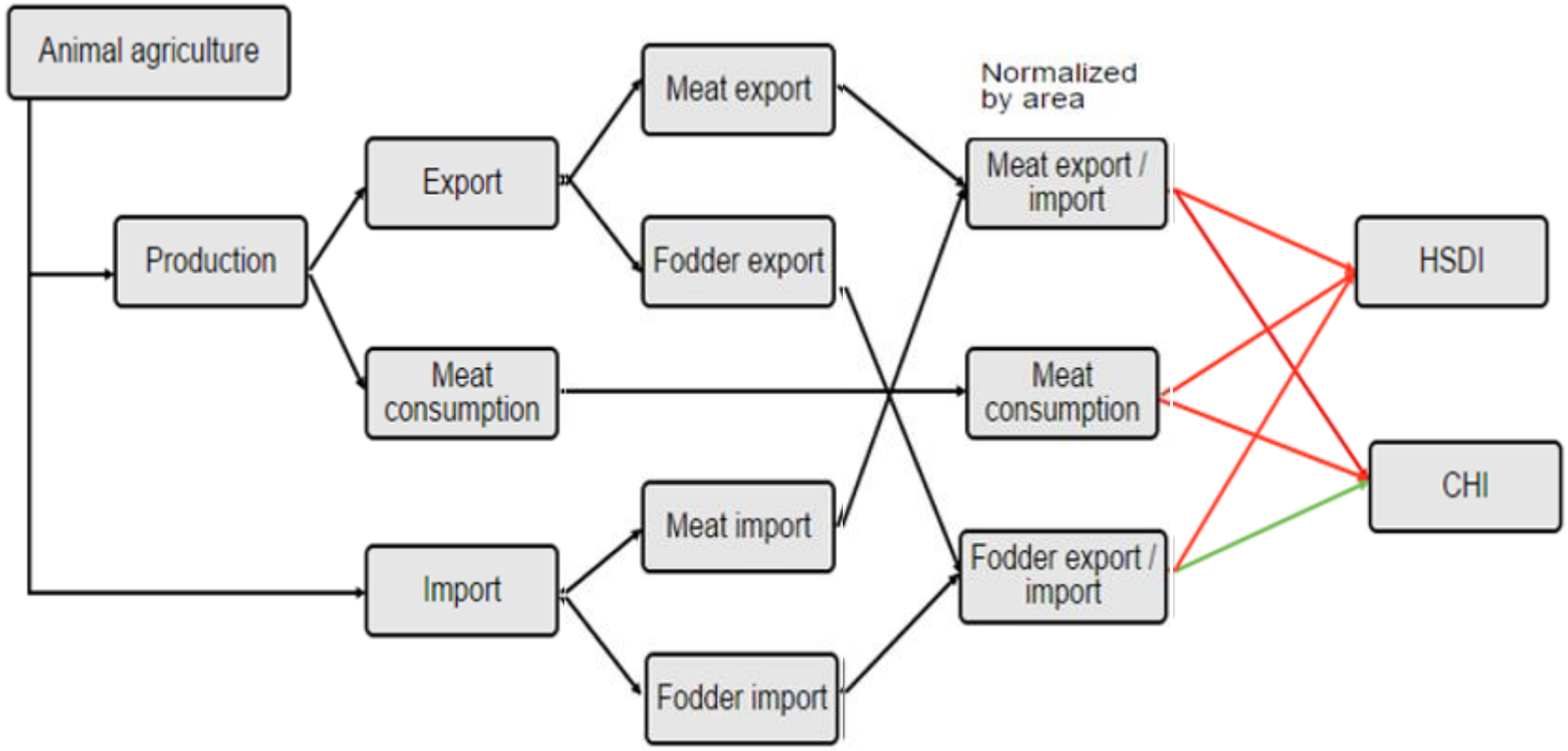
2. **Child Health Indicator**

CHI = Sanitation access indicator + Improved water access indicator + Child Mortality indicator / 3

How it connects?



Variable and hypothesis definition

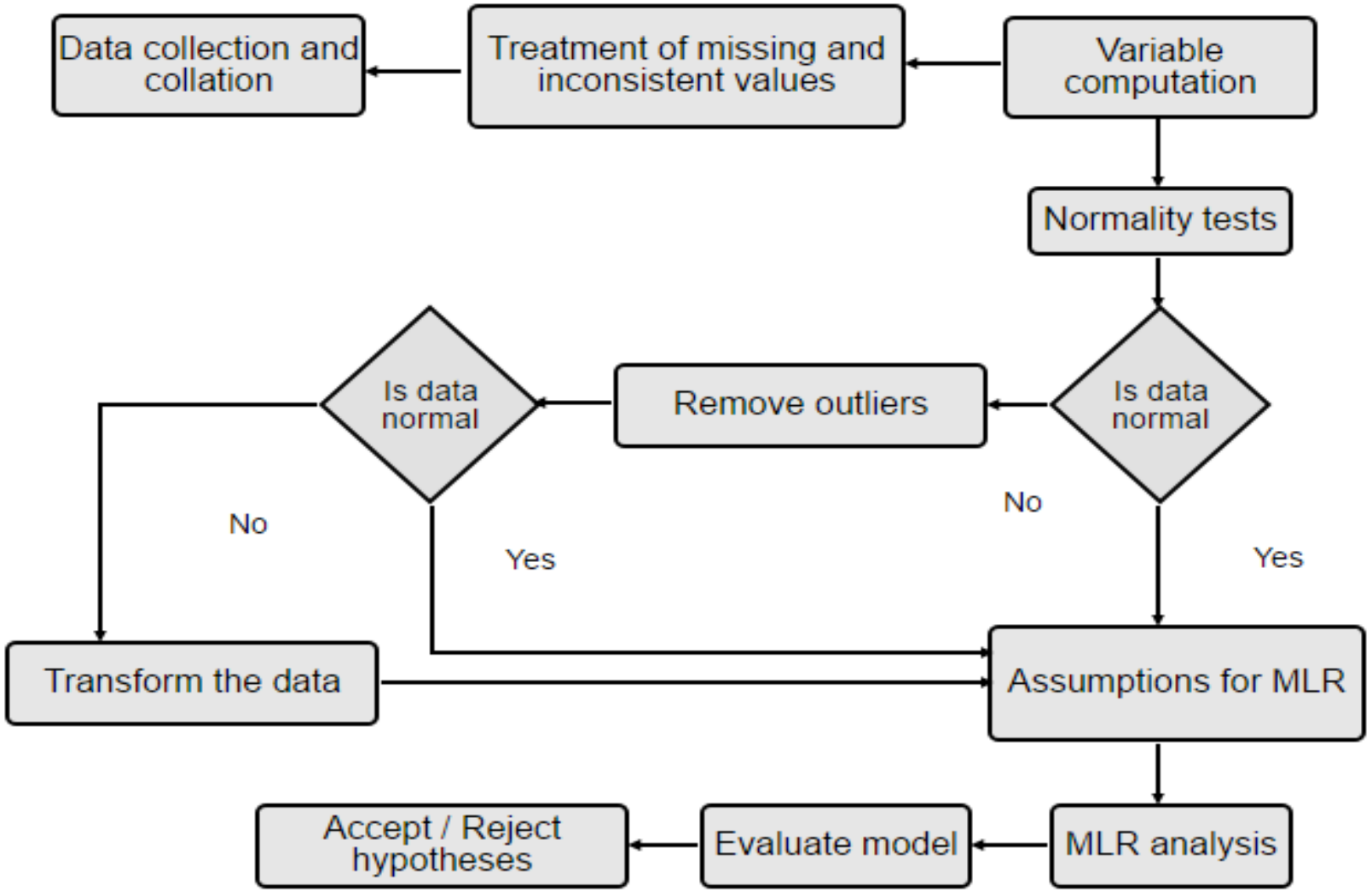


Ratio of current to previous' years values of

HSDI -→ Meat export-import ratio per unit area + Fodder export-import ratio per unit area + Meat consumption per unit area

CHI -→ Meat export-import ratio per unit area + Fodder export-import ratio per unit area + Meat consumption per unit area

Experiment


Data collection and collation
Treatment of missing and inconsistent values
Variable computation
Normality tests
Is data normal
Remove outliers
Is data normal
No
Yes
No
Yes
Transform the data
Assumptions for MLR
Accept / Reject hypotheses
Evaluate model
MLR analysis

Experiment

MLR pre-conditions

- Outliers (apart from those removed earlier) - Mahalanobis distance - (3 IVs -16.27)
- Unusual cases (where difference between predicted and actual values are off the scale) and their influence on results - Cook's distance
- Multicollinearity - Tolerance, VIF and correlation coefficients
- Uncorrelated independent variables - Correlation coefficients
- Normality - P-P plot

MLR interpretation

- Statistical significance - model significance in ANOVA table
- Explainability - R^2 / Adjusted R^2
- Individual contribution of the independent variable - Part correlation coefficients

Results and implications

Normality tests

- None of the variables met the condition of normality (0.05) except 'Trans_meat_ratio' in HSDI dataset despite applying log transformation

Multiple Linear Regression tests

HSDI

- A statistically significant model that explains HSDI in terms of Meat_ratio, Fodder_ratio and Meat_cons_ratio could not be constructed

CHI

- A statistically significant model that explains CHI_ratio in terms of Fodder_ratio was constructed.
- Model equation - ***CHI_ratio = 1.009 - 0.004 * Fodder_ratio*** → **Current to previous year's value of CHI = 1.009 - 0.004 * (Current to previous year's value of meat export to import ratio per unit area)**
- Statistical significance - **0.024 % → 97.6% of times, the predictions are not by chance**
- **R^2 - 0.013 (1.3%)**

What are the real time questions that could be answered using this model?

1. Does fodder trade have a significant impact on CHI? – YES !!

2. If the leadership of a country decides to improve its Child Health Indicator, it could do so by making use of the following equation.

(Target CHI for the next year / Current year's CHI)

*= 1.009 – 0.004 * ((Next year's fodder export per unit area /*

Next year's fodder import per unit area) /

(Previous year's fodder export per unit area /

Previous year's fodder import per unit area))

3. The above equation could also be used as a basic forecasting model that predicts CHI value based on probable fodder exports and imports in the upcoming years and take preventive counter-measures if necessary.

Contributions to knowledge

- A better Human Sustainable Development Index that considers all greenhouse gases instead of just carbon dioxide was devised.
- A robust experimental design that addresses various elements of bias while dealing with data from different nations was developed
- The shortcomings that were mostly due to unavailability of data with respect to welfare indicators and the absence of detailed drill down data for meat and fodder trade in terms quantity, as opposed to trade value, was documented elaborately.
- The non-linear nature of the dataset was well-established and this could provide a future researcher with jump-start and suggest him upfront to consider the use of more advanced types of regression or unsupervised machine learning methods.
- A statistically significant model that explains Child Health Indicator in terms of fodder export-import ratio was obtained. This could be used by the leadership of any country to improve their Child Health Indicator.

Impact and future work

- Not many researches have been done on quantifying the effects of animal agriculture in terms of welfare indicators.
- The experimental results and the underlying theory from this research could be used by environmentalists, politicians and animal rights activists
- The same research based on the same methodology could be undertaken with a different and possibly more sophisticated indicator for sustainable development or even the same indicators with a larger dataset.
- Advanced methods of regression \or hybrid unsupervised machine learning techniques could be employed to better account for the non-linear nature of data.
- Various types of meat and fodder products could be quantified individually based on their impacts on the environment and human health and these numbers could be used as weightage parameters for a quantity based data (as opposed to trade value based) data set

Thank you !!