# Analysis of food nutrients availability based on food composition information and food consumption to support land use scenarios in Brazil

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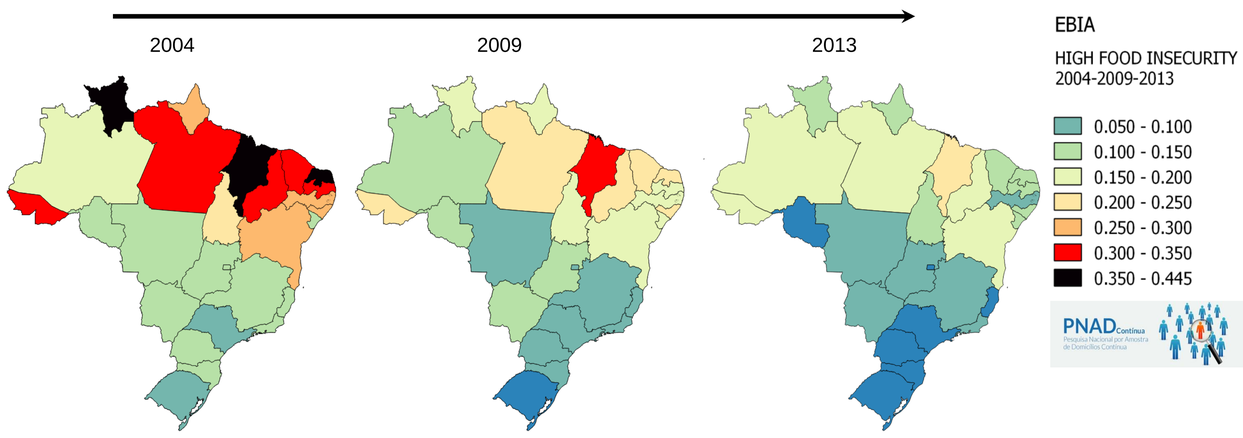
## Aim and Scope

- Food and Agriculture Organization of the United Nations (FAO) estimates > 600000 inhabitants will be undernourished by 2050 if nothing is done.
- Evaluating the adequacy of food nutrient supplies allow the understanding on how micro/macronutrients deficiencies/surpluses in the Brazilian population shall require policies that promote either agricultural intensification or smarter food choices, or both.
- Our objective was to estimate the availability of macro and micro nutrients per food type according to Food Balance Sheets (FBS) retrieved from FAO database [1]. Preliminary results focus on bovine meat were adopted to support land demand scenarios linked to food insecurity secular trend (Figure 1) and regional level indicators in Brazil [2,3].




*High food insecurity definition – Reduced food availability and/or changes in food choices among children no able to access food. Hunger, i.e. no meals during a day due to poverty.*

**Figure 1** – Temporal dynamics of the Brazilian Scale of Food Insecurity (EBIA)

## Food data and land demand scenarios

- FAO food types available in the Food Balance Sheets (FBS) were associated to food types available in the food acquisition module of the Household Budget Survey, conducted in 2008/2009 by the Brazilian Institute of Geography and Statistics (POF / IBGE).
- After comparing FBS/FAO and POF/IBGE data, for each food type received a nutritional composition content retrieved from the Brazilian Food Composition Table (TACO) [4]. Food types with missing data in TACO were retrieved from the United States Department of Agriculture (USDA).
- Preliminary analyses of the data assembled allow the evaluation of nutrition the excesses or deficiencies of micro and macro nutrients available to the Brazilian population, focused first on bovine meat (Table 1).
- Outcomes where taken into account together with food acquisition scenarios (Figure 2) to develop scenarios of land demand under different premises of meat consumption.
- Associated percentage of undernourished population and proxies of land demand (area or yield) were modelled using FEEDME model [5], according to food and nutrient content availability.

Food type categories

- cereals
- starchy roots
- cassava
- pulses
- nuts
- soybean
- coconut
- vegetable oils
- soybean oil
- vegetables
- fruits
- stimulants
- spices
- sugar & sweetners
- non-alcoholic beverages
- alcoholic beverages
- meat
- bovine meat
- poultry meat
- offals
- fishs & seafood
- eggs
- milk
- animal fats
- micelaneous

| | B | AL | AM | AN | AO | AP | AQ | AR | AS | AT | AU | AV | AW | AX | AY | AZ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | amount consumed by weight | proportion of total consumed | TACO Energy (kcal) | TACO Energy (kJ) | TACO Carbohyd rate (g) | TACO Fiber (g) | TACO Protein (g) | TACO Fat (g) | TACO Satd FA /100g fd (g) | TACO poly /100g food (g) | TACO Mono FA /100g food (g) | TACO Sodium (mg) | TACO Potassiu m (mg) | TACO Calcium (mg) | TACO Magnesi um (mg) |
| 2 | Meat, beef, strip loin, with fat, raw | 0,819 | 0,107 | 22,089 | 92,322 | 0,000 | NA | 2,273 | 1,373 | 0,600 | 0,021 | 0,590 | 4,718 | 30,560 | 0,429 | 1,93 |
| 3 | Meat, beef, strip loin, without fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 4 | Meet, beef, coxão duro, without fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 5 | Meet, beef, coxão mole, without fat, raw | 0,645 | 0,084 | 14,271 | 59,703 | 0,000 | NA | 1,790 | 0,735 | 0,329 | 0,008 | 0,312 | 5,151 | 28,289 | 0,253 | 1,77 |
| 6 | Meat, beef, tenderloin, without fat, raw | 0,133 | 0,017 | 2,490 | 10,413 | 0,000 | NA | 0,376 | 0,098 | 0,050 | 0,003 | 0,033 | 0,853 | 5,607 | 0,052 | 0,36 |
| 7 | Meat, beef, flanco, without fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 8 | Meat, beef, skirt steak, with fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 9 | Meat, beef, eye round, raw | 0,234 | 0,031 | 4,136 | 17,279 | 0,000 | NA | 0,628 | 0,159 | 0,070 | 0,003 | 0,070 | 1,654 | 11,090 | 0,092 | 0,61 |
| 10 | Meat, beef, trip tip, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 11 | Meat, beef, sirloin, without fat, raw | 0,866 | 0,113 | 18,481 | 77,212 | 0,000 | NA | 2,449 | 0,884 | 0,385 | 0,011 | 0,374 | 4,875 | 33,901 | 0,340 | 2,26 |
| 12 | Meat, beef, patinho, without fat, raw | 0,444 | 0,058 | 7,731 | 32,437 | 0,000 | NA | 1,261 | 0,262 | 0,116 | 0,012 | 0,110 | 2,848 | 18,485 | 0,174 | 1,16 |
| 13 | Meat, beef, picanha, with fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 14 | Meat, beef, picanha, without fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 15 | Meat, beef, strip loin cape, with fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 16 | Meat, beef, strip loin cape, without fat, raw | 0,112 | 0,015 | 1,921 | 8,036 | 0,000 | NA | 0,315 | 0,063 | 0,028 | 0,001 | 0,028 | 1,158 | 4,766 | 0,088 | 0,29 |
| 17 | Meat, beef, strip loin ribeye, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 18 | Meat, beef, muscle, without fat, raw | 0,361 | 0,047 | 6,711 | 27,980 | 0,000 | NA | 1,021 | 0,260 | 0,104 | 0,005 | 0,123 | 3,119 | 13,990 | 0,189 | 0,80 |
| 19 | Meat, beef, pallet, with fat, raw | | | 0,000 | 0,000 | 0,000 | NA | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,00 |
| 20 | Meat, beef, chest, without fat, raw | 0,217 | 0,028 | 7,358 | 30,825 | 0,000 | NA | 0,500 | 0,580 | 0,233 | 0,014 | 0,261 | 1,818 | 6,847 | 0,114 | 0,42 |
| 21 | Meat, beef, acém, ground, raw | 0,822 | 0,108 | 14,744 | 61,451 | 0,000 | NA | 2,088 | 0,635 | 0,291 | 0,011 | 0,258 | 5,273 | 25,506 | 0,323 | 1,50 |
| 22 | Meat, beef, acém, without fat, raw | 0,715 | 0,094 | 13,480 | 56,447 | 0,000 | NA | 1,947 | 0,571 | 0,262 | 0,019 | 0,215 | 4,681 | 21,905 | 0,468 | 1,21 |

**Table 1** – Calculated nutritional content (average by weight) of different types of bovine meat available in Brazil according to nutrients and consumed amount data.

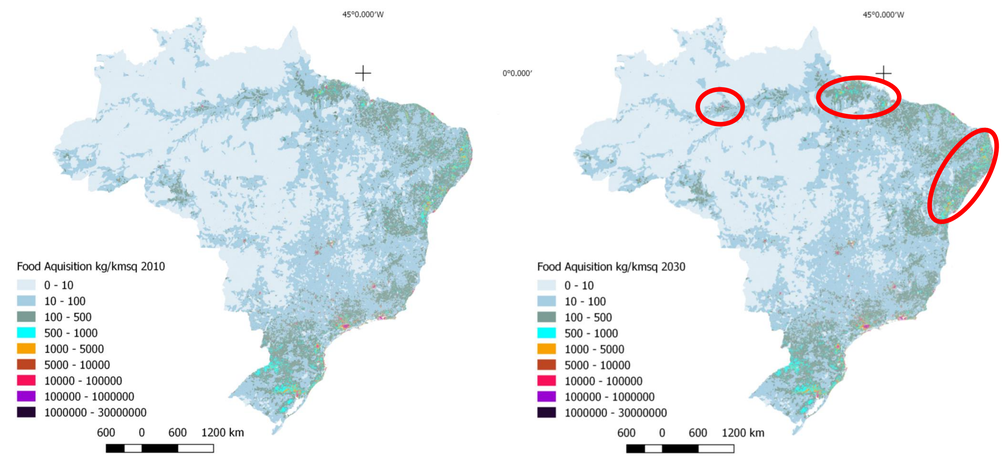
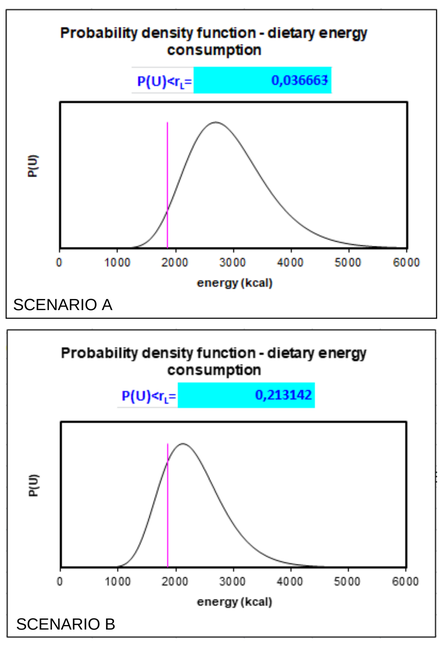



**Figure 2** – Bovine meat acquisition scenarios 2008-2030

| 2010 - 2013 mean | 1000 tonnes | 1000 tonnes | 1000 tonn | 1000 tonn | 1000 tonne | 1000 tonn | 1000 tonnes | | 1000 tonn | 1000 tonne | 1000 tonn | kg | kcal/capita | g/capita/ | g/capita/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| subject | Production | Import Quar | Stock Var | Export Qu | Domestic | Feed | Seed | Processing | Losses | Other uses | Food | Food sup | Food suppl | Protein s | Fat suppl |
| | Production quantity (1000 tonnes) | Import quantity (1000 tonnes) | Stock variation (1000 tonnes) | Export quantity (1000 tonnes) | Domestic supply (1000 tonnes) | Feed quantity (1000 tonnes) | Seed quantity (1000 tonnes) | Food Manufacture (1000 tonnes) | Waste quantity (1000 tonnes) | Other Uses quantity (1000 | Food quantity (1000 tonnes) | Food/capita/year (Kg) | Calories/capita/day | Proteins /capita/ day (g) | Fat/capita/day (g) |
| Grand Total | | | | | | | | | | | | | 3.244,01 | | |
| Vegetal Products | | | | | | | | | | | | | 2.445,01 | | |
| Animal Products | | | | | | | | | | | | | 799,00 | | |
| Cereals - Excluding Be | 84.288,00 | 10.332,50 | 149,00 | ####### | 73.877,50 | ####### | 734,50 | 2.268,50 | 8.457,50 | 1,50 | ####### | 115,41 | 961,50 | 22,48 | 2,79 |
| Wheat | 5944,50 | 7450,00 | -275,00 | 1342,50 | 11776,50 | 400,00 | 208,00 | 0,00 | 598,50 | 1,50 | 10568,50 | 53,44 | 386,00 | 10,27 | 1,13 |
| Rice (Milled Equivaler | 7668,50 | 724,00 | 421,50 | 623,00 | 8192,00 | 0,00 | 132,50 | 643,50 | 924,50 | 0,00 | 6491,50 | 32,83 | 333,50 | 6,59 | 0,56 |
| Barley | 298,50 | 1371,00 | 0,00 | 13,50 | 1656,00 | 105,00 | 9,00 | 1523,00 | 19,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Maize | 67951,00 | 744,50 | 0,00 | 18855,00 | 49840,50 | 37326,00 | 363,00 | 102,00 | 6864,00 | 0,00 | 5186,00 | 26,20 | 224,00 | 4,96 | 0,90 |
| Rye | 3,50 | 0,00 | 0,00 | 0,00 | 3,50 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 3,50 | 0,02 | 0,00 | 0,01 | 0,00 |
| Oats | 437,00 | 0,50 | 0,00 | 5,50 | 431,50 | 0,00 | 19,00 | 0,00 | 13,00 | 0,00 | 399,50 | 2,02 | 10,00 | 0,41 | 0,16 |
| Millet | 0,00 | 3,50 | 0,00 | 0,00 | 3,50 | 3,50 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Sorghum | 1802,50 | 9,00 | 2,50 | 1809,00 | 1762,00 | 10,50 | 0,00 | 0,00 | 36,50 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Cereals, Other | 182,50 | 30,00 | 0,00 | 0,50 | 212,00 | 29,00 | 3,00 | 0,00 | 2,00 | 0,00 | 178,50 | 0,91 | 8,00 | 0,26 | 0,05 |
| Starchy Roots | 27381,50 | 618,50 | 0,00 | 41,50 | 27958,00 | 11923,00 | 310,50 | 0,00 | 2674,00 | 1405,50 | 11648,00 | 58,93 | 128,50 | 1,73 | 0,33 |
| Cassava | 23096,50 | 107,00 | 0,00 | 33,00 | 23170,00 | 11544,00 | 0,00 | 0,00 | 2310,00 | 1305,00 | 7821,00 | 39,50 | 93,50 | 0,62 | 0,24 |
| Potatoes | 3559,00 | 511,50 | 0,00 | 2,50 | 4068,00 | | | | | | | | | 1,06 | 0,08 |
| Sweet Potatoes | 487,00 | 0,00 | 0,00 | 3,00 | 484,00 | | | | | | | | | 0,03 | 0,01 |
| Yams | 239,00 | 0,00 | 0,00 | 2,00 | 237,00 | | | | | | | | | 0,02 | 0,00 |
| Roots, Other | 0,00 | 0,00 | 0,00 | 1,00 | -1,00 | | | | | | | | | 0,00 | 0,00 |
| Sugarcrops | 728365,50 | | | 0,00 | 728365,50 | | | | | | | | | 0,05 | 0,09 |
| Sugar Cane | 728365,50 | 0,00 | 0,00 | 0,00 | 728365,50 | | | | | | | | | 0,05 | 0,09 |
| Sugar Beet | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | | | | | | | | | 0,00 | 0,00 |
| Sugar & Sweeteners | 40.280,50 | 60,50 | 599,50 | ####### | 12.686,00 | | | | | | | | | 0,03 | 0,03 |
| Sugar, Non-Centrifuga | 472,50 | 0,00 | 0,00 | 0,00 | 472,50 | | | | | | | | | 0,03 | 0,03 |
| Sugar (Raw Equivalent | 39683,00 | 13,00 | 599,50 | 28213,00 | 12081,50 | | | | | | | | | 0,00 | 0,00 |
| Sweeteners, Other | 89,00 | 47,50 | 0,00 | 23,00 | 113,50 | | | | | | | | | 0,00 | 0,00 |
| Honey | 36,00 | 0,00 | 0,00 | 17,50 | 18,50 | | | | | | | | | 0,00 | 0,00 |
| Pulses | 3059,00 | 308,50 | 175,00 | 19,50 | 3523,00 | | | | | | | | | 9,98 | 0,73 |
| Beans | 3047,50 | 242,50 | 175,00 | 18,50 | 3446,50 | | | | | | | | | 9,75 | 0,71 |
| Peas | 5,50 | 43,00 | 0,00 | 0,00 | 48,50 | | | | | | | | | 0,15 | 0,01 |
| Pulses, Other | 6,00 | 23,00 | 0,00 | 1,00 | 28,00 | | | | | | | | | 0,08 | 0,01 |

| Model | Active | | |
|---|---|---|---|
| | Current 2010-2013 | Scenario A - lowpro | Scenario B - middle |
| CROP | % of crops for food | % of crops for food | % of crops for food |
| WHEAT | 100 | 100 | 110 |
| MAIZE | 100 | 100 | 110 |
| SOYBEAN | 100 | 80 | 120 |
| NO CHANGE | 100 | 120 | 100 |
| Population (https://www.ibge.gov.br/apps/pop | 197453384 | 232933276 | 232933276 |
| Agricultural Land Use Change | 100,00 | 100,00 | 100,00 |
| MEAT | 40 | 40 | 100 |
| AQUATIC | 100 | 100 | 100 |
| calories-1 | 2644,314117 | 2.542,74 | |
| calories-1LUC | 2644,314117 | 2.542,74 | |
| calories-2 (with export compensation) | 2804,45554 | 2.815,34 | |
| calories-3 (with feed compensation) | 2660,377207 | 2.650,35 | |
| calories-4 (with export and feed compensation) | 2820,128078 | 2.910,46 | |
| MDER (kcal/person/day): | 1860 | | |
| Gini coefficient of variation: | 0,242 | | |

**Table 2** – FEEDME model spreadsheets for Brazil using 2010-2013 FBS estimates, with illustrated demand proxies (in red box) for scenario A (< 30% meat consumption) and scenario B (no change in meat consumption, less grain exports) in 2050




| Timeslice | | SCENARIOS 2050 | |
|---|---|---|---|
| Model | Status (2010) | A - LOWPRO - STEADY EXPORTS | B - BBQ + DECREASE EXPORTS |
| calories-3 ( available per capita) | 2.543,00 | 2.933,67 | 2.313,65 |
| MDER (kcal/person/day): | | 1840 | 1840 |
| Gini coefficient of variation: | | 0,25 | 0,25 |
| undernourished probability (%) | 0,1168 | 0,0382 | 0,116800 |
| population_undernourished (inhab) | 20543394,75 | 8655539,062 | 26437409,96 |

**Figure 4** –Probability density functions of dietary energy consumption of the Brazilian population illustrated on the left indicating its % under the risk of undernourishment in 2050 according to scenario A (up) or scenario B (down) retrieved using FEEDME. Scenarios outputs regarding % and total number of people that might be under risk of undernourishment by 2050, according to given premises

## Discussion and conclusions

- According to data from the FBS / FAO in 2013 Brazil produced **7,863,000 tons** of beef available for internal consumption (excluding Exports).
- This quantity allows an average of **21.8 g** of available protein per capita per day to the population coming from bovine meat production.
- Food acquisition scenarios indicate the growing Brazilian population will demand higher beef availability in the North and Northeast regions, increasing the need of pasture area in Cerrado region by 149% until 2050 in scenario B and 94% in scenario A ( both under poor yield increase).
- In Scenario A of **low meat consumption**, compensated by higher vegetables and grain consumption, only **3%** of Brazilian population would be **under risk of high food insecurity** while in scenario B with current trends of meat consumption around **21%** of people could starve.

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The authors acknowledge funding for this research provided by São Paulo Research Foundation (FAPESP) processes 14/50627-2 and 2016/02773-5; and by Research and Development Foundation (FUNDEP) in Minas Gerais